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Dear Colleagues,

*On behalf of the Conference Committees I have the honor and pleasure to thank you all for your true participation in the work of the **7th International Conference on Application of Information and Communication Technology and Statistics in Economy and Education (ICAICTSEE-2017)**, http://icaictsee.unwe.bg/, which took place on November 3-4th, 2017 at the University of National and World Economy (UNWE), Sofia, Bulgaria.*

I would like specially to express my gratitude to all of the program committee members for their genuine support without which it would never had happened.

Due to the current state of scientific development in all spheres of human activity, the constant knowledge and skill actualization of the academia and researchers in the field of Information and Communication Technology (ICT) is an obligatory necessity, especially when the world is in a global economic and financial crisis. The definition of long-term scientific research tasks in this area has a strategic importance, which is even truer for young researchers, lecturers and Ph.D. students.

The conference aims were conducting analysis of the current problems and presenting results of the ICT application in different areas of economy, education and related areas of scientific knowledge; outlining the existing possibilities for the application of modern ICT tools, methods, methodologies and information systems in economy and education; discussing advanced and emerging research trends with a long-term importance in the field of ICT application in economy and education.

The conference has established an academic environment that fosters the dialogue and exchange of ideas between different levels of academic and research communities.

The conference outcome is 86 published research papers (39 from foreign participants), the explosion of fresh ideas and the establishment of new professional relations.

Dimiter G. Velev
ICAICTSEE-2017 Chair

CONTENTS

Regional Innovation Policy and Its Effect in Japan − A Case Study of Regional Industry Promotion Policy by Using Open Source Software

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Abstract: In this paper, to investigate the effect of regional innovation policy by local government, taking regional industry promotion policy by using open source software as a case, we do comparative analysis among regions (Metropolitan Areas and Local Areas) from the survey results of 'Utilization and Development Contribution of Open Source Software in Japanese IT Companies' for 3 consecutive years (2012 – 2014). Result of the questionnaire survey to IT companies in Japan, it has become clear that industrial promotion policy by local government advances the practical use of OSS and contribution to OSS communities in part. Though, it has also possibilities of working a minus incentive to the development contribution to OSS in another sense. This result raises questions about the regional innovation policy's effectiveness.

Keywords: OSS, Open Innovation, Regional Innovation, Ruby, Japan.

1. Introduction

Regional-industrial promotion policies in Japan have mainly been based on the cluster theory presented by Porter (1998). On the other hand, owing to the rapid development of information technologies, networks linking business enterprises with each other and outside resources have progressed significantly. Even the field of research and development is now open to the world and connected with external resources, a concept similar to the "Open Innovation" theory put forward by Chesbrough (2003, 2006, and 2008).

In response, Matsue City, a typical peripheral regional city in Japan, has been proposing a regional industry promotion project since 2006 built around the open source programming language Ruby, not by forming a regional industry cluster but by organizing a cooperation that extends beyond regional borders. As a consequence of this regional-industrial promotion policy, the net sales of information technology industries in Matsue City increased 44 % from fiscal year 2007 to fiscal year 2013, and the number of employees of them also increased 21 %, though the net sales of whole country decreased 3.9% and the number of employees of it only increased 12.9% during this period.

So, in this study, we regard this regional IT industry promotion policy by Matsue City as a process of advancing Regional Innovation in local area. We analyze how OSS effects Japanese IT companies' business growth both through simple use and by deeper engagement as a stakeholder in OSS community, with special reference to the "Region".

2. Study Methodology and Questionnaire Survey

It should be reconsidered differently from organizational viewpoints that OSS development contributions enable to retain the competitiveness in the market, at the same time

utilizing them. As Chesbrough describes "Open Innovation" in the context that innovation happens over the boundaries between companies, the companies should carefully take efforts to integrate internal and external resources together to gain extra values. The relation between IT companies' internal engineer sources and external OSS knowledge in the community are essentially the same as what "Open Innovation" indicates and applies to the IT companies. Thus the underlying hypothesis is that process of "Open Innovation" enables business enterprises to absorb fruits of the "Community" of OSS. It is assumed that background factor of the success of the regional-industrial promotion policy by Matsue City depends on the process of "Open Innovation" beyond boundaries of enterprises and regions. Then, our research questions are,

1) Are OSS utilization and contribution different between Metropolitan Areas and Local Areas?

2) Does Regional IT industry promotion policy which Matsue City is promoting effect OSS utilization and contribution between Metropolitan Areas and Local Areas?

3) How OSS utilization and development contribution affect the business growth of IT companies?

To clear these questions, we have conducted questionnaire survey to Japanese IT companies, and then the data was collected for 3 consecutive years (2012 – 2014). With these data sets, we analyze the relation between OSS utilization and development contribution, and how these affect the business growth. The methodology in this study is to investigate the effect on the business growth by OSS utilization and contribution in Japanese IT companies. As is described by Kunai (2010), we assume, "The more IT companies contribute to OSS communities, the more they are able to acquire economic effect".

During 2012-2014, questionnaire survey slips were sent to 650 companies which accede to Information Industry Association in Japan. Then, 191 companies replied (collection rate: 29.8%) in 2012, 146 companies replied (collection rate: 22.5%) in 2013, 131 companies replied (collection rate: 20.1%) in 2014.

The number of questions is 25 in total as shown in Table 1. We adopted 6 OSS development projects for question category, such as Linux, Apache HTTP Server, Database (MySQL, PostgreSQL, etc.), Ruby, Other programming language (Perl, Python, PHP, etc.), and Ruby on Rails. Application-level software (such as ERP, CMS, CRM, etc.) was excluded in our study. Utilization of such application level software is becoming popular in Japan, however, case examples of development contribution of such software is rather limited in Japanese IT companies. So, we focused on the above 6 OSS. With regard to Ruby and Ruby on Rails, Ruby was developed by a Japanese engineer Mr. Yukihiro Matsumoto, who is in Matsue City, such as Matsue City is promoting the industry promotion policy. On the other hand, Ruby on Rails is the U.S. origin and being utilized and contributed more internationally as a web-based application framework. The origin and diffusion process of Ruby and Ruby on Rails are different, so we assumed there would be some differences and then asked separately.

3. Results of Questionnaire Survey

3.1 Regional Comparison of Utilization of OSS

We draw the utilization of OSS among Metropolitan Areas (Tokyo, Osaka, and Fukuoka), Local Areas (except Matsue), which have no OSS promotion policy, and Matsue City which has been proposing a regional industry promotion project focusing Ruby for these 9 years, from the data of 2014 Questionnaire Survey for example (Fig. 1-3).

Table 1. Question Items

Company profile:
- Q1. Home Prefecture
- Q2. Year of Business Establishment (7 scale)
- Q3. Main Business Field (7 categories + other)
- Q4. Capital Stock (8 scale)
- Q5. Number of Employee (9 scale)
- Q6. Number of Developers - programmers, software engineers, etc. (9 scale)
- Q7. Sales Amount (8 scale)
- Q8. Growth Rate of Sales - present term (7 scale)
- Q9. Prospect of Sales Growth Rate (7 scale)
- Q10. Growth Rate of Employee Number - present term (7 scale)
- Q11. Prospect of Employee Number's Growth Rate - subsequent term (7 scale)

Utilization of OSS - percentage of utilization (5 scale):
- Q12. Utilization of Linux
- Q13. Utilization of Apache HTTP Server
- Q14. Utilization of Database technologies (MySQL, PostgreSQL, etc.)
- Q15. Utilization of Programming Language Ruby
- Q16. Utilization of Other Programming Languages (Perl, Python, PHP, etc.)
- Q17. Utilization of Ruby on Rails

Contribution to OSS Communities - Human Resources and Direct Expenditures:
Yes/No, Amount of Human Resources (5 scale) and Direct Expenditures (4 scale)
- Q18. Contribution to Linux
- Q19. Contribution to Apache HTTP Server
- Q20. Contribution to Database technologies (MySQL, PostgreSQL, etc.)
- Q21. Contribution to Programming Language Ruby
- Q22. Contribution to Other Programming Languages (Perl, Python, PHP, etc.)
- Q23. Contribution to Ruby on Rails

Concrete outcome and effect - Degree of Agreement/Recpgnition (5 scale):
- Q24. OSS utilization - 10 items
- Q25. OSS contribution - 10 items

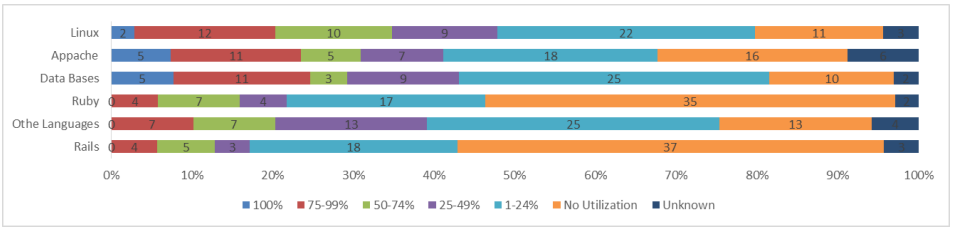

Fig. 1. Utilization of OSS in Metropolitan Areas (n=53)

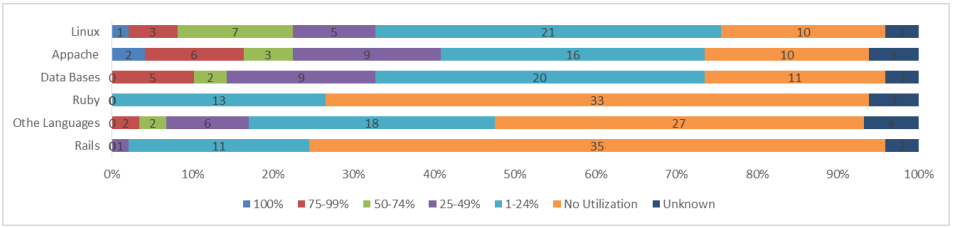

Fig. 2. Utilization of OSS in Local Areas except Matsue (n=52)

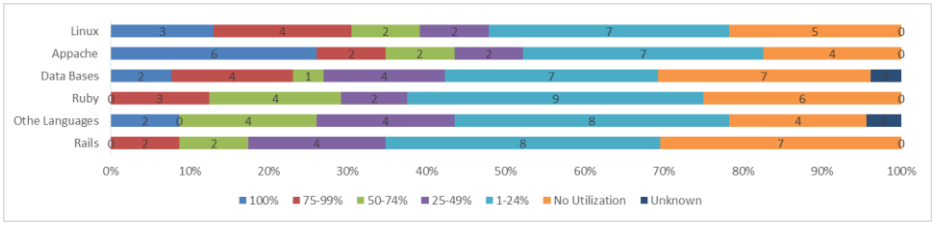

Fig. 3. Utilization of OSS in Matsue (n=22)

Tansho and Noda (2014) shows Linux and Apache are utilized widely in the responded Japanese companies. Database and Other Languages are also utilized widely. On the other hand, utilization of Ruby and Ruby on Rails are rather lower. Fig. 1-Fig. 3 shows that in Matsue City utilization of Ruby and Ruby on Rails are higher than other areas. It is said that Regional IT Industry Promotion Policy encourage the utilization of Ruby and Ruby on Rails in Matsue City.

3.2 Regional Comparison of Contribution of OSS

We draw the contribution to the development process of OSS among Metropolitan Areas (Tokyo, Osaka, and Fukuoka), Local Areas (except Matsue) and Matsue City, from the data of 2014 Questionnaire Survey for example (Fig. 4-6).

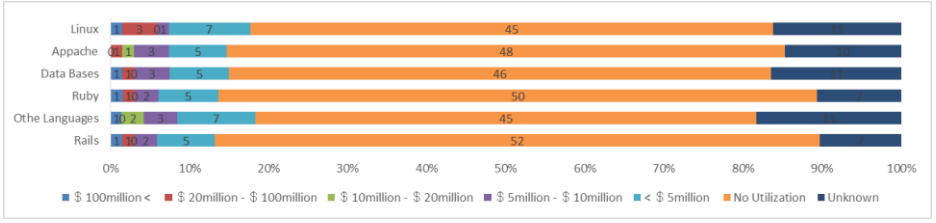

Fig. 4. Contribution of OSS in Metropolitan Areas (n=53)

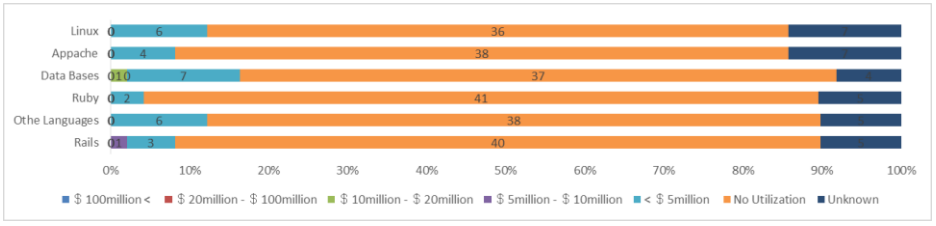

Fig. 5. Contribution of OSS in Local Areas except Matsue (n=52)

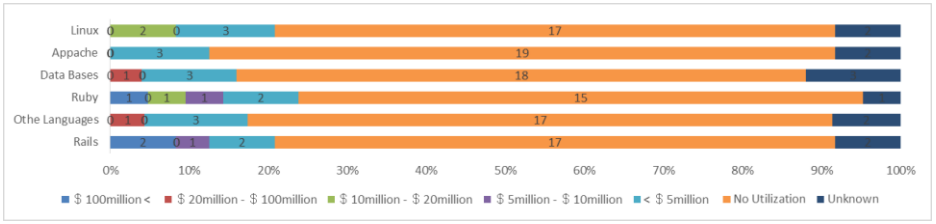

Fig. 6. Contribution of OSS in Matsue (n=22)

Figures 4 - 6 shows that in each areas in Japan the contribution of OSS is much lower than Utilization of OSS. But in Matsue City, the utilization of OSS, especially those of Ruby and Ruby on Rails, is rather higher than other areas in Japan. This is also fruits of Regional IT Industry Promotion Policy by local government of Matsue City. Then we might have cleared the research questions 1) and 2), in a part.

3.3 Regional Comparison of Correlation between Utilization and Contribution of OSS

Tansho and Noda (2014) also shows the correlations between utilization and contribution among Linux, Apache, and Database are not clearly shown. On contrast, the correlations among Ruby, Other Languages, and Ruby on Rails are shown distinctively. Then, we draw correlations between utilization and contribution of OSS among Metropolitan Areas (Tokyo, Osaka, and Fukuoka), Local Areas (except Matsue) and Matsue City which has been proposing a regional industry promotion project focusing Ruby, from the data of 2014 Questionnaire Survey for example (Table 2-4).

Table 2**.** Correlation between Utilization and Contribution in Metropolitan Areas (n=53)

Contribution / Utilization	Linux	Apache	Database	Ruby	Other Language	Rails
Linux	.135	-.030	.017	.061	-.046	-.010
Apache	.088	.050	.086	-.121	.020	.047
Database	.104	.066	.41	.004	.603**	.528**
Ruby	.113	.104	.057	.306*	.128	.102
Other Languages	-.050	-.012	.51	-.071	.107	.085
Rails	.012	.157	.110	.175	.69	.179

Spearman's Rank Correlation Coefficient **1% level of significance *5% level of significance

Table 3**.** Correlation between Utilization and Contribution in Local Areas except Matsue (n=52)

Contribution / Utilization	Linux	Apache	Database	Ruby	Other Language	Rails
Linux	.237	.236	.219	.086	.212	.028
Apache	.016	.039	-.001	-.034	-.003	-.089
Database	.198	.034	.171	.025	.585**	.535**
Ruby	.038	.038	.011	.322*	.069	.147
Other Languages	.123	.122	.130	.040	.128	.010
Rails	.056	.003	-.023	.221	.038	.218

Spearman's Rank Correlation Coefficient **1% level of significance *5% level of significance

Table 4**.** Correlation between Utilization and Contribution in Matsue (n=22)

Contribution / Utilization	Linux	Apache	Database	Ruby	Other Language	Rails
Linux	.191	.176	.176	.286	-	-.050
Apache	.071	.039	.026	.004	.008	.071
Database	.144	. 108	-	-.207	.155	.160
Ruby	.033	.187	.187	.222	-	..183
Other Languages	.128	.104	.104	-.038	-	-.064
Rails	.189	-.108	-.108	.095	-	.173

Spearman's Rank Correlation Coefficient **1% level

In Matsue City, both utilization and contribution of OSS, especially Ruby and Ruby on Rails, are rather higher than other areas in Japan, but the correlations between utilization and contribution are lower. This trends are appeared in the results of 2012 and 2013 Questionnaire Surveys. This result means OSS utilizing companies and OSS contributing companies are separated in Matsue City. Administration sectors of Matsue City pass orders of their IT systems to most of regional IT companies which use Ruby, so they accept the orders by using Ruby, without contributing to the development process of Ruby and other OSS. Regional IT Industry Promotion Policy of Matsue City has possibilities of working a minus incentive to the development contribution to OSS. This is an answer to the research questions 1) and 2), in another sense.

3.4 Correlation Analysis Results– OSS and Business Growth

Areas (except Matsue) and Matsue City, by correlation analysis. The result regarding OSS utilization is shown in Table**s 5-7**. As a whole, correlations between OSS utilization and growth rate of present term are shown in both Metropolitan Area and Local Area except Matsue. On the other hand correlations between Ruby and Ruby on Rails and growth rate of subsequent term (prospect) are shown.

Table 5. Correlation between business growth and utilization in Metropolitan Areas (n=53)

	Growth Rate of Sales		Growth Rate of Employee Number	
	present term	Subsequent (prospect)	present term	Subsequent (prospect)
Linux	.350**	.236	.376**	.296*
Apache	.209	.155	.248	.248
Database	.336**	.227	.325**	.247*
Ruby	.369**	.176	.243	.210
Other Languages	.268*	.031	.265*	.045
Rails	.337*	.065	.196	.121

Spearman's Rank Correlation Coefficient **1% level of significance *5% level of significance

Table 6 Correlation between business growth and utilization in Local Areas except Matsue (n=52)

	Growth Rate of Sales		Growth Rate of Employee Number	
	present term	Subsequent (prospect)	present term	Subsequent (prospect)
Linux	.411**	.156	.003	-.041
Apache	.409**	.201	.071	-.013
Database	.435**	.149	.087	.133
Ruby	.056	.026	-.047	.111
Other Languages	.307*	.298*	.184	.110
Rails	-.250	.050	-.054	-.014

Spearman's Rank Correlation Coefficient **1% level of significance *5% level of significance

Table 7. Correlation between business growth and utilization in Matsue (n=22)

	Growth Rate of Sales		Growth Rate of Employee Number	
	present term	Subsequent (prospect)	present term	Subsequent (prospect)
Linux	-.029	.099	-.168	-.246
Apache	-.125	-.044	-.055	-.228
Database	-.139	.228	.040	.285
Ruby	.045	.544**	.203	-.247
Other Languages	-.127	-.060	-.122	.057
Rails	-.012	.549**	.292	-.071

Spearman's Rank Correlation Coefficient **1% level of significance *5% level of significance

Tables 8-10 below indicate the result of the correlations between business growth and contribution. No significant correlation is shown in terms of growth rate of sales in Metropolitan Area. At the same time, several correlations are shown for the prospect growth rate of employee number in subsequent term in Local Area including Matsue City.

Table 8. Correlation between business growth and contribution in Metropolitan Areas (n=53)

	Growth Rate of Sales		Growth Rate of Employee Number	
	present term	Subsequent (prospect)	present term	Subsequent (prospect)
Linux	.037	-.005	.090	.087
Apache	-.018	-.056	.038	.109
Database	-.045	-.116	.018	.027
Ruby	.133	-.179	-.014	.069
Other Languages	.134	-.115	.131	.052
Rails	.123	-.183	-.021	.047

Spearman's Rank Correlation Coefficient **1% level of significance *5% level of significance

Table 9. Correlation between business growth and contribution in Local Areas except Matsue (n=52)

	Growth Rate of Sales		Growth Rate of Employee Number	
	present term	Subsequent (prospect)	present term	Subsequent (prospect)
Linux	.071	.199	.328*	.464**
Apache	.028	.282	.366*	.379*
Database	.049	.289	.218	.312*
Ruby	-.038	.315*	.137	.149
Other Languages	.089	.373*	.215	.337*
Rails	-.089	.263	.038	.141

Spearman's Rank Correlation Coefficient **1% level of significance *5% level of significance

Table 10. Correlation between business growth and contribution in Matsue (n=22)

	Growth Rate of Sales		Growth Rate of Employee Number	
	present term	Subsequent (prospect)	present term	Subsequent (prospect)
Linux	-.197	-.318	-.144	.396
Apache	.046	-.308	-.358	.411
Database	-.078	-.310	-.103	.540*
Ruby	-.288	-.079	.115	.366
Other Languages	-	-	-	-
Rails	-.173	-.019	-.011	.530*

Spearman's Rank Correlation Coefficient **1% level of significance *5% level of significance

The relationship with management index is still the stage of contemplation, and utilization and development contribution of OSS have not led to significant economic result. As already stated, the net sales and the number of employees of IT industries in Matsue City have increased since the policy started. But both utilization and contribution of OSS (including Ruby) have not affected the business growth of IT companies in Matsue City. Then, it is difficult to clear the research question 3) thus far.

4. Conclusion and Challenging for the Future

In this study, we analyze how OSS and its promotion policy effect Japanese IT companies' business growth both through simple use and by deeper engagement as a

stakeholder in OSS community, regarding comparative analysis among regions (Metropolitan Areas and Local Areas).

With regards to the research questions 1) and 2), Regional IT Industry Promotion Policy (of Matsue City) advances the practical use of OSS and contribution to OSS communities in part. Though, it has also possibilities of working a minus incentive to the development contribution to OSS in another sense. With regards to the research question 3), it is difficult to clear how development contribution affect the business growth of IT companies, including Ruby and Regional IT Industry Promotion Policy of Matsue City. This result raises questions about the regional innovation policy's effectiveness.

However, by the results of this study, we have not able to reach the final goal of our research to find the determinant and influential factor(s) affecting the business growth. However, it can be said that this result - no explicit determinant factor is found shows the complexity of the issues. This also indicates the limitation of data collection through questionnaire survey and statistical analyses. In order to reach our final goal, we recognize that a series of interviews to the IT companies' representatives and engineers are necessary in deeper level.

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A Classification Study of ITS (Intelligent Transport Systems) Related Activities Conducted in EU Member States

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Abstract. The paper reviews the development of ITS (Intelligent Transport Systems) across Europe led by EC and ITS related activities conducted in EU member states, and tries to classify activities in member states based on the dimension of governance, according to the classification of RIS (Regional Innovation System) proposed by Cooke (1992), Cooke (1998), and Asheim and Isaksen (2002). Because RIS is a relative concept which is relative to the center, and the classification of RIS is based on the dimension of governance, it is reasonable to do a classification study to analyze innovation process of ITS in Europe.

Keywords. Intelligent Transport Systems, Regional Innovation System

1. Introduction

Since national system of innovation has been proposed by Freeman in 1995, there is a number of studies about innovation systems from every aspects, such as Sectoral Innovation System (SIS), Technological Innovation System (TIS), and Regional Innovation System (RIS). Compared with neo-classical and new classical economics focusing on problems of allocation in a general equilibrium context, innovation system approach indicates a much broader and more interdisciplinary approach to economic growth theory (Lundvall, 1997). It provides a dynamic perspective and involves nonmarket-based institutions into the system. In this system, innovation policy is continuously on the run (Soete et al., 2010).

Innovation of large scale technological system related to thousands of subsystems and millions of components is a complex process. It is a conscious construction instead of an accidental discovery. As for the study of innovation process of large scale technological system such as ITS (Intelligent Transport Systems), innovation system approach provides a systematic consideration, and an analysis perspective taking government into account, which is closer to the actual situation.

This paper reviews the development of ITS led by EC, aimed to classify activities conducts in EU member states, according to the classification studies of RIS. Since RIS is a relative concept which is relative to the center, and the classification of RIS is based on the dimension of governance, we assume the activities conducted in EU member states is equivalent to RIS and EC is the center. The second section of the paper is a literature review of the classification study of RIS. The third section reviews the development of ITS across EU led by EC. The forth section introduces activities conducted in EU member states. The final section is the classification of these activities.

2. The Concept and Classification of RIS

The concept of Regional Innovation System (RIS) has been defined by Cooke et al.(1997), which was conceptualised in terms of a collective order based on microconstitutional

regulation conditioned by trust, reliability, exchange and cooperative interaction.

Cooke (1992) first classified regional technology transfer into three models based on five dimensions. The five dimensions are: primary source of initiative; primary source of funding; predominant competences; degree of coordination; degree of specialization. The three models are: the grassroots approach, the network approach, and the dirigiste approach (Table. 1) (Cooke, 1992).

Table 1. Three models of regional technology transfer

	Model		
Characteristics	**Grassroots**	**Network**	**Dirigiste**
Initiation	Local	Multi-level	Central
Funding	Diffused	Guided	Determined
Research-competence	Applications	Mixed	Basic
Coordination	Low	Potentially high	High
Specialization	Weak	Flexible	Strong

Source: Cooke, 1992. Table 1

Cooke (1998) measured and classified RIS based on regional technology transfer plus two dimension, which are the governance dimension and the business innovation dimension. From the governance dimension, there are grassroots RIS, network RIS, and dirigiste RIS. From the business innovation dimension, there are localist RIS, Interactive RIS, and globalized RIS (Figure 1) (Cooke, 1998).

In grassroots RIS, initiation process is locally organized. Funding will be diffuse in origin, comprising a mix of local banking, local government, and possibly local chamber of commerce capital, grants and loans. The level of technical specialization will be low and generic problem-solving. The degree of supra-local coordination will be low because of the localized nature of the initiation (ibid.).

In network RIS, initiation of technology transfer action is multi-level, meaning it can encompass local, regional, federal and supranational levels as appropriate. Funding is more likely to be guided by agreement among banks, government agencies and firms. System coordination is likely to be high, because of the many stakeholders and the presence of associations, forums, industry clubs and the like. Specialization within such a system is likely to be flexible rather than dedicated, because of the wide range of system demands from global to small-firm scale (ibid.).

In dirigiste RIS, technology transfer activities are animated mainly from outside and above the region itself. Initiation of actions is typically a product of central government policies. Funding is largely centrally determined. The level of coordination is very high, and the level of specialization is also likely to be high (ibid.).

In localist RIS, there will have few or no large indigenous firms and relatively few large branches of externally controlled firms, and have few major public innovation or R&D resources, but may have smaller private ones. Associationalism among entrepreneurs and between them and local or regional policy-makers will be high (ibid.).

In interactive RIS, the economy is dominated by a balance between large firms and small firms, whether indigenous or FDI in origin. Research will also be a balanced mix of public and private research institutes and laboratories. Associationalism is higher than average, expressed in local and regional industry network, forums and clubs (ibid.).

In globalized RIS, there is domination by global corporations, supported by clustered supply chains of rather dependent SMEs. The research reach will be internal and privatistic rather than public. Associationalism will be influenced by the needs of large firms (ibid.).

	Grassroots	**Network**	**Dirigiste**
Localist	Tuscany	Tempere Denmark	Tohoku(Japan)
Interactive	Catalonia	Baden-Württemberg	Québec
Globalized	Ontario California Brabant	North Rhine-Westphalia	Midi-Pyrénées Singapore

Business innovation

Governance of enterprise innovation support

Figure 1. The classification of RIS from two dimensions
(Source: Cooke, 1998. Figure 1.2)

Asheim and Isaksen (2002) distinguishes three main groups of RIS, which resemble the typology of Cooke (1998). The first type denoted as territorially embedded regional innovation network, which is similar to Cooke (1998)'s grassroots RIS. The second type is regional networked innovation systems, which Cooke (1998) called network RIS. The third type is regionalized national innovation system, which Cooke (1998) describes as dirigiste RIS (Asheim and Isaksen, 2002).

In the RIS of territorially embedded regional innovation network, firms base their innovation activity mainly on localised learning processes stimulated by geographical, social and cultural proximity without much interactions with knowledge organisations (ibid.).

In regional networked innovation system, firms and organisations are still embedded in a specific region and characterised by localized interactive learning. However, the systems have a more planned character through the strengthening of the regional, institutional infrastructure. It represents an endogenous development model as an attempt to increase innovation capacity and collaboration through public policy instruments (ibid.).

In regionalised national innovation system, parts of industry and the institutional infrastructure are more functionally integrated in national or international innovation systems, and the collaboration is extent based on the linear model, as the cooperation mainly involves specific innovation projects to develop more radical innovations and with the use of scientific, formal knowledge. It represents more of an exogenous development model (ibid.).

Table 2. Some characteristics of three main types of regional innovation systems

Main type of RIS	**The location of knowledge organisations**	**Knowledge flow**	**Important stimulus of cooperation**
Territorially embedded regional innovation network	Locally, however, few relevant knowledge organisations	Interactive	Geographical, social and cultural proximity
Regional networked innovation systems	Locally, a strengthening of (the cooperation with) knowledge organisations	Interactive	Planned, systemic networking
Regionalised national innovation systems	Mainly outside the region	More linear	Individuals with the same education and common experiences

Source: Asheim and Isaksen, 2002. Table II

3. The Development of ITS in Europe

ITS (Intelligent Transport Systems) is a large complex technological system coordinating the interaction between vehicle to vehicle, vehicle to infrastructure, vehicle to pedestrian and etc., aimed to create a more intelligent, flexible, agile and environmentally friendly future transport situation.

The development of ITS in Europe is guided by two tracks (Figure 2). The track of ITS related technologies includes EUREKA program (A Europe-wide Network for Market-Oriented Industrial Research and Development) and FP (Framework Programme for Research and Technological Development). The track of infrastructure maintenance is TEN-T project (Trans-European Transport Network).

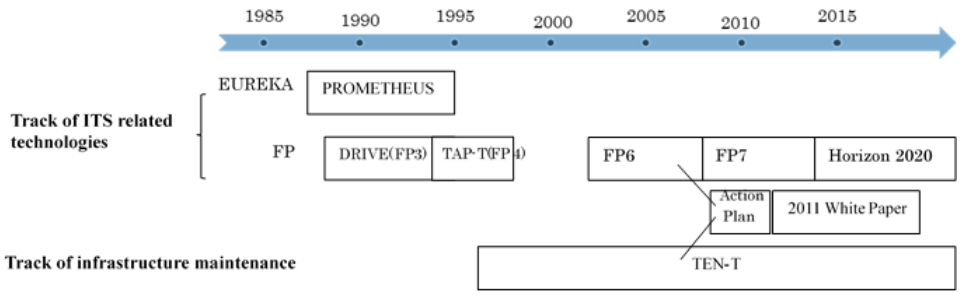

Figure 2. Two tracks and related programs of the ITS development in Europe
Sourc: Duan, 2015. Figure 2.

EUREKA has been established in 1985 by 17 states and the European Union to encourage a bottom-up approach to support European companies to strengthen R&D and innovation capability through international collaboration. For the transportation area, one of EUREKA's programs, PROMETHEUS (Programme for European Traffic System with Highest Efficiency and Unprecedented) aimed to develop driverless car, later became the prototype of automated driving (William, 1988).

FP is a funding program aimed to support and foster research in the Europe. It is found in 1983 by Commission of the European Communities, and follows a top-down structure (Ogawa, Tatsumoto, 2010). ITS representative projects such as DRIVE (Dedicated Road Infrastructure for Vehicle Safety in Europe) I and II, ATT (Advanced Transport Telematics). They developed the concept of Telematics (Telematics is a hybrid word to describe the combined use of telecommunications and information technology(DG XIII, 1990, p. 3)) which is the core technology of cooperative driving.

TEN-T is a planned aimed at integrating national networks and modes of transport, linking peripheral regions of the European Union, and improving safety and efficiency of the networks. The first Guidelines defining the TEN-T policy and infrastructure planning has been adopted by the European Parliament and the Council in 1996. They constituted a general reference framework covering the objectives, priorities and broad thrust of the measures contemplated as well as the projects of common interest in the area of the trans-European transport network (DECISION No 1692/96/EC, 23 July 1996,§1, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31996D1692:EN:NOT, (accessed 2016-12-15)). The 2001 reversion covered seaports, inland ports and intermodal terminals into the network, and specified the criteria for identifying projects of common interest in relation to these parts of the infrastructure (DECISION No 1346/2001/EC, 22 May 2001, p.1.

http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001D1346&from=EN, (accessed 2016-12-15)). The 2004 reversion intended to take account of EU enlargement and consequent expected changes in traffic flows (DECISION No 884/2004/EC, 29 April 2004, p.2. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32004D0884&from=EN (accessed 2016-12-15)).

When recognized problem of current ITS development, such as paying more attention on technical development rather than mature applications, fragmented and uncoordinated deployment, little continuity of services, and low degree of intermodality (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:2070001:0013:EN:PDF, (accessed 2017-01-21)), EC published Action Plan and Directive in 2008, combining the achievement of TEN-T and Telematics into implementation to accelerate and coordinate the uptake of ITS services, increase interoperability, set up an efficient cooperation, and solve privacy and liability issues.

4. Classification of EU Member States' ITS

ITS related programs implemented in EU member states can be classified into 3 types based on purpose. Firstly, in order to conduct technical demonstration experiments, EU is looking for cooperation from its member state. EU's projects operated in member states supported by FP are almost this type. The second is with the aim of integrating infrastructure and promoting services, such as TEN-T project. The Third are activities conducted by ITS related organizations in member states. These activities include transferring information to the public, improving transport public service in local area, developing technologies to satisfy regional needs, etc.

4.1 EU's Projects in Member States

In the period of DRIVE program in FP2 and FP3, there are two projects initiatives with European cities, regions and transport Administrations. They are POLIS (Promoting Operational Links with Integrated Services through road traffic informatics between European cities) and CORRIDOR (Cooperation On Regional Road Informatics Demonstrations On Real sites) (DG XIII, 1994).

POLIS is a network of cooperation administered by the cities themselves aimed to assist the development of a network for urban area pilot projects. During the first year, more than 40 European cities involved to a common work, and the cities have identified the necessary structure of their organization as a network (ibid.).

CORRIDOR aims at the creation of a collaboration network of all actors, such as national and regional road administrations, motorway companies, IT&T industry, service providers and operators, involved in the process towards the implementation of ATT services on European motorways. The initiative provides a framework for the exchange of experience in planning and conducting interurban pilot projects, containing cross border traffic flow and/or cross border traffic information flow. 13 European regions and representatives participate in this framework (ibid.).

TAP-T under FP4 is a program aiming to promote telematics technology into application. It clarified the role of EC, national, regional or local authorities in the implementation of Transport Telematics. The role of the Community is to create the necessary conditions for deployment of Telematics which is appropriate to the existing social and political structures. Member states authorities are encouraged to explore the role of the private sector in providing services in areas which were previously in the public domain (CORDIS's website, http://cordis.europa.eu/telematics/tap_transport/deployment/51.htm (2017-09-27)).

FP6 launched ERA-NET scheme (Integrating and Strengthening the European Research Area Scheme) which is to step up the cooperation and coordination of research activities carried out at national or regional level in the Member States and Associated States through the networking of research activities conducted at national or regional level, and the mutual opening of national and regional research programmes (CORDIS's website, http://www.cordis.europa.eu/coordination/era-net.htm, (accessed 2017-09-27)). ENT (Era-net Transport) is a network of ERA-NET for transport research. It was jointly founded in 2004 by a group of European national transportation research programmes. It includes 24 partners from 18 countries and regions in Europe and beyond in March of 2016 (Era-net Transport's website, http://transport-era.net/about/history-ent/, (accessed 2017-09-27)). Furthermore, there are several driving demonstrations conducted in member states, such as SAFESPOT and COOPERS (Co-operative Systems for Intelligent Road Safety) under FP6.

SAFESPOT is a project developing cooperative systems technology to detect in advance potentially dangerous situations by using infrastructure and vehicles to communicate safety-related information. It brings together 51 partners from academia, industry and road administration in 12 European countries, and carried out at 6 regional test centers in 2006 (CORDIS's website, http://cordis.europa.eu/news/rcn/31165_en.html (accessed 2017-09-27)).

COOPERS project provides vehicles and drivers with real time local situation based, safety related status and infrastructure status information distributed via dedicated Infrastructure to Vehicle Communication link (I2V), aimed to enhance road safety. It stablished 4 demonstration sites. The first demonstrator is focused on the North-South-Corridor from Bavaria passing through western Austria, to verify efficiency gain on using road infrastructure while adapting to rapidly changing transport demands. The second is to validate the effective co-operation of safety related road infrastructure systems and vehicles systems from a traffic management, a user and a system perspective, focusing on the ~80km corridor from Rotterdam to Antwerp. The third consists 3 of the Berlin city highway, equipped with 34 variable message signs, ~450 radar detectors and ~125 induction loops. The forth is located in the southwest and the northeast part of France and focuses on real time information services and eCall integration to improve the quality of the data (COOPERS's website, http://cvt-project.ir/En/EnNewsDetail.aspx?SubjectType=99&InfoID=1056 (accessed 2017-09-28)).

During the period of FP7, there are two field operational test called euroFOT (The large-scale European Field Operational Test on Active Safety Systems) and TeleFOT (Field Operational Tests of Aftermarket and Nomadic Devices in Vehicles).

EuroFOT demonstrates how driver assistance systems can increase safety and fuel efficiency across Europe (euroFOT's website, http://www.eurofot-ip.eu/ (2017-09-28)). In 2009, there are more than 1000 cars and trucks equipped with a range of different intelligent technologies are tested on European roads across France, Germany, Italy and Sweden (euroFOT's website, http://www.eurofot-ip.eu/en/about_eurofot/about_eurofot.htm, (accessed 2017-09-28)). It cooperated with automakers such as Volvo, Volkswagen, Ford, Audi, BMW, etc., and established operations centers across France, Germany, Italy and Sweden.

TeleFOT is aimed to assess the impacts of functions provided by after-market and nomadic devices in vehicles and raise wide awareness of their traffic safety potential (EC's website, https://trimis.ec.europa.eu/project/telefot-field-operational-tests-aftermarket-and-nomadic-devices-vehicles (2017-09-28)). It conducted two kinds of tests, Large Scale and Detailed, in the test sites of 8 countries in the north, middle and south of Europe (JARI, 2014, p.11). Except these two large-scale field operational test, there are several pilot projects for practical use also be conducted during the period of FP7, such as DRIVE C2X, COSMO (Cooperative Systems for Sustainable Mobility and Energy Efficiency), Compass4D, and CityMobil2.

DRIVE C2X focuses on communication among vehicles (C2C) and between vehicles, a roadside and backend infrastructure system (C2I). It conducted large-scale field trials under at multiple national test sites across Europe (DRIVE C2X's website, http://www.drive-c2x.eu/technology,(accessed 2017-09-28)), involving seven test sites as of 2014 (DRIVE C2X's website, http://www.drive-c2x.eu/news-item/items/DRIVE_C2X _successfully _completed_in_July_2014,(accessed 2017-09-28)).Seven test sites are Helmond (Netherlands), Brennero (Italy), Tampere (Finland), Gothenburg (Sweden), Frankfurt (Germany), Yvelines (France), and Vigo (Spain) (ITS Japan, 2013a, p. 27).

COSMO project adopted innovative traffic management systems to assess energy efficiency on fuel consumption, traffic emissions, and the energy used to operate road-side equipment. It has three pilot sites, which located in Salerno (Italy), Vienna (Austria) and Gothenburg (Sweden) (CORDIS's website, http://cordis.europa.eu/docs/projects/cnect/2/270952/080/deliverables/001-COSMOProjectFactsheetv10.pdf (accessed 2017-09-28)).

Compass4D targeted road safety and energy efficiency for road transport through the implementation and pilot of three Cooperative ITS (C-ITS) services in seven European cities. They are Bordeaux (France), Copenhagen (Denmark), Helmond (Netherlands), Newcastle (United Kingdom), Thessaloniki (Greece), Verona (Italy) and Vigo (Spain) (ERTICO's website, http://ertico.com/projects/compass4d/, (accessed 2017-09-28)).

CityMobil2 sets up a pilot platform for automated road transport systems, which is implemented in several urban environments across Europe (CityMobil2's website, http://www.citymobil2.eu/en/About-CityMobil2/Overview/, (accessed 2017-09-28)). As of 2016, the project conducted 3 large-scale demonstrations, 4 small-scale demonstrations, and 3 shorter events called showcases, which implemented in 9 European cities (CityMobil2's website, http://www.citymobil2.eu/en/City-activities/Overview/, (accessed 2017-09-28)).

4.2 With the Aim of Infrastructure Maintenance

TEN-T is a project to create a multimodal network is to ensure that the most appropriate transport mode may be chosen. It obliges EU member states to construct a cross-European network aiming at the development and integration of infrastructure (DG for Energy and Transport, 2005). In addition to aiming for infrastructure improvement, TEN-T contain a significant research element, such as the TEMPO program.

TEMPO program started in 2001 based on MIP (Multi annual Indicative Programme) (The MIP was introduced in 2001 under EC Decision COM(2001) 2654 to secure smooth and timely financing for projects of common interest on a multi-annual basis. It is a tool to grant European Community financial aid to projects of 'common interest' in the area of Trans-European Networks for Transport (TEN-T). TRIMIS's website, https://trimis.ec.europa.eu/programme/multi-annual-indicative-programme-mip-multi-annual-programme-map, (accessed 2017-09-27)). It supported 8 (ERPs) Euro-Regional Projects from 2001 to 2007. 8 ERPs are ARTS, CENTRICO, CONNECT, CORVETTE, ITHACA, SERTI, STREETWISE and VIKING (TRIMIS's website, https://trimis.ec.europa.eu/project/co-ordination-and-stimulation-innovative-its-activities-central-and-eastern-european, (accessed 2017-09-27)).

From 2007 until 2013, EasyWay project has been implemented based on MIP. It continues 8 ERPS, and provide traveller information services, traffic management services, freight and logistics services, Connected ICT Infrastructure, European studies, and Management (TRIMIS's website, https://trimis.ec.europa.eu/programme/easyway#tab-outline, (accessed 2017-09-27)).

4.3 ITS Related Organizations in Member States

ERTICO (European Road Transport Telematics Implementation Coordination Committee) is the network of Intelligent Transport Systems and Services stakeholders in Europe, connecting public authorities, industry players, infrastructure operators, users, national ITS associations and other organisations together . As of 2013, there are 33 authorities of member states participated in ERTICO (Figure 3). We will introduce some of them below.

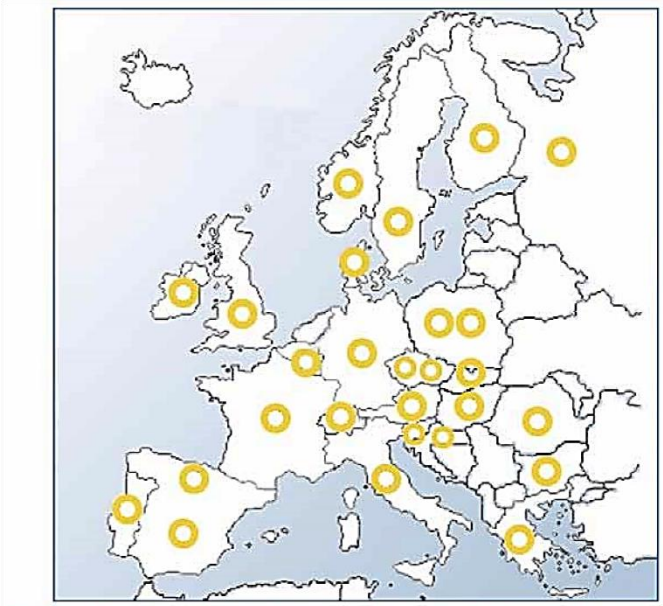

Figure 3. ERTICO related organizations of member states
Source: ITS Japan (2013b, p. 216)

ITS United Kingdom(ITS UK) is a not-for-profit public/private sector association financed by members' subscriptions, and provides a forum for all organisations concerned with ITS. It provides opportunities for practitioners and stakeholders to promote mutual understanding and to increase knowledge and awareness of ITS best practice. It also influences relevant policies, and promotes the international excellence of UK technology, expertise and solutions (ITS UK's website, http://www.its-uk.org.uk/, (accessed 2017-09-23)).

ITS Deutschland is an international representation of the interests of the German ITS sector. The purpose of the association is to promote the research, development, introduction and development of intelligent transport systems to increase traffic safety, to maintain and improve mobility and to reduce traffic-related environmental pollution. It creates open forums to improve multimodality, monitors the market and the international development, strengthens public awareness, and manages of networks of members and information (ITS Deutschland's website, http://www.its-deutschland.info/pages/de/home.php, (accessed 2017-09-23)).

ATEC ITS France aims to bring together the actors of land transport. It organizes technology seminars and annual conventions, publishes quarterly magazines, and announces an action plan every year with a view to solving France's transport problems in the course of ITS development. Its members are contractors, public and private, transport system operators, communication system operators, industrialists, consulting firms and consultants (ITS France's website, http://www.atec-itsfrance.net/home.cfm, (accessed 2017-09-23)).

5. Conclusion

Based on the relationship between ITS across Europe and in member states, we classify the activities related to ITS in member states into 3 types (Table 3), according to the classification of RIS by Cooke (1992), Cooke (1998), and Asheim and Isaksen (2002). Although RIS is limited to the geographic space of region, RIS is a relative concept which is relative to the center. Therefore the classification of RIS based on the dimension of governance is available to ITS related activities in member states.

Table 3. Classification of RIS and represent activities

Type	Represent activities	Purpose	Leading actor	Knowledge flow	Institution
Type I	Activities conducted by ERTICO's subsidiaries, such as ITS UK, ITS Deutschland, etc.	Constructing communication platform, organizing local participants	ITS related organizations in member states	Bottom-up	Informal rules embedded in member states
Type II	FP's technology demonstration experiments and pilot projects, such as TeleFOT, COSMO, CityMobil2, etc.	Technology test	Technology development teams supported by EC	Top-down and bottom-up	EC's framework and plan, consensus of the project team, regulation of member states
Type III	TEN-T's projects, such as TEMPO and EasyWay	Service promotion, infrastructure construction	EC and member state authorities	Top-down	EC's framework and plan, regulation of member states

Source: Created by the author

Type I are efforts to meet member states' demand, and to promote technologies invented in member states to EU. The main actors are organizations which supported by governments of member states and local companies. The network for knowledge flow is organized voluntarily in a bottom-up framework, from member states to EU. Institution is an informal rule formed by interaction, embedded in geographical and cultural space. The efforts conducted by ERTICO's regional organizations belong to Type I.

Type II are cooperation of EC and its member states to verify the applicability of technology in general or specific technology. Field operational tests and pilot projects, such as EuroFOT and COSMO supported by FP, are typical example. The main actors are technology development teams of researchers, companies, universities and authorities supported by EC. Member state agencies participate the experiments and provide institutional support.

Institution is developed by the executive team together with the authorities of member states. There are two pattern of knowledge flow, which are Top-down and bottom-up. When experiment conducted in member states, knowledge flowed from EU to member states. When experiment finished, the experience, tacit knowledge and know-how flowed from member states to EU.

Type III are activities with the purpose of providing infrastructure connection or services. Governments of member states are main actors, but they should follow EC's arrangement, and are responsible to participate the construction of infrastructure. The knowledge flow pattern in this type is from EU to member states.

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The Validation of the Safety Attitudes Questionnaire for Hospitals in Taiwan

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Abstract. This study aims to develop an appropriate patient safety culture scale for healthcare organizations in Taiwan by revalidating Sexton et al. [9]'s Safety Attitudes Questionnaire (SAQ). Medical staffs were asked to answer the surveys in this case hospital in Taichung, Taiwan. Six hundred and twenty-seven and 644 valid questionnaires were respectively issued in 2015 and 2016. The reliability and validity analysis, correlation analysis, and confirmatory factor analysis (CFA) were performed to analyze the data by using SPSS 24 and AMOS 18. The results of exploratory factor analysis (EFA) firstly showed that the values of EFA were around 0.64 to 0.943 in 2015, and the EFA values were around 0.618 to 0.935 in 2016, respectively. The CFA results subsequently demonstrated that the values of CFA ranged from 0.842 to 0.919 in 2015, and the values were from 0.827 to 0.917 in 2016. Therefore, the development of new version of SAQ not only has good reliability and validity but also can be applied for enhancing Taiwan medical care.

Keywords. Safety attitudes questionnaire, Patient safety culture, Medical staff.

1. Introduction

The health care industry is a high-risk and complex field that not only requires professional knowledge but also operates under uncertainty. Safety experts further state that patient safety begins with the enforcement system safety of healthcare organizations [1][2][3]. Vincent et al. [2] suggest that safety culture is one of important attributes that influences systematic safety in the organization. According to a report conducted by the Taiwan Joint Commission on Hospital Accreditation (TJCHA), the atmosphere of patient safety is the

foundation for any healthcare organizations to provide better medical services for patients. However, Lee et al. [4] point that safety activities have been initiated at many hospitals in Taiwan, but little is known about the measurement of safety culture at these hospitals. Therefore, the measurement of patient safety culture should be developed and validated to assess patient safety to improve the quality of medical services.

According to literature review, most healthcare organizations have used the Chinese version of Safety Attitudes Questionnaire (SAQ) developed by TJCHA to measure patient safety culture in Taiwan, but little knowledge has particularly recognized the validation of patient safety measurement scale in Taiwan. Based on the discussion above, the current study aims to validate the Chinese version of SAQ to better assess patient safety culture, by analyzing the data collected from a case hospital in Taiwan in 2015 and 2016.

2. Relevant Literature

Safety culture is typically defined as the awareness, faith, values and assumptions that underlie how people perceive and act upon safety issues within their organizations [5]. The Institute of Medicine defines patient safety as the prevention of medical errors by building a safe health care system [7]. Improving patient safety can reduce malpractice or errors and prevent the patients from harms. Parker [6] suggests that safety culture surveys should be used to access employees' safety attitudes in healthcare organizations. Based on the Flight Management Attitudes Questionnaire (FMAQ) and the Intensive Care Unit Management Attitudes Questionnaire [8][9], Sexton et al. [9] originally developed SAQ with six dimensions to assess patient safety culture [10][11].

Healthcare organizations are now becoming aware of the importance of assessing and monitoring organizational culture to ensure patient safety [12][13]. In order to improve patient safety and reduce medical errors, healthcare organizations should regularly recognize staffs' safety attitudes [14][15]. In addition, Deilkas [16] and Lee et al. [17] point out that conducting safety culture surveys is very useful to measure patient safety. Wagner et al. [18] also highlight that healthcare organizations with positive attitude toward patient safety culture can reduce the number of accidents and failures.

In 2014, based on the Sexton et al. [9]'s SAQ, the TJCHA developed the Chinese version of Safety Attitudes Questionnaire to adjust the Chinese safety culture survey instrument. Two dimensions (emotional exhaustion and work-life balance) are integrated into the questionnaire. Hence, the Chinese version of SAQ contains eight dimensions and 46 items [19], as presented in Table 1.

Table 1. The Chinese safety attitudes questionnaire

Teamwork climate
Tc1 Nurse input is well received in this clinical area
Tc2 In this clinical area, it is difficult to speak up if I perceive a problem with patient care(r)
Tc3 Disagreements in this clinical area are resolved appropriately (i.e. not who is right, but what is best for the patient)
Tc4 I have the support I need from other personnel to care for patients
Tc5 It is easy for personnel here to ask questions when there is something that they do not understand
Tc6 The physicians and nurses here work together as a well-coordinated team
Safety climate,
Sc1 I would feel safe being treated here as a patient

Sc2 Medical errors are handled appropriately in this clinical area
Sc3 I know the proper channels to direct questions regarding patient safety in this clinical area
Sc4 I receive appropriate feedback about my performance
Sc5 In this clinical area, it is difficult to discuss errors(r)
Sc6 I am encouraged by my colleagues to report any patient safety concerns I may have
Sc7 The culture in this clinical area makes it easy to learn from the errors of others
Job satisfaction
Jb1 I like my job
Jb2 Working here is like being part of a large family
Jb3 This is a good place to work
Jb4 I am proud to work in this clinical area
Jb5 Morale in this clinical area is high
Stress Recognition
Sr1 When my workload becomes excessive, my performance is impaired
Sr2 I am less effective at work when fatigued
Sr3 I am more likely to make errors in tense or hostile situations (e.g. emergency resuscitation, seizure)
Sr4 Fatigue impairs my performance during emergency situations
Perceptions of management,
Pm1 Managers supports my daily efforts
Pm2 Managers do not knowingly compromise patient safety
Pm3 I get adequate, timely information about events that might affect my work
Pm4 The levels of staffing in this clinical area are sufficient to handle the number of patients
Working conditions
Wc1 Problem personnel are dealt with constructively
Wc2 This hospital does a good job of training new personnel
Wc3 All the necessary information for diagnostic and therapeutic decisions is routinely available to me
Wc4 Trainees in my discipline are adequately supervised
Emotional exhaustion
Ee1 I feel like I'm at the end of my rope(r)
Ee2 I feel burned out from my work(r)
Ee3 I feel frustrated by my job(r)
Ee4 I feel I'm working too hard on my job(r)
Ee5 I feel emotionally drained from my work(r)
Ee6 I feel used up at the end of the workday(r)
Ee7 I feel fatigued when I get up in the morning and have to face another day on the job(r)
Ee8 Working with people all day is really a strain for me(r)
Ee9 Working with people directly puts too much stress on me(r)
Work-life balance
Wb1 Missed meals
Wb2 A hasty meal
Wb3All-day work without any rest
Wb4 Individual or family plan change due to work factors

Wb5 Poor sleep
Wb6 Less than five-hour sleep at night
Wb7 Late work

Note: r: reversed question

3. Methodology

Medical staffs were asked to answer the Chinese version of SAQ in a case hospital in Taiwan. Seven dimensions consist of teamwork climate, safety climate, job satisfaction, stress recognition, perceptions of management, working conditions, and emotional exhaustion. The structures of the data were measured excluding work-life balance since its scales were measured using frequency data. In 2015, a total of 694 questionnaires were collected using convenience sampling, and 627 valid questionnaires were used for the analysis. In 2016, a total of 751 questionnaires were collected, and 664 valid questionnaires were issued. SPSS 24.0 and AMOS 18.0 were then used for statistical data analysis.

4. Research Results

(1) Demographics of the respondents

The examination of the sample profile in 2015 demonstrated that the majority of respondents were female (94.6 percent), age ranged from 21 to 30 years (41.6 percent), and more than 11 to 20 years working experiences were around 26.0 percent, followed by 5 to 10 years (23.4%), most of them had bachelor's level degree (96.4%). On the other hand, the sample profile in 2016 show that the majority of respondents were female (94.6 percent), the largest age group was around 21 to 30 years (43.2%), followed by 31 to 40 years (35.2%), and more than 11 to 20 years working experiences were around 23.4 percent, followed by 5 to 10 years (22.1%), similarly most of them had bachelor's level degree (95.6%).

(2) Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA)

This study adopted exploratory factor analysis to test the validity of the Chinese version of the SAQ. Kaiser [20] argues that a Kaiser-Meyer-Olkin (KMO) value of over 0.9 means the dataset has excellent suitability for factor analysis, values greater than 0.8 mean favorable suitability, and values greater than 0.7 stand for appropriate suitability. The results of validation revealed that the KMO value of all SAQ dimensions were above 0.7, indicating that there was an adequate sample size for factor analysis. Similarly, the KMO values of all dimensions measuring SAQ in 2016 were greater than 0.7, which indicate satisfactory level of factor analysis. After the confirmation of KMO, all items were validated by conducting EFA and CFA, respectively.

5. Discussion

The current study aims to validate the Chinese version of SAQ by investigating the perceptions of medical staffs in a case hospital in Taiwan in 2015 and 2016. As shown in Table 1, this study suggests that teamwork climate could be measured by items tc1, tc4, tc5, and tc6. Safety climate could be measured by sc2, sc3, and sc4. Job satisfaction is measured by jb1, jb2, jb3, and jb5. Stress recognition is measured by sr1, sr2, and sr4. Perceptions of management could be measured by pm1, pm2, and pm3. Working conditions are suggested to be measured by wc1, wc3, and wc4. Emotional exhaustion could be measured by ee2, ee5, and ee6. By analyzing the data from 2015 and 2016, this study identified a more suitable and rigorous questionnaire for healthcare organizations to access patient safety culture in Taiwan.

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Identifying the Attributes of Satisfaction of Patient Safety Culture on the Perceptions of Physicians and Nurses

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Abstract. How to enhance hospital staffs' satisfaction in healthcare organizations has emerged as an essential issue for improving the quality of medical services. The current study aims to identify the antecedents of patient safety culture satisfaction from the viewpoints of physicians and nurses respectively to comprehensively develop implications for a better medical quality. Linear regression is used to assess the data by adapting Sexton et al. [11]'s Safety Attitudes Questionnaire. The results highlight that safety climate, perceptions of management, and working conditions have significant impacts on satisfaction of patient safety culture for both physicians and nurses.

Keywords. Safety attitudes questionnaire, Patient safety culture satisfaction, Medical quality, Linear regression.

1. Introduction

How to enhance employees' satisfaction in healthcare organizations has emerged as a critical factor in enhancing medical services and quality. Many behavior studies have examined the impacts of satisfaction in a long-term physician-patient relationship and further indicate that satisfaction is the essential instrument for promoting patient loyalty [1][2]. Evidence reveals that if hospital staffs are satisfied with work, coworkers, supervision, and organization, they are more likely to create a variety of outcomes, such as loyalty, quality healthcare, management maintenance, less burnout and turnover, and among others [3][4]. However, most studies have emphasized the importance of patient safety culture for benefiting

healthcare organizations [5][6], little knowledge has particularly recognized the perceptions toward the satisfaction of patient safety culture from the viewpoints of medical staffs as well as the antecedents of such that satisfaction. Therefore, it is critically important to identify the satisfaction of patient safety culture and its antecedents in order to comprehensively develop implications for a better medical quality. Following this introduction, the second section of this paper describes a review of the literature on patient safety culture and patient satisfaction. The third section then presents the methods used in the empirical study. Finally, the results are discussed.

2. Relevant Literature

Establishing a better patient safety culture in hospitals has become one of critical issues for hospital managers to enhance medical quality. A better patient safety culture not only improve physician-patient relationship [7][8], but also reduce medical errors [5] and job dissatisfaction [9]. Lee et al. [10] also state that hospital staffs are more likely to work cooperatively if healthcare organizations regard patient safety culture as one of priorities in improving medical services. Safety Attitudes Questionnaire (SAQ) originally developed by Sexton et al. [11], is widely used for measuring patient safety attitudes in healthcare organizations. The questionnaire contains 30 items, grounded into six dimensions: teamwork climate, safety climate, job satisfaction, stress recognition, perceptions of management, and working conditions. In 2014, based on the Sexton et al. [11]'s SAQ, the Taiwan Joint Commission on Hospital Accreditation (TJCHA) developed the Chinese version of Safety Attitudes Questionnaire to adjust the Chinese safety culture survey instrument. Two dimensions (emotional exhaustion and work-life balance) are integrated into the questionnaire. Hence, the Chinese version of SAQ contains eight dimensions and 46 items.

Satisfaction is an emotional evaluation of the quality and trading relationship, as perceived by customers [12]. In the medical industry, patient satisfaction is defined as patients' overall evaluation about hospital experience which is associated with patient loyalty [13]. Tam [14] states that patient satisfaction describes an evaluation given by patients within a medical encounter. Positive satisfaction tends to maintain the current physician-patient relationship and to enhance the word of mouth and patient loyalty [1].

3. Methodology

The Chinese version of SAQ developed by TJCHA was used to assess the patient safety culture. Seven dimensions and 39 items were measured the structure of the data exclude work-life balance since its scales were measured using frequency data. An overall satisfaction of patient safety was measured following the concept of Oliver [15] research. An intra-organizational online survey was then send to physicians and nurses in a case hospital in Taiwan in 2016. Each question used a five-point Likert's scale whereas the assessment of work-life balance was excluded since the four-point frequency scale was used to access that dimension. A total of 450 questionnaires were collected using convenience sampling, and 432 valid questionnaires were used for the analysis (48 for physicians and 384 for nurses).

4. Research Results

For physicians, examination of the sample profile showed that majority of respondents were male (83.3 percent), age ranged from 41 to 50 years (43.8 percent), and education of the bachelor (69.0 percent) or graduate degree (31.0 percent), and more than 5 years working experiences were around 54.7 percent. For nurses, most respondents were female (96.4

percent), age ranged from 21 to 40 years (78.4 percent), education of the bachelor's level (95.6 percent). Around one-half of respondents with relevant working experiences were more than five years in the hospital.

As shown in Table 1, for physicians, the highest mean score was stress recognition (3.91), while the lowest mean score was emotional exhaustion (3.09). On the other hand, teamwork climate (3.88) and emotional exhaustion (3.02) were the highest and lowest mean scores for nurses receptively. Additionally, the Cronbach's α values for all the constructs exceed 0.8, which indicated that the scales had great reliability and internal consistency.

Table 1 The results of Mean, SD, Cronbach's alpha

Research constructs	Mean		SD		Cronbach's α	
	P	N	P	N	P	N
Teamwork climate	3.91	3.88	.765	.720	.871	.863
Safety climate	3.71	3.73	.770	.701	.905	.891
Job satisfaction	3.88	3.52	.787	.854	.932	.939
Stress recognition	3.96	3.69	.802	.810	.860	.882
Perceptions of management	3.67	3.59	.814	.706	.839	.820
Working conditions	3.62	3.59	.796	.726	.891	.899
Emotional exhaustion	3.09	3.02	.788	.627	.912	.899
Overall patient safety satisfaction	3.54	3.50	.967	.772	n/a	n/a

Note: P: physicians; N: nurses; SD: standard deviation; n/a: not applicable

Linear regression with forward selection was subsequently used to identify essential dimension(s) that affect the overall satisfaction of the patient safety culture from the viewpoints of physicians and nurses. Seven dimensions were used as independent variables in the regression analysis for physicians. The results showed that the adjusted R square values were 0.57, 0.59, and 0.62 for the three models, respectively. Model 3 was selected since it has the largest adjusted R square. The regression results indicated that working conditions, job satisfaction, and emotional exhaustion had positive influences on the overall satisfaction of the patient safety culture. Furthermore, job satisfaction had the highest standardized coefficient (β = 0.37), which represented the most positive effects on overall satisfaction, followed by working conditions with β = 0.30. On the other hand, for nurses, the results showed that the adjusted R square values were 0.46, 0.50, and 0.52 for the three models, respectively. Model 3 with the largest adjusted R square was chosen. Working conditions, safety climate, and perceptions of management had positive impacts on the overall satisfaction of the patient safety culture. Furthermore, working conditions had the most positive effects on overall satisfaction (β = 0.29). Safety climate (β = 0.25) was the second critical dimension in this regression analysis.

5. Discussion

In sum, patient safety culture is the goal of healthcare organizations. In a highly competitive healthcare industry, establishing a better satisfaction of patient safety culture have become keys to enhance medical quality for healthcare organizations. The current study identifies the potentially relevant factors that cause satisfaction of patient safety culture from physicians and nurses in the medical service industry. For physicians, more attention to working conditions, job satisfaction, and emotional exhaustion, whereas working conditions,

safety climate, and perceptions of management should be focused on for nurses, to increase the development of patient safety culture satisfaction.

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'What matters to nurses': A Study on the Influences on Satisfaction of Patient Safety Culture in Novice Nurses and Genuine Nurses

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Abstract. Satisfaction of patient safety culture is a critical factor in enhancing the attainment of goals and objectives in healthcare organizations. Nurses, frequently contacting with patients, are one of the most important roles among medical staffs in a hospital. However, certain attributes are critical for satisfaction of patient safety culture in the perspective of nurses' work experience. Thus, this research aims to understand the key attributes between novice nurses and genuine nurses in satisfaction of patient safety culture by adapting Sexton et al. (2006)'s Safety Attitudes Questionnaire. The results show that teamwork climate and perceptions of management significantly influence satisfaction of patient safety culture for novice nurses while perceptions of management, safety climate, and working conditions are critical factors for genuine nurses.

Keywords. Safety attitudes questionnaire, Patient safety culture satisfaction, Nurses, work experiences.

1. Introduction

The contributions to patient satisfaction by nurse specialists are equivalently to physicians in healthcare organizations [1]. Hospital practitioners with appropriate mindset on patient safety in teamwork are achievable to execute tasks so that patient safety culture is asserted in clinical organizations

[2]. Novice nurses and genuine nurses are important in the perspective of human resources and the development of a hospital. Past studies focused on the issue of a graduate transitioning from a novice nurse to a genuine nurse.

Novice nurses who possess less clinical related work experience face a myriad of challenges including confidence in the specialty and the ability to cooperate with colleagues in a new workplace [3,4]. To decrease anxiety and gain confidence on the novice nurses, improvements to work-ready skills must be made [5]. Most studies emphasize on what novice nurses should to notice to become experts.

On the other hand, clinic related work experience toward nurses may be related to the patient safety. As nurses are with less clinical experience, an injured patient is more susceptible to wound infections and thus increasing mortality rate [6]. However, certain studies indicated that the relationship between work experience and patient safety is non-existent [7,8]. The passage of time is not the only consideration for enriching work experience. In addition, work experience is enriched in the situation that nurses are able to elaborate the knowledge they learned through working in a workplace [9]. In other words, the workplace where nurses work is important for the nurses' growth and to obtain real experience. The time for nurses' graduation from school is not the only indicator to define novice nurses. In this study, novice nurses are not only a graduate but the new one in the hospital.

Based on the background in the above two sections, certain attributes are identified toward novice nurses and genuine nurses in patient safety culture. Therefore, this study aims to understand the key attributes between novice nurses and genuine nurses in satisfaction of patient safety culture by adapting Safety Attitudes Questionnaires (SAQ) developed by Sexton et al. [10]. Following the introduction, the second section of this study presents literature review; the third section demonstrates the methods adopted in the empirical investigation; and the research results and discussion are in section four and five respectively. Conclusion is in the final part.

2. Literature Review

A literature search is conducted to uncover the relationship between work experience and patient safety. Certain studies have concluded that work experience and patient safety exist positive relationship [11-13], whereas the relationships in other researches are not significant [7, 8]. Tourangeau et al. [6] showed that less experienced nurses exist higher opportunity of wound infections and mortality rate when taking care of patients. In other words, there is a correlation between work experience and the risk to patient safety.

Nurses face numerous challenges when working with their colleagues [14]. Certain studies have investigated the issues on graduate nurses. Graduates who possess insufficient practice experience are distinct from other staffs [4]. Novice nurses are characterized as inexperience and are unfamiliar with the new clinical area [15, 16]. When novice nurses start a new work in workplace, they might feel unconfident and inadequacy [3]. The feelings of novice nurses in their work environment are discouragement and burnout and the situation in high levels of exhaustion lasts in the first 18 months. Graduate nurses working in their positions suffer from significant anxiety because of vulnerable skills on adapting the social and work environment, position conflict, and self-confidence [15]. Inadequacy of clinical capability for graduate nurses discourages their confidence [17].

Novice nurses have been closely investigated. On the other hand, genuine nurses are equally worth to bear in mind. The study conducted by Benner [9] showed that the passage of time is not the only consideration to assess experience but what is learned from the situation that nurses are able to elaborate knowledge through working in a workplace. Specifically, whether novice or genuine nurses enter a new workplace, both of them are taken as novice nurses facing a new work environment where they are able to cooperate with new colleagues and enhance experience.

In the Australian health practice, healthcare delivery under an interdisciplinary team needs teamwork and communication skills. Nurses who possess these skills are comfortably able to involve in the work environment [18]. Patterson et al. [19] suggested that nurses

working in health clinic require the skill to communicate with colleagues. To decrease anxiety and gain confidence for nurses, work ready skills are suggested to be improved [5].

None of past studies have addressed relative attributes linked to patient safety in the perspective of novice nurses and genuine nurses respectively. In this study, we are eager to investigate the attributes associated to patient safety between novice nurses and genuine nurses in a hospital. To figure out the attributes that novice nurses and genuine nurses separately concern in patient safety, the Chinese version of SAQ are sent to the staffs by an intra-organizational online survey in the case hospital in Taiwan.

3. Research Methods

3.1 Data Collection Procedure

The perceptions of patient safety culture among hospital staffs in a case hospital are investigated to improve medical quality for patient. The practitioners in the case hospital including physicians, nurses, technicians, and administrators response the Chinese version of SAQ by an intra-organizational online survey in 2016. The best general and teaching hospital in Taiwan is chosen as a representative case [20]. To focus on the issue of nurses in this study, nurses are separately allocated into two categories, novice nurses with work experience under one year and genuine nurses with work experience over one year in the hospital. A pretesting is performed by surveying fifty hospital members to ensure the accuracy of the questionnaire [21]. After the process of pretesting, the formal surveys are sent to the respondents within November 7 to November 21, 2016 in the case hospital. A total of 667 questionnaires are collected, and 588 valid questionnaires are used for the analysis (48 for physicians, 384 for nurses, 74 for technicians, and 82 for administrators). 83 samples are collected for novice nurses while 301 samples are collected for genuine nurses.

3.2 Measurement and Analysis Methods

As presented in Table 1, the Chinese version of SAQ is used to investigate the levels of perceptions about patient safety among two categories of nurses in the hospital. Forty-six question items are grounded into eight safety culture dimensions. Teamwork climate is assessed using six question items (questions 1 to 6); safety climate is measured using seven question items (questions 7 to 13); job satisfaction is measured using five question items (questions 14 to 18); stress recognition is accessed using four question items (question 19, 21, 25, and 26); four question items (questions 27 to 30) are used to measure perceptions of management; four question items (questions 31 to 34) are used to assess working conditions; nine question items (question 20, 22, 23, 24, 35, 36, 37, 38, 39) are used to assess emotional exhaustion; work-life balance is measured using seven question items (questions 40 to 46). One question (question 47) is added to assess the overall satisfaction of the patient safety culture in the case hospital, i.e., "overall, I am satisfied with everything about the patient safety hospital provided." Additionally, each question uses a five-point Likert's scale whereas the assessment of work-life balance is excluded since the four-point frequency scale is used to access that dimension. Eleven questions are reversed to confirm the wording is more accurate [22]. The scores for each of eight dimensions are calculated by summing the scores of the items measuring a particular dimension.

The degree of correlation among seven patient safety culture dimensions for two categories of hospital nurses are firstly examined by using Pearson correlation analysis, respectively [23].

Table 1. The Chinese version of safety attitudes questionnaire

Teamwork climate	(1) Nurse input is well received in this clinical area
	(2) In this clinical area, it is difficult to speak up if I perceive a problem with patient care(r)
	(3) Disagreements in this clinical area are resolved appropriately (i.e. not who is right, but what is best for the patient)
	(4) I have the support I need from other personnel to care for patients
	(5) It is easy for personnel here to ask questions when there is something that they do not understand
	(6) The physicians and nurses here work together as a well-coordinated team
Safety climate	(7) I would feel safe being treated here as a patient
	(8) Medical errors are handled appropriately in this clinical area
	(9) I know the proper channels to direct questions regarding patient safety in this clinical area
	(10) I receive appropriate feedback about my performance
	(11) In this clinical area, it is difficult to discuss errors(r)
	(12) I am encouraged by my colleagues to report any patient safety concerns I may have
	(13) The culture in this clinical area makes it easy to learn from the errors of others
Job satisfaction	(14) I like my job
	(15) Working here is like being part of a large family
	(16) This is a good place to work
	(17) I am proud to work in this clinical area
	(18) Morale in this clinical area is high
Stress recognition	(19) When my workload becomes excessive, my performance is impaired
	(21) I am less effective at work when fatigued
	(25) I am more likely to make errors in tense or hostile situations (e.g. emergency resuscitation, seizure)
	(26) Fatigue impairs my performance during emergency situations
Perceptions of management	(27) Managers supports my daily efforts
	(28) Managers do not knowingly compromise patient safety
	(29) I get adequate, timely information about events that might affect my work
	(30) The levels of staffing in this clinical area are sufficient to handle the number of patients
Working conditions	(31) Problem personnel are dealt with constructively
	(32) This hospital does a good job of training new personnel
	(33) All the necessary information for diagnostic and therapeutic decisions is routinely available to me
	(34) Trainees in my discipline are adequately supervised
Emotional exhaustion	(20) I feel like I'm at the end of my rope(r)
	(22) I feel burned out from my work(r)
	(23) I feel frustrated by my job(r)
	(24) I feel I'm working too hard on my job(r)
	(33) I feel emotionally drained from my work(r)
	(36) I feel used up at the end of the workday(r)
	(37) I feel fatigued when I get up in the morning and have to face another day on the job(r)
	(38) Working with people all day is really a strain for me(r)
	(39) Working with people directly puts too much stress on me(r)
Work-life balance	(40) Missed meals
	(41) A hasty meal
	(42) All-day work without any rest

	(43) Individual or family plan change due to work factors (44) Poor sleep (45) Less than five-hour sleep at night (46) Work overtime
The overall satisfaction of the patient safety culture	(47) overall, I am satisfied with everything about the patient safety hospital provided

Note: r: reversed question

Linear regression with forward selection is subsequently used to identify essential dimension(s) that affect the overall satisfaction of the patient safety culture from the viewpoints of two categories in nurses. The decision maker is able to clarify which dimension has a greater impact directly on the dependent variable by forward selection [24]. To identify the cause and effect, the seven dimensions in Chinese version of SAQ are considered as the independent variables, whereas the overall satisfaction is taken as the dependent variable. F test under 95% of confidence interval is the criteria of adding variable(s) into a linear regression model.

4. Results

4.1 Sample Characteristics and Descriptive Statistics

The sample profile indicates that most nurses are females (95.2% for novice nurses and 98.8% for genuine nurses). As shown in Table 2, all the average values in seven dimensions for novice nurses are higher than genuine nurses. The Cronbach's α values of all seven patient safety culture dimensions are greater than 0.7, which demonstrates good internal consistency [25]. The Cronbach's α is not reported for overall patient safety culture satisfaction since the dimension is only assessed with one item [26].

Table 2. Average value and Cronbach's alpha coefficient for novice nurses and genuine nurses

	Novice Nurses (n=83)		Genuine Nurses (n=301)	
	Mean	α	Mean	α
1. TC	3.97	0.865	3.86	0.864
2. SC	3.78	0.875	3.72	0.896
3. JS	3.70	0.927	3.68	0.943
4. SR	3.56	0.794	3.50	0.898
5. PM	3.73	0.840	3.55	0.813
6. WC	3.72	0.907	3.55	0.895
7. EE	3.14	0.873	2.98	0.879
8. PS	3.65	n/a	3.46	n/a

Note: TC: teamwork climate; SC: safety climate; JS: job satisfaction; SR: stress recognition; PM: perceptions of management; WC: working conditions; EE: emotional exhaustion; PS: overall patient safety culture satisfaction; α: Cronbach's alpha coefficient

4.2 Correlation Analysis Results

Pearson's correlation analysis is observed to examine the strength and direction of the relationships among seven patient safety culture dimensions and overall satisfaction of the patient safety culture for two work-experience categories in nurses. For novice nurses, safety

climate is highly correlated to teamwork climate, perceptions of management, and working conditions. Perceptions of management are highly correlated to working conditions. Overall patient safety culture satisfaction is associated with perceptions of management. In addition, emotional exhaustion is negatively related to stress recognition, from Table 3.

Table 3. Pearson's correlation analysis for novice nurses (n = 83)

	1	2	3	4	5	6	7
1.TC							
2.SC	.755**						
3.JS	.576**	.676**					
4.SR	-.057	.050	.032				
5.PM	.620**	.784**	.628**	.009			
6.WC	.615**	.712**	.635**	.013	.879**		
7.EE	.311**	.316**	.472**	-.390**	.378**	.368**	
8.PS	.601**	.649**	.485**	.055	.690**	.684**	.247*

Note:* p-value < 0.05; ** p-value < 0.01; TC: teamwork climate; SC: safety climate; JS: job satisfaction; SR: stress recognition; PM: perceptions of management; WC: working conditions; EE: emotional exhaustion; PS: overall patient safety culture satisfaction

For genuine nurses, safety climate is highly correlated to teamwork climate, job satisfaction, perceptions of management, and working conditions. Job satisfaction is highly correlated to teamwork climate, perceptions of management, and working conditions. Working conditions is highly correlated to perceptions of management. Overall patient safety culture satisfaction is associated with working conditions. In addition, emotional exhaustion is negatively related to stress recognition, from Table 4.

Table 4. Pearson's correlation analysis for genuine nurses (n = 301)

	1	2	3	4	5	6	7
1.TC							
2.SC	.831**						
3.JS	.736**	.801**					
4.SR	.007	.040	.021				
5.PM	.670**	.759**	.749**	.047			
6.WC	.690**	.802**	.726**	.064	.805**		
7.EE	.323**	.308**	.337**	-.540**	.256**	.235**	
8.PS	.571**	.663**	.580**	.055	.657**	.677**	.228*

Note:* p-value < 0.05; ** p-value < 0.01; TC: teamwork climate; SC: safety climate; JS: job satisfaction; SR: stress recognition; PM: perceptions of management; WC: working conditions; EE: emotional exhaustion; PS: overall patient safety culture satisfaction

4.3 Linear Regression Results

Seven patient safety dimensions are used as independent variables in the regression analysis for novice nurses. The first selected variable is perceptions of management, followed by teamwork climate. The results show that the adjusted *R* square values are 0.469 and 0.513 for the two models, respectively. Model 2 is selected since it has the largest adjusted *R* square. As shown in Table 5, the results indicate that perceptions of management and teamwork climate have positive influences on the overall satisfaction of the patient safety culture. Additionally, perceptions of management has the highest standardized coefficient ($\beta = 0.515$), which represents the most positive effects on overall satisfaction, followed by teamwork climate with $\beta = 0.282$.

Table 5. Coefficients of two models using seven dimensions for novice nurses (n = 83)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	VIF
		B	Standard Error	Beta			
1	(Constant)	0.838	.334		2.507	.014	
	PM	.755	.088	.690	8.573	.000	1.000
2	(Constant)	.340	.364		.933	.354	
	PM	.564	.108	.515	5.246	.000	1.623
	TC	.305	.106	.282	2.866	.005	1.623

For genuine nurses, the regression results demonstrate that the first selected variable is working conditions, followed by safety climate and perceptions of management. The results show that the adjusted *R* square values are 0.457, 0.496, and 0.512 for the three models, respectively. Model 3 with the largest adjusted *R* square is chosen. As presented in Table 6, the results show that working conditions, safety climate, and perceptions of management have positive impacts on the overall satisfaction of the patient safety culture. Furthermore, working conditions has the most positive effects on overall satisfaction (β = 0.280). Safety climate (β = 0.262) and perceptions of management (β = 0.233) are the second and third critical dimensions in this regression analysis.

Table 6. Coefficients of three models using seven dimensions for genuine nurses (n = 301)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	VIF
		B	Standard Error	Beta			
1	(Constant)	.866	.166		5.218	.000	
	WC	.730	.046	.677	15.926	.000	1.000
2	(Constant)	.532	.174		3.061	.002	
	WC	.439	.074	.408	5.946	.000	2.800
	SC	.367	.075	.336	4.904	.000	2.800
3	(Constant)	.419	.175		2.399	.017	
	WC	.302	.084	.280	3.588	.000	3.749
	SC	.286	.078	.262	3.672	.000	2.124
	PM	.254	.078	.233	3.242	.001	3.163

5. Discussion

This study aims to assess the key attributes between novice nurses and genuine nurses in satisfaction of patient safety culture. Certain suggestions are addressed as follows. In a strategic position, the managers are suggested to closely consider the alignment between strategic levels and operation levels. The managers put themselves in the shoes of both novice and genuine nurses so that the quality of medical services is assuredly enhanced by the top-down action. Second, either novice nurses or genuine nurses necessarily understand the fundamental capabilities in their positions and response difficulties and suggestions to proper persons such as colleagues or supervisors by the bottom-up action and thus the satisfaction on patient safety in the operation level is enhanced. In sum, patient safety is the goal of a hospital. Positive reinforcement on improving patient safety in healthcare area can be addressed when both top-down action and bottom-up action are certainly executed.

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Analyzing Critical Factors of Medical Treatment Loyalty from A Case Hospital with A Friendly Environment for Elderly Patients

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Abstract. The number of people with the age of 65 years old or more accounts for up to one-third of the total patients in this case hospital. With the rise of the ageing society, creating and improving the medical environment is important and indispensable for the elderly people. The questionnaire in this study has six dimensions, one medical treatment loyalty question, and seven demographic variables and is used to survey the elderly people aged 65 and above and their companions in this case hospital. Linear regression with forward selection is used to explore how six dimensions and demographic variables impact medical treatment loyalty. The results show that physical environment has the highest positive influence on the willingness to continue the medical treatment in this hospital followed by hospital image. That is, the better physical environment or hospital image provided by this case hospital, the better medical treatment loyalty. In contrast, medical identity has a negative impact on the willingness to continue the medical treatment in this hospital. A companion tends to have a negative influence toward medical treatment loyalty than the patient. Therefore, hospital management needs to improve physical environment and hospital image as well as to seek medical supports from patients' companions to strengthen medical treatment loyalty.

Keywords. Age-friendly hospital, Demographic variable, Physical environment, Hospital image, Linear regression, Medical treatment loyalty.

1. Introduction

In 2004, World Health Organization [1] reported that the world is ageing because people are living longer and fewer children were born. By 2025, there would be more people aged 60 and more than children under the age of 15. In 2015, there are more than 901 million people aged 60 or more consisting of 12% of the global population. In addition, the projected numbers of older people are to be 1.4 billion by 2030 and 3.2 billion by 2100 [2]. Moreover, population ageing is projected to have a profound effect on the number of workers per retiree in various countries.

World Health Organization [1] summarized that the rapidity of population ageing is expected to outpace social and economic development in developing countries such that developing countries would become old before they become rich. In contrast, industrialized

countries would become rich while they were growing old. With ageing comes an increased risk of developing chronic disease and disability. In order to deal with the increasing burden of chronic disease, there is a need for health promotion and disease prevention in the community and disease management within healthcare services [1].

Groene [3] pointed out that the role of health promotion in hospitals has been changed. In fact, health promotion has become an integral part of the healthcare process and is related to clinical, educational, behavioral, and organizational issues in order to improve the care quality for patients and for elderly people particularly with chronic diseases and long-term conditions. World Health Organization [4] also emphasized that healthcare centers need to modify their structures to better fit the needs of elderly patients by following Age-Friendly Principles, including (1) information, education, communication and training, (2) health care management systems, and (3) the physical environment of the primary health care center.

In Taiwan, there is a framework to promote healthy ageing in and by hospitals entitled "Taiwan's Framework of Age-Friendly Hospitals" [5]. Chiou and Chen [5] concluded that health-promoting and age-friendly hospitals or health services play a positive role to improve healthy and active ageing. Besides, age-friendliness and support for healthy ageing is the responsibility and priority for healthcare organizations as a whole rather than individual healthcare professionals or individual departments of healthcare organizations. In this study, the case hospital has the number of people with the age of 65 years old or more accounting for up to one-third of the total patients. With the rise of the ageing society, creating and improving the medical environment is important and indispensable for the elderly people. Therefore, this case hospital located in Changhua City, Taiwan is intended to create a friendly environment for elderly patients relentlessly. In order to create a safe, professional and friendly medical environment sustainably, it is essentially important for this case hospital to identify critical factors linking to medical treatment loyalty from elderly patients' viewpoints.

2. Taiwan's Framework of Age-Friendly Hospitals

By considering Age-Friendly Principles of World Health Organization, Health Promoting Hospitals and Health Services (HPH) of World Health Organization, and the Vancouver Island Health Authority's Elder-Friendly Hospital Initiative, the Taiwan Network of HPH, which is a member of the International Network of HPH, developed Taiwan's Framework of Age-Friendly Hospitals to promote healthy ageing in and by hospitals in Taiwan [5]. This framework is composed of vision, values, missions, and strategy in four dimensions, including management policy, communication and services, physical environment, and care processes [6].

Management policy includes developing an age-friendly policy, organizational support, and continuous monitoring and improvement. The assessment of management policy is to address the development of organizational culture and perspectives of the seniors and the providers and the development of resources, performance of practices and outcome of care. Communication and services has the following guidance. Hospital staffs speak to elderly persons in a respectful manner using understandable language and words. In addition, the hospital makes every effort to adapt its administrative procedures to the special needs of elderly persons particularly with low educational levels or with cognitive impairments. For physical environment, the hospital follows the common principles of Universal Design whenever practical, affordable, and possible. The hospital facilitates transport to and within its facilities for all, including elderly persons. Care processes include patient assessment, intervention and management, and community partnership and continuity of care [5].

Yan and Kung [7] conducted a preliminary study on elderly patients' satisfaction toward hospital brands and age-friendly policies based on four dimensions of Taiwan's

Framework of Age-Friendly Hospitals. The questionnaire furthers incorporated hospital image and physician-patient relationship. The numbers of question items in hospital image, physician-patient relationship, management policy, communication and services, physical environment, and care processes were nine, three, six, four, six, and fifteen, respectively. Their findings are briefly summarized below. Elderly patients have relatively greater needs of healthcare. In addition, better physician-patient relationship has a more positive impact on elderly patients' satisfaction toward management policies, communication, and medical procedures. Therefore, hospital management needs to pay much attention to the needs of elderly patients so as to create a safe, professional and friendly medical care environment where elderly patients are respected through visionary leadership and organizational culture. In this study, the designed questionnaire is borrowed from the questionnaire developed by Yan and Kung [7].

3. Research Method

The developed questionnaire based on Yan and Kung [7] has six dimensions, one question related to medical treatment loyalty, and demographic variables. The numbers of question items in hospital image, physician-patient relationship, management policy, communication and services, physical environment, and care processes are nine, three, six, four, six, and fifteen, respectively. For each question in six dimensions, each respondent is asked to use a Likert five-point scale to assess the agreement from strongly disagree to strongly agree with the respective numerical values from one to five. Further, in order to simplify the analyses, dimensions are used instead of individual questions. The score for each dimension is to aggregate the scores of individual questions. One question regarding to medical treatment loyalty is as follows: The willingness to continue the medical treatment in this hospital, with three scales to be chosen, i.e., high willingness with a value of three, medium willingness with a value of two, and unwillingness with a value of one. The demographic variables include medical identity, gender, age, education, living status, place of residence, chronic disease, and reason to the case hospital.

This study has received the approval certificate approved by the Institutional Review Board of Show Chwan Memorial Hospital with protocol number of RD105045. Convenience sampling is used to conduct the survey to the patients whose ages are 65 years old or more in this case hospital. Cronbach's α is applied to assess if the survey results have good reliability, while Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity are used to ensure the survey results have factor validity by removing question items with both factor loading and community values less than 0.50 [8]. Linear regression with forward selection is used because it starts with an empty set and continually adds one variable with the highest performance to a particular dependent variable at a time. That is, the model selection criteria are tractable and disclosed which independent variable is critical to a particular dependent variable [9]. In this study, medical treatment loyalty is the dependent variable, whereas medical identity, gender, age, education, living status, place of residence, chronic disease, and reason to the case hospital are the independent variables.

4. Results

Two hundred and fifty eight questions have been issued but only two hundred and forty four questions are valid, representing a 94.6% effective return rate. The demographic information about 244 patients is provided in Table 1, where chronic disease and reason to the case hospital are a multiple choice for each elderly patient. The reliability of this survey is assessed by Cronbach's α, where the measured value of 0.975 represents the survey results

having good reliability [10]. The questionnaire based on Yan and Kung [7] has the content validity. In addition, KMO measure of sampling adequacy and Bartlett's test of sphericity were further used to assess the construct of the questionnaire. In order to ensure the construct of the questionnaire, any question item having both factor loading and community values less than 0.5 is to be removed [8]. Following the above procedure, two items are removed. Thus, the total number of the question items is from 43 to 41. The reliability of 41 questions assessed by Cronbach's α is 0.974, indicating the survey results have good reliability [10].

Table 1 Demographic Information about 244 Patients in this Case Hospital

Demographic Variable	Frequency	Percentage
Medical identity		
Patient	191	78
Companion	53	22
Gender		
Male	105	43
Female	139	57
Age		
65-74 years old	135	55
75-84 years old	82	34
85 years old	27	11
Education		
Illiterate	44	18
Elementary school	116	48
Junior high school	25	10
Senior high school	41	17
College and above	18	7
Living status		
Live alone	10	4
Live with family	232	95
Others	2	1
Place of residence		
Changhua City	108	44
Changhua County	115	47
Others	21	9
Chronic disease		
Hypertension	119	44
Gyperlipidemia	31	11
Diabetes	58	21
Others	62	23
Reason to the case hospital		
Recommendation by	135	45
relatives and friends	82	27
Nearby	42	14
Quality medical skills	32	11
Hospital's reputation	11	4
Others		

The purpose of this study is to identify critical factors that will have significant impact on the willingness to continue the medical treatment in this hospital. Linear regression with forward selection is used, where the willingness to continue the medical treatment in this hospital is the dependent variable. Six dimensions including hospital image, physician-patient relationship, management policy, communication and services, physical environment, and care processes are independent variables. Demographic variables including medical identify, gender, age, education, living status, place of residence, chronic disease, and reason to the case hospital are also independent variables. It is worth to note that each category in chronic disease uses 0-1 notations where 0 indicates the patient does not have chronic disease, while 1 shows the patient has that particular chronic disease. Besides, each option in reason to the case hospital uses 0-1 notations, where 1 indicates the patient's reason to the case hospital. Therefore, there are four independent variables in chronic disease and five independent variables in reason to the case hospital. In summary, there are twenty one independent variables in this study.

Three models were generated by linear regression by SPSS 24, and their respective adjusted R-square values are 0.381, 0.401, and 0.420, showing Model 3 is the best model. The results of linear regression with forward selection are presented in Table 2 with $\alpha = 0.05$. From Table 2, Model 3 shows that physical environment, hospital image, and medical identity are three critical variables to influence the willingness to continue the medical treatment in this hospital. Specifically, physical environment has the most positive impact on the medical treatment loyalty with the largest standardized coefficient of 0.494, followed by hospital image with the second largest standardized coefficient of 0.202. That is, the better physical environment or hospital image, the better medical treatment loyalty. In contrast, medical identify has a negative impact on the willingness to continue the medical treatment in this hospital. The result indicates that the patient's companion has a negative influence toward medical treatment loyalty than the patient.

Table 2 Linear Regression Results of Model 3

Model	Demographic Variable	Unstandardized Coefficients	Standardized Coefficients	t	p
1	Physical Environment	0.083	0.619	12.269	< 0.001
2	Physical Environment	0.065	0.482	7.112	< 0.001
	Hospital Image	0.020	0.202	2.985	0.003
3	Physical Environment	0.066	0.494	7.395	< 0.001
	Hospital Image	0.010	0.202	3.037	0.003
	Medical Identity	-0.185	-0.147	-2.998	0.003

5. Conclusion

Due to the rise of the ageing society in Taiwan and the patients aged 65 or more accounting for up to one-third of the total patients, this case hospital is intended to create an age-friendly hospital for elderly patients. In order to create a safe, professional and friendly medical environment, it is essential for hospital management to identify critical factors linking to medical treatment loyalty from elderly patients' viewpoints. The questionnaire based on Yan and Kung [7] with six dimensions, one medical treatment loyalty question, and seven demographic variables is used to survey the patients aged 65 years old or more and their companions in this case hospital. Linear regression with forward selection is applied to identify critical factors to influence the willingness to continue the medical treatment in this hospital. The results show that physical environment is the most essential variable to impact medical

treatment loyalty followed by hospital image. On the contrary, medical identify has a negative impact on medical treatment loyalty. That is, the better physical environment or hospital image, the better medical treatment loyalty. Hospital management needs to relentlessly enhance physical environment and hospital image. In addition, a companion tends to have a negative influence toward medical treatment loyalty than the patient. Hospital management needs to seek medical supports from companions to strengthen medical treatment loyalty.

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On Different Approaches to Cognitive Profile - Based User Interface Adaptation

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Abstract. Cognitive profile-based user interface adaptation allows modifying basic interfaces considering the current user's (operator's) cognitive and psychophysiological characteristics to increase the efficiency of user-system interaction. However, for such an adaptation data should be gathered on the users and means should be developed to manipulate the interface's elements. An optimal level of adaptation has to be found to balance the cost of adaptation and its benefits. This paper considers different approaches and levels of user-system interaction's adaptation.

Keywords. User interface, Cognitive profile, Adaptation, Personalization, Automated testing.

Adaptation of the automated system's user interface (UI) to the features of the cognitive profile of the operators allows to increase the effectiveness of their interaction with the information in the system and reduce the level of information load on the user [2;3]. However, the creation of UI adaptation means and the process of adaptation itself require time and resources. This often complicates the implementation of adaptive approach for the automated systems with high responsibility level, and in some cases makes it impossible. It is necessary to determine the possibility of adapting UI by different levels depending on the requirements of the organizational process and the impact of such adaptation on the effectiveness of the user's interaction with information in the system.

In addition to the personalized adaptation of the UI, it is proposed to implement adaptations taking into account the cognitive type of the user. The cognitive type is the ranges of values of the individual characteristics of the cognitive profile, common to a particular group of users; each cognitive type in terms of the adaptation process is considered a separate cognitive profile with a single recommended UI template. This approach can significantly accelerate the process of adaptation and reduce the cost of it in the case of a significant number of the system's users.

On the basis of cognitive adaptive approach [1;4;5] experimental UI adaptation software was created, with which experiments were conducted to determine the effectiveness of UI adaptation depending on various factors that affect it. The experiments were attended by 100 users of automated systems of various purposes, which were invited to perform tasks, typical for these systems, using a basic UI, a UI, adapted to the user's cognitive type of user and a personalized (individual) UI.

First group of experiments. Comparison of the efficiency of users' interaction with information when working with UI of varying levels of adaptation.

The users have been offered a series of tasks, during which they worked with data from different specialties, fulfilling the task specified for them.

For each task, the means of the system determined the time spent on the task and the number of errors and the indicator value of the efficiency of the user's activity was calculated using the formula

$$E = \sum_i \frac{1}{F^{(i)} k_T T^{(i)}} = \sum_i \frac{1}{k_T T^{(i)}} \cdot \frac{1}{k_l F_l^{(i)} + k_C F_C^{(i)} + k_S F_S^{(i)}}, \quad (1)$$

where $F^{(i)}$ – the number of the user's mistakes in the process of making the *i-th* decision in the current session of work; $F_l^{(i)}$ – mistakes of late response to information from the system; $F_C^{(i)}$ - mistakes of making the wrong choice; $F_S^{(i)}$ – user's mistakes caused by state of information overload and stress; k_l, k_c and k_s – coefficients of weight of corresponding mistakes; $T^{(i)}$ – time taken to make *i-th* decision; k_T - coefficient of time's weight's coefficient.

The efficiency indicator was compared for the cases of a user working with a basic UI, with an UI adapted to the user's cognitive type, and with an interface customized on the basis of an adapted UI, taking into account the feedback from the user. Below in tab. 1 the results of comparison are shown for one of the test subjects.

Experiment I.98. This experiment is as close as possible to the tasks and features of the work process to the real use of automated control system for technological processes in energy units (ACS TP EU), the basic UI is based on a typical interface of such automated systems (Fig. 1).

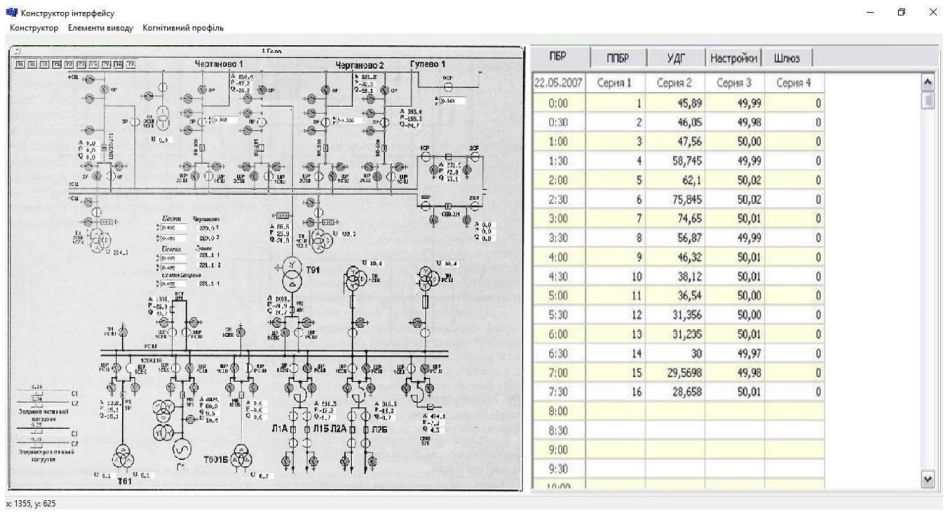

Fig. 1 – Basic UI for experiment I.98

Taking into account the characteristics of the cognitive portrait of the subject 74 (tab. 1) the adapted interface is constructed by adding two text output elements to the basic UI (fig. 2).

Per request of test subject 74 to increase the level of parallelism of the user interface for building a personalized UI additionally one text and one graphic output elements were used (fig. 3) for the presentation of the general scheme of the power station.

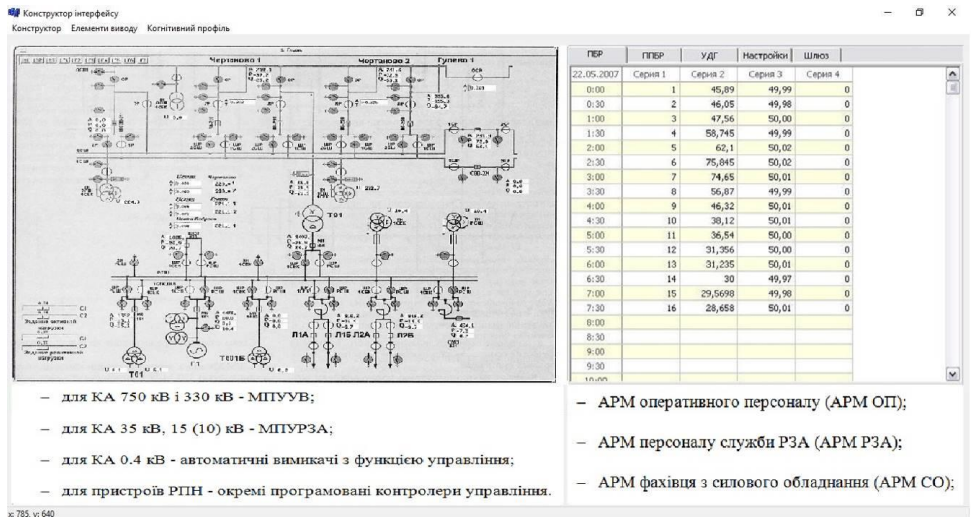

Fig. 2 – Adapted UI for experiment I.98

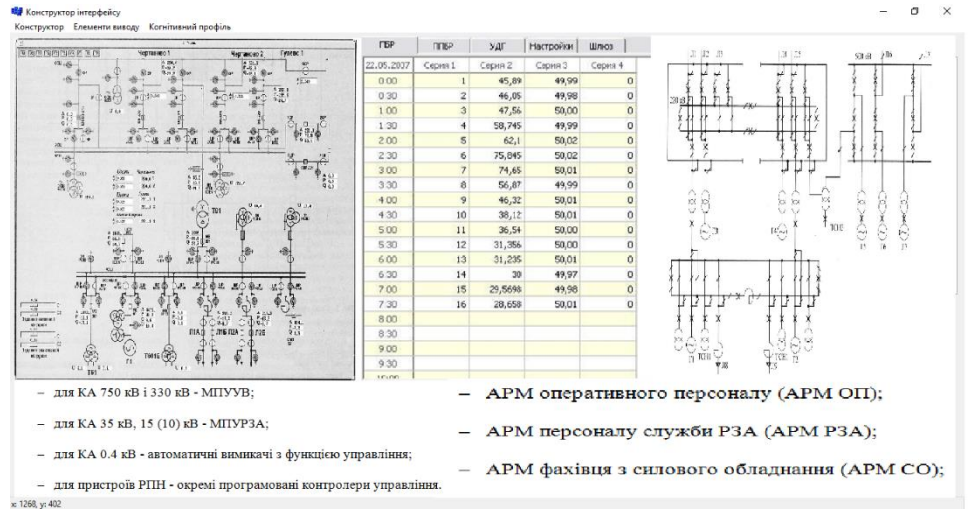

Fig. 3 – Personalized UI for experiment I.98

Table 1 - Experiment I.98. Test subject 74. Specialty – Energy Unit Management. Type of activity – Management

Cognitive characteristics	Field dependence		Reflexivity	Lability	Equivalence range
	0.6		0.7	0.8	0.8
Cognitive type - 14					
Interface	Number of elements			The speed of the task, sec	Number of mistakes	Efficiency indicator
	graphic	textual	tabular			
Basic	1	0	1	620	1	1.84
Adapted	1	2	1	600	0	2.00
Personalized	2	2	1	590	0	2.03

The dynamics of efficiency indicators suggests that the adaptation of the user interface to the characteristics of the user's cognitive profile increases the efficiency of their activities and allows reducing the number of mistakes made in the processing of information.

When using the generalized cognitive type of user instead of its individual cognitive profile for adaptation, the efficiency of data interaction is slightly less than with personalized UI, but this approach to adaptation is suitable for more automated systems, including activities with a high level of the operators' responsibility, because it allows you to limit the number of UI templates and provides better control and coordination of the adaptation process.

Second group of experiments. Comparative analysis of working with the basic and personalized interfaces.

Test subjects were asked to process 20 files from the real control system (COMTRADE-compatibly formatted logs of system events and errors) using the basic UI (Fig. 1), and then – using a personalized UI. For each file processing session, the number of mistakes of different types and the time taken to work with the file was measured. On the basis of measurements, the efficiency indicator was calculated according to formula (1).

Below are the results of experiments for subjects 11, 43 and 74 . Tab. 2 and tab. 3 show the results of experiments of group I for subjects 11 and 43 (for greater clarity of the results of experiments of group II).

Table 2 – Experiment I.14. Test subject 11. Specialty – Psychology. Type of activity – testing

Cognitive characteristics	Field dependence		Reflexivity	Lability		Equivalence range	
	0.3		0.6	0.8		0.5	
Cognitive type - 12							
Interface	Number of elements			The speed of the task, sec		Number of mistakes	Efficiency indicator
	graphic	textual	tabular				
Basic	0	1	0	960		3	1.06
Adapted	0	1	1	880		2	1.23
Personalized	0	2	1	750		2	1.44

Table 3 – Experiment I.54. Test subject 43. Specialty – Methods of optimization. Type of activity – Testing

Cognitive characteristics	Field dependence		Reflexivity	Lability		Equivalence range	
	0.2		0.7	0.8		0.6	
Cognitive type - 4							
Interface	Number of elements			The speed of the task, sec		Number of mistakes	Efficiency indicator
	graphic	textual	tabular				
Basic	0	1	1	1050		3	0.97
Adapted	0	2	2	970		1	1.18
Personalized	0	2	1	900		1	1.27

For subjects 74 personalized UI has been built (experiment I.98, (fig. 3), for subjects 11 and 43 in the construction of personalized UI (fig. 4, fig. 5) their tendency to the text format of data presentation (tab. 2, tab. 3) is considered, but the graphic element of the output was left

in the workspace because of the requirements for the working process of the ACS TP EU operators of the (the presence of a graphic element of the output to display the general scheme of the controlled object in the form of a mnemoscheme)

Fig. 4 – Personalized UI for experiment II.11

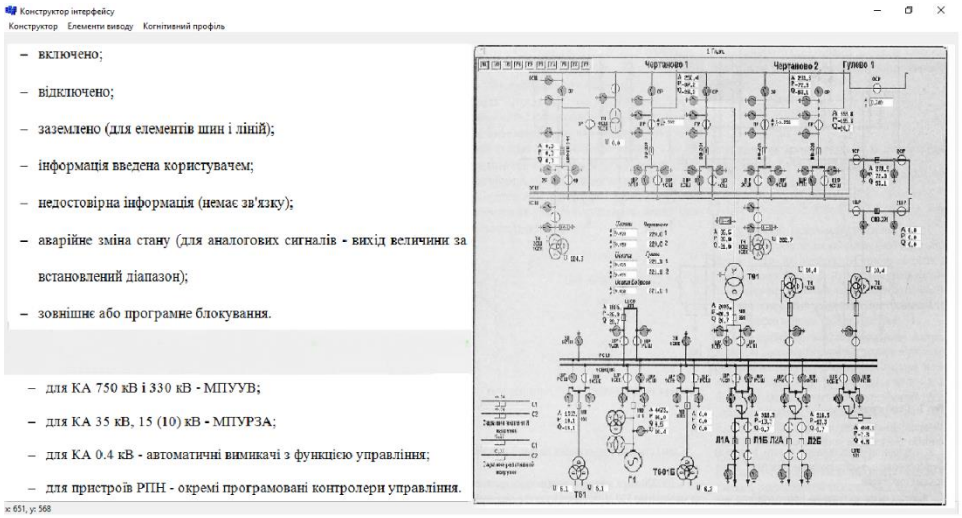

Fig. 5 – Personalized UI for experiment II.43

The excerpt from the experiment results for several of the processing sessions of the COMTRADE-formatted data files is summarized in Table 4. In the last three columns of the table cases of maximum and minimum increase of the efficiency indicator value are highlighted for each test subject.

According to the results of the experiment, the increase rate of efficiency indicator is up to 20% for the subject 74. In the case of subjects 11 and 43, cognitive portraits of which indicate a tendency to work with the text format of data with a low pace, an increase in the efficiency indicator is even greater (up to 30% for the subject 11 and more than 30% for the

subject 43), which indicates the positive effect of the "user-system" interaction's personalization on the effectiveness of such interaction. According to personal impressions of subjects, when working with personalized UIs, they were less nervous and tired.

Table 4 - Measurement results The efficiency indicator in the experiments II.11, II.43, II.74

No.	Basic UI			Personalized UI			Increase in efficiency,%		
	Sub.11	Sub.43	Sub.74	Sub.11	Sub.43	Sub.74	Sub.11	Sub.43	Sub.74
1	1.02	0.87	1.73	1.25	1.15	1.95	22.5	32.2	12.7
5	1.05	0.92	1.89	1.15	1.12	2.02	**9.5**	21.7	**6.9**
6	0.96	0.99	1.58	1.13	1.29	1.76	17.7	30.3	11.4
8	1.20	1.12	1.35	1.35	1.40	1.59	12.5	25.0	17.8
11	0.98	0.91	1.55	1.19	1.09	1.75	21.4	**19.8**	12.9
12	1.13	1.02	1.68	1.28	1.35	2.01	13.3	32.4	**19.6**
13	1.18	1.05	1.85	1.42	1.28	2.15	16.8	21.9	16.2
17	0.93	0.90	1.82	1.20	1.19	2,10	29.0	32.2	15.4
19	0.91	0.88	1.64	1.03	1.14	1.93	10.8	29.5	17.7
20	0.99	0.93	1.52	1.26	1.26	1.81	**27.3**	**35.5**	19.1

Significant differences in the magnitude of the increase of the efficiency indicator for various information processing sessions using a personalized interface can be explained by the additional features of data files, the complexity of data, the amount of information that in this case is not sufficiently taken into account when constructing a personalized adapted UI.

But despite this, the overall dynamics of the growth rate of efficiency suggest that the adaptation of the user interaction with the information in the system is appropriate both for constructing a personalized UI and for an adapted UI, when taking into account the individual characteristics of each user is impractical or impossible (for example, in high-level responsibility management systems).

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Muticriteria Balance Layout Problem of 3D-Objects

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Abstract. The paper studies the optimal layout problem of 3D-objects. The problem takes into account placement constraints (non-overlapping, containment, distance constraints), as well as, behaviour characteristics of the mechanical system (equilibrium, moments of inertia and stability characteristics). We construct a mathematical model of the problem in the form of a multicriteria optimisation problem and call the problem the Multicriteria Balance Layout Problem (MBLP). We also consider several realisations of MBLP problem that depend on forms of objective functions and combinations of behaviour constraints.

Keywords. Layout problem, Behaviour Constraints, Placement Constraints, Mathematical Model, Multicriteria Optimisation

1. Introduction

3D layout optimisation problems have a wide spectrum of practical applications. In particular, these problems arise in space engineering for rocketry design. Their distinctive feature consists of taking into account behaviour constraints of a satellite system. Behaviour constraints specify the requirements for system's mechanical properties such as equilibrium, inertia, and stability. Many publications analyze problems of the equipment layout in modules of spacecraft or satellites (see, e.g. [1, 2]). These problems are NP-hard.

In the research we consider the balance layout problem in the following statement: arrange 3D-objects in a container taking into account special placement and behaviour constraints so that the objective function attains its extreme value (see, e.g. [3]).

We consider here an extension of the balance layout of 3D-objects considered in [3]. The paper studies 3D optimisation balance layout problem taking into account minimal and maximal allowable distances. Classes of adjusted phi-functions and adjusted quasi-phi-functions are derived for analytical description of non-overlapping, containment and distance constraints. A circular cylinder, a paraboloid, or a truncated cone are taken as a container. We consider cylinders, spheres, tores, spherecylinders and straight convex prisms as the placement objects. An exact mathematical model of the problem in the form of NLP problem is provided.

The aim of this study is to develop a mathematical model of 3D layout optimisation problem taking into account behavior constraints in the form of multicriteria optimisation problem. We call the problem the Multicriteria Balance Layout Problem (MBLP).

To describe placement constraints (non-overlapping of objects, containment of objects in a container with regard for the minimal and maximal allowable distances) analytically we employ phi-function technique [4]. We also formalise behaviour constraints (equilibrium, moments of inertia, and stability constraints) based on [3].

The variety of forms of objective functions and combinations of placement and behaviour constraints generates various variants of the MBLP problem.

2. Problem Formulation

MBLP: Pack 3D-objects $A_i \in A$, $i \in I_n = \{1, 2, ..., n\}$, inside container Ω, so that the vector function attains its extreme value with regard for placement and behaviour constraints.

The placement constraints in the MBLP problem are generated by non-overlapping of objects A_i, A_j, $i > j \in I_n$, which have to be placed inside container Ω, and containment of object A_i in container Ω, $i \in I_n$. In addition, the minimal ρ_{ij}^- and maximal $\rho_{ij}^+ \geq \rho_{ij}^-$ allowable distances between objects A_i, A_j, $i > j \in I_n$, may be specified. Also, the minimal allowable distance ρ_i^- between object $A_i \in A$, $i \in I_n$, and the lateral surface of container Ω may be given. Without loss of generality we set $\rho_{ij}^- = 0$ (or $\rho_{ij}^+ = \varpi$) if a minimal (or a maximal) allowable distance between objects A_i and A_j is not given, $i > j \in I_n$. Here ϖ is a given sufficiently great number. In particular, the condition $\rho_{ij}^+ = \rho_{ij}^-$ provides the arrangment of objects A_i and A_j on the exact distance. We also set $\rho_i^- = 0$ if a minimal allowable distance between object A_i and the lateral surface of container Ω is not given.

Placement constraints in the MBLP problem may be presented as the following:

$$\rho_{ij}^- \leq \mathrm{dist}(A_i, A_j) \leq \rho_{ij}^+, \; i > j \in I_n,$$

and

$$\mathrm{dist}(A_i, \Omega^*) \geq \rho_i^-, \; i = 1, ..., n,$$

where $\Omega^* = R^3 \setminus \mathrm{int}\,\Omega$.

To describe the placement constraints analytically we employ the phi-function technique (see, e.g., [4,5]).

Let us consider the constraints of mechanical characteristics of system Ω_A.

The equilibrium constaints are defined by the following system of inequalities:

$$\mu_{11}(u) = \min\{-(x_s(u) - x_e) + \Delta x_e, (x_s(u) - x_e) + \Delta x_e\} \geq 0,$$

$$\mu_{12}(u) = \min\{-(y_s(u) - y_e) + \Delta y_e, (y_s(u) - y_e) + \Delta y_e\} \geq 0,$$

$$\mu_{13}(u) = \min\{-(z_s(u) - z_e) + \Delta z_e, (z_s(u) - z_e) + \Delta z_e\} \geq 0,$$

where (x_e, y_e, z_e) is the expected position of O_s, $(\Delta x_e, \Delta y_e, \Delta z_e)$ are admissible deviations from the point (x_e, y_e, z_e).

The constraints of moments of inertia are defined as the following:

$$\mu_{21}(u) = -J_X(u) + \Delta J_X \geq 0,$$

$$\mu_{22}(u) = -J_Y(u) + \Delta J_Y \geq 0,$$

$$\mu_{23}(u) = -J_Z(u) + \Delta J_Z \geq 0,$$

where $J_X(u), J_Y(u), J_Z(u)$ are the moments of inertia of the system Ω_A with respect to the axes of coordinate system O_sXYZ, $\Delta J_X, \Delta J_Y, \Delta J_Z$ are admissible values for $J_X(u), J_Y(u), J_Z(u)$, where

$$J_X(u) = J_{x_0} + \sum_{i=1}^{n}(J_{x_i}\cos^2\theta_i + J_{y_i}\sin^2\theta_i) + \sum_{i=1}^{n}(y_i^2 + z_i^2)m_i - M(y_s^2 + z_s^2),$$

$$J_Y(u) = J_{y_0} + \sum_{i=1}^{n}(J_{x_i}\sin^2\theta_i + J_{y_i}\cos^2\theta_i) + \sum_{i=1}^{n}(x_i^2 + z_i^2)m_i - M(x_s^2 + z_s^2),$$

$$J_Z(u) = \sum_{i=0}^{n} J_{z_i} + \sum_{i=1}^{n}(y_i^2 + z_i^2)m_i - M(x_s^2 + y_s^2),$$

$J_{x_0}, J_{y_0}, J_{z_0}$ are the moments of inertia of container Ω with respect to the axes of the coordinate system $Oxyz$, $J_{x_i}, J_{y_i}, J_{z_i}$, $i \in I_n$, are the moments of inertia of object A_i with respect to the axes of coordinate system $O_i x_i y_i z_i$ (see Appendix B).

The stability constraints are defined by the following system of inequalities:

$$\mu_{31}(u) = \min\{-J_{XY}(u) + \Delta J_{XY}, J_{XY}(u) + \Delta J_{XY}\} \geq 0,$$

$$\mu_{32}(u) = \min\{-J_{YZ}(u) + \Delta J_{YZ}, J_{YZ}(u) + \Delta J_{YZ}\} \geq 0,$$

$$\mu_{33}(u) = \min\{-J_{XZ}(u) + \Delta J_{XZ}, J_{XZ}(u) + \Delta J_{XZ}\} \geq 0,$$

where $J_{XY}(u), J_{YZ}(u), J_{XZ}(u)$ are the products of inertia of system Ω_A with respect to the axes of the coordinate system O_sXYZ, $\Delta J_{XY}, \Delta J_{YZ}, \Delta J_{XZ}$ are admissible values for $J_{XY}(u), J_{YZ}(u), J_{XZ}(u)$, respectively,

$$J_{XY}(u) = \frac{1}{2}\sum_{i=1}^{n}(J_{x_i} - J_{y_i})\sin 2\theta_i + \sum_{i=1}^{n} x_i y_i m_i - M x_s y_s,$$

$$J_{YZ}(u) = \sum_{i=1}^{n} y_i z_i m_i - M y_s z_s,\ J_{XZ}(u) = \sum_{i=1}^{n} x_i z_i m_i - M x_s z_s.$$

Behaviour constraints of the BLP problem we define as the system of inequalities

$$\mu_1(u) \geq 0, \mu_2(u) \geq 0, \mu_3(u) \geq 0,$$

where

$$\mu_1(u) = \min\{\mu_{11}(u), \mu_{12}(u), \mu_{13}(u)\}, \quad (1)$$

$$\mu_2(u) = \min\{\mu_{21}(u), \mu_{22}(u), \mu_{23}(u)\}, \quad (2)$$

$$\mu_3(u) = \min\{\mu_{31}(u), \mu_{32}(u), \mu_{33}(u)\}. \quad (3)$$

Here $O_s = (x_s, y_s, z_s)$ is the center of mass of system Ω_A, where

$$x_s(u) = \frac{1}{M}\sum_{i=1}^{n} m_i x_i,\ y_s(u) = \frac{1}{M}\sum_{i=1}^{n} m_i y_i,\ z_s(u) = \frac{1}{M}\sum_{i=1}^{n} m_i z_i,$$

$M = \sum_{i=0}^{n} m_i$ is the mass of system Ω_A.

3. A Mathematical Model

A mathematical model of the MBLP problem can be presented in the form

$$extrF(p,u) \text{ s.t. } (u,p) \in W \tag{4}$$

$$W = \{(u,p) \in R^{\xi} : \Upsilon(u,p) \geq 0, \mu(u,p) \geq 0, \zeta \geq 0\}, \tag{5}$$

where $F(p,u) = (F_1(p,u), F_2(p,u), \ldots, F_k(p,u))$,

$\Upsilon(u,p)$ describes placement constraints, $\Upsilon(u,p) = \min\{\Upsilon_1(u), \Upsilon_2(u,p)\}$,

$\Upsilon_1(u)$ is responsible for non-overlapping constraints,

$\Upsilon_2(u,p)$ is responsible for containment constraints,

$\mu(u) = \min\{\mu_s(u), s \in U_t\}$ is responsible for behavior constraints, $U_t \in P(U)$, $P(U)$ is the power set of $U = \{1,2,3\}$, functions $\mu_1(u), \mu_2(u), \mu_3(u)$ are given by (1)-(3), $\zeta \geq 0$ is the system of additional constraints of metric characteristics of container Ω and placement parameters of objects. If $s = \varnothing$, i.e. behaviour constraints are not involved in (5), then our objective function $F(u)$ meets mechanical characteristics of system Ω_A.

Depending on the different combinations of objective functions $F_1(p,u), F_2(p,u), \ldots, F_k(p,u)$ different variants of mathematical model (4)-(5) can be generated. The most frequently occurring objective functions found in related publications are the following: 1) size of container Ω; 2) deviation of the center of mass of system Ω_A from a given point; 3) moments of inertia of system Ω_A (see, e.g., [3,6-11]).

Let us consider some of realisations of model (4) - (5):

- $F(p,u) = p$ s.t. $(p,u) \in W \subset R^{\xi}$,

  $W = \{(p,u) \in R^{\xi} : \Upsilon_1(u) \geq 0, \Upsilon_2(p,u) \geq 0, \mu(p,u) \geq 0, \zeta \geq 0\}$;

- $F(u) = d$, $(p,u) \in W \subset R^{\xi}$,

  $d = (x_s(u) - x_e)^2 + (y_s(u) - y_e)^2 + (z_s(u) - z_e)^2$,

  $W = \{(p,u) \in R^{\xi} : \Upsilon_1(u) \geq 0, \Upsilon_2(p,u) \geq 0, \mu_2(p,u) \geq 0, \mu_3(p,u) \geq 0, \zeta \geq 0\}$;

- $F(p,u) = (F_1(p,u) = p, F_2(p,u) = d)$, $(p,u) \in W \subset R^{\xi}$,

  $W = \{(p,u) \in R^{\xi} : \Upsilon_1(u) \geq 0, \Upsilon_2(p,u) \geq 0, \mu_2(p,u) \geq 0, \mu_3(p,u) \geq 0, \zeta \geq 0\}$;

- $F(p,u) = (F_1(p,u) = J_X(p,u), F_2(p,u) = J_Y(p,u), F_3(p,u) = J_Z(p,u))$

$$(p,u) \in W \subset R^{\xi},$$

$$W = \{(p,u) \in \square^{\xi} : \Upsilon_1(u) \geq 0, \Upsilon_2(p,u) \geq 0, \mu_1(p,u) \geq 0, \mu_3(p,u) \geq 0, \zeta \geq 0\}.$$

4. Conclusion

In this paper we formulate the optimisation layout problem of 3D-objects into a container taking into account placement (non-overlapping, containment, distance) and behaviour (equilibrium, inertia and stability) constraints. We call the problem as Multicriteria Balance Layout Problem (MBLP). In order to describe placement constraints analytically we employ phi-function technique. A mathematical model of the problem in the form of multicriteria optimisation problem is proposed. We also consider some variants of the MBLP problem depending on the forms of the objective functions, shapes of objects and containers, combinations of placement and behaviour constraints.

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Train Arrangement in Scheduling for Rail-rail Transshipment Yard

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Abstract. Article considers problem of scheduling freight trains in rail-rail transshipment yards. Besides scheduling the service slots of trains, article additionally solves the problem of train arrangement, i.e. assigning each train to a railway track. Mathematical model and solving method for described problem are given. The key feature of given mathematical model is that is uses combinatorial objects (tuples of permutations) instead of traditional Boolean variables. Solution method is based on generation of combinatorial sets as well, which is quite unusual approach comparing with existing solution methods for described problem.

Keywords. Train scheduling, Transshipment yard, Freight transportation, Train arrangement, Combinatorial set, Beam search, Combinatorial generation.

1. Introduction

Intermodal transportation [1] as well as train routing and scheduling [2] are important areas of operations' research nowadays. Particularly, a problem of Container Processing in Railway Yards has got lots of attention recently. A survey [3] describes the problem setting and its various extensions pretty well.

One of the main issues of the Container Processing in Railway Yards area is a problem of scheduling freight trains in rail-rail transshipment yards (TYSP) [4]. The original paper [4] describes five levels of depth for the overall train scheduling problem:

(i) to bundle each train to a service slot, i.e. to schedule trains;
(ii) to assign each train of a bundle to a railway track;
(iii) to make a decision on positions of trains' containers;
(iv) to assign container moves to portal cranes;
(v) to determine a sequence of moving containers for every gantry crane [4].

The article [4] solves the level (i) of the problem (scheduling the service slots for trains). The article provides a mathematical model and two solution algorithms: an exact algorithm that uses dynamic programming and a heuristic algorithm that utilizes a beam search procedure. A complexity proof for given algorithms is also described there.

Later works bring further improvements to the initial mathematical model and improve solution algorithms. In [5], the original TYSP is extended by new real-world restrictions and a lot of new solution algorithms are given. In [6-9], a branch-and-bound algorithm (developed for the first time in [5]) is improved with a more effective Lagrangian lower bound.

However, [4] and all later works solve only the level (i) of TYSP (scheduling the service slots for trains).

In this article, a deeper problem of assigning every train to a railway track is considered. A mathematical model and a solving method for this problem are given here.

A distinctive feature of the given mathematical model is that Boolean variables are not used and the model mostly works with combinatorial objects (tuples of permutations). The proposed solution method is based on generation of combinatorial sets.

A problem of assigning trains to railway tracks in every service slot is considered. It could be an important task because a total cost of loading/unloading operations in real systems can depend on a distance between a source train and a target train. If a target train and a source one are served within the same time slot, it seems appropriate to place them on the closest railway tracks. If trains are served in different time slots, it is also important to place both trains in such a way that movements of the gantry crane are made as short as possible. In this case, the crane should firstly move containers from the source train to a storage area and then from a storage area to the target train. Thus, both trains should be as close to the storage area as possible.

The remainder of this paper is organized as follows. Section 2 describes a mathematical model of the proposed approach. Section 3 gives details to a solution algorithm. Section 4 presents computational results. Conclusions are given in the final section.

2. Mathematical model

A mathematical model is a further extension of the one proposed in [4] as it describes a more detailed problem: the problem of assigning every train to a railway track (the level 2 according to [4]). Our model describes the problem using combinatorial structures instead of Boolean variables.

We should dwell on the problem [4] once again. There are G tracks and a given set I of trains, where each train has a predefined number of wagons and a certain load factor, defining a number of containers carried by this train. Each train is then assigned to a service slot $t = 1,\ldots,T$ of G simultaneously served trains. This assignment is restricted to the earliest available slot e_i of a train i (the earliest arrival time) and the latest available slot l_i (the latest departure time). The transshipment yard typically deals with distinct bundles of trains (also known as *service slots*). It means that G trains (one per a track) are simultaneously served and jointly leave the system after all container moves required for that bundle of trains have been accomplished. Then another bundle of G trains enters the yard [4]. Every iteration is a service slot.

Thus, some special situations are also considered in [4]:

(1) revisits, i.e. situations, when a train to have already been unloaded has to enter the transshipment yard again to be loaded with items to have been delivered after the first train's visit;

(2) split moves when a train i that carries a container dedicated to a train j and is served in a service slot t before a service slot t' of the train j.

A core decision of the transshipment yard scheduling problem (TYSP) involves assigning every train i of the given train set I to a service slot $t = 1,..., T$ [4]. In addition to [4], this article solves the problem of assigning every train to one of the tracks at each slot**.** At most G trains can be assigned to each slot t because G is a number of parallel railway tracks of the transshipment yard [4].

Let us construct the mathematical model of the problem in terms of combinatorial optimization.

Let's describe each time slot t using a tuple K^t containing an amount of all trains assigned to the slot t; we consider assigning every train to a certain railway track, their order

is important, so $K^t = (k_1^t, k_2^t, ..., k_g^t, ..., k_G^t)$. Here $k_g^t \in I$ denotes an amount of trains assigned to the time slot *t* and located on a railway track $g \in G$.

It's worth noting that while forming a time slot, we are choosing *G* trains from $|I|$ possible ones, so that we are choosing K^t from a set of permutations $P_{|I|}^G$ (permutations of $|I|$ elements are taken from *G* at one time). So, choosing an optimal time slot K^t can be treated as the combinatorial optimization problem of choosing the optimal permutation from the set $K^t \in P_{|I|}^G$.

In this way, decision variables are time slots $K^t, t = 1, 2, ..., T$ to have been formed by the trains.

A decision result should meet three points:

1. A number of trains' revisits.
2. A cost of split moves for containers (which depends on assignment of trains to railway tracks) is to be minimized.
3. A cost of moves for containers between trains at the same time slot (which also depends on assignment of trains to railway tracks) is to be minimized.

The objective #1 is the same one as in [4]; the objective #2 is a more general case for the one described in [4] where an only number of split moves is considered; the objective #3 is a new one compared to [4] because trains' assignment to railway tracks is taken into account.

As described in [4], we have the multi-objective optimization problem (the objectives #1 and #2 exist here, but the objective #3 is new) and use linear scalarization to formulate the problem as the single-objective optimization one. Let's describe an objective function and constraints.

$$\alpha_1 \sum_{i \in I} y_i + \alpha_2 \sum_{t=1}^{T} \sum_{t'=t+1}^{T} \sum_{p=1}^{G} \sum_{q=1}^{G} z_{tt'} A_{k_p^t k_q^{t'}} C_{pq}^* + \\ + \alpha_3 \sum_{t=1}^{T} \sum_{p=1}^{G} \sum_{q=1}^{G} A_{k_p^t k_q^t} C_{pq} \to \min \quad (1)$$

$$z_{tt'} = \begin{cases} 1, if\ t < t' \\ 0, if\ t = t' \end{cases},$$

$$k_g^t \in I \quad \forall t = 1, 2, ..., T, \forall g = 1, 2, ..., G, \quad (2)$$

$$e_{k_g^t} \le t \le l_{k_g^t} \quad \forall t = 1, 2, ..., T, \forall g = 1, 2, ..., G, \quad (3)$$

$$k_p^t, k_q^{t'} : t \le t' + y_{k_q^{t'}} \cdot M, \quad (4)$$

$$y_i \in \{0, 1\} \quad \forall i \in I \quad (5)$$

where $I = \{1, 2, \ldots, N\}$ is a set of the trains (indices *i* and *j*) [4];

L_i is a set of the trains carrying containers dedicated to the train *i* [4];

T is a number of the time slots for trains' (un-)loading (an index *t*) [4];

G is a number of parallel tracks within the transshipment yard (an index *g*) [4];

$A = [A_{ij}]$, $i,j = 1, 2, \ldots, N$ is a number of containers the train *i* receives from the train *j* [4];

e_i is the earliest time slot the train *i* may be assigned to [4];

l_i is the latest time slot the train *i* may be assigned to [4];

M stands for a Big integer value (e.g., $M = T - 1$) [4];

$\alpha_1, \alpha_2, \alpha_3$ are given weights for the objectives #1-#3, $\alpha_1, \alpha_2, \alpha_3 \geq 0$;

y_i denotes a binary variable: 1, if the train *i* has to revisit the yard; 0, otherwise [4];

$K^t = (k_1^t, k_2^t ..., k_G^t) \in P_{|I|}^G$ is the time slot *t* formed by *G* trains assigned to the railway track;

C_{pq} determines a cost of picking a container from the source train on a track *p* and dropping it to the target train on a track *q*, if the trains are served within the *same time slot*;

C_{pq}^* is a cost of picking a container from the source train on a track *p* and dropping it to the target train on a track *q*, if the trains are served at *different time slots* (a cost of the split move).

Costs C_{pq} and C_{pq}^* are *predefined* values that can be calculated once (during an initialization procedure).

$$C_{pq} = c_{pq} \tag{6}$$

$$C_{pq}^* = c_{p0} + c_{0q} \tag{7}$$

Here c_{pq} is a constant cost of moving a container from the track *p* to the track *q*.

The storage area is denoted by a fictitious track 0. If the container is moved directly, the movement cost C_{pq} is just a cost of the direct container move c_{pq}. But if the trains are served at different time slots, then, first of all, a container should be moved from the source train to the storage area (c_{p0}) and later from the storage area to the target train (c_{0q}), so that $C_{pq}^* = c_{p0} + c_{0q}$.

All constants c_{pq} depend on the specific transshipment yard. In the simplest case, if the cost depends only on a distance between railway tracks, and neighboring tracks are located approximately at the same distance, c_{pq} can be calculated as $|p - q|$. The condition (3) ensures that each train is served within the acceptable time slot [e_i; l_i].

Similar to the condition (4) in [4], our condition (4) ensures that the source train k_p^t arrives before the target train $k_q^{t'}$ (but if the target train revisits, then the condition is always satisfied due to a right summand).

3. Solution algorithm

We use the *beam search procedure* from [4] with an only distinction that we arrange the trains while forming every slot in order to minimize a sum of the move costs:

- between the trains within the current slot (a *direct move cost*);
- from the trains at the current slot to the staging area (if the trains have containers for other trains that are not at the current slot) – a *split move begin cost*;
- from the staging area to the trains at the current slot (if the staging area has containers for the trains at the current slot) – a *split move end cost*.

For now, minimization of the move costs is achieved by a simple exhaustive search over all permutations of the trains.

Let us briefly recall main steps of the algorithm [4]:

1. At the first step, t=0 and we have no schedules yet. It means that we have an empty node in an acyclic graph [4]. Let us call it a parent node.
2. Increase t and generate a set of possible time slots $K^t = (k_1^t, k_2^t ..., k_G^t) \in P_{|I|}^G$.
3. Calculate a value of (1) for each generated slot and select the best BW (a beam width and a predefined parameter) in terms of (1).
4. For each BW selected slot, build a new node in the acyclic graph [4] which is located under the parent node and recursively call the step 2 with setting this node as the parent one.

4. Computational experiments

We implemented the solution algorithm in Python 2.7. A developed application is available online at http://tsy-litvinenkoapps.rhcloud.com/.

Computational experiments were carried out to show how train arrangement impacts a solution quality and time. We generated a bunch of test instances. Every instance is a combination of following input parameters:

- 9 options of a train count N=6,7, … ,14;
- 4 options of a track count G=2,3,4,5;
- 4 options of a track-track move cost:

$$c_{pq} = cost\_coef * |p - q| \text{ , } cost\_coef = 1,10,50,100;$$

- 5 various numbers of the target trains for each train: when each train carries containers for 1,2,3,4,5 other trains; in other words, a various sparseness of a matrix A: $\sum_{i=1}^{N} A_{ij} = 1,2,3,4,5, \quad j = 1,2...N$. Let us denote this parameter as *cargos_per_train*.

Objective weights were taken equal for all instances $\alpha_1 = \alpha_2 = \alpha_3 = 1$.

We solved each of 9*4*4*5=720 instances twice: without train arrangement (solving only the level 1 issue described in [4]) and with train arrangement (solving also the level 2). For every instance, we calculated a relative time increase and a relative cost decrease of the solution with arrangements compared to the solution without arrangements:

$$cost\_decrease = (c_1 - c_2)/c_2,$$
$$time\_increase = (t_2 - t_1)/t_1$$

where c_1 and c_2 determine values of the expression (1) for the solutions with and without arrangements; t_1 and t_2 define the solution time for the solutions with and without arrangements respectively.

One can find a full set of the solution data at https://goo.gl/D36bf7.

We have analyzed in what way each described input parameter may impact both the time increase and the cost decrease. Results are depicted in Figs. 2-5. Y-axis in all diagrams contains logarithms of *cost_decrease* and *time_increase* ($y=lg$ *cost_decrease*, $y=lg$ *time_increase*), while X-axis contains values of a specific input parameter.

The diagrams show that G and *cargos_per_train* directly impact both the cost decrease and the time increase while n generally impacts the time increase and *cost_coef* does not seem to impact either the time increase or the cost decrease.

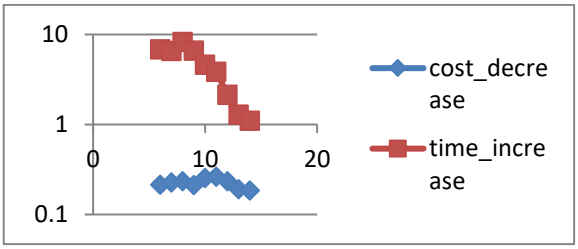

Fig. 2. *cost_decrease* and *time_increase* (y axis) for various *N* (x axis)

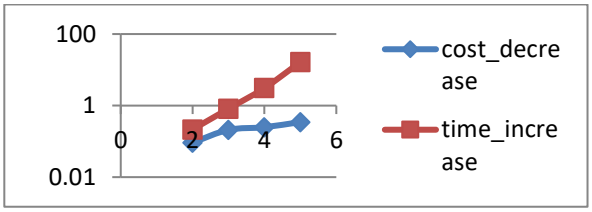

Fig. 3. *cost_decrease* and *time_increase* (y axis) for various *G* (x axis)

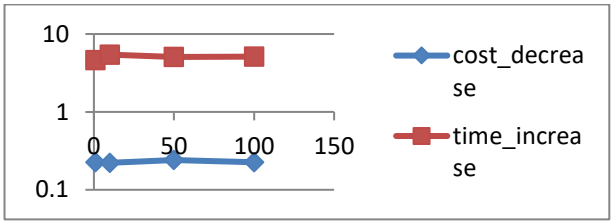

Fig. 4. *cost_decrease* and *time_increase* (y axis) for various *cost_coef* (x axis)

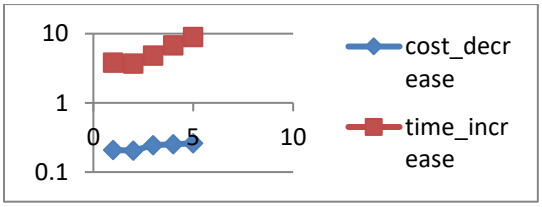

Fig. 5. *cost_decrease* and *time_increase* (y axis) for various *cargos_per_train* (x axis)

5. Conclusion

This article solves the second level of the transshipment yard scheduling problem, which includes assignment of the trains to the certain tracks. The mathematical model and the solving method have been given for the described problem. The article also describes TYSP in terms of the combinatorial optimization instead of using Boolean variables. In computational experiments, we figured out that the solving problem for the second level allows decreasing the total schedule cost. However, more computational time is required to arrange the trains to the tracks. The algorithm of the train arrangement could be improved in order to decrease computational time.

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Analysis of Organized Criminal Groups in Shadow Information Economics

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Abstract. The paper analyzes current approaches to identifying the structure of cybercriminal organizations and their comparison to the "traditional" ones. Command structure is thoroughly analyzed and compared to traditional criminal hierarchy. The paper also traces some similarities between traditional crime and its cyber counterpart. Further research directions are suggested.

Keywords. Information security, Cybercrime, Shadow information economics, Underground economics.

1. Introduction

A set of complex research aimed at outlining the most distinct features and characteristics of the interactions between separate criminal groups and individuals in order to be able to conduct an efficient struggle against shadow information economics (SIE). Unfortunately, research existing to date is focused on comparing activity and structure of "traditional" organized crime groups and attempts linking them to SIE goods and services.

The most prominent among them are the ones that make a comparison to the actions of Italian criminal syndicate "Cosa Nostra", Japanese "Yakuza", Russian mafia, etc. We can agree that "traditional" organized crime syndicates do employ information and communication technologies in their daily activity not only as a means of communication, but as a means of profiting and money laundering as well. The latter was prominent even before cryptocurrencies were introduced, but now it grew even to a larger extent.

Confrontation in the boundaries of criminal economics and law enforcement in the domain of information and communication technologies began with a change of paradigm, when the actions of individuals were aimed at gaining profits by means of developing specialized malicious software, etc. Emergence of malicious software at the early stages of development led to development of a market for computer viruses, worms, Trojan programs, fraudware, etc.

While the scientific base of research has expanded, more complex mechanisms of influencing criminally aligned information systems emerged (e.g. the concept of GRID systems evolved into botnets). A gradual knowledge transfusion from information and computing services into the criminal domain occurred. Some of the impact over this process was exerted by specialized government structures that developed certain mechanisms of influence in the conditions of confrontation between countries (e.g. Stuxnet, DuQu, Flame).

These actions were sometimes masked as being directed towards struggle against cyber-terrorism.

2. The link between "classical" crime and SIE

In order to trace a link between "classical" crime and SIE, one would have to analyze a set of complex of estimative criteria, including the form, typology, and many others.

The following forms are used:

• First form – organized groups acting on a certain territory. They perform "regular" crimes, and their authoritative leaders may or may not have previous criminal records.

• Second form – organized groups based on a certain territory and performing economic crimes along with "regular" ones.

• Third form – organized groups that have international connections.

• Fourth form – organized groups of entrepreneurs that perform illegal economic activity, and launder money via private organizations and banking systems.

The following typology of traditional criminal groups exists:

• Simple organized group;

• Structured (complex) organized group;

• Organized criminal group;

• Criminal organization (community);

• Criminal syndicate, mafia.

Each of the abovementioned typologies are defined below.

Simple organized group – a relatively primitive form of association into groups of around 2 to 4 people. They tend to have a common long-term criminal goal. Even though these groups are organized, stable, united, and their actions bear a premeditated, planned character; they do not have a complex structure, subordination, and no clear leader. The methods of criminal activity are usually similar, well thought out, and worked out. Decisions are made collectively and crimes are performed together. This group of criminals usually include burglars, scammers, apartment thieves, and street robbers, minors. This kind of groups tend to function no longer than 3 years due to change of members.

Structured (complex) organized group – compared to the previous group, this one is much more resistant, hierarchical, and tends to have a clear leader. This kind of groups tends to have 5 to 10 or even more members. Criminal activity tends to bear a regular character, more often than not, including property, mercenary, and violent crime.

Organized criminal group – multi-member criminal formation, encompassing tens or even hundreds of people actively partaking in criminal activity.

Criminal organization – a form of criminal activity that presumes formation of an armed group aiming to assault governmental structures, public and private companies, and individuals. The difference compared to the previous form is presence of arms and heavily criminal direction, including but not limited to open assault. Criminal organizations bear increased threat level.

Criminal syndicate – stable, complex, hierarchical criminal formation. Criminal syndicates tend to bear the following five defining characteristics:

1. Presence of a material base – common monetary funds used to mutual aid and bribing officials.

2. Collegial form of leadership, when the management is performed by a circle of people having equal standing.

3. A codex of informal behavior norms, laws, traditions, and sanctions for misconduct.

4. Functional-hierarchic system – division of the organization to composite groups, presuming interregional connections and communication, clear separation of duties between the members (leading core, bodyguards, bank holders, communicators, controllers, etc.).

5. Information base – intelligence and counter-intelligence, data gathering.

3. Types of criminal syndicates

Criminal syndicates are widely spread in the world, the most recognized among them being Camorra and La Cosa Nostra (LCN) in Italia, Yakuza in Japan, Triads in Hong-Kong, Medellin Cartel in Columbia. Most of them deal in drugs, and have some influence over civil processes.

LCN is considered one of the most influential criminal syndicates in the world. The term is used by FBI in relation to traditional American mafia, including 25 ethnical Italian criminal groups active in the US.

The laws of LCN:

1. Interests of the organization are above those of family, children, country, or religion;
2. The orders from superiors are to be carried out without question, including murder;
3. Never provide any information or help to law enforcement;
4. Pay the fees to the boss regardless of their intent;
5. Never disclose any information about the organization to outsiders;
6. Respect all members of the syndicate, regardless of personal feelings, always pay your debts and the debts of other members of the group;
7. Refrain from any relationships with wives, sisters, or daughters of other members, with the exception of honorable intentions.

The structure of LCN represents a pyramid, including the following layers:

1. Associates – individuals whoa are not the members of LCN, but whose actions depend on LCN;
2. Soldiers – soldier, rookie, a person promoted from being an associate by proving themselves;
3. Groups of soldiers (decina) – despite the name, may include anywhere from five to thirty soldiers;
4. Capodecina – a commander of a group of soldiers;
5. Underboss – second in command of the syndicate;
6. Adviser (consigliere) – typically an elderly member of the syndicate, advising the Boss and sometimes being an intermediary;
7. Boss – the leader of LCN.

An example of organization and structure is represented on Figure. 1.

In authors' opinion, existing attempts at uniting "traditional" crime and SIE are far from perfect and require further research. It is important to trace the differences between "classical" crime and cybercrime in order to achieve that. Main differences are represented on Fig.2. The comparison between "classical" crime and cybercrime demonstrates that the same type of crime remains, but it is performed on a totally different level using information technologies, granting a wider coverage and greater efficiency.

Another example of this type of research is a paper by Kaspersky Lab, which is related to organized financial cybercriminal groups, and the result is presented on Fig. 3.

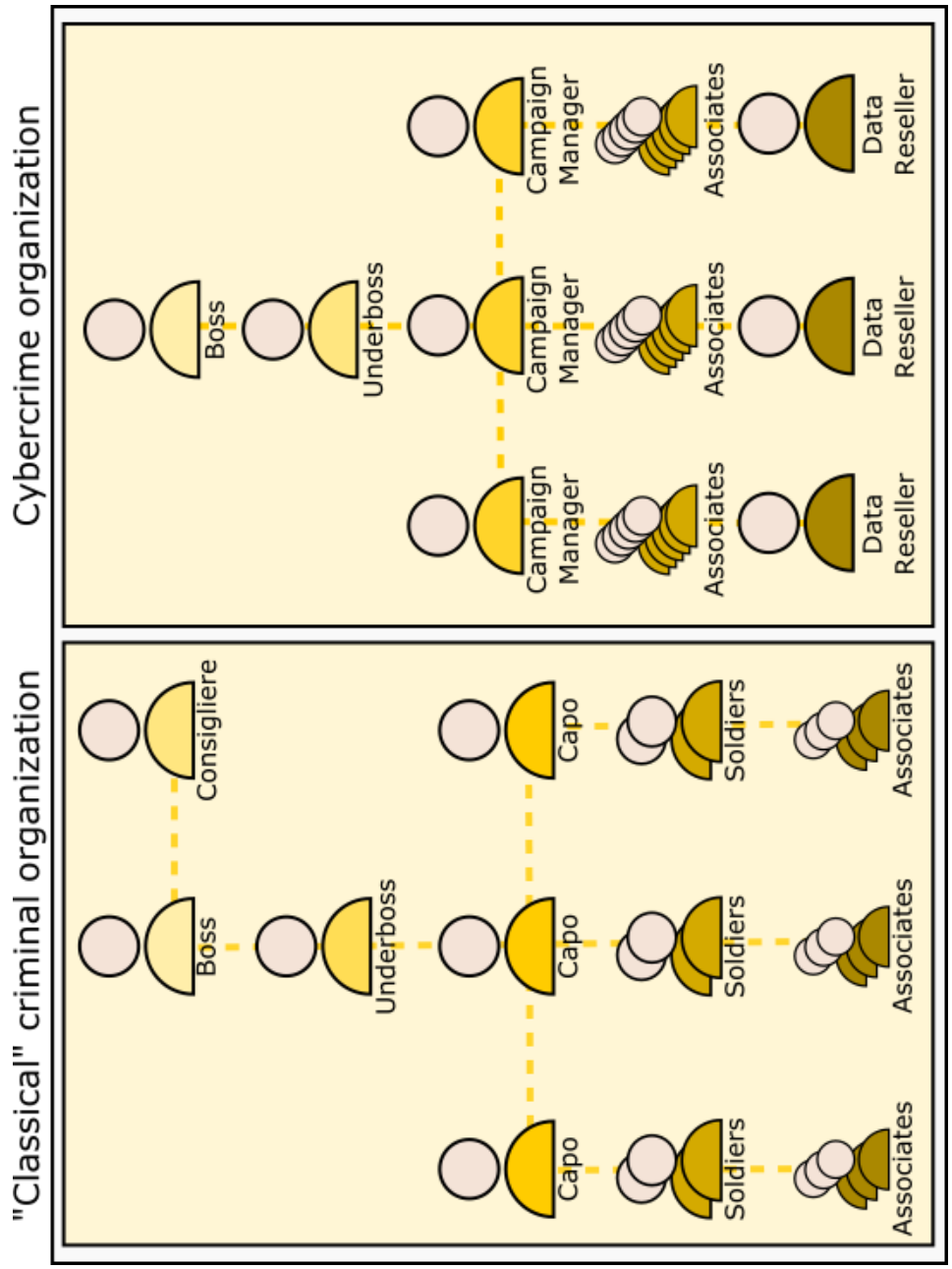

Fig. 1. Pyramidal structure of a criminal syndicate.

Traditional criminal techniques	Cybercrime
Burglary: Breaking into a building with the intent to steal.	**Hacking:** Computer or network intrusion providing unauthorized access.
Deceptive callers: Criminals who telephone their victims and ask for their financial and/or other personal information	**Phishing:** A high-tech scam that frequently uses unsolicited messages to deceive their financial and/or personal identity information.
Extortion: illegal use of force or one's official position or powers to obtain property, funds or patronage.	**Internet extortion:** Hacking into and controlling various industry databases (or the threat of), promising to release control back to the company if funds are received or some other demand satisfied.
Fraud: Deceit, trickery, sharp practice, or breach of confidence, perpetrated for profit or to gain some unfair or dishonest advantage.	**Internet fraud:** A broad category of fraud schemes that use one or more components of the internet to defraud prospective victims, conduct fraudulent transactions, or transmit fraudulent transactions to financial institutions or other parties.
Identity theft: Impersonating or presenting oneself as another in order to gain access, information, or reward.	**Identity theft:** The wrongful obtaining and using of another person's identifying informtion in some way that involves fraud or deception, typically for economic gain.
Criminal exploitation: Criminal victimization of minors for indecent purposes such as pornography and sexual abuse.	**Child exploitation:** Using computers and networks to facilitate the criminal victimization of minors.

Fig. 2. Comparison between Traditional criminal techniques and Cybercrime.

The next model, represented on Fig. 4, thoroughly represents the possibilities of criminals in the conditions of appearance and development of SIE.

Another example of information technology misuse is the so-called “Laundromat”, represented on Fig. 5.

It is important to underline the fact that this scheme was used in Bulgaria, Serbia, and affected national and private banks, governments and law systems. This should be a topic of research for the public and law enforcement.

The authors propose a new model describing current organization of SIE from the point of view of criminal organization, represented on Fig. 6. The following groups of participants are outlined:

- Research
- Development
- Spread
- Profiteering
- Laundering.

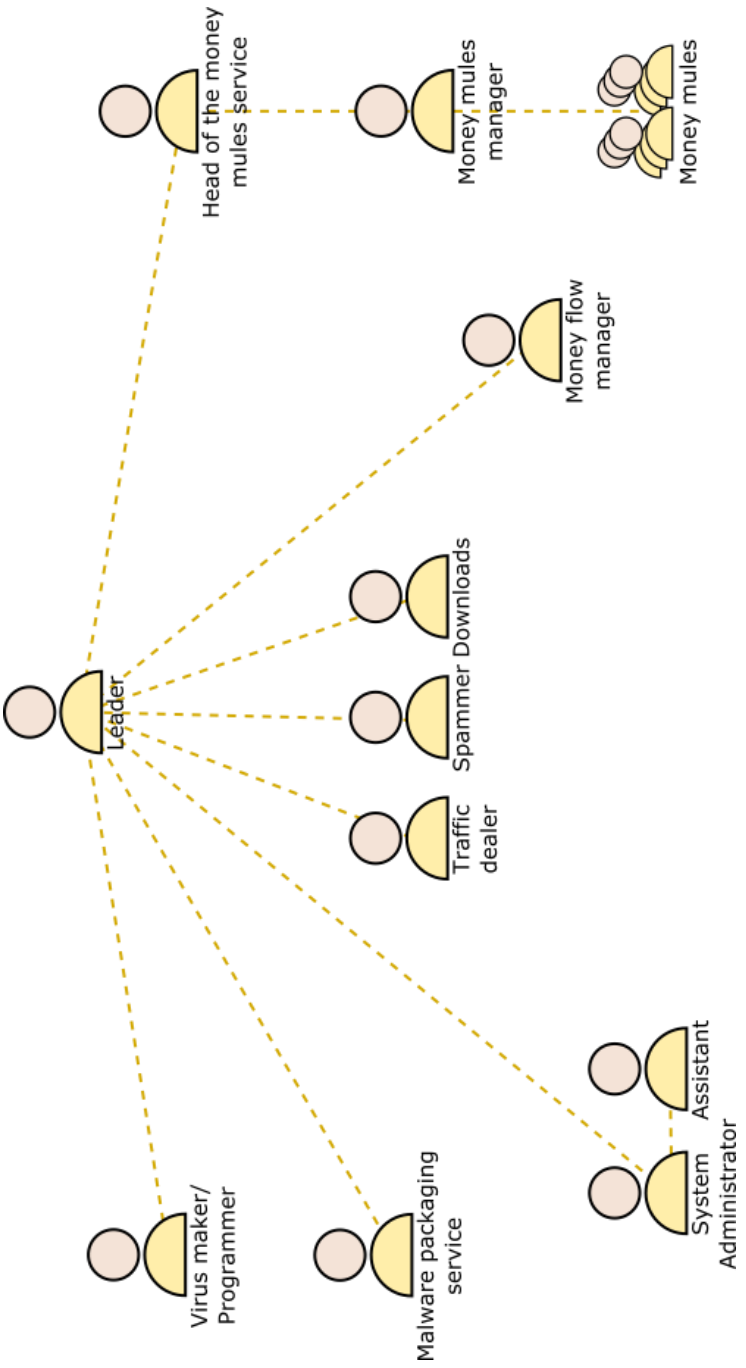

Fig. 3. How a financial cybercrime group is organized

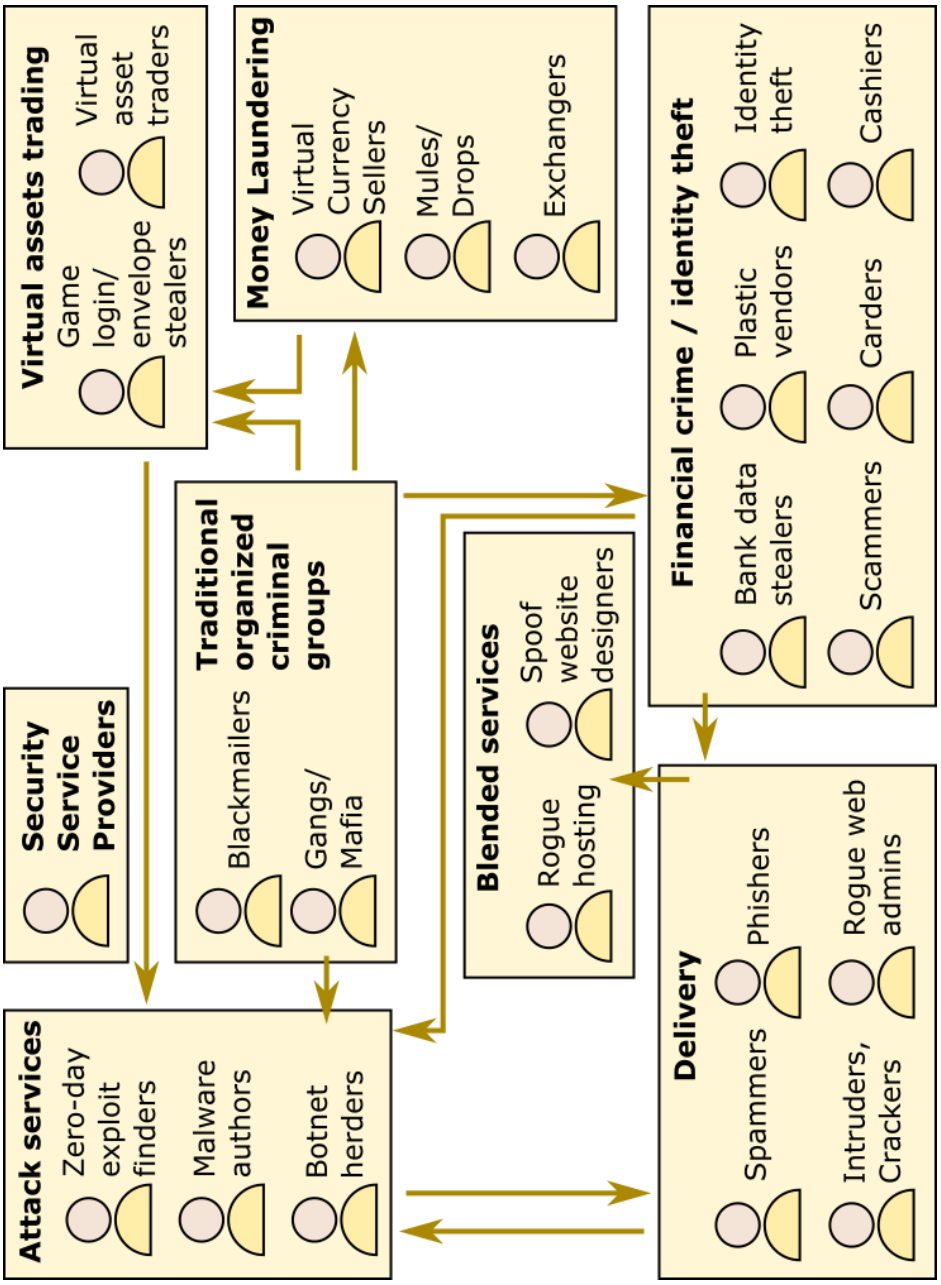

Fig. 4. The underground economy ecosystem.

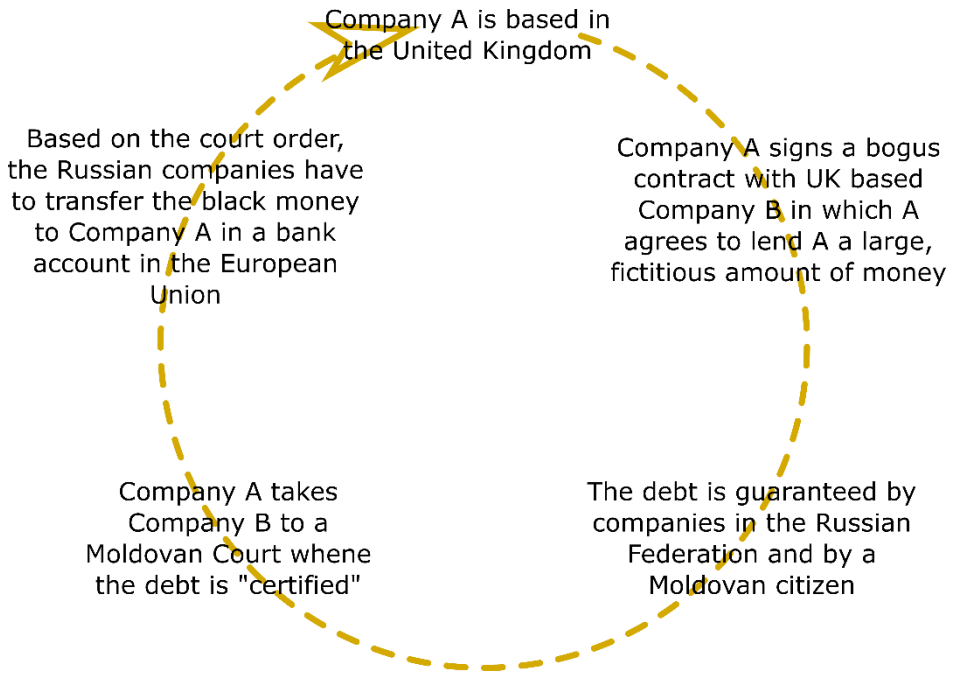

Fig. 5. The Laundromat.

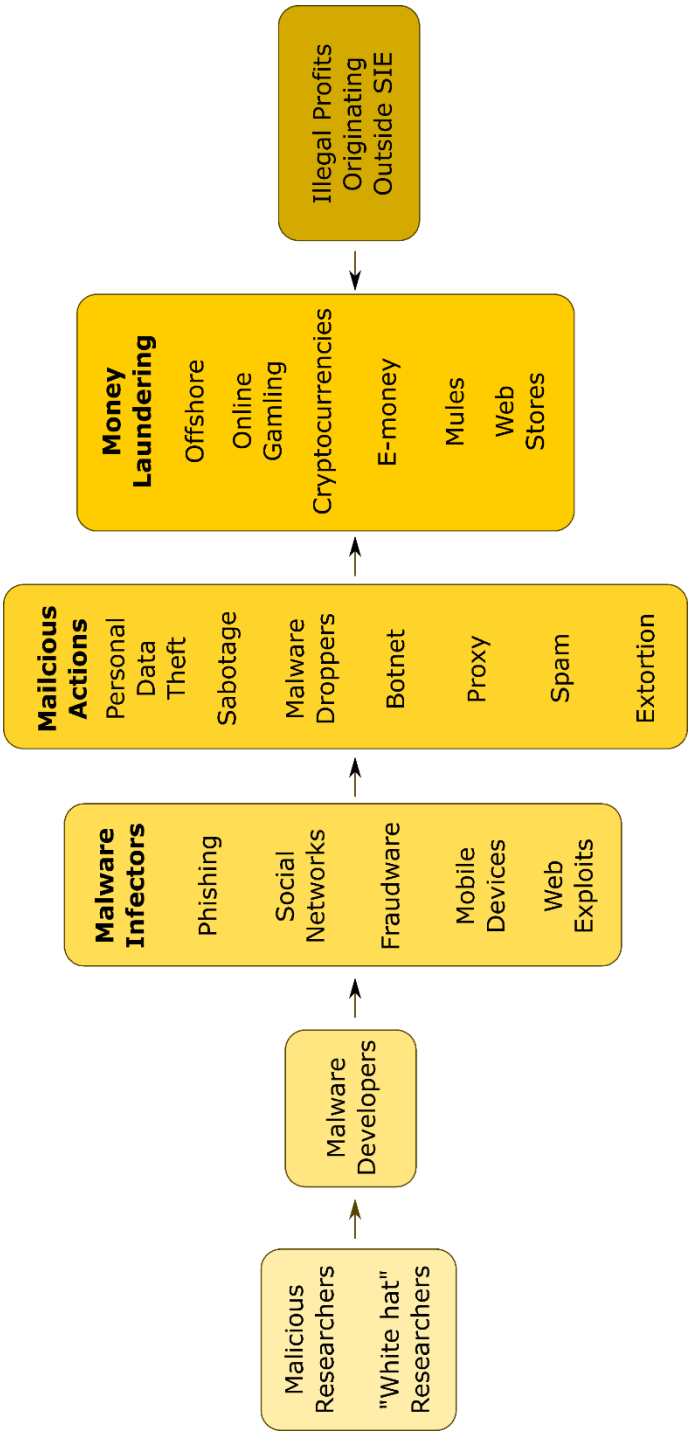

Fig. 6. SIE structure.

4. Conclusion

Conducted analysis of the structure of organized crime in SIE provides the following conclusions:

- First of all, this domain requires in-depth research aimed at the subject of SIE;
- Second, further research of possible ways to hinder interaction between "traditional" criminals and SIE is required;
- Third, it is important to research all the touch points between SIE and its surroundings aimed at profiteering;
- Finally, a research of mechanisms of interaction between buyers and sellers in the domain of SIE is required.

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Software Fault Patterns - The Project

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Abstract. The project Vulnerability Path Analyses and Demonstration (VPAD) sponsored by Office of Assistant Secretary of Defense (OASD) for Network and Information Integration (NII) - Department of Defense (DoD) of USA is one of the most ambitious projects in the area of computer security. This paper analyses the project achievements and fails, and tries to formulate the directions for further research on the topic.

Keywords. Computer security, Vulnerabilities, Software weaknesses, Research directions.

1. Terms, Intentions and Participants

The first step to prevent cyber-attacks is to collect and efficiently manage the knowledge about exploitable weaknesses ("exploitable weakness" is called "vulnerability") in such a way that can be utilized by the community to build more comprehensive prevention, detection and mitigation solutions.

DoD funded the project [1]. The performing organizations are Lockheed Martin Corporation and KDM Analytics Inc. The project ran in the period 31 March 2009 - 30 November 2011.

Project task was to develop SwA Ecosystem based on Object Management Group (OMG) standards [2]. KDM Analytics has developed the concept SwA Ecosystem that OMG then has accepted as a standard. The SwA is an open standards based plug and play environment for automated vulnerability testing tools and services. It is based on integrated ISO/OMG Open Standards:

- Semantics of Business Vocabulary and Rules (SBVR) for formally capturing knowledge about vulnerabilities;
- Knowledge Discovery Metamodel (KDM) for achieving system transparency in unified way;
- Software Assurance Metamodel: Argumentation Metamodel (ARM) and Software Assurance Evidence Metamodel (SAEM) that is intended for presenting Assurance Case and providing end-to-end traceability: requirement-to-artifact;
- Software Metrics Metamodel representing libraries of system and assurance metrics.

For more details, refer to [2-3].

How mentions [1]: "Focus of this effort was to advance semantic formalisms of Software Fault Patterns (weaknesses) and to create Test Case Generator (TCG) capable of automatically generate various programming language test cases of fault code constructs. Such constructs could then serve as test cases to test the effectiveness of various static code analysis tools, thus providing enhanced tooling to reduce software vulnerabilities."This means:

1. The software weaknesses must be formalized following the Software Fault Patterns (SFP). The term "formalization" is used in its weak meaning, i.e. the text must be preformatted and reformulated using SBVR and following the SFP schema.
2. TCG for various programming languages had to be developed. Strictly speaking, TCG is the only SwA tool. The leading idea is that the new weaknesses will be formalized as SFP and the tool will generate test cases using them. These test cases are not test cases for black box test but they are code patterns for weaknesses - the report authors are using very freely the terms. The test cases are for white box static code analyses.
3. The weaknesses test cases are intended for analyses of static code analysis tools. The idea is that a test case is generated for particular programming language and a static code analyses tool for the same language can be tested its effectiveness in finding weaknesses in the code, but how this can be done is not very clear from the report.

The project motivation is based on the ascertainment that the available weaknesses classifications do not support automatization. That is why; there is a need for new clear and systematic weaknesses classification that supports automatization. The project idea SFPs (originally WC – Weakness Clusters) to be backbone of this new classification. Selected SFPs and their definitions must be formalized to be suitable for usage in based on standards based tools for software analysis and assurance.

More precisely, there are two plans: the original plan for the research and that one of the actually executed project. Usually, under the plan below must be understood the original plan – not that one of the funded project.

2. The Plan

The project plan has two phases.

Phase 1 had to:

- develop white box definitions for SFPs based primary on CWEs (Common Weaknesses Enumerations) [4]. The intention was these definitions to be the starting point of a formalization process that would generate specifications suitable for input to standards-based analysis tools.
- group CWEs by SFPs.

Phase 2 had been intended to parametrize the new SFPs and to update the old ones from the previous phase.

The formalization process by [1] consists of the next steps:

1. The first transformation normalizes weaknesses definitions in the form of patterns and the corresponding pattern rules associated with white-box knowledge.
2. The second transformation extracts common patterns and associated conditions (pattern rules) collectively referred as SFPs and redefines existing weaknesses as specializations of common patterns.
3. The third transformation is to redefine each SFP with focus on invariant core and variation points as parameters. This way, weakness specializations are represented by parameters in the corresponding SFP.
4. The forth transformation formalizes each SFP using SBVR and KDM, resulting in Structured English and XMI representations of each weakness.
5. The final transformation is the conversion of each XMI into an executable Prolog rule.

Phase I is a preliminary phase. This phase defines SFPs and group CWEs by them.

SFPs, in object-oriented terms, are something like parent classes to CWEs.

Phase II redefines CWEs as patterns. After that, it extract common pattern from CWEs to SPFs and redefines weaknesses as specializations of SFPs common patterns.

Phase I groups CWEs by SFPs but in that phase only white-box definitions of CWEs and SFPs are manipulated – not patterns. Phase II works with patterns. The last one are generalized and specialized in weaknesses. The idea was that specialization would be done in the form of parametrization – SFPs would be specialized into CWEs, but SFPs to be specialized into SFPs had not been excluded. The generalization and specialization means that SFPs and CWEs will be redefined again.

In the next step, Phase II redefines one more time SFPs using SBVR [5] and KDM [6] resulting Structured English and XMI representations.

Finally, Phase II converts the XMI representations into executable Prolog rules.

3. The Concepts

In [1] several key concepts have been used without any explanation. The authors of the report have used concepts very freely and that postulates to try clarify them.

Phase I defines SFPs as "white-box definitions". What means that term? The researchers have not explained that and such a term is not available in the specialized publications. I guess that researchers under the term "white-box definition" understand textual description of SFP with a focus on internal structure testing of a system or a component, i.e. that descriptions are suitable to extract test cases. These are not formal specifications, but informal textual ones.

"White-box" means that the source code is available and can be analyzed. In reality, the serious cyber-attacks are constructed under these conditions; even if the source code is unavailable, then reverse engineering with suitable tools is applied.

Phase I uses as a source CWEs. In essence, category, class and base weaknesses have to be used SFP white-box definitions. Very important for that phase are base weaknesses because they are abstract descriptions but with enough details for deriving specific methods for detect and prevent the corresponding weaknesses, i.e. base weaknesses are good for extraction of white-box test cases. Class weaknesses are more abstract than base ones; they are tool for creation of additional hierarchy levels. Class and base weaknesses are not linked to any programming language or technology. Only variant weaknesses are linked to particular programming languages or technologies.

Phase I groups CWEs by SFPs. This means that new SFP hierarchy would be created using categories, classes and bases. Therefore, variants would be grouped by SFPs.

Is that approach realistic? First contra is that CWEs are not organized in above described manner. For example, it is supposed that leaves of CWE hierarchy must be variant weaknesses but that is not the case. Even more, CWEs are not organized in hierarchy: a weakness of any kind can participate several times in the hierarchy; a class can be linked to particular programming language or technology and so on. This means that CWE hierarchy is the main problem of the project and all CWEs must predefined and classified in some new way – that is one of the main considerations the project to be initiated.

Initially, the project had no idea to develop hierarchy of SFPs but did not exclude such an option. Original idea was to be created one level hierarchy to simplify user understanding on the weaknesses.

Phase II begins with weaknesses definition normalization into the form of patterns with rules. These terms are described better in the report. The pattern is defined by a start statement

that introduces the weakness and an end statement that can realize the weakness as vulnerability. The last one may occurs under some conditions – "pattern rules". This, again, is textual description that is structured in start statement, end statement and possibly pattern rules.

The third transformation is very important. It extracts the invariant core from SPFs and fix the variations as parameters. These concepts are not defined in the report.

The "invariant" is a formal logical condition that is preserved during the program code execution but that is not the case. Following the presentation logic of the report "invariant core" is textual description of the invariant. The idea behind the invariant core is that it can be used for generation of scenarios independent of programming language or technology. The parametrization, i.e. variation points, link test scenarios with concrete programming languages or technologies. Here again is not mentioned, but not excluded, how to create a hierarchy of SFPs. Success of this operation totally depends on the accuracy of text descriptions from the previous step.

The fourth step applies SBVR and KDM to SFP and weakness descriptions. These are OMG specifications.

SBVR stands for Semantics of Business Vocabulary and Rules. It is "targeted at business rules and business vocabularies, including those relevant for usage in conjunction with those rules."

Semantics by [7] is "the meaning or relationship of meanings of a sign or set of signs". In SBVR, the signs can be of any form: words, phrases, codes, numbers, icons, sounds, etc.

SBVR includes two types of vocabularies:

- Terminological Dictionary, which deals with all kinds of terms and meanings (other than meanings of Business Rules).
- Rulebook, which deals with the specification of the meaning of business rules, and builds on the "Vocabulary for Describing Business Vocabularies."

These two groupings can be used independently.

"A business vocabulary contains all the specialized terms, names, and verb concept wordings of concepts that a given organization or community uses in their talking and writing in the course of doing business." [5]

"Business Rule: *rule that is under business jurisdiction*

'Under business jurisdiction' is taken to mean that a business (or any other semantic community) can, as sees fit, enact, revise, and discontinue the business rules that govern and guide it….

The more fundamental question in defining 'business rule' is the meaning of 'rule.'…

…

… if rules are to serve as guides for conduct or action, they must also provide the actual criteria for judging and guiding that conduct or action. In other words, for the context of business rules (and probably in most other contexts), rules serve as criteria for making decisions. The SBVR's interpretation of 'rule' therefore encompasses the sense of 'criteria' as given by authoritative dictionaries." [5]

"a Rule is 'an element of guidance that introduces an obligation or a necessity.' The two fundamental categories of Rule are:

- **Structural Rule**: These are rules about how the business chooses to organize (i.e., 'structure') the things it deals with.
- …
- **Operative Rule**: These are rules that govern the conduct of business activity. In contrast to Structural Rules, Operative Rules are ones that can be directly violated by people involved in the affairs of the business…" [5]

Rules can be described in the terms of introduced terminology and the formal logic means.

SVBR application on SFP and CWE description means:

1. vocabularies Terminological Dictionary and Rulebook to be developed and then
2. SFP and CWE descriptions to be reformulated using above-mentioned vocabularies.

KDM stands for Knowledge Discovery Metamodel. It is "a meta-model for representing existing software, its elements, associations, and operational environments" [6]. KDM could be used for variation point specification. If SBVR is at the business level then KDM is at IT level, but it is independent of programming languages and technologies.

KDM has XMI specifications too.

This effort will generate two description: one in SVBR Structured English and one in XMI. SVBR Structured English is a kind of pseudocode specialized for SVBR. XMI is used for descriptions interchange among different kind of tools. XMI descriptions from SBVR and KDM can be used for Prolog rule generation.

4. Project Execution

The project was underfunded. VPAD Phases I and II were focused on steps 1, 2 and 3. The lack of funds stipulated steps 1 and 2 to be executed simultaneously instead step 2 to follow step 1. CWEs were grouped in clusters automatically using available CWEs descriptions. SFPs were defined on the base of these clusters with some manual adjustments. The result is represented as "CWE VIEW: Software Fault Pattern (SFP) Clusters" with id 888.

The result is not impressive one. The bad basic information base and the project underfunding stipulate in the resulted view.

5. Analysis and Conclusion

The project aim was to identify SFPs and to deliver their definitions in the form of white-box definitions suitable for usage in standards based tools for software analysis and assurance.

The research object is the available CWE taxonomy that must be reorganized and formalized to deliver executable specifications for every weakness. The available CWE taxonomy is not formalized. Something more, CWE taxonomy has its own internal classification logic. There are more abstract and more specific CWEs. The project aim to create new classification for all CWEs is not correct. One CWE can be view, category, class, base, or variant. Usually, the common information stays at the higher levels and in not included at the lower levels of the CWE taxonomy. What in reality was the intention to classify in that project? CWE-888 view contains class, base and variant weaknesses and do not contain any view or category.

Better approach is to include all information from the higher levels in variant CWEs and then to use only them in the process. In reality, in CWE hierarchy, not all the leaves are variants, this means that in non-variant leaves the hierarchy is under development. This is not the project approach: CWE-888 view contains class, base and variant weakness and does not contain views and categories.

The first transformation transforms weakness definitions in the form of patterns and pattern rules associated with white-box knowledge. This means that all weaknesses must be reviewed following the pattern "white-box knowledge". Therefore, weakness descriptions will be restructured following above mentioned format and that will be the starting point of further formalization process. Note: CWE-888 contains original descriptions.

The problem of the first transformation is that the weakness descriptions do not contain the need knowledge to perform that transformation. The knowledge is not represented very clearly, or is established as some considerations of the topic or worst. To restructure some knowledge that knowledge must be available. That is why in the report, the weaknesses characteristics are classified as discernible and non-discernible.

Very frequently, weaknesses are not associated with particular vulnerability. There are many cases in which for a given weakness is not shown in which vulnerability it occurs but this must be obligatory for every variant weakness.

The second transformation extracts and associated with them conditions (pattern rules) - SFPs, and redefines CWEs as specializations of SFPs. The idea behind that transformation is to organize CWEs in groups around SFPs, i.e. SFPs to be something abstract parents to the weaknesses. In CWE terminology, SFPs are base weaknesses and weaknesses under them are variants (in object-oriented terms - specializations). Note: in CWE-888, primary and secondary clusters are categories.

The task of the second transformation is to redefine weaknesses as SFP specializations. In other words, the task of this this transformation is to establish a new classification of weaknesses. In the results, the view is organized at three levels: primary clusters, secondary clusters and weaknesses. The last level contains classes, bases and variants. Primary and secondary clusters are categories of SFPs and CWE-888 is a view. This organization is very wrong from CWE terminology point of view. Categories and classes are only with structuring purpose. The test cases must be extracted from the bases and specialized on variants.

In CWE-888, primary clusters are 21; secondary clusters are 58. Some of the primary clusters do not have secondary clusters.

The third transformation redefines all SFPs with a focus on the invariant core of SFP in its group and variation points in the core as parameters of weaknesses in the group. In that way, variation points are represented as parameters in the corresponding SFP.

The third transformation again redefines SFPs, but this time the focus is on the invariant core of the SFP group. The invariant core is included in SFP description and weaknesses are redefined as parametrizations of its SFP. In such a way, the third transformation finalize the classification resulting in new descriptions. The transformation continues to clarify the informal classification. The results are SFP descriptions as invariants and weakness descriptions as parametrized specialization.

The fourth transformation formalizes SFPs and CWEs using SBVR and KDM resulting in SBVR Structured English and XMI representations. The essence of the fourth transformation is the application of SVBR and KDM for further formalization of these informal descriptions. This technology has been developed by KDM Analytics and has been standardized by OMG. The descriptions are finally structured and represented in XMI, i.e. a knowledge base is created.

The fifth transformation generates Prolog knowledge base using XMI representations.

The project was underfunded and only the first three steps had been executed. The first two transformations had been performed simultaneously using technics for automatic clusterization of CWEs. The weakness descriptions remain the same; SFPs are created on the base of this automatic clustering with some manual adjustments. The work was partly done. There are no information for further development of that project.

Acknowledgement

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Building a Model for Consolidating Information in Clusters of Small and Medium-sized Enterprises

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Abstract. The aim of the present article is to improve the level of information provision of the cluster by consolidating the information in an ERP system at the cluster level. The tasks of the research are development of conceptual model for progress of ERP system, development of software model and software module for output of consolidated information. The methodology used is methods of analysis and synthesis. The model is approbated to the MS Dynamics Navision ERP system. The proposed solutions allow consolidation of cluster-level information for cluster management purposes.

Keywords. Conceptual model, Software model, Software module, ERP system, SQL queries.

1. Introduction

The ERP systems allow a vast amount of company processing, which in term allows every company (small and medium-sized enterprise - SME) from the cluster to utilize the capabilities of the system. After a concluded research from the authors of the clusters – members of the Business Clusters Association (AUC) in Bulgaria, a conclusion was established that states an existing problem with the information generalization of separate companies in the cluster and it is not resolved with the features of the basic ERP systems [1, 4, 5]

For consolidating information on cluster level, there is a necessity for developing a model for further improvement of the ERP system, including alternative solutions with modern tools for extracting, transforming and loading (ETL - Extract, Transform, and Load), as well as usage of BI (Business Intelligence) platforms (Tableau, QlikView etc..) and technologies from the "Big Data" groups. Although BI platforms and technologies of the "Big Data" groups are solutions with complex architecture, they are most commonly used by big corporations. For clusters of SMEs in Bulgaria, a better alternative are SQL queries, which belong to the group of tools for ETL (Incumbent Batch ETL Tools), as they are free (don't require additional education). The ERP systems offer interface for their initial setting, as well as planning for stored procedures.

The goal of the model in development is the further development of the ERP systems, in a way that allows the consolidation of information from separate companies of the cluster and the usage of this consolidated information when using the cluster.

2. Alternative software solutions for consolidating information

For the goals of the conducted research technologies and options of modern solutions including (ETL - Extract, Transform, and Load) were analyzed, which can be used for consolidation of data from different sources like databases among other things. The ETL tools are organized in four categories:

- Incumbent Batch ETL Tools;
- Cloud Native ETL Tools;
- Open Source ETL Tools;
- Real-Time ETL Tools.

Incumbent Batch ETL Tools

Until not so long ago, the majority of tools for ETL in the world were for batch processing. Historically, most companies used their free computing resources, to conduct batch processing for consolidation of data in outside of work hours (typically at night). For example, your credit account is updated a day after you concluded your financial transaction.

Examples of Incumbent Batch ETL tools are - IBM InfoSphere DataStage; Informatica PowerCenter; Microsoft SSIS; Oracle Data Integrator Enterprise Edition.

Cloud Native ETL Tools

With the movement of IT to the "cloud" a resurgence of more and more services based on Cloud ETL took place. Some of them offer a dynamic real time support.

Examples of Cloud Native ETL Tools would be - Alooma; Fivetran; Matillion; Snaplogic; Stitch Data.

Open Source ETL Tools

ETL has a number of tools and projects which are open source. Most of them are created as a modern layer for controlling of "planned" workflow and batch processes. For example, Apache Airflow is created by AirBnB and Apache NiFi for the NSA.

Examples of Open Source ETL Tolls would be - Apache Airflow; Апачи Кафка; Apache NiFi; Talend Open Studio.

Real-Time ETL Tools

If we work with payrolls or taxes, then you don't need your data to be updated in real time. Most of the applications nowadays require access to real time data from numerous sources. For example if you upload a picture in your facebook, profile, you want your friends to see it instantly and not on the following day.

Processing in real time triggered a change in the architecture: from the model based on batch processing to the real time data rendering model, based on distributed message queues and stream processing.

Examples of Real-Time ETL Tools would be - Alooma; Confluent; StreamSets; Striim. Apart from the above mentioned ETL tools, two new technologies are catching attention: Business Intelligence – BI and Big Data, as they contain ETL tools in their functionality.

Business Intelligence (BI) solutions

Regarding classic Business Intelligence (BI) solutions, at the bottom of the corporate IT architecture would be the standard ERP, CRM, POS and other transactional systems. The integration of the data they have collected is done on a higher level with the ETL tools, cleaning tools which also keep the quality of the data in check as well as Master Data Management. On the next level are the storage systems like Data Warehouses, and above them are the BI tools for statistics, extraction of data (Data Mining) and operational analysis (OLAP). At the top of this classical architecture are platforms for corporative interaction and Enterprise collaboration. [6]

Big Data

Big Data is a new generation technology and architecture , which allows the extraction of big volumes of data (above a few tens of terabytes). These processes generate information of different structures – structured or unstructured, with great speed.

The new architectures also connect to relational databases, but they are bui9ld in a way to handle big volumes of information. There are many arguments, justifying the investment in Big Data – from risk reduction to the creation of products and services which are of a higher quality. There are two leading arguments: establishing more correct and based on facts decisions and improving the user experience. Of course, those are leading reasons for investments in the traditional BI solutions, but according to a research from NewVantage [7], the real „quantum leap" for the corporations using Big Data technologies is the speed at which they can take actions or the so called (time-to-answer, TTA). [7]

The solutions of BI and Big Data are licensed for servicing huge volumes of data (tens and hundreds of terabytes on a daily basis in banks, telecom operators and social networks), requiring the creation of a complex IT infrastructure, long time for configuring and short time for answer.

The clusters of SMEs in Bulgaria at this stage, do not have the above discussed requirements towards processing big volumes of data, both unstructured and time to answer (in real time), and from another don't have the financial capacity for buying and supporting of real-time, BI and Big Data solutions.

For the reasons viewed above, the consolidation of data in clusters of SMEs, **SQL queries** were chosen, which can be counted towards the **Incumbent Batch ETL Tools**.

SQL queries

A language based on structured queries SQL (Structured Query Language) is developed for work with relational databases. SQL is a multifunctional language for working with databases with constructions for: creation, altering or deletion of data; defining data (tables, columns); protection of access to specific elements of the databases via groups or single users; operations for control of data like creating or archiving copies, block copying and actualization and transactions management. [3]

SQL queries that are part of the ETL group of batch tools are especially convenient for clusters of SMEs, as they in terms are:

- Universal – because they are applicable to different ERP systems, using relation databases SMDB;
- Free –because they are included in the SMDB of the ERP system, for which the software taxes are already payed;
- Executed in the same environment – SMDB of the ERP system offers an interface for their setting and their execution;
- Executed like a batch daily tool – they could be planned for not attentive execution and executed like a packet of stored procedures everyday outside of business hours (for example every night).

3. Creation of a conceptual model for development

The already created conceptual model includes 12 stages listed on figure1. The following stages will allow the creation of a database with consolidated information for the companies in the cluster.

1. Creation of a list of all the databases in the ERP system;
2. Creation of a list of all the tables in the databases;
3. Analysis on all the schemas, links and keys (PK and FK);
4. Creating a new DB Cluster;
5. Creation of new tables in DB Cluster (Clusters and Enterprises);
6. Input the data in the new tables (Clusters и Enterprises);

7. Add a column EnterpriseID with PK to some of the tables;
8. Input the data (the corresponding company ID) in the new column;
9. Copies of one company are created in the DB Cluster;
10. Add data for the rest of the companies in the DB Cluster;
11. Update the data of the tables in the DB Cluster;
12. Create consolidated queries from DB Cluster for the cluster management;

4. Creation of a software model for development

The developed software model includes the execution (one time or in a loop) of different stages from the ones listed above (check figure1 as well) and executed SQL code. The syntax is for **SQL Server/Oracle/MS Access and for MySQL**, which will make the already developed software model more universal, as the listed systems for management of data bases (SMDB) work with the most world known and in Bulgaria ERP systems (MS Dynamics Navision, Oracle, SAP). Execution of the stages will lead to the creation of a DB Cluster with information from the companies in the cluster. One part of the stages will be executed one time, while others will be executed periodically as a saved procedure, which is planned as a task for loop execution.

The software model is tested only on the ERP system MS Dynamics Navision, as the expectations are that his execution should allow the consolidation of data from SMEs to a cluster level.

In the developed software model the ERP System works with two hypothetical companies (Корона и Профит) from a cluster, the data that is situated in different DBs (DBCronos и DBMedea), including tables with the same structure and different data for each of the companies. The used tables are part of the tables of module Sales of the ERP system Microsoft Dynamics Navision [2], as the goal is to test the developed and presented in **point 1.** Conceptual model for development of an ERP system.

The SQL quesries are executed from a Microsoft SQL Server Management Studio Environment [3]. Part of the commands for the software model are:

1. (One Time) Making a list of the present DBs:

```
SELECT name, database_id, create_date
FROM sys.databases;
```

2. (One Time) Making a list of tables in those DBs:

```
SELECT so.name, su.name, so.crdate
FROM  sysobjects so
JOIN    sysusers su on so.uid = su.uid
ORDER BY so.crdate;
```

3. (One Time) Creating a layout of the BD to determine the links and connections between used characteristics:

```
SELECT OBJECT_NAME(object_id) referencing,
OBJECT_NAME(referenced_major_id),
* FROM sys.sql_dependencies;
```

4. (One Time) Creating a new DB Cluster:

```
CREATE DATABASE Cluster;
```

The SQL commands from the software model, which are meant to be used in a loop are in a saved procedure SQL Consolidate. That procedure is executed daily as a planned assignment for endless execution.

```
SET ANSI_NULLS ON
GO
SET QUOTED_IDENTIFIER ON
GO
-- =============================================
-- Author:          Емил Денчев
-- Create date: 27.03.2017
-- Description:
-- =============================================
CREATE PROCEDURE SQL_Consolidate
  -- Add the parameters for the stored procedure here
  @p1 int = 0,
  @p2 int = 0,
AS
BEGIN
  -- SET NOCOUNT ON added to prevent extra result sets from
  -- interfering with SELECT statements.
  SET NOCOUNT ON;
  use cluster;
  UPDATE DBCronos.dbo.Products
SET EnterpriseID = 1;

INSERT INTO Cluster.dbo.Employees (EmployeeID, EmployeeName, EmailAddress,
EnterpriseID)
SELECT DISTINCT A.EmployeeID, A.EmployeeName, A.EmailAddress,
A.EnterpriseID
FROM DBCronos.dbo.Employees A
LEFT JOIN Cluster.dbo.Employees B
ON A.EmployeeID = B.EmployeeID
WHERE B.EmployeeID IS NULL;

  SELECT @p1, @p2
END
GO
```

5. Conclusion

In these conditions of fast development and dynamic business environment, the taking of fast and precise decisions from the management side of a cluster of SME, it is really vital to have a consolidated information on a cluster level.

If the companies in the cluster (SME) use an ERP system with a similar model to the one developed above then they and the managements of the cluster:

1. Will achieve access to better practices and ready „**know-how**" included in the business information system for resource management of the enterprise (ERP system), in the form of a developed branch business model and business processes. This is important, as they don't have enough resources (financial, material, human etc.) for engaging in solitary activities for solving already established problems, like rearranging and optimizing the business processes and thus acquiring advantages;

2. In every moment in time the management of the cluster will have online access to an information resource (like reports) for the condition of each of the companies in the cluster, as well as general information on a cluster level or group of clusters, which can be used for both the goals of the operational management and for analysis, strategic planning and forecasting of future activities.

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An Analytical Outlook towards Digital Training Security Transformations

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Abstract: Todays' transcending digital world is inevitably changing our understandings for living, working, communicating, entertaining and learning. The modern educational process requires some key points to be noted in this context for approaching successful and effective implementation. Namely – disruptive smart innovations, active learning and trainees' achievements suitable assessment. So, the technological evolution addressing the new generations to come is a rather transforming one, presenting an ingenious outlook towards the future educational role in the new digital age. This, mainly, is emerging from the disruptive information environment, that creates numerous socio-technological divides, gaps and ambiguities. The paper marks future security landscape evolution plausible understandings that are further used in a system-of-systems effectiveness assessment model. This provides a better analytical identification for the importance of the selected entities roles towards the digital future. Some final results experimental validation is also given, using virtual and mixed reality interactive training layers for users' response monitoring and comparative assessment.

Keywords: Digital interactive training, Security transformations, System-of systems modelling, Virtual and mixed reality validation

1. Introduction

Modern digital transformation provides an inevitable opportunity to adequately cope the new generations from the educational and learning perspective, assuring flexible, speedy and amusing interactive environment for multipurpose training. One of the biggest problems in the digital world is the informational and cognitive overloads towards the human factor [1], [2].

Presently, emerging due to the disruptive wearable technologies of mobile devices with smart interactions via social networks, the informational and cognitive overloads produce negative phenomena like: attention deficit, digital dementia and digital stress. These phenomena however are also combined with tech environment users' severe addiction related to biochemical responsive changes in their bodies [3]. However, it is expected for the new Y- & Z- generations to establish a suitable training framework that allows proper development of their knowledge and skills for the transcending digital future [4].

But naturally, all the educational efforts are with an uncertain role defined for the human factor social transformations necessities, resulting from the total digitalization disruptive wave [5].

The human needs for creativity, innovations, collaborative work, social resilient behavior, emotions, values and believes statement are expected to be suitably joined to the constantly evolving smart computers, robots and communications, shaping new jobs within the future transformed reality [6].

Meeting the future socio-technological dynamics and security challenges is a rather complex objective that definitely could benefit from the digital training evolution. An important moment here is the human assisted artificial intelligence – AI and the future machine replicating of AI, having a progressive role by means of generative, user oriented adaptive learning [7].

Supportive role in the process could also be given to the virtual-augmented reality overlaid mixing, together with 3D real prototype printing [8].

This new education & training concept is encompassing a fruitful solution for 'active learning' edutainment of original & innovative imaginary ideas for the future [9].

A generalized problem towards all these digital transformations' merits is the appropriate, adaptive interfacing and multimodal interaction between humans (H-) and machines (M-), being simultaneously creators, tutors & trainees. A plausible approach in support of the H-M interactions studying and progressive developments is the establishment of future mixed and virtual realities experimental polygons, incorporating realistic avatar (embodied or only virtual) interfacing solutions [10].

Further on in the paper, a future snapshot of the digital age transformation key moments will be given as a research landscape for system-of-systems effectiveness analysis. The obtained results are also experimentally validated, using mixed and virtual realities interactive training, implementing users' response monitoring and assessment.

2. Digital Transformation Future Landscape Establishment

A futuristic outlook towards the digital transformation could be achieved, using expert beliefs and literature data (see e.g. some recent studies from [11] and [12]). The aggregated results here encompass about 250 participants in the age of 19-23 (students from the University of National & World Economy), giving their opinion towards year 2037 and the digital age expected dynamic transformation landscape.

The results from the presented survey outline several general conclusions for the digital age near future (up to year 2037) transformational facets:

(i) significant threats are expected to emerge from: 'Socio-Cultural Changes', 'Total Digitalisation', 'Technological Excesses';

(ii) these findings are closely correlating with priority challenges to: 'Cultivation of Digital Social Resilience', 'New Digital Economy', 'Global Legal Framework & Regulation';

(iii) the three key driving factors in the digital transformation are expected from: 'Innovative & Transformation Technologies', 'Mixing Digital & Objective Reality', 'Global Connectivity, Interaction & Governance';

(iv) and finally, the driving factors are expected to transform future digital world, keeping some divided for the future society, due to: 'Technological Superiority', 'Transhumanisation' and AI 'Singularity'.

Being rather intriguing, these findings produce a technologically sensitive future digital landscape that is roughly granulated. So, further a more detailed study of the expected digital transformation effects, using system modelling will be given, outlining and assessing the plausible entities of interest from the education & training perspective.

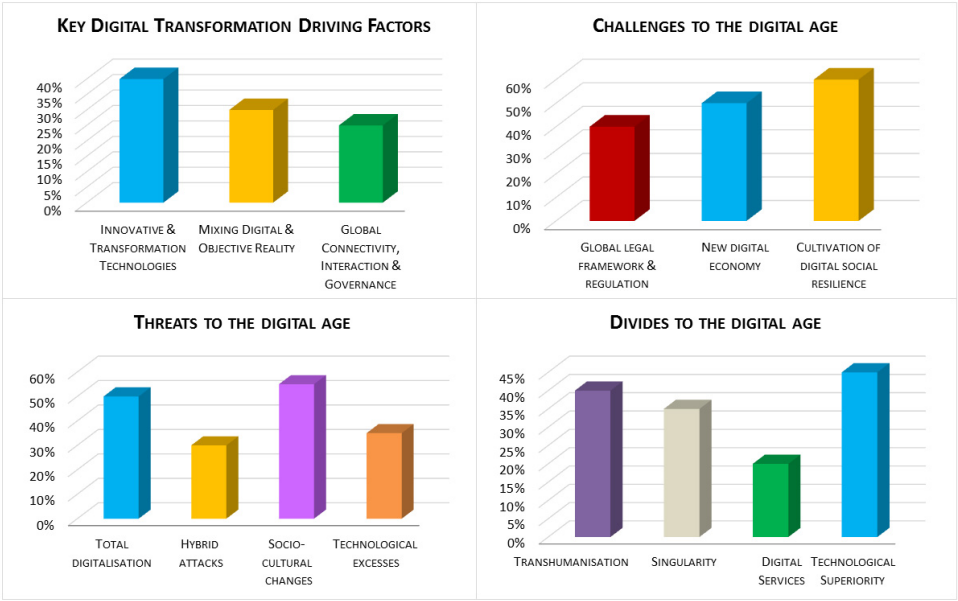


Fig. 1. Digital age transformation, threats, divides and challenges landscape towards year 2037.

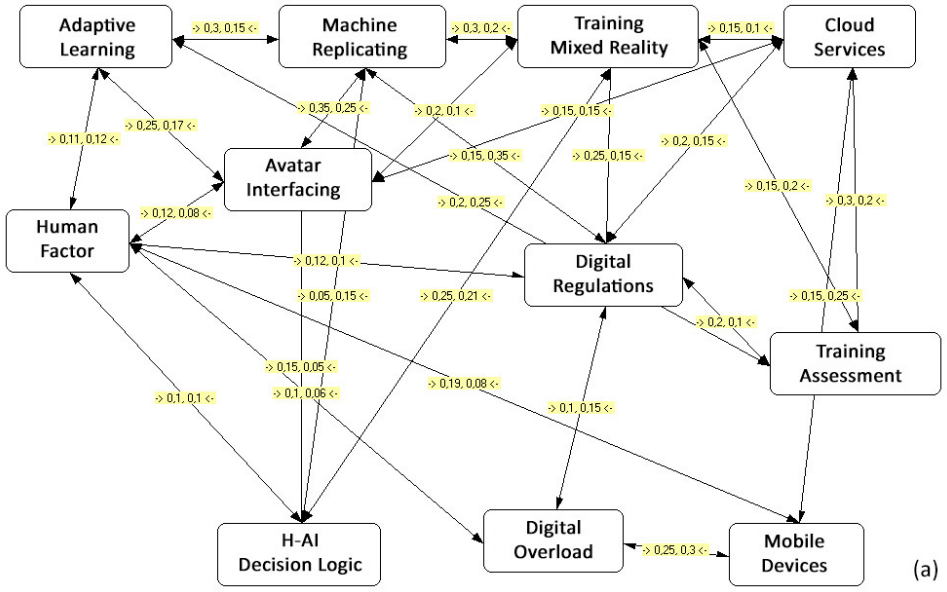
3. Effectiveness System Modelling & Assessment

The ideas behind the proposed system modelling are following the one presented in [13], encompassing a graph-based interpretation of the 'Entity – Relationship' base with feed-forward and feed-backward connectivity assumption for each model entities' couple.

Further on, the entities' assessment distribution is a probabilistic one, based on the Bayesian approach in accordance with a selected scenario objective [14]. The results are visualized into a 'System Effectiveness Diagram' – 'SE Diagrams', providing a 3D entities' effectiveness visualization (noting *Perpetual* vs *Intermittent* entities' two behavior dynamics classes, graphically divided by the NW/SE diagonal plane), defining both active (white) and passive (grey) ones in each of the two subclasses), in accordance with the relations' probabilistic weights as follows: E_f – forward entities relationship effectiveness, E_b – backward entities relationship effectiveness, E_s – resulting, generalized system effectiveness.

The presented concepts have been successfully accomplished in I–SCIP-EA software environment and further used in the present modelling and assessment phase. The current model establishment was supported with some young researchers and expert data gathered from the working discussions amongst around 300 participants from 15 nations throughout the world (Argentina, Bulgaria, India, Iran, Italy, China, Macedonia, Montenegro, New Zealand, Serbia, South Korea, Turkey, UK, Ukraine, USA) during: 'Digital Future Securing' training course within SRS' 2017 [15], BISEC 2017 [16] & ICICSG' 2017 [17].

The model results (encompassing 11 entities and 26 bi-directional relations) with the relevant SE Diagrams (concerning present – year 2017 and future expectations towards year 2027 for the digital training transformation) are depicted in Figure 2.


Adaptive Learning
Machine Replicating
Training Mixed Reality
Cloud Services
Avatar Interfacing
Human Factor
Digital Regulations
Training Assessment
H-AI Decision Logic
Digital Overload
Mobile Devices
-> 0,3, 0,15 <-
-> 0,3, 0,2 <-
-> 0,15, 0,1 <-
-> 0,35, 0,25 <-
-> 0,2, 0,1 <-
-> 0,15, 0,15 <-
-> 0,25, 0,17 <-
-> 0,11, 0,12 <-
-> 0,15, 0,35 <-
-> 0,25, 0,15 <-
-> 0,2, 0,15 <-
-> 0,15, 0,2 <-
-> 0,3, 0,2 <-
-> 0,2, 0,25 <-
-> 0,12, 0,08 <-
-> 0,12, 0,1 <-
-> 0,05, 0,15 <-
-> 0,25, 0,21 <-
-> 0,15, 0,25 <-
-> 0,2, 0,1 <-
-> 0,15, 0,05 <-
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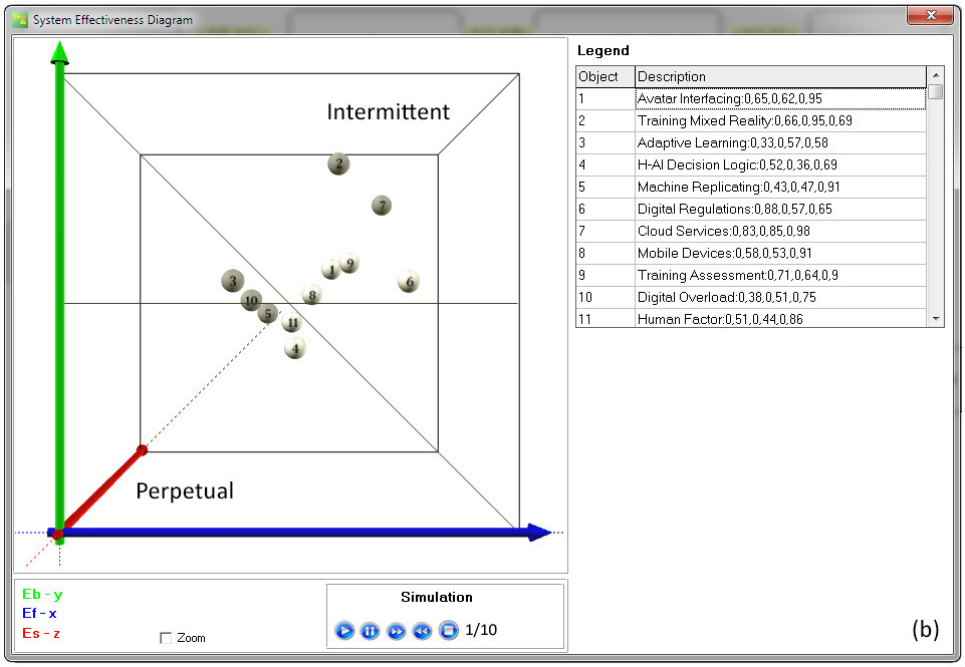
-> 0,1, 0,1 <-
-> 0,1, 0,15 <-
-> 0,25, 0,3 <-
(a)


System Effectiveness Diagram
Intermittent
Perpetual
Legend
Object | Description
1 | Avatar Interfacing:0,65,0,62,0,95
2 | Training Mixed Reality:0,66,0,95,0,69
3 | Adaptive Learning:0,33,0,57,0,58
4 | H-AI Decision Logic:0,52,0,36,0,69
5 | Machine Replicating:0,43,0,47,0,91
6 | Digital Regulations:0,88,0,57,0,65
7 | Cloud Services:0,83,0,85,0,98
8 | Mobile Devices:0,58,0,53,0,91
9 | Training Assessment:0,71,0,64,0,9
10 | Digital Overload:0,38,0,51,0,75
11 | Human Factor:0,51,0,44,0,86
Eb - y
Ef - x
Es - z
Zoom
Simulation
1/10
(b)

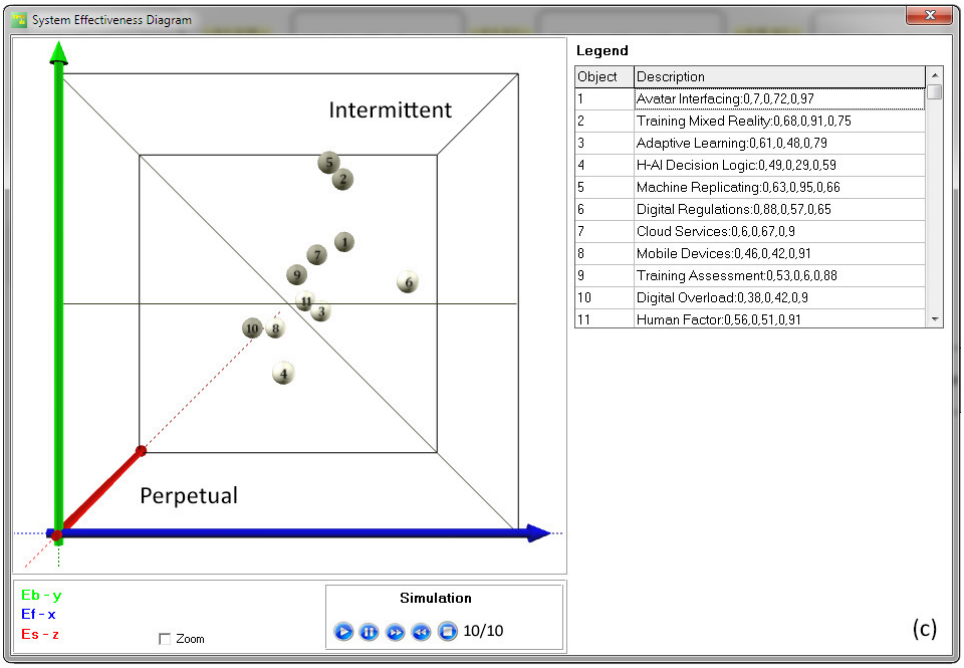


Fig. 2. Digital training transformation system modelling (a) and effectiveness assessment results, concerning technological progressive implementation scenario for the current (2017 – (b)) and future (2027 – (c)) time horizon.

As it is clear from Figure 2 results, some model effectiveness plausible beliefs could be drawn for the present (2017) and future (2027) beliefs, concerning the digital training transformation as follows:

2017:

Perpetual: 4 – 'H-AI Decision Logic'(active), 8 – 'Mobile Devices' (passive), 'Digital Overload' – 10 (passive), 11– 'Human Factor' (active).

Intermittent: 1 – 'Avatar Interfacing' (active), 2 – 'Training Mixed Reality'(passive), 3 – 'Adaptive Learning' (active), 5 – 'Machine Replicating' (active), 6 – 'Digital Regulations'(active), 7 – 'Cloud Services' (passive), 9 – 'Training Assessment' (active).

2027:

Perpetual: 4 – 'H-AI Decision Logic'(active), 8 – 'Mobile Devices' (active), 'Digital Overload' – 10 (passive).

Intermittent: 1 – 'Avatar Interfacing' (passive), 2 – 'Training Mixed Reality' (passive), 3 – 'Adaptive Learning' (active), 5 – 'Machine Replicating' (passive), 6 – 'Digital Regulations' (active), 7 – 'Cloud Services' (passive), 9 – 'Training Assessment' (passive), 11– 'Human Factor'(active).

The presented results are giving possibility for several key aggregated wrap-ups, concerning the future of digital training transformation effectiveness as for both human and technologies, taking into account the already outlined transformational landscape context (see Section 2):

(i) Future training mixed reality is expected to go through several transformations, assuring avatar interface haptic advancing, machine generation, improvement and hypermedia representation of knowledge. This will produce a dynamic, multilayered assessment of the achieved trainees' results, with respect to the constantly evolving necessity for digital overload balancing due to the natural expectation of mixing digital and real world as a transformational side effect;

(ii) Technological developments, related to artificial intelligence will still require human in-the-loop support, accentuating at the same time on mobile devices with suitable adaptable interface, software and web broadband network access;

(iii) The new cloud based technological innovations and mobile services are giving possibilities for fast innovations economic benefits but open and new hybrid (both human & machine) attack vectors, giving also priorities to web embodiment of their users, due to 'Internet of Things' human implantation plans;

(iv) The near future plausible expectations towards year 2027, will not demonstrate completely phenomena like: 'transhumanisation' and 'singularity' that could become more significant towards year 2037, keeping at the same time the importance of global social resilience cultivation in the new digital age;

(v) Regulating the new technological training transformation will be of vital importance for achieving knowledge contents control, successful political and economic governance and keeping simultaneously the human factor digital overload at an acceptable level.

Having a plausible nature, the presented general wrap-ups for the upcoming digital training transformations were further experimentally validated, using futuristic lab like environment with user response multilayered monitoring.

4. Experimental Validation

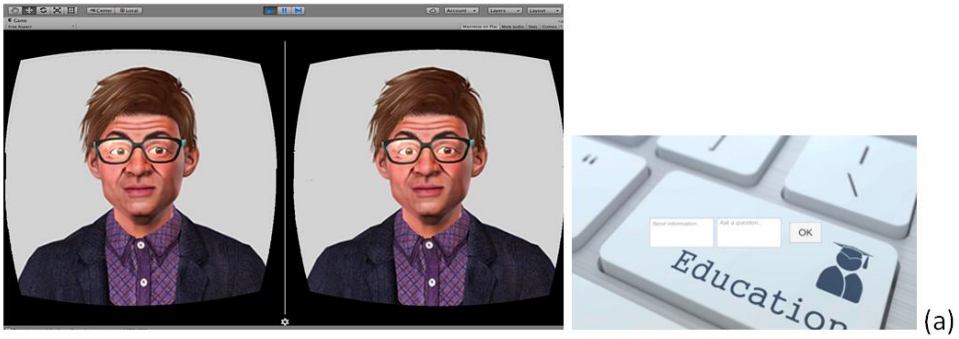
The accomplished ideas in this section are combining both virtual (4.1) and (4.2) mixed reality layers that will be further briefly described. Finally, some aggregated results' key assessments, concerning both experimental layers are presented.

4.1. Virtual Reality Training Layer

The virtual reality training has been designed, following the ideas for Intelligent Teaching Avatar [18], but concerns the possibility to build a mobile application that could be used both in standalone or advanced mode, implementing also decision logic from a smart cloud service. Additionally, 2D/3D avatar user interaction was provided, using Turbo-X VR headset with Samsung I9105 Galaxy S II Plus mobile device, having installed a tailored CyanogenMod 13 ROM+Kernel custom software update.

The virtual teacher/assistant 'John' [19] application (see Figure 3) has been designed in Unity 2017.1 and successfully animated in Reallusion's CrazyTalk® v.8.

The intelligent part was organized, following a rule-based knowledge representation, using Stanford University NLTK 3.3 open source Python module and a neural network layer. The application complete interface incorporates also mind maps, combined with trainees chatting capability to the virtual teacher avatar.



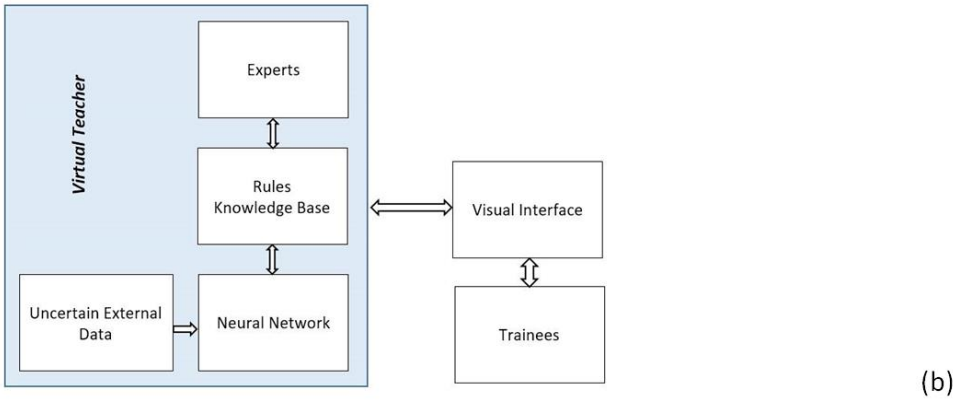


Fig. 3. John – virtual teacher [19] 3D mode Unity VR screenshot with mobile interface (a) and the training environment architecture (b).

4.2. Mixed Reality Training Layer

The mixed reality experimental layer was ad-hoc organized in the framework of CYREX 2017 [20]. Following a futuristic scenario simulation script, interactively played (for about 180 minutes) from the trainees, an exploration of several digital transformation hybrid threats dynamics (industrial espionage, social engineering, malware distribution and targeted attacks) was performed.

The scenario multirole architecture included six main teams: a start-up company – *Neuronet* (bought from a multinational corporation – *Digital Delights*), producing an innovative entertainment VR brain bio-implant, finally provoking violence due to human-machine compromised interaction (influenced from a hacktivist group – *Cyber Revenge*).

Other exercise participants were: *United Digital World* – an NGO responsible for digital techs global regulation, using another corporation – *Quantum* for developing counter bio-implant (modifying the violence effect into users' circadian rhythm changes) and public PR body – *Digi Media*.

The participants' teams used several types of smart gadgets: phablets, tablets, smart watches, wrist bands, desktop and mobile computers, numerous open cloud services (data storage and sharing, encryption, chats, social media, avatars and other multimedia usage, e-mail accounting) some accessed directly or with encrypted QR codes.

Training was mainly organized in a closed Facebook social network group and participants network access to the cloud services via VPN.

Fig. 4. Moments and architecture of CYREX 2017, exploring mixed reality training [20].

Their behavior was explored and archived remotely via scenario events response times' comparison with the planned ones, similar to [21]. On-place selected trainees' biometrics monitoring was also performed with smart stickers (for temperature and galvanic skin response) together with brain, heart rate variability watch gadgets and video supportive recording. This approach provided an opportunity for deeper trainees' analysis, concerning their physiological, cognitive and behavioral responses.

5. Results Assessment

Being with experimental origin the presented results from both training layers validation have been tested in practice as follows: (i) a group of 25 students, exploring the virtual reality teacher prototype, during SRS 2017 follow-up research work; (ii) a group of 30 international participants, during CYREX 2017, studying the established mixed reality.

Finally, two q-based independent surveys were performed among the trainees in order to assure comprehensiveness for the layers' multicriteria joint assessment, though having different experimental nature.

Five key indicators were explored (see Figure 5), giving an aggregated and balanced quantitative assessment (ranked in percentages and evaluating both *Positive* and *Indefinite* indicators' measures for comprehensiveness) to: 'Environment Adequacy', 'Scenario Complexity', 'Technological Effects', 'Human Factor Effects' & 'Training Satisfaction'.

Several, assumptions need to be added here, concerning the selected indicators for aggregated training assessment, assuring their better understanding: 'Human Factor Effects' indicator refers to issues like: bio monitoring placebo effects, high-speed training resulting stress, headache, fatigue, easy post-training defocusing, after-training objective reality mixing, digital dementia & stress, attention deficit, entertainment addiction.

'Technological Effects' indicator outlines issues related to: private information, data and knowledge conscious/unconscious smart sharing and generating, equipment and infrastructure possible damages/improvements, software compromising and developments.

'Environment Adequacy' indicator addresses issues like: training environment high complexity ambiguities, bounded or slow interactions, limited knowledge base intelligence, environment design and knowledge optimization.

'Scenario Complexity' and 'Training Satisfaction' indicators, are giving accent towards users' expectations for the future digital training, taking into account the established training environment functionalities, fast memorizing and learning cognitive effects, regarding the selected training approach and experimented scenarios.

The obtained validation results are giving higher training satisfaction to virtual reality layer vs mixed one, providing a more futuristic outlook assessment to the environment adequacy. The possibilities for multiple scenario complex implementations are however observed in the mixed reality layer, having also a higher technological disruptive perspective.

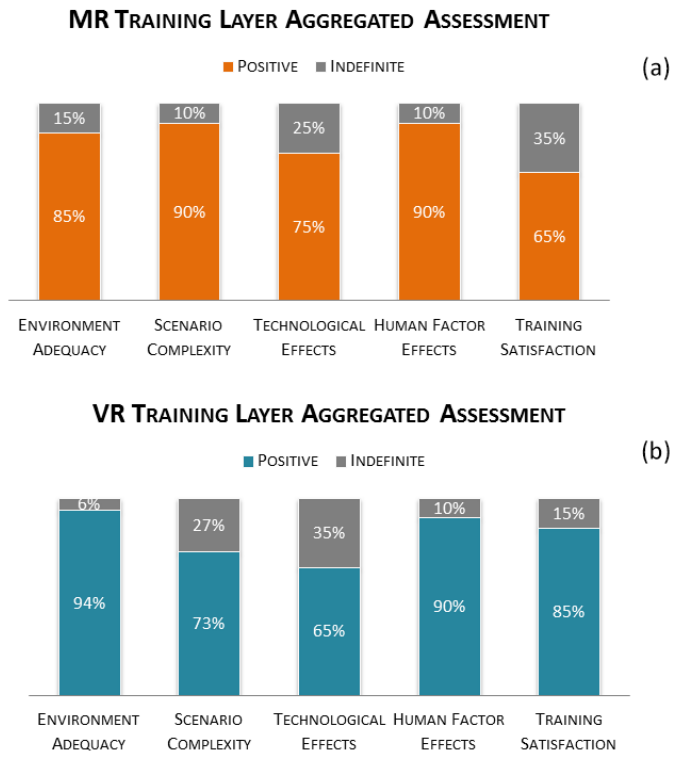


Fig. 5. Mixed (a) and virtual reality (b) training layers aggregated assessment results.

6. Discussion

Future digital training will generate numerous advanced opportunities for fast and adaptive learning, oriented towards the new and upcoming generations' cognitive needs and desires. This unique by age transformation is also establishing and a completely new security environment from both technological and human perspectives.

Due to the accelerated technological disruptions and innovations in the globally connected smart mobile interactive environment, the human factor is spending more time in the technological world, producing a lot of ambiguities towards the real one. Thus, creating a new life-style of perpetual education via mobile hypermedia information and data sources processing, draws phenomena of both negative and positive human physiology, cognitive responses and skills establishment.

The new unfolding mixed reality will definitely become more complex, incorporating virtual services and building an attractive world for spending your life time. This overlaid digital transformation evidently requires and an adequate, dynamic assessment of the achieved learning and educational results.

Definitely future social resilience will be also dependent on an appropriate educational focus, keeping creativity and ingenuity in the forthcoming transhumanised world for at least a generation more time with the current AI singularity development trend.

Keeping suitable digital regulations in this environment could benefit from digital divides like: technological and economic superiority towards structured issues of human life.

However, appropriate human factor training will remain vital, concerning unstructured issues for achieving social well-being with the new digital economics, occupations and governance.

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GIS based ICT Application for Disaster Risk Reduction through Community Participation in Emergency Response (Case Study: Bangladesh)

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Abstract. Bangladesh, due to its geographical setting and climatic condition, is the most disaster prone country in the world. Substantial loss of agricultural production, disruption of communication, damage and economic loss take place due to such disasters every year. Over the periods, risk reductions programmes have been carried out by individual organizations with the development partners according to their own views and targets focused on relief and rehabilitation. A Public - private partnership approach is now felt necessary to achieve the national goal. The cyclone SIDR hit the coast of Bangladesh in 15 November, 2007 and caused severe damage to the lives and properties of thousands of people of the coastal districts. Among these, five districts namely Patuakhali, Barguna, Bagerhat, Jhalokhathi and Pirojpur were the worst affected. A study was conducted in the SIDR affected area through peoples' participations/households survey and a sustainable management information system was developed to reduce the risk during emergencies. For better planning, management and monitoring of Water Supply, Sanitation and Hygiene (WASH) related activities, a GIS based Management Information System (GMIS) was developed to collect and analyze the data for meaningful information generation to improve interventions by the WASH cluster member agencies in the SIDR affected districts. The study area covers 16 upazilas (sub-district) of SIDR affected five districts- mainly focusing on peoples' participation in emergencies during disasters to reduce the associated risks and damages. Further, CEGIS has also developed community based flood warning system for local community under Nagarpur and Daulatpur upazila under Tangail and Manikganj District of Bangladesh through mobile based SMS and flag system. This is very dynamic and innovative system where community participation has been ensured effectively and the system can be replicated any places of the world.

Keywords. Disaster, GMIS, Vulnerability, Community Participation, SMS Gateway WATSAN, WASH, Livelihood, Hygiene.

1. Introduction

The geographical setting of Bangladesh makes the country vulnerable to natural disasters. The major disasters concerned here are the flood, cyclone, storm surge, flash flood, drought, tornado, riverbank erosion, salinity and landslide. These extreme natural events are termed disasters when they adversely affect the whole environment, including human beings, their shelters, or the resources essential for their livelihoods resulting in loss of agricultural production, disruption of communication, injury, damage and destruction of immobile infrastructure, disruption to essential services and national economic loss. Major disaster prone areas of Bangladesh are portrayed in the Figure 1.

1.1. Cyclone

Tropical cyclones from the Bay of Bengal accompanied by storm surges are one of the major disasters that frequently occurred in Bangladesh. The country is one of the worst sufferers of all cyclonic casualties in the world. The funnel-shaped northern portion of the Bay of Bengal causes tidal bores when cyclones make landfalls, and thousands of people living in the coastal areas are affected. Some recent cyclones and number of death is given in Table 1. Figure 2 shows major cyclones that hit Bangladesh Coast.

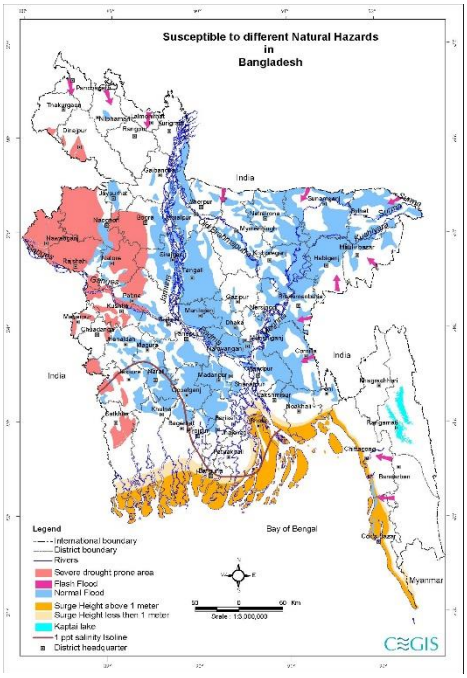

Fig. 1. Major disaster prone areas of Bangladesh

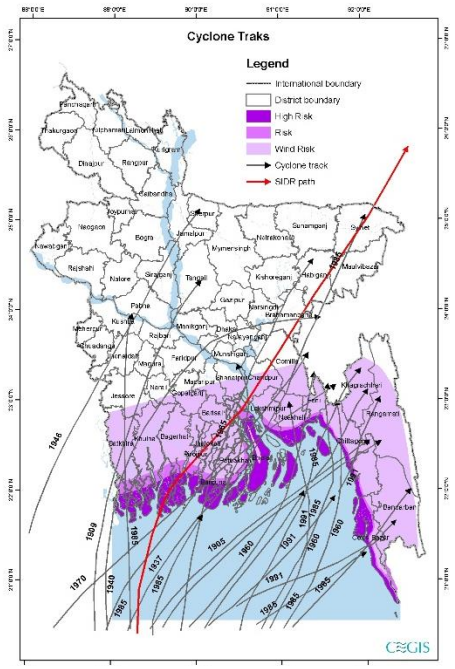

Fig. 2. Major cyclones hitting the coastal zone

Table 1. Major cyclones that hit the Bangladesh coast (*Sarker et. al*. 2008)

Date	Death
November 12, 1970	167000
April 29, 1991	138000
November 15, 2007	10000
May 26, 2009	330

1.2. Flood

Major portion of Bangladesh is part of the Ganges Delta, one of the largest flood plains in the world. The total catchment area of the major rivers in Bangladesh is more than 12 times the size of Bangladesh. Floods are annual phenomena mostly occurring during the months of June to October. Most of the water comes from neighbouring countries. Regular river floods

affect 20% of the country increasing up to more than 68% in extreme years. The floods of 1987, 1988, 1998, 2000, 2004 and 2007 were particularly catastrophic, resulting in large-scale destruction and loss of lives.

Approximately, 37%, 43%, 52% and 60% of the country is inundated with floods of return periods of 10, 20, 50 and 100 years respectively (MPO, 1986). Generally four types of floods occur in Bangladesh.

- Flash floods caused by overflowing of hilly rivers of eastern and northern Bangladesh (in April-May and September-November).
- Rain floods caused by drainage congestion and heavy rains.
- Monsoon floods caused by major rivers usually in the monsoon (during June-October).
- Coastal floods caused by storm surges.

In the year 2000, Bangladesh faced an unusual flood over its usually flood-free south-western plain, which also caused loss of life and massive damage to property.

1.3. Initiatives for Reducing Risk Induced by Disaster

Bangladesh government has developed different mechanism for the emergency response during natural disasters. For the purpose of emergency information exchange and relief management, an Emergency Operations Centre (EOC) has been established at the Ministry of Food and Disaster Management (MOFDM) as operational unit. EOC gets activated with the first information of the disaster emergency situation and works on the overall direction from MOFDM for handling all aspects of emergency situation. The emergency and relief management system during disasters recognizes the key role of the Cabinet Secretary in the Inter-Ministerial Co-ordination and in supervising the district administration and ensures the services of the Armed Forces as well as Non-governmental Organisations (NGOs) working in the country. Under the system, Directorate of Relief and Rehabilitation (DRR) within the administrative control of the MOFDM acts during emergency situation and operates relief activities for distribution to the remote field levels. A dynamic professional and well known organization which is called Disaster Management Bureau (DMB) has been established under the MOFDM to perform specialist functions at the time of emergency to help EOC by extending technical support services through MIS/GIS for information exchange. In addition, there exists Cyclone Preparedness Program (CPP) which plays very useful role during cyclone. Further different development agencies like UNDP, WFP, DFID and UNICEF have developed emergency WASH (Water Supply Sanitation and Hygiene) clusters for emergency disaster responses. However, the most effective process is the Peoples' Participation in emergency response to reduce the disaster damages in Bangladesh.

1.4. Peoples' Participation in Risk Reduction

Peoples' participation in disaster risk reduction refers to the assessment of hazards, vulnerabilities and risks, developing the ability to cope by preparing coping strategies and finally preparing implementation plans of risk reduction options by the local community.

Rural people, especially the poor, landless, fisher-farmers, women and disable are highly vulnerable to hazards. The increasing frequency of hazards and subsequent loss of lives and resources are making them more vulnerable. Since the adaptive capacity is essential to reduce the vulnerability, therefore, it is necessary to ensure an effective peoples' participation in all stages of disaster risk reduction. Considering all these factors, the need to practice wider participation in preparing risk reduction actions is inevitable, where all the stakeholders and their representatives participate in planning and implementation processes through consensus.

2. Methodology

In order to assess the role of community participation in natural disasters risk reduction particularly in emergency response management, CEGIS has employed following methodology in the Cyclone SIDR affected areas.

2.1. Households Survey to Assess the People Response during Emergencies

The process consist of several sub-activities: (i) household survey questionnaire design and development, (ii) field test of the questionnaire, (iii) update and finalizing questionnaire, (iv) determining sampling techniques and size, (v) conduct HH survey, (vi) database development and data analysis.
A Flow Chart showing the methodology is shown in the Figure 3.

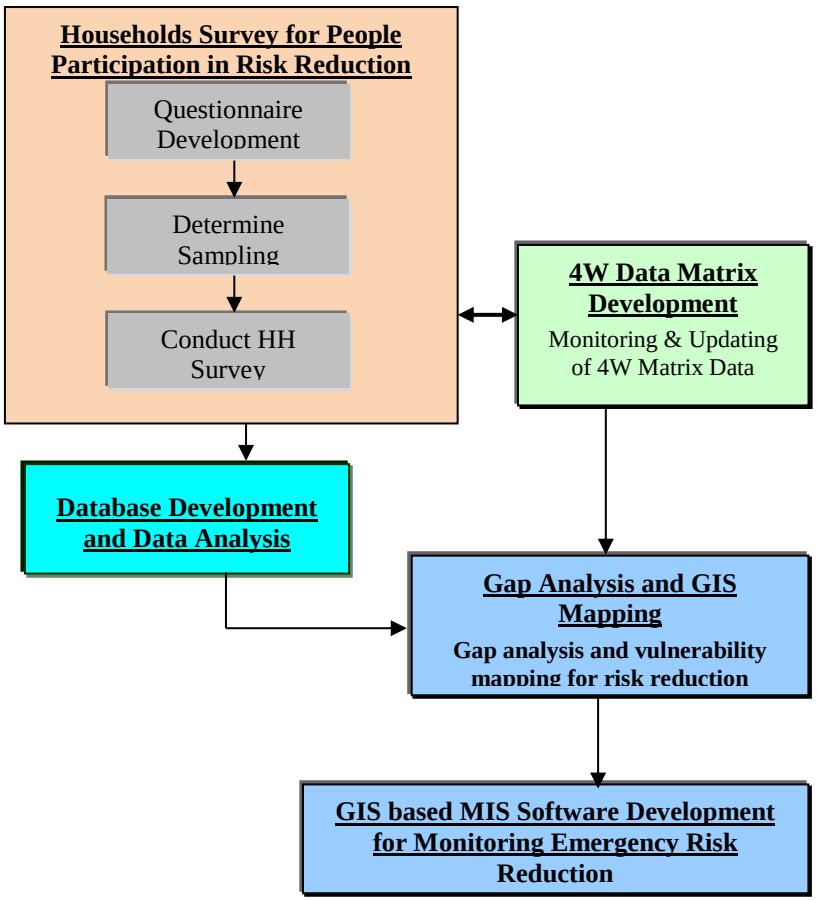

Fig. 3. Methodology of the case study

2.1.1. Household survey questionnaire design and development

For collection of WASH related household data, a well-defined questionnaire is necessary. Several consultation meetings with UNICEF were also done during questionnaire development. The questionnaire has been developed covering all the aspects of water supply,

sanitation and hygiene status in the SIDR affected area. The major attributes of the questionnaire are (i) household location, (ii) household head and occupation, (iii) sources and types of the water sources, (iv) fetching of water, (v) affected status of water point by SIDR, (vi) sanitation status (which includes types of latrine, damage by SIDR, repairing status so on), (vii) Hygiene practices and awareness status of the SIDR affected area and (viii) overall observation of the study area.

2.1.2. Field test of the questionnaire

The developed questionnaire has also been tested through reconnaissance field survey at Manikganj to find the additional and surplus item, understanding ability of the respondents and the surveyors etc .This area is chosen because it is a highly disaster prone area and tornadoes, Norwester and flood hits this area frequently.

2.1.3. Update and finalizing questionnaire

The questionnaire was then updated and finalized discussing with UNICEF and based on lesson learnt from the reconnaissance field survey at Manikganj.

2.1.4. Sampling techniques and size

Determination of sampling techniques is an important issue. For this study the normally distributed "Multi-stage Systematic Random Sample" technique has been used to conduct the household survey because it is unbiased. The ArcGIS software has been used for properly randomly distribution to make it unbiased and as well as well distributed.

Further, the sample size is an important factor for any survey, as sampling in research is unavoidable, since time, money and efforts do not allow studying all possible members of a population. To determine the sample size for this study the following formula has been used, where the sample size n and margin of error E are given by:

$$x = Z(c/100)^2 r(100-r) \tag{1}$$

$$n = Nx/\{(N-1)E^2 + x\} \tag{2}$$

$$E = \sqrt{[(N-n)x/\{n(N-1)\}]} \tag{3}$$

where N is the population size, which is about 6,90,347 households of the SIDR affected five districts, r is the fraction of responses that we are interested in, and Z (c/100) is the critical value for the confidence level c. (Ref: Basic Statistics: A Modern Approach by Morris Hamburg). Thus, the largest sample size 384 is determined at 5% margin of error, 95% of confidence level and 50% response distribution. This calculation is based on pre-assuming that the sample distribution follows normal distribution.

2.1.5. Conduct household survey

The field data were collected through door to door survey in sampled and selected households using developed questionnaires.

2.1.6. Data matrix development for monitoring the disaster response activities

The 4W matrix of WASH intervention reflects Who is working Where, When and What. The major information collected under 4W matrix are water supply and sanitation access or coverage to the population through different mode of WATSAN technologies and as well as hygiene practices. The 4W matrix data collected from different sources are: (i) Local government (Upazila Parishad and Union Parishad), (ii) Department of Public Health Engineering (DPHE) field offices, (iii) Local Administration Offices and (iv) WASH cluster

partner agencies. Further, damage of household and affected population of different districts under the study area was also collected. During the survey period (February – May 2008) the 4W matrix data have been updated through several visits and meetings with relevant agencies in the field area.

2.2. Database Development and Data Analysis

After collecting and processing household and 4W matrix data, a well organized data has been developed. Then all the data were converted into GIS format for spatial analysis and mapping purposes using different GIS techniques. After database development different types of data analysis were performed based on the following indicators:

2.2.1. Analysis gender status of surveyed household head

From the collected and processed sample field survey data, the district wise household heads gender data was analysed for the study area and presented. It is observed that the only 6% of the total surveyed household's heads is female and substantial percentage (94%) is male.

2.2.2. Analysis of water supply data

Source of water supply is one of the important parameter of the household survey. A brief description of the district wise water supply status is given below in Table 2.

Table 2. Availability of drinking water sources

District	Tube well	Pond Sand Filter (PSF)	River/ Khal	Pond	Rain Water Harvesting	Tap	Other	Total
Bagerhat	25	8	11	40	11	2	3	100
Barguna	37	2	20	36	1	4	-	100
Patuakhali	48	-	15	36	-	1	-	100
Pirojpur	34	3	21	37	1	4	2	100

Frequency of drinking water collection in a day is an important issue in the water scarce and severe affected areas. Therefore, frequency of drinking water collection data were collected and processed for the study area and presented in Table 3 below

Table 3. Frequency of drinking water collection

District	Range 0	Range 1-2	Range 3-5	Range 5-10	Range >10	Total
Bagerhat	104	97	77	24	2	304
Barguna	4	79	64	39	3	189
Jhalokati		5	17	3	3	28
Patuakhali	8	71	66	54	9	208
Pirojpur	2	75	97	20		194
Total	118	327	321	140	17	923
%of total	13	35	35	15	2	100

Furthermore, District-wise functional and non- functional status of water points are described below for the study area in Table 4.

Table 4. Status of drinking water points

District	Functional	Non Functional	Total
Bagerhat	98	2	100
Barguna	93	7	100
Patuakhali	99	1	100
Pirojpur	96	4	100

Ownership of the water point data were collected and processed for the study area. From the collected and processed sample field survey data, the water point ownership data were analysed for the study area and presented in Table 5 below.

Table 5. District-wise ownership status of drinking water points

District	Own	Neighbour	Community	Total
Bagerhat	135	79	90	304
Barguna	54	51	84	189
Jhalokati	9	3	16	28
Patuakhali	70	46	92	208
Pirojpur	79	37	78	194
Total	347	216	360	923
% of total	38	23	39	100

Water point damage data is crucially important for the present study and damage data were collected through the household survey. From the collected and processed sample field survey data, the district wise water point damage data were analysed and presented in Table 6.

Table 6. District wise water point damages status in the study area

District	Tube-Well		Pond Sand Filters (PSF)		River/Khal		Pond	
	Af	N-Af	Af	N-Af	Af	N-Af	Af	N-Af
Bagerhat	11	60	20	3	19	14	74	35
Barguna	26	44	4	-	33	4	50	6
Jhalokati	-	14	-	-	4	-	10	-
Patuakhali	27	71	-	-	14	17	56	14
Pirojpur	8	47	4	-	40	-	70	-
Total	72	236	28	3	110	35	260	55
Af=Affected, N-Af=Not Affected								

Water point repairing data is very important for the present study and repairing data were collected through the household survey. From the collected and processed sample field survey data, the district-wise water point repairing and reconstruction status data were

analyzed for the study area and presented in Table 7. A summery of district wise water coverage is shown in Table 8.

Table 7. District wise water point repairing and reconstruction status

District	Repaired	Not Repaired	Not Affected	Newly Built	Total
Bagerhat	118	20	3	1	142
Barguna	93	22	2	3	120
Jhalokati	7	3	4	-	14
Patuakhali	74	23	-	-	97
Pirojpur	66	45	16	-	127
Total	358	113	25	4	500
% of total	72	23	5	1	100

Table 8. District wise water coverage summarized from 4W matrix data

Item	Bagerhat	Barguna	Jhalokati	Patuakhali	Pirojpur
Population	1,120,181	782379	160,900	891,938	780,620
Affected population	889,960	674,420	159,222	336,345	708,296
Water Coverage (%)	39	50	24	65	28
Damage (%)	47	61	64	54	44
Proportion of WS restored (%)	35	12	3	29	25

2.2.3. Analysis of sanitation data

Types of latrines usage in the SIDR affected area are one of the important parameter of the household survey. Data analysis result on the latrines usages status for study area is described below in Table 9.

Table 9. Latrine usages in the study area

District	Latrine with septic tank	Pit latrine with ring and slab	Pit latrine without ring and slab	Hanging latrine	Anywhere/no specific place	Total
Bagerhat	5	78	11	5	1	100
Barguna	6	69	16	9	1	100
Patuakhali	5	63	14	17	2	100
Pirojpur	6	81	9	2	1	100

Information on repair/newly built Latrines after SIDR in the surveyed area is given below. From the Table 10, 45% of latrines are repaired, 5% are newly built and 30% of latrines are still needed to be repaired.

Table 10. Summary information of repair/newly built latrines due to SIDR

District	Repaired	Not repaired	Newly built	Not applicable	Total
Bagerhat	62	45	5	36	148
Barguna	41	28	5	15	89
Jhalokati	4	1	1	8	14
Patuakhali	48	42	4	17	111
Pirojpur	45	27	4	20	96
Total	200	143	19	96	458
% of total	44	31	4	21	100

2.2.4. Analysis of hygiene data

Hygiene practice in the SIDR affected area is another important parameter of the household survey. Summary of hygiene practice is depicted in the Table 11. From the table, the 98% of households use ash, 97% use washing soap and 92% use bath soap.

Table 11. Summary information of soap and ash users by district

District	Total HH	Bath soap	Wash soap	Ash
Bagerhat	140	125	137	134
Barguna	84	76	79	83
Jhalokati	14	14	14	14
Patuakhali	98	87	95	98
Pirojpur	91	90	91	90
Total	427	392	416	419
% of Total	100	92	97	98

2.3. GAP Analysis and Vulnerability Mapping

2.3.1. Gap analysis

During the post SIDR period, WASH related services provided by different agencies to the SIDR affected area were not sufficient or does not cover 100% area or households. Baseline information is a pre-requisite for any kind of gap analysis. Due to lack of base information, the GAP analysis has been carried out for the present study, considering available data parameters collected from the sampled field survey. The GAP analysis has been done under this study using (i) the data from household survey and (ii) the data from public water point survey. The detail description of GAP analysis using these two types of data has been briefly described below:

a) GAP Analysis using house-holds survey data

During this WASH related households survey, several important information on water and sanitation collected are (i), affected water points, (ii) rehabilitated water points, (iii) newly built water points, (iv) affected latrine, (v) rehabilitated latrines and (vi) newly built latrines etc and these parameters are used to analyze the for water supply and sanitation.

b) Gap analysis for water supply

From the collected sampled household level water sources data, the district wise gap of water point has been analyzed using the equations and the result is presented in Table 12. The table shows that the highest percentage of gap is at Pirojpur district, which is 39% and lowest percentage of gap is at Bagerhat district, which is 21%.

Table 12: District- wise water sources gap using household survey data

District	Total	Affected	Repaired	Newly built	Gap	% of Gap
Bagerhat	284	144	119	1	24	21
Barguna	177	121	87	7	27	25
Jhalokati	18	14	7	2	5	36
Patuakhali	202	99	67		32	32
Pirojpur	141	127	65	2	60	39

c) Gap analysis for sanitation

Further, District-wise affected versus gap for sanitation facilities has been analyzed and presented in Figure 4. It has been found that at Pirojpur district the gap versus affected ratio is 1:2.30, at Bagerhat the ratio is 1:9, at Barguna the ratio is 1:2.30, at Patuakhali 1: 2.15 and at Jhalokati 1:1.5 only.

2.3.2. Vulnerability analysis and mapping

The goal of this research is to reduce vulnerabilities during the disaster and enhance the resilience of poor people and ecosystems impacted by water scarcity, floods, SIDR and other water-related shocks. Vulnerability (V) is a dual concept which entails the likelihood of events that may result in a series of negative livelihood outcomes, as well as the coping mechanisms that people employ to face risk events such as floods, cyclones, arsenic hazard, etc. To identify the degree of vulnerability, a vulnerability mapping exercise has been carried out for the present study. Steps followed for this WATSAN vulnerability mapping are:

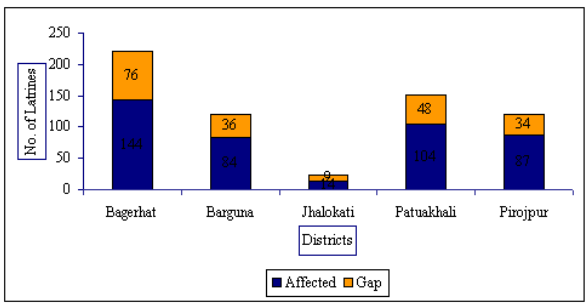

Fig. 4. Affected Vs gap for sanitation facilities (latrines) using household survey data

a) Selection of vulnerability indicators

The degree or magnitude of WATSAN vulnerability calculated as for this study considering several factors or indicators. The indicators used for this study are: (i) proportion of elderly people (age => 60 years), (ii) proportion of landless households, (iii) proportion of female widow, (iv) presence of water scarcity, (iv) severely affected unions, (v) NGO services, and (vi) percentage of shelter less people during Sidr etc. All these above indicators were taken into consideration in conceptualizing the vulnerability index calculation for this study based

on the union wise available data. The indicators used for vulnerability computation has been presented in Table 13. The table explains the relationship between the indicators and the vulnerability to risk.

Table 13: Indicators used for vulnerability computation

SL	Indicator	Degree of vulnerability
1	Proportion of elderly people (age => 60 years)	Higher the % of elderly people, higher the vulnerability
2	Proportion of landless households	Higher the % of Landless HH, higher the vulnerability
3	Percentage of widow	Higher the % of Female widows, higher the vulnerability
4	Water scarcity	Presence of water scarcity, higher the vulnerability
5	Severely affected by SIDR	Severely affected indicating higher the vulnerability
6	NGO services	Presence of NGO services indicating lower the vulnerability
7	Percentage of shelter less people during Sidr etc.	Higher the shelterless people higher the vulnerability

b) Vulnerability index calculation

Individual tables 14a-g were generated for different indicators containing the indicator parameter and their score values. The relative score value has been used for the calculation of vulnerability with the upper limit value of 3 and lower limit value of 1 at different scale of interval. It can be mentioned that in the lookup table higher the score the higher the vulnerability.

Table 14a. Proportion of elderly (age => 60 years) people (V_1)

Percentage (%) of elderly people	Score
< 4	1
>= 4 to <=8	2
>8	3

Table 14b. Proportion of landless households (V_2)

Percentage (%) of landless households	Score
< 30	1
>= 30 to <=50	2
>50	3

Table 14c. Percentage of widow (V_3)

Percentage (%) of widow	Score
< 0.5	1
>= 0.5 to <=3	2
>3	3

Table 14d. Water scarcity (V_4)

Water scarcity	Score
Not water scarce (Value = 0)	1
Water scarce (Value = 1)	3

Table 14e. Severely affected by SIDR (V_5)

Severely affected by SIDR	Score
Value = 0 (not affected)	1
Value = 1 (affected)	3

Table 14f. NGO services (V_6)

NGO services	Score
NGO services (Value = 1)	1
No services (Value = 0)	3

Table 14g. Percentage of shelter less people during emergencies (V_7)

Percentage (%) of shelter less-people	Score
< 80	1
>= 80 to <=90	2
>90	3

After calculating the individual score, combined vulnerability for each administrative unit were calculated using following formulae:

$$V_I = V_1 *0.15 + V_2 *0.15 + V_3 *0.15 + V_4 *0.20 + V_5 *0.20 + V_6 *0.10 + V_7 *0.05 \quad (4)$$

where:

V_I = Final vulnerability Index

V_1 = Individual score for proportion of elderly (age => 60 years) people

Weights for $V_1 = 0.15$
V_2 = Individual score for proportion of landless households
Weights for $V_2 = 0.15$
V_3 = Individual score for percentage of widow
Weights for $V_3 = 0.15$
V_4 = Individual score for water scarcity area Weights for $V_4 = 0.20$
V_5 = Individual score for severely affected by SIDR
Weights for $V_5 = 0.20$
V_6 = Individual score for NGO services
Weights for $V_6 = 0.20$
V_7 = Individual score for percentage of shelter less people during emergencies
Weights for $V_7 = 0.05$

From calculated scores, the three major classes were generated as (i) High, (ii) Medium and (iii) Low. The class with the score has been presented in Table 15.

Table 15. Vulnerability index (VI)

Vulnerability type	Index
Low	1.00 to 1.50
Medium	1.51 to 2.00
High	2.01 to 3.0

c) Vulnerability mapping

After calculating union wise vulnerability index, the union-wise vulnerability data were linked with spatial data of the study area unions. Further these vulnerabilities were classified into three classes (low, medium and high) using ArcGIS software. The sample vulnerability map is presented in Figure 5. It may be noted that the classification that has been made using ArcGIS is dynamic and it can be reclassified changing the degree of V or VI.

2.4. GIS based MIS Software Development for Emergency Response Monitoring

For effective monitoring of SIDR affected area in Bangladesh, a GIS based web enable monitoring system named as GIS based MIS (GMIS) has been developed under this project. The web-based system is developed with the aim that all the partners in the process will have access to the system through internet or intranet based system on their access authorization. The system is developed using open source software development tools to reduce the cost and licensing obligations. The user interfaces, input/output formats has been designed and developed in consultation with UNICEF Bangladesh.

The major components of the GMIS are (i) Data Explorer, (ii) GMIS Mapping, (iii) Reporting, (iv) Photos and Maps, (iv) Knowledge Based, (v) Data Management. The software is capable to monitor the emergency response status of the affected area and hence suggests an immediate response in recovering any particular disaster.

It has been observed from the case study that, peoples' participation plays a substantial part in activities related to emergency recovery of any disaster. Community participation can more effectively be introduced in the whole process by incorporating a SMS-based feedback service in the developed GIS based MIS software (Figure 6). This will increase the efficiency as well as broaden the scope of the whole risk reduction process by providing easy access to

information to the community, decision makers and planners and as well as the politician for the greater benefit of the country to reduce the disaster risk reduction during emergencies.

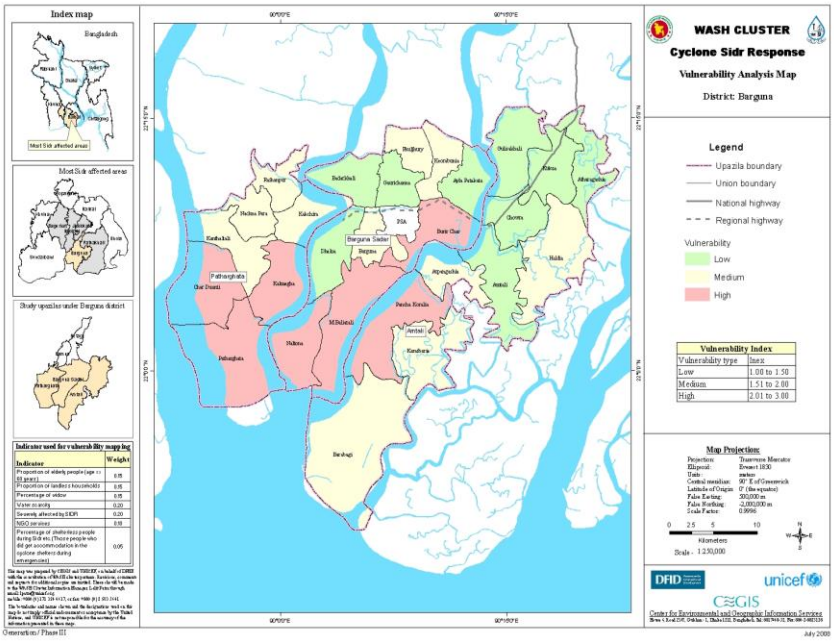

Fig. 5. Cyclone SIDR Response in Bangladesh

Fig. 6. Development of GIS based MIS software
for emergency WASH cluster in Bangladesh

2.5. Flood Forecasting and Early Warning: A Case-Study of a Community based Risk Reduction Management

The study emphasised to develop the community based flood forecasting system using satellite imageries and GIS. The objectives of the study were:

- To disseminate of Flood Level information to the community with a lead time before the flood occurs and
- To reduce risk from flood by empowering the community with flood warning information before it comes

A community based warning system is developed and warning message are disseminated to the community during flood disaster. Water level data from different gauge stations in major rivers maintained by Bangladesh Water Development Board (BWDB) are collected. Then these data are interpreted and analyzed based on Digital Elevation model (DEM) using GIS to determine probable flood level at local tributaries and surrounding floodplains. Interpreted information are shared with local people as and when the water level is likely to exceed the safety limit; at the earliest time by warning them using coloured flags and mobile SMS ('+/-' indicates 9 inch increase/decrease in water level) at frequent intervals.

An example of information dissemination by using flag is shown in the table 16.

Table 16. Use of coloured flags for information dissemination

Water level change	Flag	Description
Today flood status	**Top flag:** No flag, Green, Yellow, Red	**No flag –** the water level at gauge is at below the Normal Flood level **Green –** the water level at gauge is within the Normal Flood range **Yellow –** the water level at gauge is within the Moderate Flood range **Red –** the water level at gauge is above the Moderate Flood range
Water level after 48 hr	Except the topmost flag	**No Flag -** WL change < 1 bighat (22 cm) **White Flag** – decrease of WL **Blue Flag –** increase of WL

3. Community Participation in Emergency Response During SIDR

3.1. Water Sources

From the household survey data and field observations, it has been found that substantial amount of damaged water sources have been repaired. Further, major portion (more than 70%) of the damaged water sources have been repaired by the community itself and about 10-15% of the water sources have been repaired by N/GOs. However, following specific issues were noticed (Figures 7-9).

1. In the case of water points, majority of the PSF has been severely damaged
2. From the local people's perception about water points, it is known that participation of NGOs in repairing the water points especially the ponds and tube wells are insufficient

3. Water points are mainly affected by the saline water, damages trees, dead body of human and the livestock
4. DPHE, UNICEF and DANIDA has contributing in repairing the water points in the study area and amount of contribution need to be substantially increased.

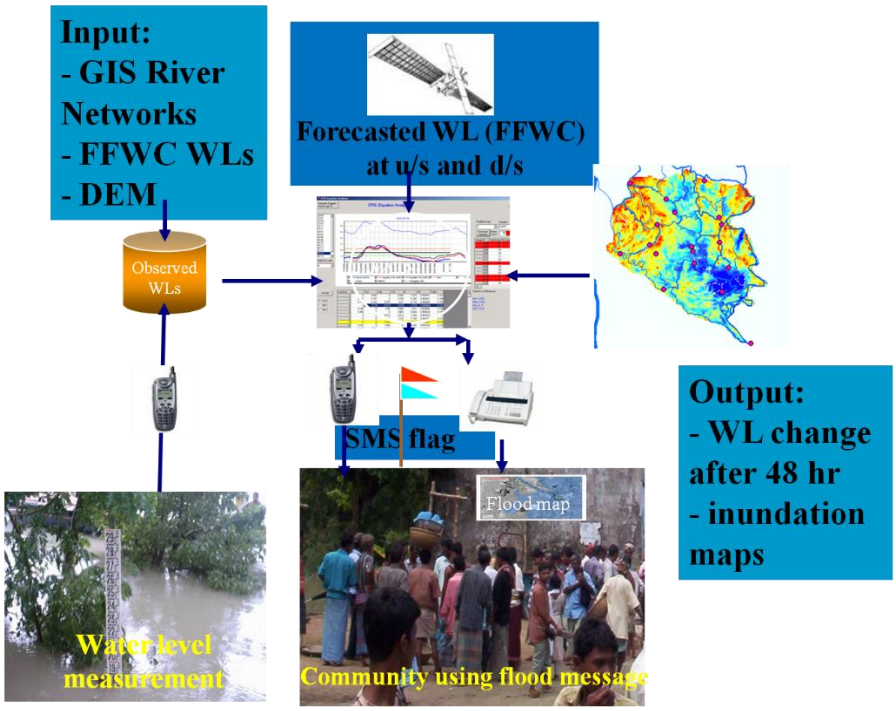

Fig. 7. Conceptual diagram of the Flood Forecasting System

Fig. 8. Information dissemination in occurrence of flood

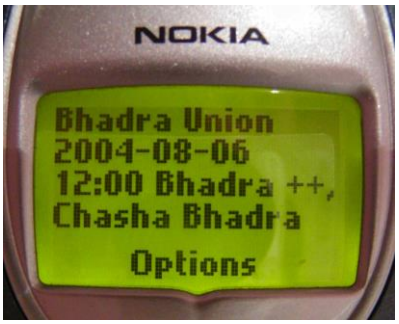

Fig. 9. SMS based Symbolic Information System

3.2. Sanitation

From the household survey data and field observations, it has been found that substantial amount of damaged latrine has been repaired which is about more than 50%. Further, major portion (more than 80%) of the damaged latrine have been repaired by the community itself and about 10-15% of water points have been repaired by N/GOs. The following specific findings are derived.

1. Majority of the surveyed households have been using the sanitary latrines which is about 70%
2. Majority of the damaged latrines have been repaired and built by the household owners e.g. community itself
3. About 10% of the surveyed households have been sharing latrines.

3.3. Hygiene Practice

Hygiene practices information has been collected from the field through interviewing the people of sampled households using developed field questionnaires. Usually majority of the interviewed people replied positive answers regarding the hygiene practices especially for the usage of soap before taking their meals and after defecations. High accuracy data on hygiene practices can be obtained through detailed demonstration at house level, which needs 6-7 hours for each house household. However, according to the reported household survey data, it is observed that substantial proportion of the people wash their hands with water before and after taking food, after defecation, before preparing, serving and feeding children. The following conclusions are drawn from this specific survey.

1. The survey found that about 50% of the people (only living in the surveyed households) have been using soap/ash/soil to wash hands after defecation.
2. The people of the surveyed households have been using ash or soil and as well as soap for washing their hands after defecation
3. Twenty four percent of the people have been using soap for washing hands before taking their food.

Most of the people learnt about hygiene practice from their families, neighbours, media and religious culture. This is also indication of Peoples' Participation to reduce disaster damages during emergencies.

3.4. Result on community perception in disseminating early warning

The second case study has been proved that the community has been involved voluntarily and spontaneously. The local community including the village women were also actively involved and played important role to disseminate the warning among the people of the vicinity to reduce the emergency disaster risks and damages.

4. Outcome of the study

The study generate tow outcomes; (i) the GIS based disaster risk assessment and management system, (ii) community based early warning system through mobile *sms* system with flagging to reduce the disaster risk of the local people

5. Conclusion

It has been found that the local community significantly participates in the emergency response during and after the cyclone SIDR disasters in the coastal areas of Bangladesh

The study further reveals that the public-private partnership approach of risk reduction can be very effective for reducing disaster damages during emergencies.

The developed system can be replicated in any place of the world through further updated to reduce the disaster risk of livelihood and locality.

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Building a Data Warehouse for the Management of Population in Lubumbashi City

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Abstract. Cities are constantly changing and authorities face immense challenges in obtaining accurate and timely data to effectively manage urban area. This is particularly problematic in the developing world where municipal records are often unavailable or not updated. Business Intelligence brings solutions that impact hugely any area of life. In this article, we applied it to the field of health and migration in the city of Lubumbashi (Lubumbashi is the second city of the Democratic Republic of Congo) so as to allow the urban authorities to highlight the vital information needed for decision-making and therefore anticipate the phenomena or scourges that are the basis of the administrative mismanagement of the city. Our goal was to represent the demographic situation of the city of Lubumbashi through three facts: birth, death and migration (displacement of population). Through this research, the successful completion of a data warehouse (based on maternity, morgue, and migration service data) consolidates the data into a single database for easy decision-making necessary. The top down approach has been used to build this data warehouse.

Keywords. Business intelligence, Data warehouse, Earth observation, Sustainable urban development, Rapide urbanization.

1. Introduction

Today, managing large volumes of data for decision-making remains a major challenge for most organizations, as operational systems called "transactional" are limited or even inadequate to provide clear, reliable and relevant information to decision-making.

Leaders of the politico-administrative entities must be able to take the most opportune decisions. These decisions, which will strongly influence the entity strategy and therefore its future, should not be taken lightly or too quickly, given their impact on the survival of this entity.

Several approaches have been developed, but nowadays "decision-making systems" offer decision-makers quality information that they can use to make their decision-making choices. These systems use a wide range of technologies and methods, including Data Warehouse ("Data Warehouse"), "Online Data Analysis" (OLAP or OnLine Analytical Process), and "data mining" which represent the fundamental and essential elements for the implementation of a good decision-making system.

In this article, we focus on the design of a data warehouse for the demographic sector of the city of Lubumbashi.

The city of Lubumbashi is the second largest city in the Democratic Republic of Congo. It has nearly 2.8 million inhabitants and is experiencing a relatively large population growth. But according to our research at the Lubumbashi town hall, the demographic data collected are intended for physical archiving and the inconvenient use of this information does not reassure the management planning of the population of the city. In addition, the data come from various sources (hospitals of different municipalities, migration services, registrars) and are usually presented in tabular form, and we wonder how the mayor can rely on such data to consider good decisions for the management of his city.

We are not unaware that one of the greatest assets of an organization is its information, but this information is often embedded in many data, dispersed, unstructured and most of the time heterogeneous [1].

We therefore think that decision makers in the population field must have a general and detailed view of demographic phenomena. They must be exposed to important facts, the basis of their decisions. The main data covered by this analysis are those from the Census of Population, which focuses on the phenomena of birth, death and displacement of the population.

Hence the big question: how can information be collected from various data collected to make decision making effective?

We believe that the use of a data warehouse would be the ideal solution to consolidate data that can guide decision makers in decision making.

2. Material and method

For designing a data warehouse, the two most commonly discussed methods are the approaches introduced by Bill Inmon [2] and Ralph Kimball [3]. Debates on which one is better and more effective have lasted for years. Both philosophies have their own advantages and differentiating factors, and enterprises continue to use either of these. For these research, we will use the Top Down design, a Bill Inmon's enterprise data warehouse approach [2]. This method proposes a three-step approach that starts from the needs of the decision-maker to the multidimensional needs diagram. The resulting schema will be transformed into a logical data model for the construction of the cubes.

Business Intelligence (also known as Decision Support System, or BI) refers to the means, tools, and methods that make it possible to collect, consolidate, model, and retrieve data, material or immaterial, of an enterprise in order to provide decision support and to allow business strategy managers to have an overview of the activity being addressed [1].

2.1. Data sources

Business data is often stored in one or more relational or non-relational databases. Data sources are diverse and varied and the goal is to find ETL tools "Extract, Transform, Load" to extract, clean, transform and put them in the data warehouse. Data sources feed decisionmaking systems and consist of relational DBMSs and other files that constitute operating data sources (Excel file, XML file, CSV file, flat files, etc.).

This data must be extracted, transformed and loaded into a *data warehouse*. Data stores or datamart are subsets of the data warehouse that are business oriented (business function) [4].

The decision-making system architecture is composed of four main parts (Fig.1): data sources, data warehouse, OLAP server (a technology designed to obtain summary reports and to help management to have a cross-sectional view of a company's business) and visualization tools.

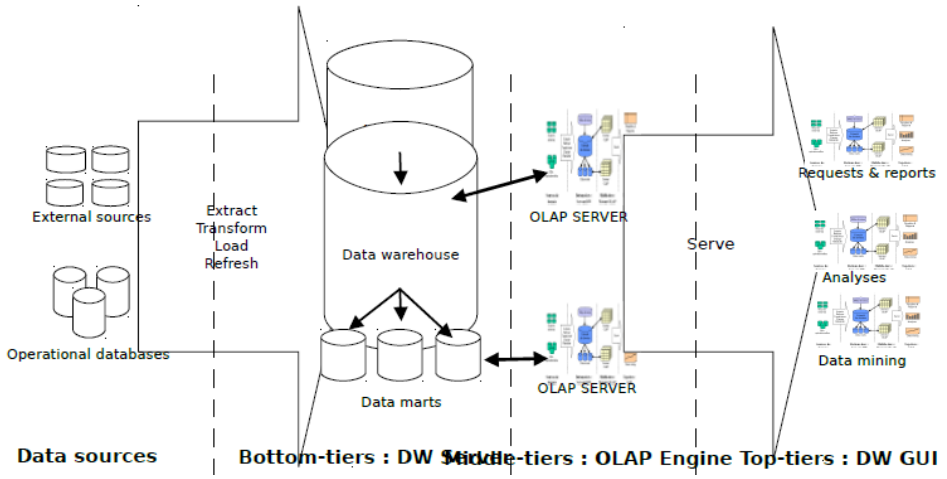

Fig. 1. Decision-making system architecture [4]

2.2. What is a data warehouse?

Bill Inmon defines data warehouse as follows: "A data warehouse is a collection of topicoriented, integrated, nonvolatile, time-scalable data organized for a data warehouse decision help process" [2].

- *Subject oriented data:* A data warehouse is organized around the main themes of the organization, unlike the transactional approach used in operational systems that are designed around applications and functions such as: credit cards, customer creditworthiness, resources human, public health...

- *Integrated Data*: Data comes from different sources. This requires managing any inconsistencies (data format, nomenclature, data aggregation, ...)

- *Time-variant*: different values of a given data are kept to make comparisons and the follow-up of the evolution of values over time. In a data warehouse, each value is associated with a time.

- *Non-volatile data*: this is the consequence of the historization. In an operational environment, data may be updated or deleted, but such operations do not exist in a data warehouse.

- *Organized data for a decision-making process*: data are organized in such a way to allow the execution of decision support processes (Reporting, Data Mining ...).

3. Results

3.1. Introduction

Multidimensional modeling involves considering an analyzed subject as a point in a multidimensional space. The data is organized in such a way to highlight the analyzed subject and the different perspectives of the analysis. In [5], the author shows that habitual relational modeling becomes unsuitable for decision making and OLAP-type multidimensional analysis.

The goal of **data warehouse modeling** is to provide abstractions to detach how to represent data from their physical layout. The use of decision-making systems (decision analysis via OLAP processes) requires different data representations from those proposed in the production databases [6].

3.2. Data warehouse dimensional modeling

This paragraph is devoted to the needs analysis and the design of the entire data warehouse. We will define the different elements that contribute to its realization.

3.2.1. Conceptual level

The conceptual level of multidimensional modeling is used to describe the multidimensional database of the data warehouse regardless of the implementation choices, it determines the elements we need for the realization of the data warehouse.

The goal of this approach is to design a multidimensional framework based on the needs of decision makers and management rules for decision data [7]. It has three stages; (1) data collection, (2) needs specification and (3) needs formalization.

(1) Needs collection

In this step, we determine initial decision needs by defining the types of information that may be of interest to each group of decision makers. We then collect relevant **standard queries** by interviewing decision makers, developing a **questionnaire** to better characterize their needs, and analyzing decision data, interview results, and questionnaires to identify the **business rules** applied to those data.

a. Standard queries

Standard queries can be collected from old analysis reports or by interviewing decision makers. We propose here a pseudo-language of structuring of the requests which makes it possible to facilitate the definition of the needs on the basis of three clauses which answer to different types of questions. The **Analyze** clause answers the question **What**? It defines the data to be analyzed. The **According To** clause answers the questions **Who**? **Where** ? **When**? It indicates the parameters of the analysis. Finally, the **For** clause answer the question **For Whom** or **What Data**?

- The **ANALYZE** clause

To best respond to this clause, our analysis focuses on three phenomena: births, deaths and displacements of the population.

a1. The **ACCORDING TO** clause

The topics of analysis mentioned above are focused on several parameters. The response to the ACCORDING TO clause defines the different data analysis parameters. This answer goes through three questions:

- **WHO**: the analysis concerns patients giving birth, newborns, deceased persons and displaced persons.
- **WHERE**: in the city of Lubumbashi.
- **WHEN**: from the year 2013 to the year 2017 period.

a2. The **FOR** clause

This clause refers to the data analyzed in the system for decision making. It also allows you to restrict the data by defining analysis parameters. For example, saying that the analysis will cover a four-year period from 2013 to 2017.

The standard queries predefinition is carried out in the Table 1.

b. Questionnaire

In business intelligence, the questionnaire is a data collection tool in which the decision maker is guided through a set of questions in order to obtain precise information necessary for multidimensional modeling. This questionnaire must allow to modify and possibly add new elements in standard queries. After data collection, we found that policy makers also want to analyze births and deaths by age group. Hence the addition of a new analysis axis "Group-Age".

Table 1

Analyze		According to	For
Birth	R1	The mothers age	Year 2016
	R2	Childbirth type	The month of March
	R3	Hospitals	The Ruashi[2] commune
	R4	Newborns conditions	The feminine gender
Death	R5	Death cause	The rainy season
	R6	Death age	Age less than 25
	R7	Age group	The Death type
Displacement	R8	The destination	Reason for study
	R9	The province	Roadways

[2] Ruashi is one of the seven communes of the city of Lubumbashi

c. Business rules

The management rules govern the information system. These rules are often represented as constraints that must be respected to enable the operational system to function properly. This step is carried out in parallel with the two previous steps: queries and questionnaires.

Among the management rules in an operational system, we find:

- A mother can give birth to one or more newborns
- A newborn belongs to one and only one mother
- A newborn can be born with one or more anomalies
- A mother can give birth by high or low way
- A death can be accidental or not
- A death always has a cause

(2) Needs specification

At the output of the previous step, we obtain a list of standard queries formulated in our pseudo-language and a set of management rules. The specification step allows the data collected to be analyzed to specify the needs of the decision makers. These needs will be organized in terms of parameters and measures to prepare the definition of the multidimensional scheme.

a. Needs matrix

From the simplified formulation of the requests describing the needs of the decisionmakers, we define the needs matrix in three stages. A step of constructing a square matrix according to the properties of the analysis extracted from standard queries. A step of filling the matrix to characterize the properties linked by an analysis relation based on the standard queries; the Analyze clause is used to indicate the analyzed properties, while the According to and For clauses allow you to extract the properties that parameterize the analysis.

In the matrix, each box marked (ok) indicates that the online property is analyzed according to that in column (Table 2).

After this simplification, we can find properties that are both indicators and parameters. To deal with this particular case, we proceed to a new reading of the matrix to show if these properties are used as indicators or as parameters. We note that the type of property can determine its nature; the indicators are numerical properties while the parameters are textual descriptors [2].

Table 2.

	Region	City	District	Commune	Year	Month	DaysNumber
Age							
Birth number	ok	ok	ok	ok	ok	ok	ok
Birth rate							
Death number	ok	ok	ok	ok	ok	ok	ok
Child mortality rate	ok	ok	ok	ok	ok	ok	ok
Old-age mortality rate	ok	ok	ok	ok	ok	ok	ok
Displacement rate	ok	ok	ok	ok	ok	ok	ok
Displaced number							

(3) Needs formalization

After collecting and clarifying the needs of the decision makers, we realize in this step the formalization of these needs in the form of a multidimensional diagram.

a. Transformation of the needs matrix

At this level, we propose to formalize the needs specified in the previous steps as a multidimensional scheme.

a1. Facts definition

The determination of the subjects of the analysis makes it possible to draw up the list of facts of the multidimensional model. During this step, we group the measurements into facts (analysis subjects).

The definition of the facts can be done automatically by grouping the analyzed measurements through identical parameters. At this point, we also define the aggregate functions compatible with each measure from the questionnaires. However, before we can determine all possible analysis topics, we will give some golden rules of the fact tables. There is a list of rules that must be followed to determine fact tables while saving time and design [8]. We group the measures in the facts Birth, Death and Displacement. For each of these measures, we define the aggregation functions needed for the analysis.

- Birth (Fact):

	Measures	Aggregation function
1	MotherAge	AVG, MAX, MIN[3]
2	BirthRate	
3	LivingBirth	SUM, AVG,
4	BornDead	SUM, AVG
5	MotherTotal	SUM, AVG
6	BirthTotal	SUM, AVG

3 AVG : Average, MAX : Maximum, MIN : Minimum

- Death (Fact):

	Measures	Aggregation function
1	DeceasedAge	AVG, MAX, MIN
2	MortalityRate	
3	DeathTotal	SUM, AVG

- Displacement (Fact):

	Measures	Aggregation function
1	MobilityRate	
2	DisplacementTotal	SUM, AVG

a2. Dimensions definition

This step realizes the automatic regrouping of the parameters in dimensions (axes of analysis), the enrichment of these dimensions by new properties such as the weak attributes which will be grafted to the different dimensions of the analysis and the definition of the granularity of the analysis by choosing the best level of analysis for each dimension. The analytical power of the warehouse is proportional to the richness and quality of the dimensional attributes [9].

The automatic grouping of the parameters generates the dimensions (D1, D2, D3, D4) (Table 3). The analysis of these dimensions makes it possible, for example, to divide the dimension D2 into four dimensions: Address, Patient, BirthType and GroupAge. The denomination of the dimensions is made by the designer according to this information.

At the data collection stage, we enriched the dimensions of the analysis with the information collected in the questionnaires. Thus, a patient is characterized by his name, his first name and his address.

a3. Hierarchies definition

This step consists of organizing the parameters of each dimension in the hierarchies [10]. This operation is performed from the questionnaire and the management rules defined during the data collection step. For the Month dimension, for example, we define two hierarchies: one for the season and one for the year.

a4. Definition of the multidimensional requirements schema:

We realize the automatic attribution of the dimensions to the facts from the needs matrix. Each dimension with parameters that have intersections with an indicator of a fact is assigned to this fact.

In addition to the flake model that normalizes dimensions, there is another model called "star", which consists of a single fact table, one of the dimensionless tables. This model is suitable for the "top-down" approach of multidimensional modeling [10].

b. Model in FLOCON

This model is derived from that of the star. However, dimension tables are normalized and redundancies eliminated (Fig. 2).

c. Construction of data marts with the model in FLOCON:

- Data mart for Birth (Fig. 3);
- Data mart for Death (Fig. 4);
- Data mart for Displacement (Fig. 5).

4. Discussion

The approach to designing a data warehouse depends on the business objectives of an organization, nature of business, time and cost involved, and the level of dependencies between various functions. Top down approach is suitable for stable businesses that can afford the time taken for design and the cost involved. Also, with every changing business condition, they do not change the design; instead, they accommodate these into the existing model.

The bottom up approach introduced by Ralph Kimball [3] could give us too another design of the data warehouse with its advantages and disadvantages, but the most important thing for consolidating data was to design an unique database composed of three data marts in order to made easy the decision-making process.

Table 3.

Automatic grouping	Enrichment	Granularity of the analysis
D1 (Id-patient) **D2** (city, province, region, district, commune, year, id-patient, cesarean delivery, gender, ageGroup) **D3** (gender) **D4** (city, province, region, district, commune, year, month, ageGroup, age, deathcause) **D5** (displacementreason)	Dim hospital (idHospital) Dim Patient (idPatient) Dim delivery type(idType) Dim birth type (idBirthType) Dim baby (idbaby) Dim anomalies (idanomaly) Dim agegroup () Dim dead (iddead) Dim death cause () Dim death type (accidental, nonaccidental) Dim morgue (idmorgue) Dim displacementtype () Dim displaced (iddisplaced) Dim adress (city, region) Dim time (month, year)	Dim hospital (idhospital, name, TypeHospital) Dim Patient (idPatient, name, first name, gender, phone number, civil status) Dim deliveryType (idType,deliveryType) Dim birthType (idBirthType, birthType) Dim Baby (idBaby, name, firstname, gender, weight, size, eyesColor) Dim Anomalies (idAnomalie, name, Cause) Dim AgeGroup (IdGroupe, AgeGroup) Dim dead (idDead, deadName, firstNameDead, gender) Dim deathCause (idCause, name) Dim DeathType (IdDeathType, typeName) Dim Morgue (idMorgue, name) Dim displacementType (idDisplacementType, name) Dim displaced (idDisplaced, name, firstname) Dim Adress (Idcity, region, district, commune, number) Dim time (idtime, day, week, month, year)

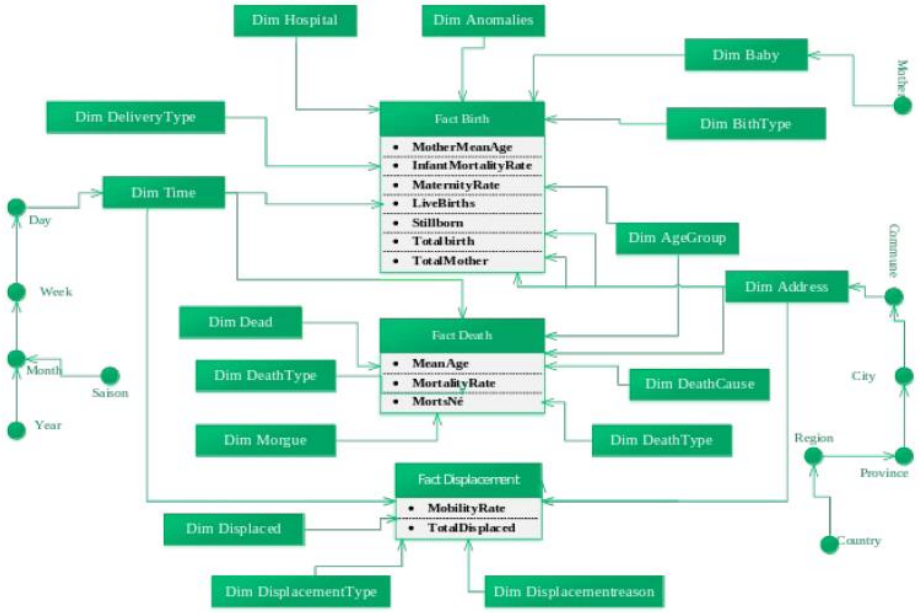

Fig. 2. Need multidimensional schema

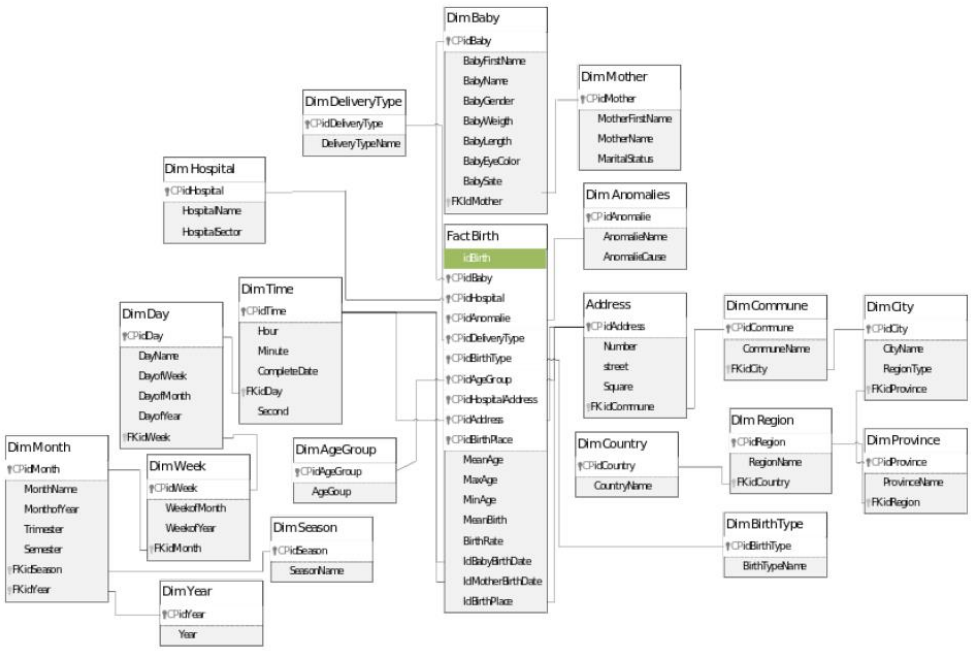

Fig. 3. Data mart of Birth in model of FLOCON

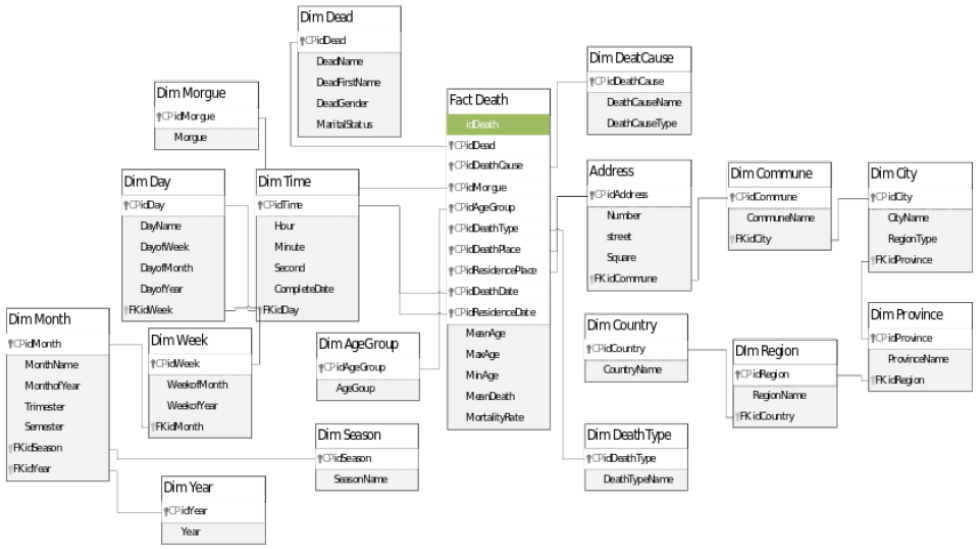

Fig. 4. Data mart of Death in model of FLOCON

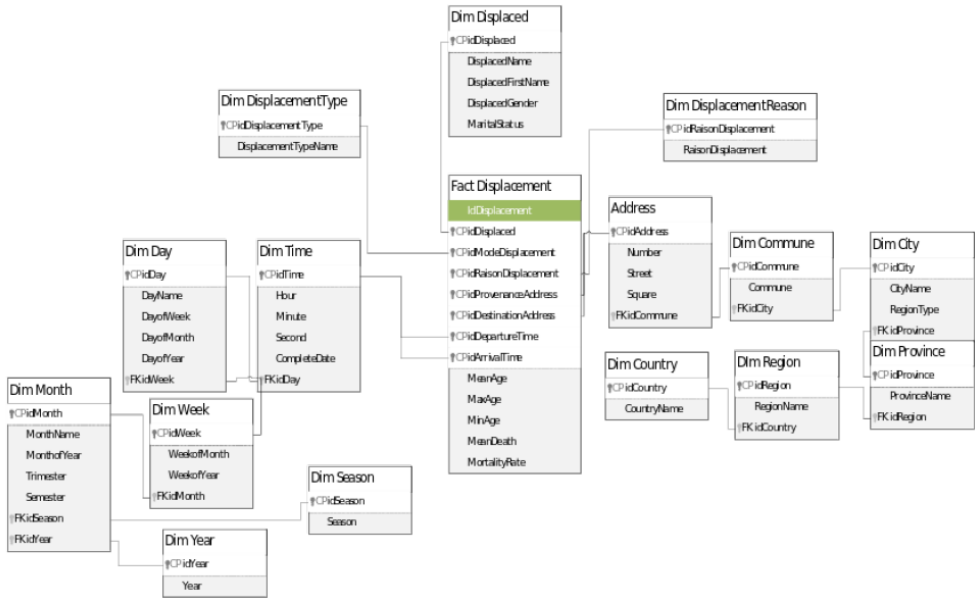

Fig. 5. Data mart of Displacement in model of FLOCON

5. Conclusion

Thanks to the top down approach, we built a data warehouse for the management of the city of Lubumbashi through three facts: Birth, Death and displacement of population.

The approach to designing a data warehouse depends on the business objectives of an organization, nature of business, time and cost involved, and the level of dependencies between various functions. Top down approach is suitable for stable businesses that can afford the time taken for design and the cost involved. This approach has disadvantages such as: the heaviness of the design, the time constraint and requires many design constraints. This data warehouse will provide precise information to the mayor of Lubumbashi city and his staff can for good decision-making in the management of the city.

We would like also to do a regressive model for prediction, but this approach will be done in another publication.

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Advanced Structural Organization of the Signal Recovery Processes in Measuring Systems

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Abstract. Algorithms of digital filtration for suppression of weak nonlinear dynamic and nonlinear static distortions in continuous signals' registration and transmission devices are considered. Aspects of computing process' stability and accuracy provision are investigated. Results of numerical experiments are represented. Examples of practical application in control systems and communication are demonstrated.

Key words. Measuring systems, Digital filter, Restoration of signals, Nonlinear dynamic distortions, Stability.

1. Introduction

At present, the application of computer-integrated approach in various technical devices and control systems has become the habitual phenomenon. The special interest is represented with cases where the digitalization way of improvement of their physical, technological and economical properties has no alternative. Application of analogue or digital filters for correction of dynamic characteristics of the element in system allows to reduce the technical requirements to this element. It frequently allows not only to reduce the cost of the whole system, but also to improve its basic technical parameters essentially. Here, as examples, it is relevant to mention the inertial measuring converters or executive elements, communication line with large attenuation etc.

There is a wide spectrum of powerful math methods and computer tools for solving such problems [2-5]. However, known computer algorithms do not always provide the effective usage of this equipment. This problem is not only the question how to solve a computing problem, but mainly how to formulate it.

The majority of computing problems arising in this case can be divided into two classes: the direct problems and the inverse ones. In technical systems the solution of an inverse problem usually name as recovering of signal $x=By$. The initial data are the output signal y and mathematical model of investigated object A. The block which solves this problem is named as the block of realization of the inverse operator $B=1/A$, and the block, which solves a direct problem of simulation of object $y=Ax$, is named as the block of realization of direct operator A.

One of the effective methods of solving the signal recovery problem is the inverse operators' method. The essential feature of this method is the explicit using of the direct operator for obtaining the inverse one. As a rule, block A is an element of one of feedback circuits in the structure of block B [1].

The concept of direct and inverse operators is especially often used in the theory of ill posed problems solving. The solution of these problems is characterized by instability or high sensitivity to errors of the initial data. These problems are also called as inverse because their

sense consists in recovering the input signal of the inertial measuring device from its registered output signal. On the contrary, the direct problem of simulation of such measuring device (or realization of the direct operator) is correct. This problem is characterized by insensibility to initial data errors that is rather rough measurements are allowed.

The most important advantage of the inverse operators' method is the technology of construction of stable computing process, which realizes unstable (complex) inverse operator on the base of explicit application of stable (simple) direct operator. Moreover, the inverse operators' method allows organizing two independent loops for adaptation the block *B* to the processes of ageing of the object A model and changing the errors quality [1].

2. Examples of Application in Technical Systems

In control systems, the problem of maintaining the stability is good-enough solved by known classical methods with the selection of regulator parameters at realization of a principle of a deviation control. However, the necessity of use of the inverse operator arises at realization of more simple principle of specifying influence control. It is necessary not for increasing the stability of a control system, but contrary for decreasing its roughness. Introduction of the inverse operator allows to solve automatically one more problem which is paid not enough attention in the theory of automatic control. It is a problem of dimensions. And not only in sense of discrepancy in dimensions of physical values on the input and output of controlled object, but also in the sense of discrepancy in number of inputs and outputs of this object.

The usual combined control system from proportional and specifying action can be represented in two variants: Fig. 1 and Fig. 2. Here *X* is input, and *Y* is output signal of controlled object *B*, *RB* is computing model of the inverse operator of this object, *I* is inverter, *S* is adder, *R* is regulator.

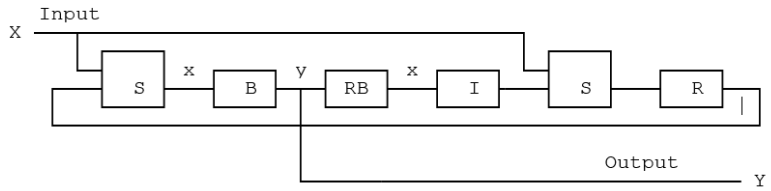

Fig. 1

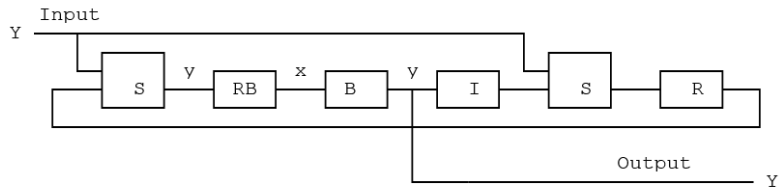

Fig. 2

In the case when block *RB* is instantaneous element with unit gain (*RB*=1) the both structures Fig. 1 and Fig. 2 coincide completely.

In case when *R*=0 the specifying action control is realized. In case of switching-off of the first adder input, the second input of which is connected to output of regulator, the proportional action control is realized. The structures Fig. 1 and Fig. 2 differ only by a place of connection of block *RB*. Block *RB* carried out some of standard functions from the block *R*,

for example, differentiation or integration. A case when R=1 is quite possible, when block *RB* carried out all functions according to robustness and stability balance of control.

The organization from output is especially convenient at control of multi-connected objects. For example, usual carburetor engine has at least two outputs: tachometer (crankshaft rotation speed) and flow-meter (fuel consumption). Inputs are the structure of a combustible mix (ratio petrol/air) and the ignition timing. The classical control circuit consists in control from the first input (at RB=1) with organization of a feedback of the first output on the second input. However, it is possible to organize the control from the first, or on the second output. In the first case the dynamics of automobile control is improved, and in the second case the fuel consumption decreases.

The algorithms of realization of the inverse operator are important not only for increasing the efficiency of power-intensive equipment operation. Let's represent some other examples of their use: increasing the resolution of observation systems; increasing the speed of information interchange in communication lines (compression of spectrum at digital transmitting of continuous signals, multi-tone coding); increasing the capacity of telephone exchange by reduction of signal recognition time in tone dialing; increasing the information capacity of information recording devices (magnetic and thermoplastic record); for images recognition in technical diagnostics by transients; for synthesis of band-pass filters [1].

The special attention can be paid to full-scale `semi-virtual reality-type simulators, where simplified (base) object plus computer plays the role of complex object. In Fig. 3 the block diagram of such simulator is presented, where U are control signals, which the person generates acting on controls, block *RB* realizes the inverse operator the base object mathematical model B, M is computing model of simulated object, Z are output signals of object or model.

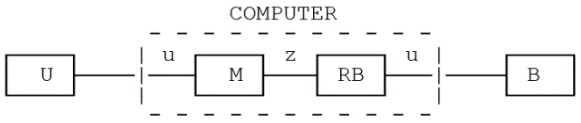

Fig. 3

The inverse operators' method also useful in construction of numerical algorithms for solving the various applied problems.

3. Simple Numerical Experiment

As a simple example, we can consider the calculation of square root as inverse operation to square. This numerical experiment demonstrates an opportunity of application of the inverse operators' method not only to solving the problems for linear dynamic systems or systems with weak nonlinearity usual in applications mentioned above, but also for essentially nonlinear problems. Certainly, the known classical algorithms for of a square root calculation are better in many senses, except one: they cannot be applied to calculation of other inverse functions. There is one more parameter, on which there may be superiority in comparison with traditional algorithms. It is balance of accuracy and speed.

The analogue prototype of our digital filter is the known circuit with connection of the direct operator in a feedback of operational amplifier (Fig. 4), where B is the object, described by direct operator, M is mathematical (electronic) model of this object, *OA* is operational amplifier, *OR* are operational resistors, I is inverter. The dotted line leads round blocks, which form block *RB*, which carries out the inverse function relative to object. In other words,

according to the object signal and its mathematical model this block restores the input signal of object. However, this structural diagram cannot be converted into discrete form explicitly. That is why the similar analogue structures received the name 'non-algorithmic' [1].

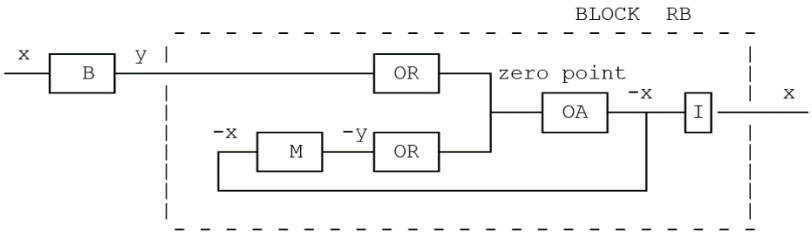

Fig. 4

In Fig. 5 other variant of this computing structure transformed to algorithmic form is represented. Here S is adder, I is inverter, R is regularization unit (linear instantaneous element with gain r). In fact, the second adder is accumulator (there is the feedback on its second input). This circuit is realized in digital computing elements, but already it cannot be realized in analogue ones.

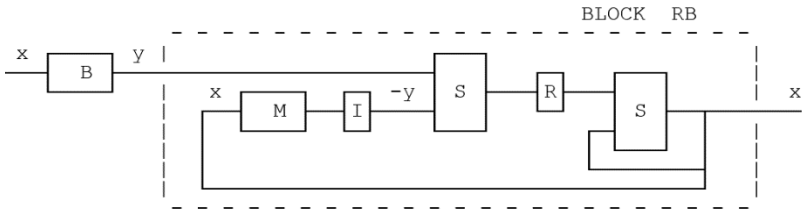

Fig. 5

In other cases, e.g. for dynamic objects (differential or integral equations) the block *RB* has another structure (Fig. 6) and allows both types of realization (analogue and digital or non-algorithmic and algorithmic). Here the regularization unit not only limits the magnitude of residual between the output signals of object and its model, but also limits the amplification in a loop of positive feedback by restored signal. The modification of these structures with several regularization units also represent the practical interest.

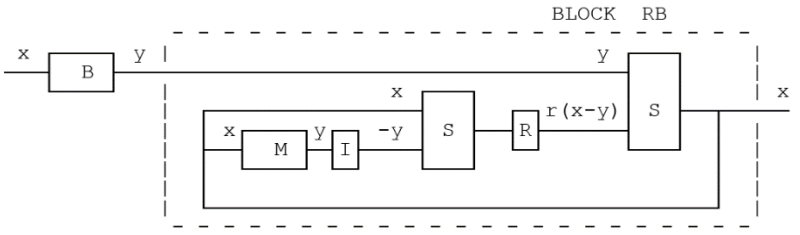

Fig. 6

The structural diagrams Figs. 5 and 6 can be easily converted into corresponding recurrent formulas:

$$x(i) = x(i-1) + r\left(y(i) - M(x(i-1))\right), \quad (1)$$

$$x(i) = y(i) + r\left(x(i) - M(x(i-1))\right), \quad (2)$$

where y is output signal and x is input signal of computing process, M realizes the mathematical model of direct operator, and r is regularizing parameter. In the case of square root calculation $M(x)=x^2$, and we have two additions and two multiplications at the iteration step. Due to the double recursion by calculated output signal the term bi-recursive digital filter (BRDF) can be used to characterize such algorithms realizing the inverse operators' method in application to signal recovery problems. In mathematical literature (1) corresponds to Friedman iterative regularization, and (2) corresponds to Lavrentyev algorithm respectively.

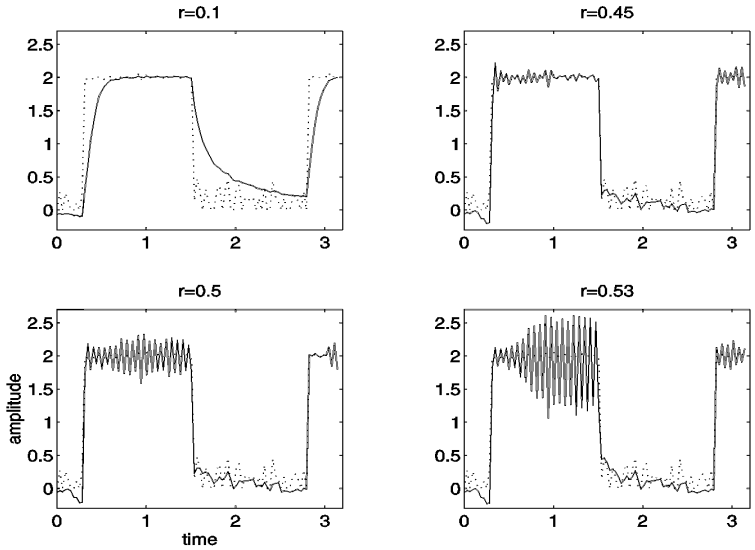

Fig. 7

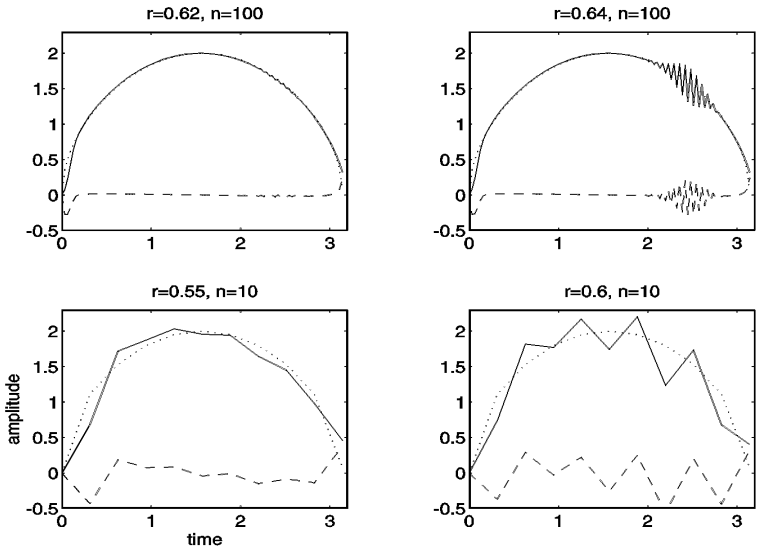

Fig. 8

The graphs in Figs. 7 and 8 represent the results of restoring the squared signal using BRDF with one iteration at every time step. The initial time interval was divided into 100 discrete intervals. In Fig. 7 the initial signal $x(t)$ was rectangular meander with addition of normal white noise having the amplitude 0.1 of initial signal. Fig. 8 corresponds to the un-noised sinusoid. In both cases, magnitude of initial signal was 4. Dotted lines correspond to standard function $sqrt(x)$.

Graphs in Figs. 7 and 8 show that parameter r has the influence on the stability of computing process. At variations of magnitude and type of signal or characteristics of noise, it is possible to choose such r, which provides the best balance of stability and accuracy of computing process. The instability especially appears in places of fast amplitude variations or sign of initial signal derivative. At change of digitalization step, the balance of accuracy and stability of calculations on BRDF algorithm will change, while the traditional algorithm does not have such property. With increasing the quantity of digitization units, the accuracy, naturally, grows, and for providing the stability it is necessary to change the regularizing parameter r.

4. Experiment

The results of given numerical experiments show that for advancing the structural organization of the signal recovery processes in measuring systems proposed BRDF algorithm can be effectively used, which demonstrates the major advantage in achieving high performance, which is particularly critical for real time signal processing.

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The Challenge of Technical and Non-Technical Loss Detection Using Fuzzy logic: A Survey of the Electric Power System in Albania

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Abstract. Calculation and analysis of technical power losses, as well as measures to reduce them represent important task and challenge to the distribution system. The losses in distribution networks have always been key elements in predicting investment, planning work, evaluating the efficiency and effectiveness of network. Optimization of technical losses in electricity transmission and distribution grids is an engineering issue, involving classic tools of power systems planning and modeling. The driving criterion is minimization of the net present value (sum of costs over the economic life of the system discounted at a representative rate of return for the business) of the total investment cost of the transmission and distribution system plus the total cost of technical losses. Technical losses are valued at generation costs. Non-technical losses represent an avoidable financial loss for the utility. Although it is clear that the amounts of electricity involved in non-technical losses are being consumed by users that do not pay for them, experience shows that a significant percentage of those amounts (in some cases more than 50 percent) becomes reduced demand when those users have to pay for that electricity, because they adjust their consumption to their ability to pay for electricity services. That reduction in demand has exactly the same effect as a reduction in technical losses: less electricity needs to be generated. Thus, from the country's perspective, reductions in non-technical losses are also positive.

Keywords. Forecasting, Technical losses, Non-Technical losses, Fuzzy logic,

1. Research Motivation

Our modern society and daily sctivities srtongly depend on the availability of electricity. Electrical power grids allow to distribute and deliver electricity from generation infrastructure such as power plants or solare cells to consumers such as residences or factories. One frequently appearing prolem are losses in power grids, which can be classified two categories:technical and non-technical losses.

Power system losses can be divided into two categories: technical losses and non-technical losses.

Technical losses are naturally occurring losses (caused by actions internal to the power system) and consist mainly of power dissipation in electrical system components such as transmission lines, power transformers, measurement systems, etc. Technical losses are possible to compute and control, provided the power system in question consists of known quantities of loads. In this thesis, it will be argued that the distortion of load quantities caused by NTL will distort the computations for technical losses caused by existing loads, thereby rendering any results ineffectual.

Non-technical losses (NTL), on the other hand, are caused by actions external to the power system, or are caused by loads and conditions that the technical losses computation

failed to take into account. NTL are more difficult to measure because these 3 losses are often unaccounted for by the system operators and thus have no recorded information. The most probable causes of NTL are:

- Electricity theft
- Non-payment by customers
- Errors in technical losses computation
- Errors in accounting and record keeping that distort technical information

Total losses in OSHEE network consist of technical and non-technical losses as following in Fig.1.

In electricity supply to final consumers, losses refer to the amounts of electricity injected into the transmission and distribution grids that are not paid for by users. Total losses have two components: technical and non-technical. Technical losses occur naturally and consist mainly of power dissipation in electricity system components such as transmission and distribution lines, transformers, and measurement systems. Non-technical losses are caused by actions external to the power system and consist primarily of electricity theft, non-payment by customers, and errors in accounting and record-keeping. These three categories of losses are respectively sometimes referred to as commercial, non-payment, and administrative losses, although their definitions vary in the literature.

Metering and billing for electricity actually consumed by users is integral to commercial management of an electricity utility. Another critical task is collection of the billed amounts. Effective performance in both functions is critical to ensure the financial viability of the company. From the operational point of view, metering-billing and collection are separate functions and they require specific management approaches.

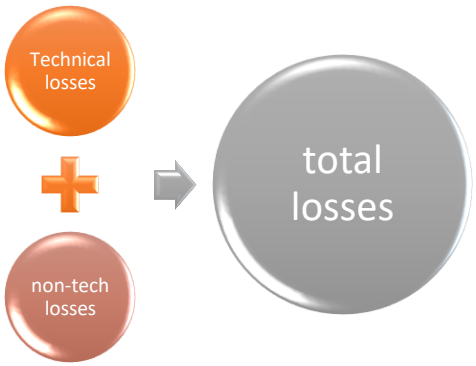

Fig.1.

Below gives summaty results of total losses values in the OSSH network. The main figures of the calculation, regarding the volume of losses in the OSSH grid, are:

- Total system losses: 28.04 % (with represents 1 794 451 MWh)
- Total technical losses: 19.08 % (1 190 872 MWh)
- Total non-technical losses: 8.96% (447 951 MWh)

Graphs showing energy distribution at the OSSH distribution network will be presented.

Technical losses make up approximately 27% of total losses and, of the rest almost consists of non-technical losses (Fig. 2).

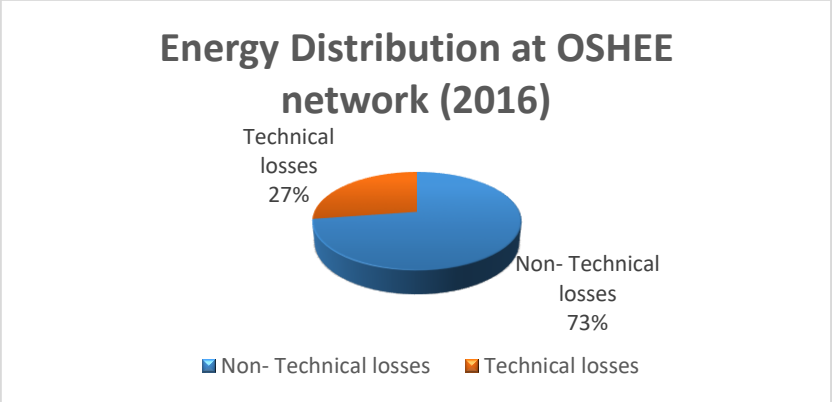

Fig.2.

As result of our detailed calculation at all levels which takes into account energy inputs, own consumption and sales at individual voltage levels an uses them to detailed calculation of tecnical losses for network elements. Thus the model calculates total losses and tevhnical losses for each individual network element. Non –technical losses are calculated at totale level.

Our approach calculatet, in addition to above mentioned dimensions of network elements and voltage level, detailed numbers on zones level as to better understand the structure of the losses (Fig.3).

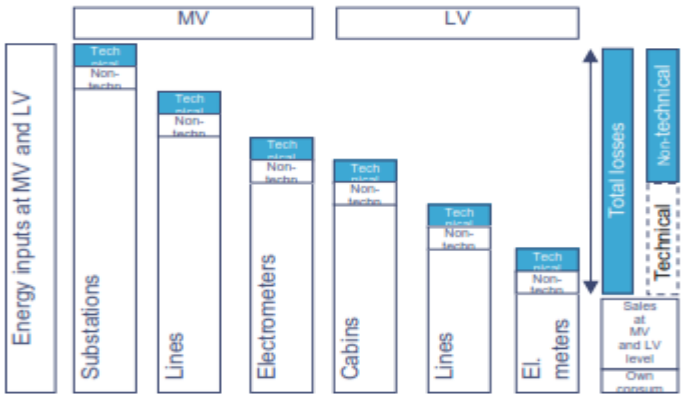

Fig. 3. Technical and non- technical losses at level

2. Introduction

The calculation technique of losses is based on the technical information provided for each voltage level in combination with the iterative and direct methods using the calculation programs by which the modeling of technical losses is performed. Technical losses in the distribution network in Albania are divided into three levels of tension (Fig. 4.).

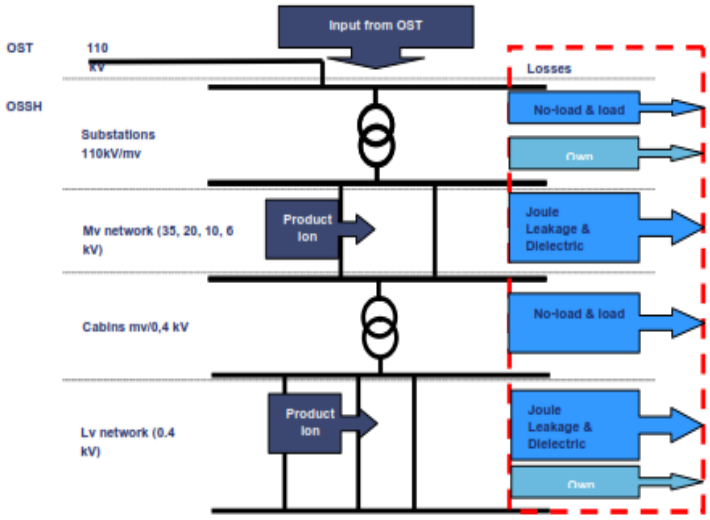

Fig. 4.

Technical losses occur mostly due to power dissipation. This is naturally caused by internal electrical resistance and the affected components include generators, transformers and transmission lines.

- High voltage (HV) which includes electrical substations in 110/35/ kV, 110/35/10/6 kV, 110/20/ kV as well as transmission lines 35kV
- Medium voltage (MV) that includes transformation cabin 20/0.4kV, 10/0.4kV, 6/0.4kV and feeders 6/10/20/kV
- Low voltage (TU) which includes low-voltage power transmission lines.

Purchases inflows into the OSSH network when OSSH purchases energy from OST at HV and MV level as well as from small producers. Hourly data measured received from OST were reconciled with OSSH values and were further split between individual voltage levels and zone.

Own consumption represents energy outflow and was based on the data provided by OSSH.

Sales represent energy outflow in the form sales to commercial customers at MV and LV level and households at LV level.

Assembling daily profiles

The power flow was used to get maximum power at each voltage level and thus allow the consumption of full time load and full time losses for each voltage level.

The picture below illustrates the basic principles of creating load diagram. The first load profile (black line) is he load profile which was constructed from measured values in delivery points. It is the sum of partial profiles of each delivery point in the zone representing the base diagram. The curves of other inputs and outputs are then derived from it.

No-load losses are constant value. The profile of load losses is given by the load profile.

Illustration of assembling load curves (Fig. 5 and Fig. 6.).

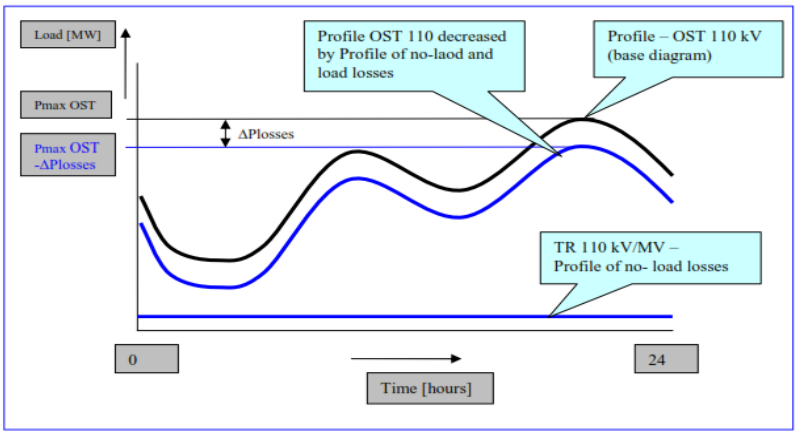

Fig. 5.

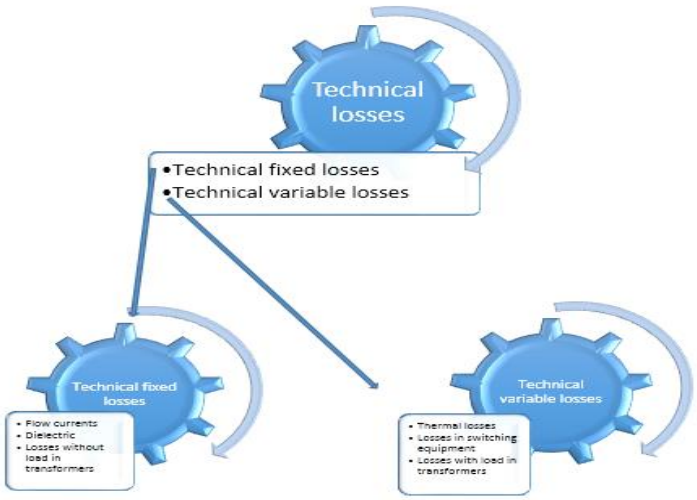

Fig. 6.

Technical losses of high-voltage TL power represent losses in electrical substations 110/35kV, 110/35/10/6/kV, 110 /20kV as well as transmission lines 35kV.

To determine the technical power losses, the monthly energy balance for the high voltage switchboard is based on the electrical network of the network operation and the metering points of the electricity with the OST and local HPP connected to The 35 kV m bay of the substation. This balance has two components:

1. **The energy purchased by DSO** representing the electricity transmitted through the OST electrical network, the energy measured through the 147 metering points installed in the 110 kV as well as the energy purchased from local power-related manufacturers as well as energy purchased from local power producers connected to 35 kV of electrical substations.

2. **The consumption of electricity** that consists of electricity consumption of receivers 6/10/20/kV together with the energy produced by the HPP connected to us 6/10/20 kV of the electrical substations measured by the meters of the respective electrical substations; consumption for substantive needs as well as consumption of connected customers in the network 35kV.

3. Non-technical losses

The complementary non-technical losses (NTL) are primarily caused by electricity theft. In most countries. In Albania technical losses account for the most of the total loss: About 30% of the total loss consists of non-technical losses, in A**lbani**a technical losses are very problematic

- Meter tampering in order to record lower consumptions
- Bypassing meters by rigging lines from the power source
- Arranged false meter readings by bribing meter readers
- Faulty or broken meters
- Un-metered supply
- Technical and human errors in meter readings, data processing and billing

NTL cause significant harm to economies, clouding loss of revenue and profit of electricity providers, decrease of the stability and reliability electrical power grids and extra use of limited natural resources which in turn increases pollution.

NTL detection methods reported in the literature fall into two categories: expert systems and machine learning. Expert systems incorporate handcrafted rules for decision making. In contrast, machine learning gives computers the ability to learn from examples without being explicitly programmed. Historically, NTL detection systems were based on domain-specific rules. However, over the years, the field of machine learning has become the predominant research direction of NTL detection. To date, there is no authoritative survey that compares the various approaches of NTL detection methods reported in the literature. We are also not aware of any existing survey that discusses the shortcomings of the state of the art. In order to advance in NTL detection, the main contributions of this survey are given.

4. FES implementation

The fuzzy expert system (FES) consists of a set of rules. These rules are developed in a standard way. Different rules are designed and defined to determine the suitable node at which DG could be placed in fuzzification process. In the fuzzification process, the power loss factor (PLF) and voltage index (VI) are converted into fuzzy. Linguistic terms for power loss factor (PLF) is described by very low (VL), low (L), medium low (ML), medium high (MH), high (H), very high (VH) and linguistic terms for voltage index is described as low (L), medium low (ML), medium (M), medium high (MH), high (H). Different membership functions are generated to represent all these linguistic terms. Trapezoidal type membership functions are used in the following fuzzy expert system and they are shown in the Fig. 7 and Fig. 8 respectively. The power loss factor (PLF) and the voltage index (VI) are the two inputs to the fuzzy (FIS), which determines the optimal position for allocation of DG by fuzzy inferencing. The inference involves heuristic rules for the determination of output decisions. In this fuzzy inference system there are two input variables (PLF, VI) and (7, 5) fuzzified variables respectively so that the fuzzy inference system has a set of 35 rules.

The DG unit is allocated in a radial distribution system in such a way that power loss factor should be maximum and the voltage index should be minimum. These two objectives

are more important while designing the heuristic rules for fuzzy inference system (FIS). All these rules are expressed as the following way.

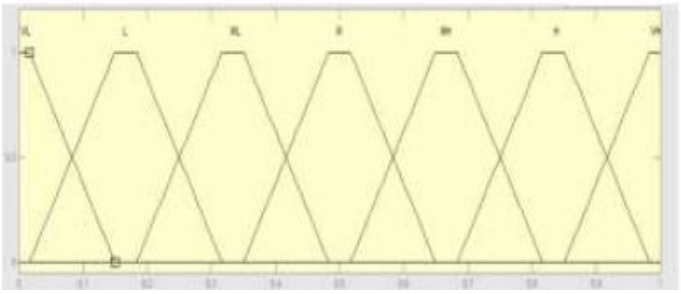

Fig. 7 Power loss factor membership functions

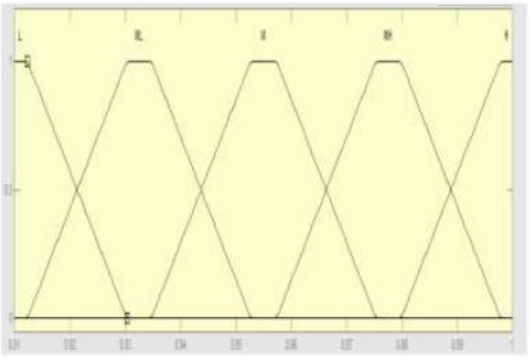

Fig. 8 *Voltage index membership functions*

IF premise (antecedent).THEN conclusion (consequent). To determine the DG suitability at a node a set of fuzzy rules have been employed. The rule base for optimal DG placement is presented in the fuzzy decision matrix shown in Table 2 and illustrated in Fig. 10. The output of fuzzy inference system is DG placement suitability index and it is also described by the linguistic terms very low (VL), low (L), medium low (ML), medium (M), medium high (MH), very high (VH). These linguistic terms are also represented by membership functions and it is shown graphically in Fig. 9.

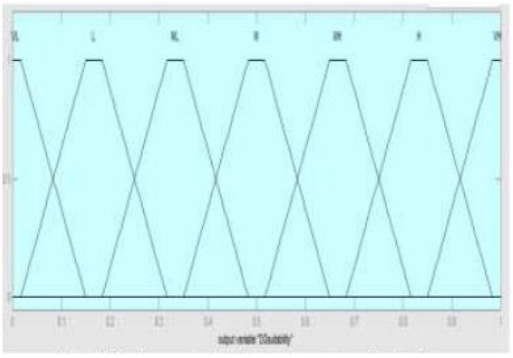

Fig. 9. DG placement suitability index membership functions

TABLE II
FUZZY DECISION MATRIX

AND		Voltage index (VI)				
		Low (L)	Medium Low (ML)	Medium (M)	Medium High (MH)	High (H)
Power loss factor (PLF)	Very Low (VL)	VL	VL	VL	VL	VL
	Low (L)	VL	VL	VL	VL	VL
	Medium Low (ML)	M	ML	L	VL	VL
	Medium (M)	MH	M	ML	L	L
	Medium High (MH)	H	MH	MH	ML	L
	High (H)	H	MH	M	M	ML
	Very High (VH)	VH	H	MH	M	L

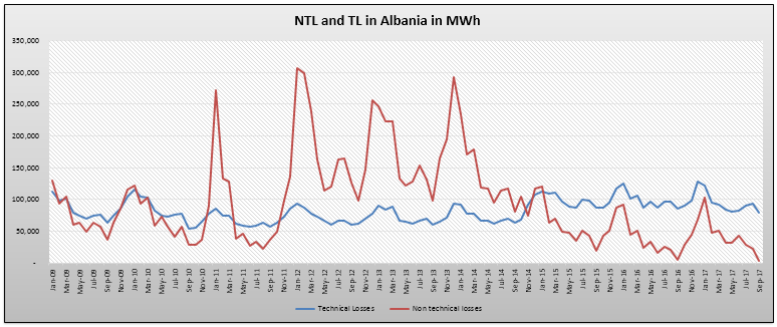

Fig. 10. TL and NTL in MWh

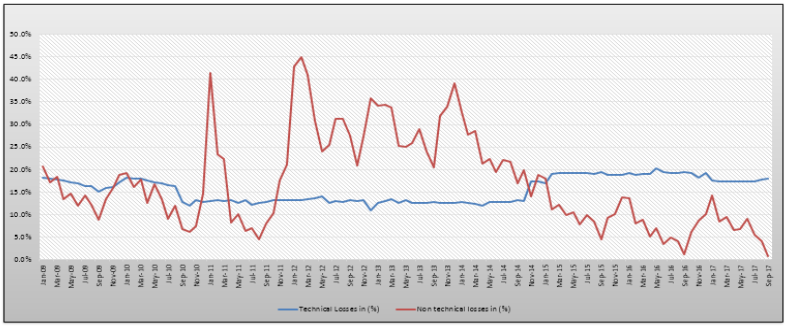

Fig. 11. TL and NTL in %

Figures 10 and 11 graphically show technical and non technical losses in MWh and in%. As can be seen from both graphs, technical losses are more conspicuous, while non-technical losses are variable and variable.

In the table below are summarized the historical data and those provided for the technical and non technical losses with our model (Fig. 12).

We have also presented and calculated the deviations in percentage for technical and non-technical losses (Fig. 13 and Fig. 14).

Technical Losses	Technical Losses in	Non technical losses in	FRC_Technical Losses in	FRC_Non technical losses in	DEV_Technical Losses in	FRC_Non technical losses in
Oct-15	87,547	42,354	87,000	42,000	-0.6%	-0.8%
Nov-15	94,973	50,771	94,000	52,000	-1.0%	2.4%
Dec-15	117,797	87,402	120,000	85,000	1.9%	-2.7%
Jan-16	125,071	91,710	120,000	90,000	-4.1%	-1.9%
Feb-16	101,612	44,565	100,000	43,000	-1.6%	-3.5%
Mar-16	106,426	50,978	100,000	49,000	-6.0%	-3.9%
Apr-16	87,210	23,653	87,000	23,000	-0.2%	-2.8%
May-16	96,196	32,779	96,000	33,000	-0.2%	0.7%
Jun-16	87,523	15,320	87,000	15,000	-0.6%	-2.1%
Jul-16	96,096	25,137	96,000	25,000	-0.1%	-0.5%
Aug-16	95,846	21,142	95,000	21,000	-0.9%	-0.7%
Sep-16	85,682	4,878	85,000	5,000	-0.8%	2.5%
Oct-16	90,184	29,173	90,000	30,000	-0.2%	2.8%
Nov-16	98,349	44,592	100,000	42,000	1.7%	-5.8%
Dec-16	128,233	68,513	120,000	70,000	-6.4%	2.2%
Jan-17	122,373	102,343	120,000	102,000	-1.9%	-0.3%
Feb-17	95,095	47,392	95,000	47,000	-0.1%	-0.8%
Mar-17	92,156	51,553	92,000	51,000	-0.2%	-1.1%
Apr-17	83,507	32,612	83,000	35,000	-0.6%	7.3%
May-17	80,943	31,738	80,000	32,000	-1.2%	0.8%
Jun-17	82,518	43,366	82,000	43,000	-0.6%	-0.8%
Jul-17	89,929	29,075	89,000	30,000	-1.0%	3.2%
Aug-17	93,735	22,164	93,000	23,000	-0.8%	3.8%
Sep-17	79,080	2,653	79,000	2,700	-0.1%	1.8%

Fig. 12. Deviation for TL and NTL

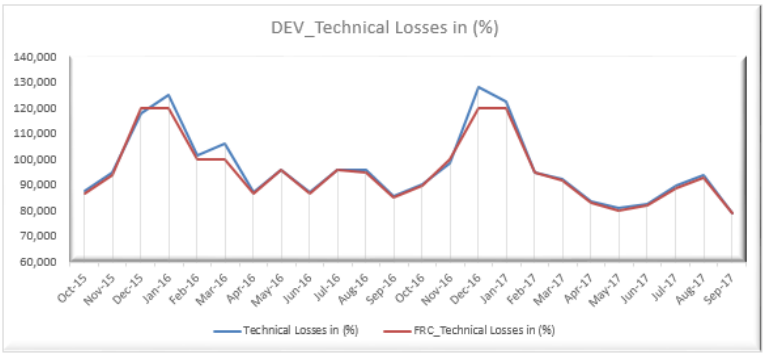

Fig. 13. Deviation for TL

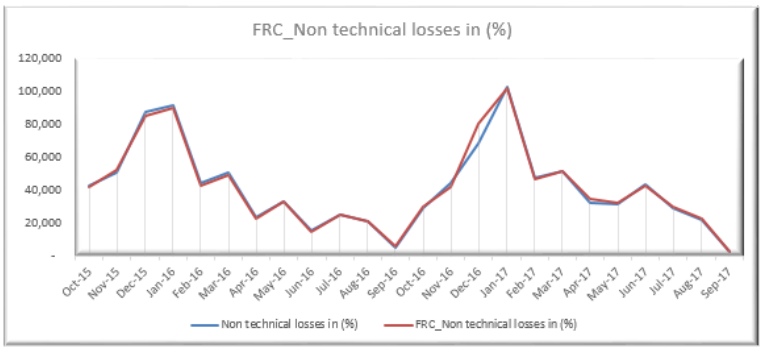

Fig. 14. Deviation for NTL

5. Conclusions and future work

This article is intended to provide a presentation of technical and non-technical losses, in the distribution network in Albania. Losses in the power system have a significant impact both in OSHEE and in the Albanian economy.

From the calculation of technical losses TL we come to the conclusion that:

- it is necessary to reset the network to us 6/10 kV with the voltage network 20 kV
- replacement of LV nets with bare airborne conductor airborne isolation with self-contained ABC
- construction of electrical wastes 110/20 kV

These conclusions should be taken into account when drafting the investment plan in the company.

NTL are nearly impossible to measure using traditional power system analysis tools. This is due to the lack of information on both NTL and the legitimate loads in the system, which translates to insufficient inputs for any meaningful loss calculations.

Electricity theft, a common form of NTL, involves tampering with meters to distort the billing information or direct connections to the power system. Utilities contacted for this thesis all agreed that electricity theft is the most prominent form of NTL, while customer non-payment can also lead to significant problems in areas that fail to handle the situation properly.

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Systems Analyses of Network Traffic Filtering based on the Specified Criteria

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Abstract. The article is investigated the structure of network traffic filtering and filtering algorithms, and traffic control. Set out the structure of software and hardware tools, algorithms of filtering incoming and outgoing traffic, algorithms control integrity and authenticity of updates, provides a conceptual scheme of the server-side database and the scheme to build a dialogue with the system administrator network traffic filtering on the specified criteria.

Keywords. Information society, hardware, software, criteria, multi-level, traffic filtering, back-end, front-end, out coming http-traffic filtering, incoming http-traffic filtering, blacklist, availability, scalability.

1. Introduction

An integral part of the modern information society is the global internet. Nowadays it is difficult to work without the internet company employee progressive or advanced training. But the uncontrolled use of the internet poses a threat to the following: improper use of time and the destruction of moral standards and without that are not yet fully formed.

The trends are clear: network bandwidth continues to increase dramatically, network device applications, such as bridging, switching, routing, firewalls, network address translation, virtual private networks, intrusion detection, and prevention, multicast routing, traffic shaping, etc, are continuing to increase in complexity and the market continues to demand that separate applications be merged into one device. Network utilization continues to increase to match the available bandwidth, and single processors mixed with ASICs, and FPGAs do not meet these demands. So the logical solution to these requirements includes multiple processors. Additionally, a clean division of work effort and functionality is needed to use them. This requires decomposition and repackaging of functions, placing some in hardware and some in software so that the resulting system can scale and adapt more easily to handle increased loads and alternative functionalities and configurations.

2. Multi-level architecture of network traffic filtering on the specified criteria

Multi-level hardware and software architecture of servers used to provide scalability network filtering on the specified criteria that is able to prevent excessive network traffic and data servers, which is the server application. This architecture also allows you to distribute the functions of the server side application on the number of references to them.

Greatest level - the level of front-ends, which is responsible for the execution of the authorization database updates and versions of the client part of application, as well as the treatment system to the site through which the monitoring and remote system administration. If a user requests data statistics or change system settings to traffic filtering on the specified criteria, the server-level front-end proxy server to do any server-level back-ending, which determines the first two characters of the user's login. Thus, carried out between the server level addressing front-end and server-level back-end. In this case, if the server-level front-end overload in a given time, it forwards the request to the user to another less loaded server.

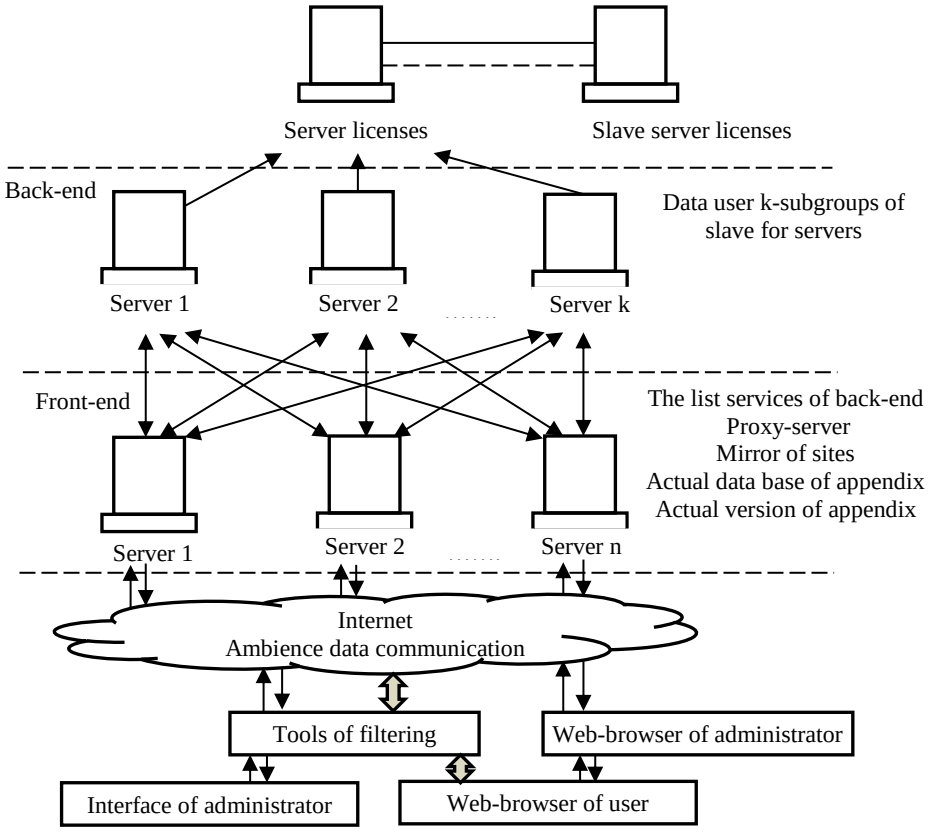

Fig.1 Multi-level hardware and software architecture of the network traffic filtering on the specified criteria

For fault tolerance, the server part of the system of traffic filtering on the specified criteria level servers back-end connected to the ring with each other (Figure 2), which allows you to duplicate a database of users each subgroup [1].

At last, the third level, multi-level server-side filtering system is the license server that stores information about user licenses and the server that makes it overlaps.

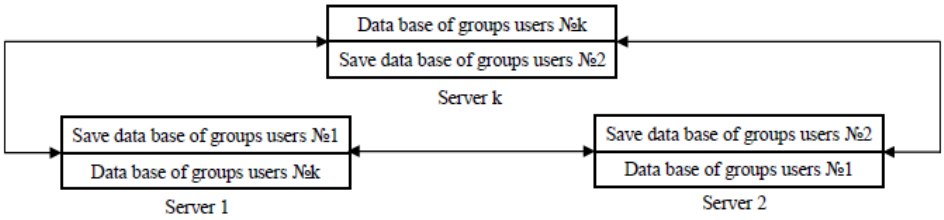

Fig.2. Connection server-level back-end

3. Algorithms of traffic filtering

The general scheme of the system of traffic filtering network traffic filtering on the specified criteria is presented Figure 3.

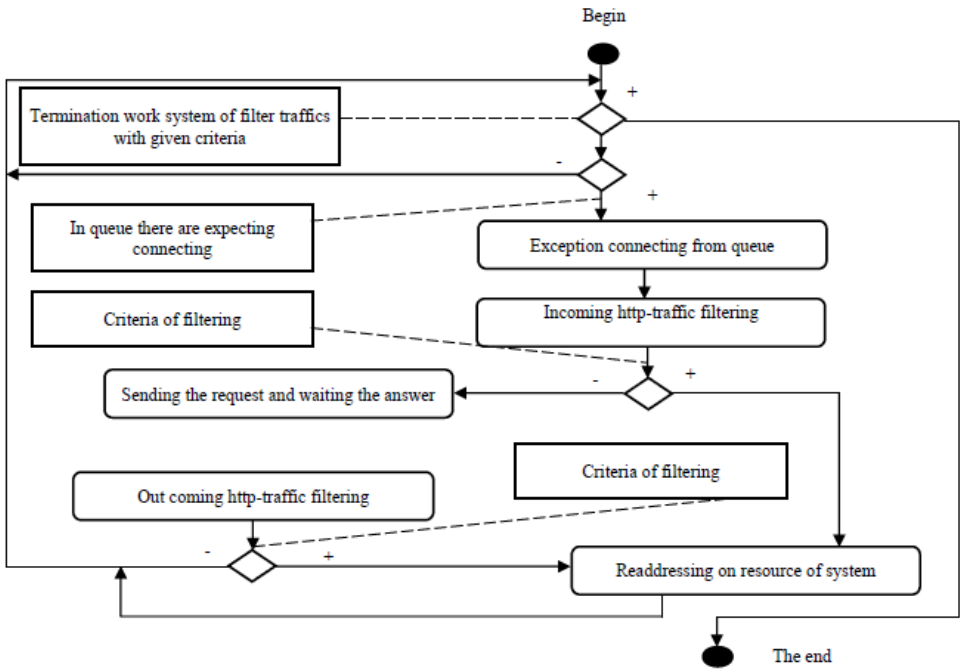

Fig.3 The general scheme of traffic filtering

System network traffic filtering on the specified criteria checks for pending connections queue, if any, we exclude the first of the queue. The analysis of the selected out coming traffic connection (Figure 4), the results of which it is determined whether or not the connection is contrary to criteria filtering system [2]. Unless contrary to the contents of the query on the specified criteria filtering system, then there is a «send request» and then waiting for a response, or is redirected to a system resource.

Once the answer comes to the requested resource is a filtration of incoming http-traffic system of network traffic filtering on the specified criteria (Figure 5).

According to the analysis of the incoming content is determined by its compliance with the specified filter on the specified criteria. If the content is found to be negative, it is redirected to a system resource, in the opposite case the content is delivered to the user application.

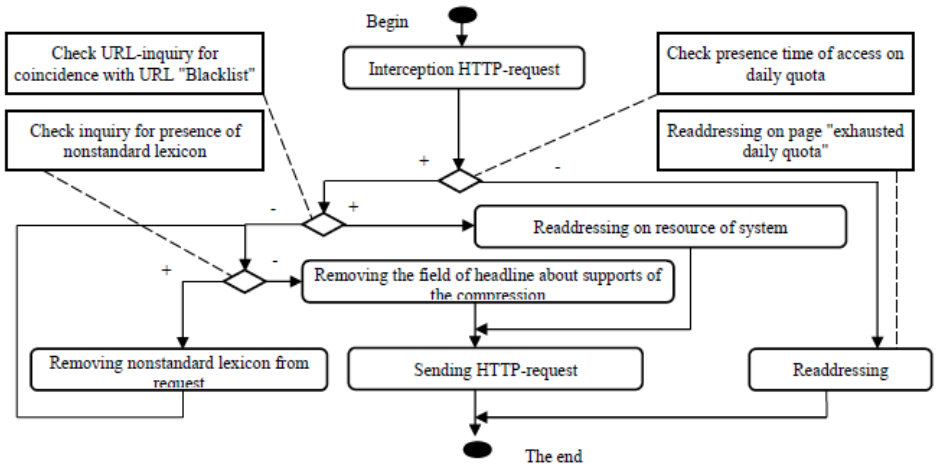

Fig.4 Scheme of out coming traffic filtering

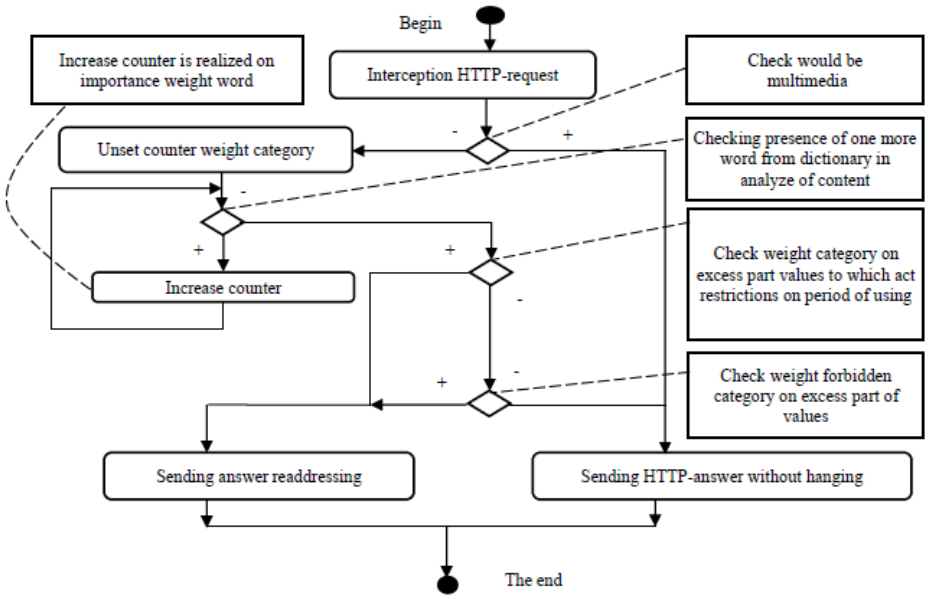

Fig.5 Scheme of incoming traffic filtering

4. Conclusions

In conclusion, it should be noted, that the multi-level hardware and software architecture allows high availability, scalability, as well as the implementation of the function for remote administration and monitoring system network traffic filtering.

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Application of the Correlation Method for the Identification of Linear Dynamic Systems Models

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Abstract. The article presents the correlation method of identification of linear dynamic systems models based on the application of a 'white noise' type input effects. Using computational experiments, the effect of the valid signal and the number of experiments on the quality of the sought-for model have been studied. The recommendations for the planning of active experiments for the identification of linear dynamic systems have been formed.

Key words: Identification, Correlation method, Wiener-Hopf equation, 'White noise'.

1. Introduction

The complexity and variety of processes occurring in complex systems, as well as due to the great number of their constituent elements, the methods of development of mathematical models based on the consideration of the principles of physics of the processes being studied, are often turn out to be ineffective and time-consuming. It may be explained by the complexity or insufficient information about the phenomena being observed in the processes being studied, as well as the bad quality results. Thus, the most acceptable identification method under production conditions are those based on the experimental data [1, 2, 4].

The association between the response $y(t)$ and the effect $u(t)$ for linear one-dimensional stationary dynamic objects can be set as an integral Volterra operator [3, 5]

$$y(t) = \int_0^\infty \omega(s)u(t-s)ds, \tag{1}$$

where $u(t)=0$ at $t<0$, $\omega(s)$ – kernel of the Volterra operator.

The impulse transition function of the system (1) may be determined experimentally, if choose a δ function or a stepped effect of the A amplitude in the input signal characteristics. In the first case:

$$\int_0^T \omega(s)\delta(t-s)ds = y(t), \quad \omega(t) = y(t), \tag{2}$$

and in the second case -

$$\int_0^T \omega(s)A\cdot 1(t-s)ds = A\int_0^T \omega(s)ds = y(t), \tag{3}$$

from which

$$\omega(t) = \frac{1}{A}\frac{dy(t)}{dt}, \tag{4}$$

where T – is the moment of time from which the weight function is not included to the corridor, which was determined earlier.

In the first case, there is the complexity of the physical realization of a δ function, and in the second case, there is the incorrectness of the differentiation problem of the results of the computational experiments set in the form of table functions, which contain significant interferences. Thus, the extension of the methods of active experiments for the identification of linear dynamic systems using the variety of input effects and their statistical characteristics is a crucial task [1].

The objective of this article is to study the methods for identification of dynamic systems in the form of Volterra operator model setting stochastic signals.

2. Wiener-Hopf equation

Let`s take a closer look at the linear stationary one-dimensional object being described (1), at that the output signal consists of both the valid signal $\int_0^\infty \omega(s)u(t-s)ds,$ and error $\eta(t)$. The schematic structure of the computational process is presented in Figure 1. In such a case, the output effect will be described as follows:

$$y(t) = \int_0^\infty \omega(s)u(t-s)ds + \eta(t). \tag{5}$$

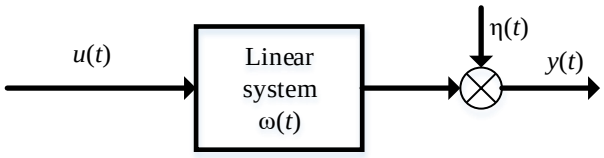

Fig. 1. The structure of identification of the linear object impulse response

Equation (5) connects single realizations of random input and output signals. To go to the determined values, we should multiply both parts (5) by $u(\theta-\tau)$ and apply the mathematical expectation operation and, as a result, we will receive the following equation:

$$M\left[u(t-\theta)y(t)\right] = \int_0^\infty w(\tau)M\left[u(t-\theta)u(t-\tau)\right]d\tau + M\left[u(t-\theta)\eta(t)\right].$$

Considering that the ratio

$$K_{uu}(\theta-\tau) = M\left[u(t-\theta)u(t-\tau)\right],$$

$$K_{uy}(\theta) = M\left[u(t-\theta)y(t)\right],$$

$$K_{u\eta}(\theta) = M\left[u(t-\theta)\eta(t)\right],$$

the corresponding autocorrelation function of the input signal and the mutual correlation functions should be determined. Let`s move to the signals correlation functions equation:

$$K_{uy}(\theta) = \int_0^\infty w(\tau) K_{uu}(\theta - \tau) d\tau + K_{u\eta}(\theta).$$

Considering that the input signal $u(t)$ and the error $\eta(t)$ are uncorrelated, that is $K_{u\eta}(\theta) = 0$ in such a case we will have:

$$K_{uy}(\theta) = \int_0^\infty w(\tau) K_{uu}(\theta - \tau) d\tau . \quad (6)$$

Equation (6) is the Wiener-Hopf equation.

Equation (6) connects the determined values, signals correlation functions, and its solution, and makes it possible to evaluate the pulsed weight function of the linear stationary system according to the minimum error criterion [1]:

$$J = \frac{1}{T} \int_0^T \left[y(t) - \int_0^\infty w(\tau) u(t - \tau) d\tau \right]^2 dt .$$

The use of analytical methods while resolving the Wiener-Hopf equation (6) causes material difficulties, associated, first of all, with the difficulties of obtaining an analytical description of the correlation functions providing the input-output signals obtained experimentally under normal operation of the object. Second, theoretically speaking, the correlation functions are to be determined according to the infinite rules. In actual practice, they are evaluated according to the finite interval of time [0, *T*], causing approximate evaluation of the actual correlation functions. Random errors in the evaluation of the correlation functions cause significant errors while finding of *w*(*t*), and the analytical method of resolving the Wiener-Hopf equation becomes incorrect [1].

The structure of equation (6) makes conditions for minor errors in the correlation functions to cause material errors in the resolution while evaluating the impulse transition function. Thus, in order to obtain appropriate resolutions of the Wiener-Hopf equation the smoothing of the resolution should be applied. Moreover, as long as during the experiment it is possible to receive only the correlation functions evaluations, the value of the impulse transition function also turns out to be approximate.

The simplest means of identification *w*(*t*), making it possible to omit the resolution of the convolutional equation (6), meaning the application, as an input effect, of the signal whose correlation function`s properties are close to those of the Dirac delta $K_{uu}(\tau) = c\delta(\tau)$, that is a 'white noise' type signal, where *c* is the noise intensity. In such a case, the Wiener-Hopf integral kernel provides this an approximate evaluation of the weight function of the object

$$K_{uy}(t) \approx cw(t).$$

In such a way, according to the mutual correlation function value, the object`s $\omega(t)$ is being determined:

$$\omega(t) \approx \frac{1}{c} K_{uy}(t).$$

3. Active experiment with arbitrary signals

Upon practical realization of the mentioned approach to the input of the object being studied, except for the regular signal $u(t)$, the 'white noise' signal $x(t)$, with the intensity of c, is added. The scheme of identification is presented in Fig. 2.

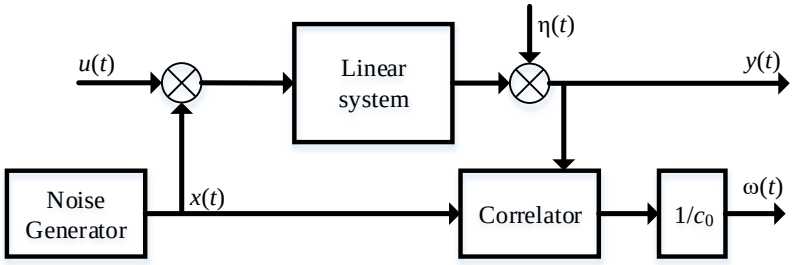

Fig. 2. The scheme of identification of the object under the test effect in the form of 'white noise'

In such a case, the system output signal is determine according to the equation

$$y(t)=\int_0^\infty u(t-\tau)w(\tau)d\tau+\int_0^\infty x(t-\tau)w(\tau)d\tau+\eta(t),$$

from which it is possible to receive as follows

$$K_{xy}(t)=\int_0^\infty w(\tau)K_{xu}(t-\tau)d\tau+\int_0^\infty w(\tau)K_{xx}(t-\tau)d\tau+K_{x\eta}(t). \quad (7)$$

If there is no correlation of the input $u(t)$ and optional signal $x(t)$ as well as $x(t)$ and $\eta(t)$ signals, we have $K_{xu}(t-\tau)=0$ and $K_{x\eta}(t)=0$. In such a case, the equation (7) may be as follows

$$K_{xy}(t)=\int_0^\infty w(\tau)K_{xx}(t-\tau)d\tau,$$

from which it is possible to receive as follows

$$w(t)\approx\frac{1}{c}K_{xy}(t).$$

The absence of the effect of the input command signal and external errors on the accuracy of determination of $w(t)$ is the big lead of the abovementioned method since the correlator being determined by $K_{xy}(t)$ filters all signals, which are not correlated with the 'white sound' generator signal.

4. Computational experiments

The abovementioned method of identification of the linear dynamic system is realized under Matlab environment. The effectiveness of the abovementioned approach has been studied using a number of computational experiments performed on such model problems. There has been set the model of the linear object in the form of transition function by a program module tf(num, den, ,'InputDelay', tau) whose realization under Matlab environment causes no difficulties. There has been performed the experiment by setting the 'white noise' signal

and the impulse transition characteristic has been determined. The accuracy of the development of the model was evaluated by comparing the exact value of the impulse transition characteristics received by impulse(W, t) function.

The transition function describing the relaxation circuit $W_1(p) = \frac{1}{p+1}$ has been chosen for the model problems. The input has been receiving the 'white noise' type signal (Fig. 3), the output signal is presented in Figure 4. The received autocorrelation function of the 'white noise' type input signal is presented in Figure 5, the impulse transition characteristic is presented in Figure 6.

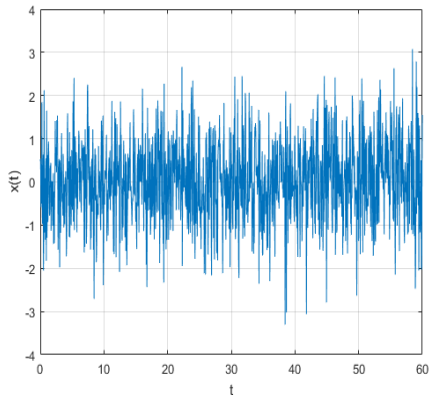

Fig. 3. 'White noise' type input signal

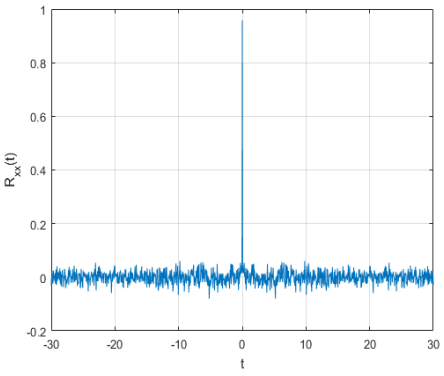

Fig. 5. Autocorrelation function of the 'white noise' type input signal

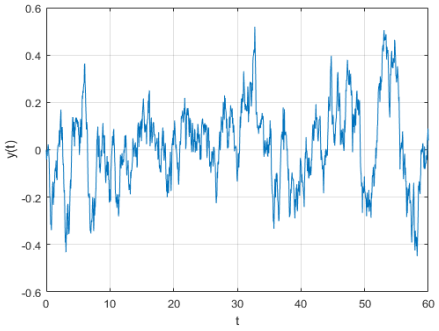

Fig. 4. Response of the system being described by the transition system W_1 to the input effect of the 'white noise' type

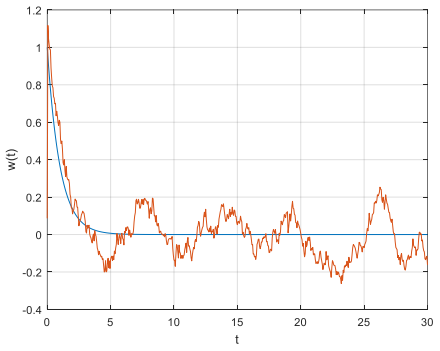

Fig. 6. Impulse transition characteristic and its exact value

To improve the accuracy of the receipt of the impulse transition characteristic there have been performed a number of experiments and searched average characteristics of the impulse transition characteristics. Thus, having performed 100 experiments, there has been received the autocorrelation function of a 'white noise' type signal (Fig. 7), the impulse transition characteristic (Fig. 8), as well as the error of the received impulse function (Fig. 9). Moreover, there have been developed the transition characteristic of the obtained model (Fig. 10) and the evaluation of this function comparing to the exact value (Fig. 11).

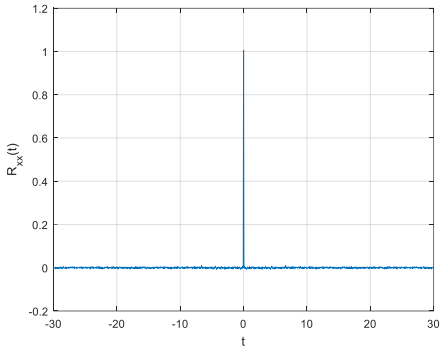

Fig. 7. Autocorrelation function of the 'white noise' type input signal

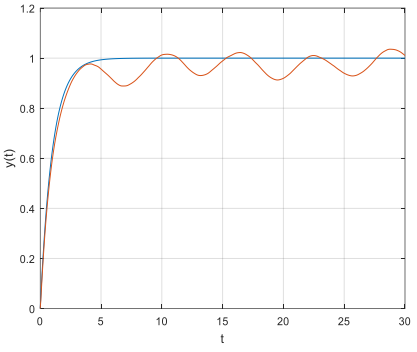

Fig. 10. Transition characteristic and its exact value

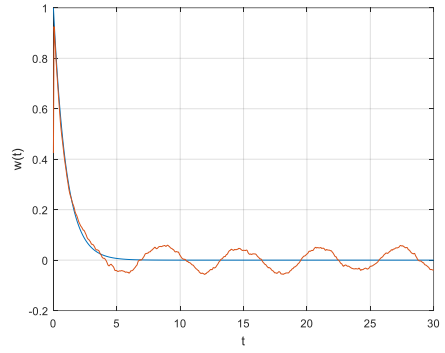

Fig. 8. Impulse transition characteristic and its exact value

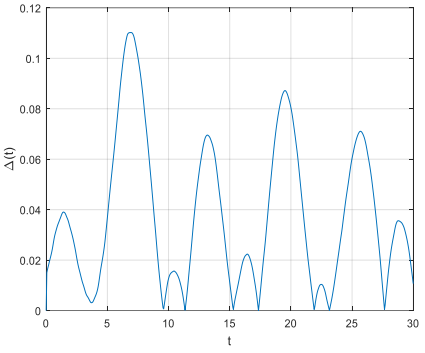

Fig. 11. The absolute error of the transition characteristic received

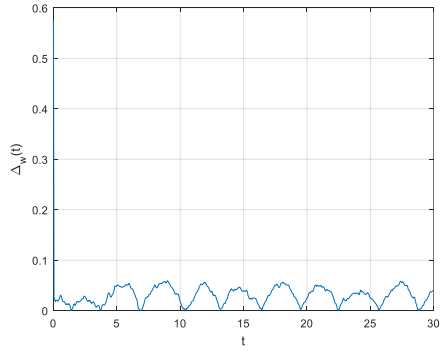

Fig. 9. The absolute error of the impulse transition characteristics received

The type of the valid input signal is of great importance while identifying. There have been studied the effect of various input signals on the quality of the identification operation. In particular, while setting the sinusoidal signal, there were received the results presented in Figures below: the input signal is set as a sum of the valid signal and the 'white noise' type signal (Fig.12), the response of the object to the corresponding input signal (Fig. 13), the

impulse transition characteristic (Fig. 14) and its error (Fig.15), the transition characteristic (Fig. 16) and its error (Fig. 17).

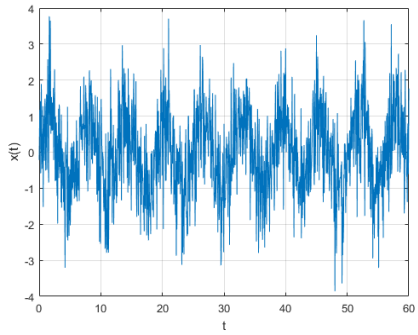

Fig. 12. Input sinusoidal signal with the 'white noise' applied

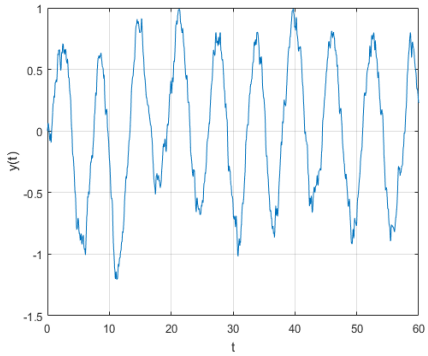

Fig. 13. Response of the systems being described by the transition function W_1 to the input sinusoidal signal with the 'white noise' type signal

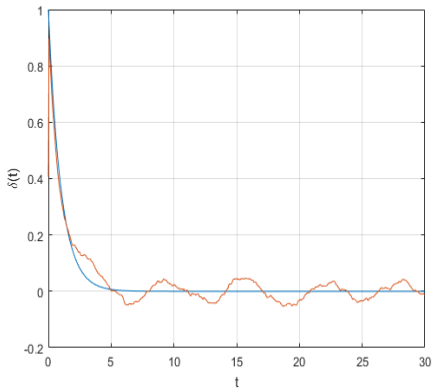

Fig. 14. Impulse transition characteristic and its exact value

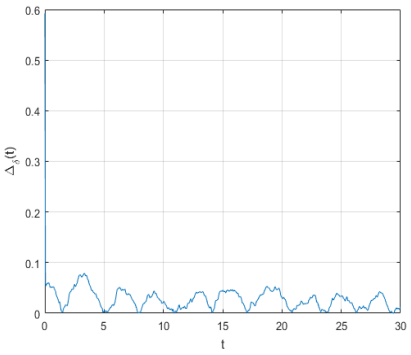

Fig. 15. Absolute error of the impulse transition characteristic developed

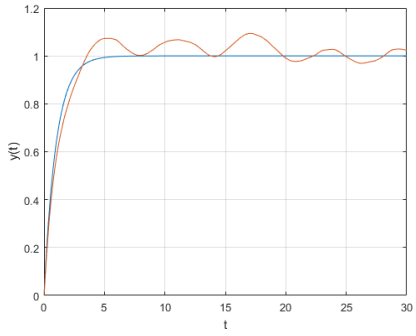

Fig. 16. Transition characteristic and its exact value

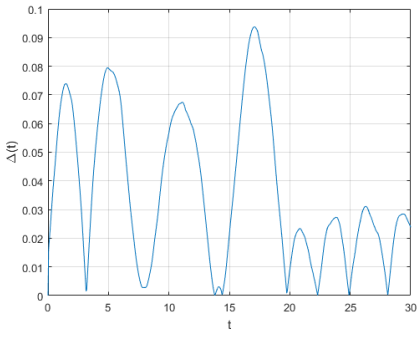

Fig. 17. The absolute error of the transition characteristic received

The evaluation of the influence of the type of input effects and a number of the computational experiments under the same conditions (modeling time T=30 c, Δt=0,05 c) is presented in Table 1, showing that the error decreases with the increase in the number of computational experiments, and the size of the error heavily depends on the input signal type. The setting of the zero-signal interfered with the 'white noise' type signal provides the most effective results.

Table 1. Evaluation of the influence of the type of the input signals and a number of the computational experiments on the relaxation circuit identification process

Valid signal	A number of experiments	Integral absolute error of the impulse characteristic	Integral absolute error of the transition characteristic
0(t)	5	0.8591	6.4341
	10	0.5907	2.7466
	20	0.5134	2.0749
	50	0.2899	1.5208
	100	0.2333	1.0281
	200	0.1636	0.4218
	500	0.1072	0.3171
	1000	0.0987	0.0869
Sin(t)	5	5.3156	6.1622
	10	2.6362	3.1643
	20	2.1102	2.5935
	50	0.9266	2.5061
	100	0.7808	1.8916
	200	0.5693	1.7111
	500	0.4235	0.8495
	1000	0.3092	0.3058
1(t)	5	3.5210	55.2251
	10	3.4412	51.1284
	20	2.3879	43.6535
	50	2.4577	34.9030
	100	1.8732	25.6021
	200	0.6162	9.4508
	500	0.4582	7.9982
	1000	0.1378	1.7325

Also, there have been studied the process of identification of the linear systems set by the oscillatory link $W_2(p)=\frac{1}{p^2+p+1}$ and the series connection of the relaxation circuit and the delayed link $W_3(p)=\frac{1}{p+1}e^{-10p}$.

The impulse transition characteristic received $W_2(p)=\frac{1}{p^2+p+1}$ and its exact value are presented in Figure 18, its error is presented in Figure 19, the transition characteristic is presented in Figure 20, the transition characteristic error is presented in Figure 21.

The impulse transition characteristic $W_3(p)=\frac{1}{p+1}e^{-10p}$ received as a result of experiment and its exact value is presented in Figure 22. The impulse transition characteristic

error, the transition characteristic and the transition characteristic error are presented in Figures 23, 24, 25, correspondingly.

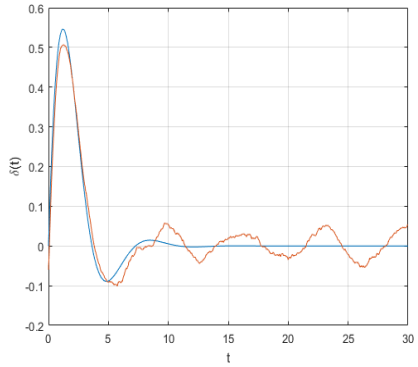

Fig. 18. Impulse transition characteristic W_2 and its exact value

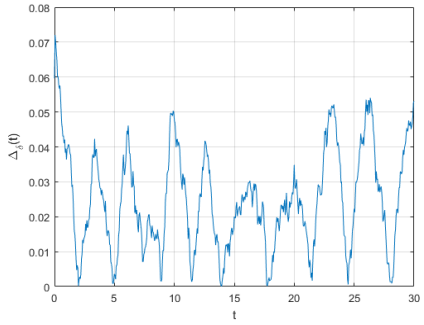

Fig. 19. The absolute error of the impulse transition characteristic received W_2

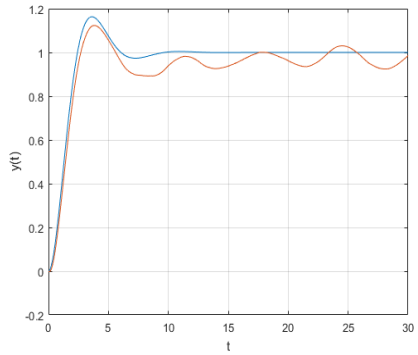

Fig. 20. Transition characteristic W_1 and its exact value

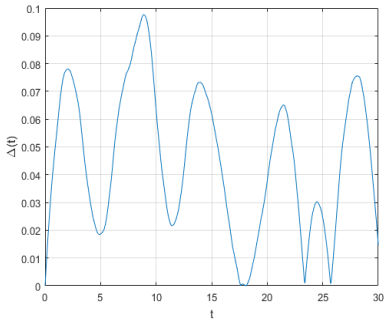

Fig. 21. The absolute error of the transition characteristic received W_2

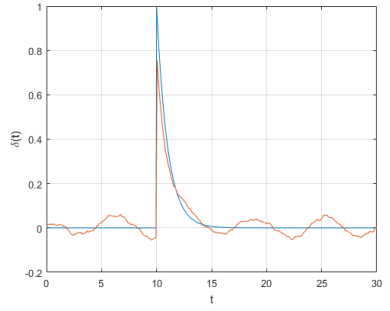

Fig. 22. Impulse transition characteristic W_3 and its exact value

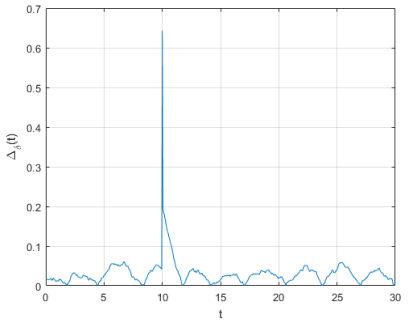

Fig. 23. The absolute error of the impulse transition characteristic developed W_3

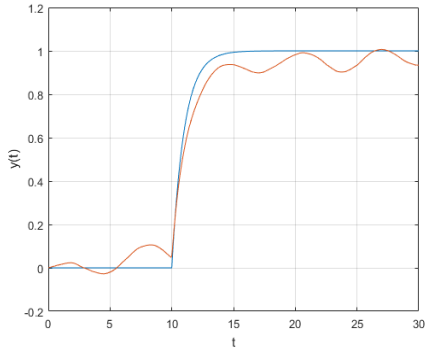

Fig. 24. Transition characteristic W_3 and its exact value

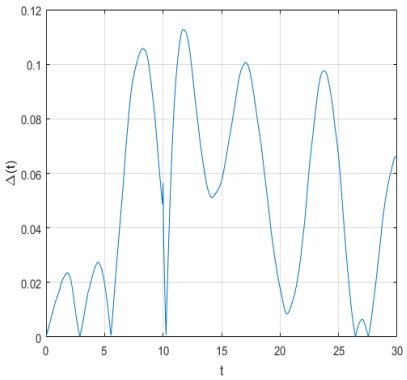

Fig. 25. The absolute error of the transition characteristic received W_3

Evaluation of the accuracy of identification of the types of input effects and a number of the computational experiments under the same conditions (modeling time T=30 c, Δt=0,05 c) for the models set W_2 та W_3 are presented in table 2 and 3, correspondingly.

Table 2. Evaluation of the influence of the type of input signals and a number of the computational experiments on the oscillatory link identification process

Valid signal	A number of experiments	Integral absolute error of the impulse characteristic	Integral absolute error of the transition characteristic
0(t)	5	0.8993	9.6504
	10	0.5474	5.4496
	20	0.4077	3.0052
	50	0.3638	1.9981
	100	0.1757	1.6814
	200	0.1470	1.2749
	500	0.1150	1.1155
	1000	0.0973	0.3448
Sin(t)	5	6.2645	10.6870
	10	3.1925	6.1918
	20	1.7419	3.8693
	50	0.7491	2.3604
	100	0.4855	1.7807
	200	0.4369	1.7626
	500	0.1918	0.9425
	1000	0.1610	0.7368
1(t)	5	5.5543	94.6582
	10	4.0686	82.0233
	20	2.6635	22.8863
	50	2.0547	14.3071
	100	1.9943	10.5043
	200	0.4568	6.7182
	500	0.3363	5.7974
	1000	0.2736	3.1284

Table 3. Evaluation of the influence of the type of input signals and a number of the computational experiments on the delayed link identification process

Valid signal	A number of experiments	Integral absolute error of the impulse characteristic	Integral absolute error of the transition characteristic
0(t)	5	0.9212	15.6732
	10	0.8509	10.9971
	20	0.5496	6.7883
	50	0.4854	5.2272
	100	0.4169	4.8200
	200	0.3108	3.7375
	500	0.2598	2.7876
	1000	0.2367	1.2773
Sin(t)	5	2.6557	16.5880
	10	2.3186	7.5234
	20	1.9657	5.0099
	50	1.0339	4.3046
	100	0.9214	3.5389
	200	0.6322	2.6459
	500	0.4092	1.0226
	1000	0.3190	0.3996
1(t)	5	4.9898	79.0347
	10	4.7075	27.2904
	20	3.3973	25.3509
	50	3.1003	21.9991
	100	2.4638	15.2230
	200	2.1364	10.1134
	500	1.3428	3.0225
	1000	0.6105	2.8619

5. Conclusions

Computational experiments have demonstrated the effectiveness of the identification of the nonlinear dynamic models using the Wiener-Hopf equation. The appearance of the sought-for model and the type of the input valid signal influence the result markedly. Thus, before planning active experiments it is necessary, if possible, to analyse the object being studied and determine the possible type of model and the optimal valid input effect.

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Developing Software for Solving Some Combinatorial Generation and Optimization Problems

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Abstract. Software for solving various problems of combinatorial generation and combinatorial optimization is described. Firstly, programmatic implementation of algorithm for generating classical combinatorial sets (combinations, permutations, arrangements) and algorithm for generation of k-compositions of combinatorial sets were described. Then, implementation of algorithm for generation of permutations with partially fixed order of elements was described. Also article describes applications for solving three different combinatorial optimization problems – pickup and delivery problems with 3D loading constraints, problem of scheduling freight trains in rail-rail transshipment yards with train arrangement and problem of optimization of linear function on a set of cyclic permutations.

Keywords. Software, combinatorial generation, Combinatorial optimization, Combinatorial set, K-set, Permutations with partially fixed order of elements, Cyclic permutations, Pickup and delivery problem, Train scheduling.

1. Introduction

Combinatorial optimization is important scientific area which results are used in developing and implementing solutions for many scientific and applied problems [1]–[4]. Combinatorial generation is widely used to solve problems of modeling, combinatorial optimization, etc.

Despite of wide use of combinatorial generation and combinatorial optimization results in real world, existing software solving for such problems use different algorithms for solving different combinatorial problems.

This article is dedicated to describing software that uses the same method of generating combinatorial sets [5]. Software solves next problems:

- generation of various classic combinatorial sets (permutations, combinations etc.) and compositional k-images of combinatorial sets (k-sets) [5], [6]
- generation of permutations with partially fixed order of elements [7]
- solving of one-to-one pickup and delivery problem with 3D loading constraints [8]
- solving problem of scheduling freight trains in rail-rail transshipment yards with train arrangement [9]
- optimization of linear function on a set of cyclic permutations [10], [11]

The remainder of this paper is organized as follows. Section 2 describes generation software for generation various classic combinatorial sets and k-sets. In section 3, additional module to software from section 2 is described which allows generating of permutations with partially fixed order of elements. Section 4 presents a description of software for solving of one-to-one pickup and delivery problem with 3D loading constraints. Section 5 is dedicated to description of a program for solving problem of scheduling freight trains in rail-rail

transshipment yards. In section 6, software for solving problem of combinatorial optimization of linear function on a set of cyclic permutations is described. At the end of the paper, conclusions are given.

2. Software for generating classic combinatorial sets and k-sets

Article [5] describes method of generation of various classic combinatorial sets (permutations, combinations etc.) and compositional k-images of combinatorial sets (k-sets). Algorithms *GenBase* and *Gen_k-set* from [5] were implemented in Delphi 7. Let's describe how software works on example. Suppose we have k-set with below structure [5].

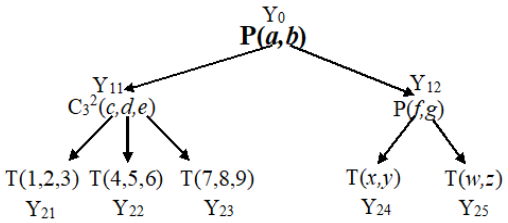


Fig.1. Example of k-set

Here $P(a,b)$ is a set of permutation of elements a and b, $C_3^2(c,d,e)$ – 2-combinations from set (c,d,e) of 3 elements, $T(1,2,3)$ – tuple of 3 elements (123) etc. Screenshot of developed software with results of generation of k-set from Fig.1 is given below.

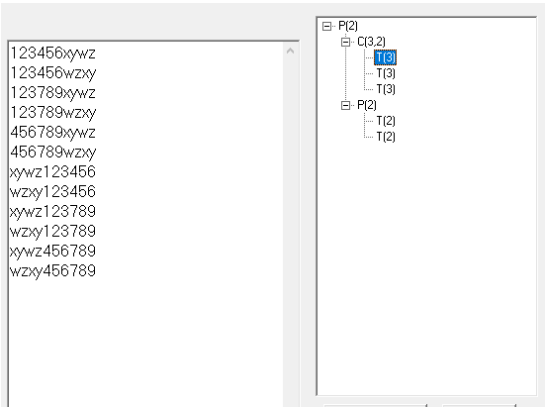


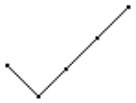
Fig. 2. Screenshot of software with results of generating k-set from Fig. 1.

3. Module for generation of permutations with partially fixed order of elements

Article [7] describes permutations with partially fixed order of elements which generalize well-known class of permutations with given ups and downs [12], [13]. For generating such class of permutations, algorithm *PartOrderedPerm* was used. This algorithm was implemented as a module to software for generating k-sets described in section 2.

Let's demonstrate developed software module work on example of generating permutations with concrete partially fixed order of elements (example 2 from [7]).

On Figure 3, screenshot with example of generating permutations from elements $A = \{1, 2, 3, 4, 5\}$ with partially fixed order of elements which is represented by sets $D'(\pi) = \{1\}, \overleftarrow{D}'(\pi) = \{3, 4\}$ is given. Note that order of elements on position 2 is not fixed, so order of elements in result permutations can correspond to diagrams



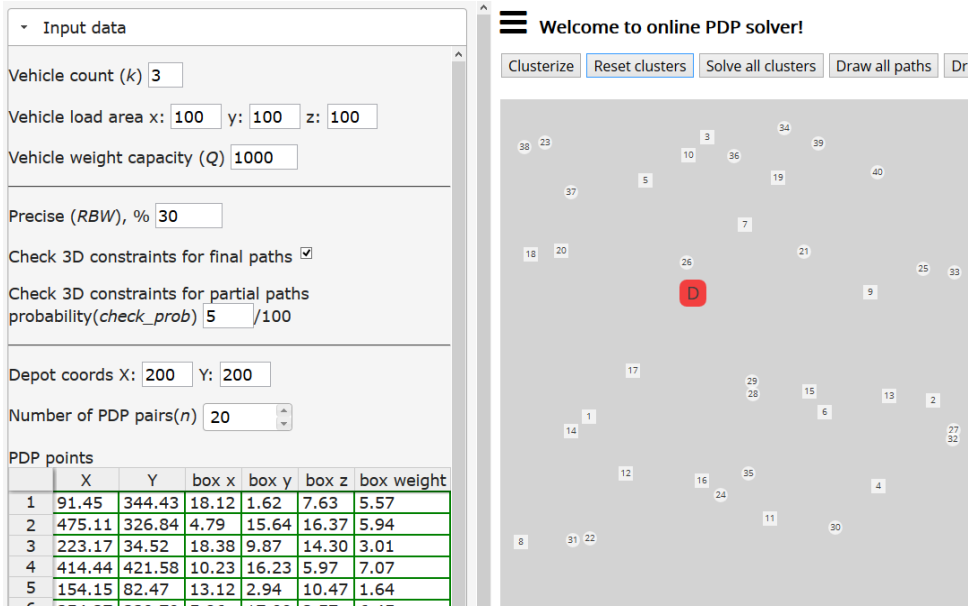
and

Fig. 3. Screenshot of software with results of generating of permutations with partially fixed order.

4. Web application for solving pickup and delivery problem

Article [14] gives mathematical model and heuristic solution algorithm for one-to-one pickup and delivery problem with 3D loading constrains. On the basis of solution algorithm from [14], web application that solves the described problem and has a user-friendly interface was developed. Application is available online at http://rebrand.ly/pdp-app.

Screenshots of developed application are depicted below.



	X	Y	box x	box y	box z	box weight
1	91.45	344.43	18.12	1.62	7.63	5.57
2	475.11	326.84	4.79	15.64	16.37	5.94
3	223.17	34.52	18.38	9.87	14.30	3.01
4	414.44	421.58	10.23	16.23	5.97	7.07
5	154.15	82.47	13.12	2.94	10.47	1.64

Fig. 4. A screenshot with all input parameters and PDP points

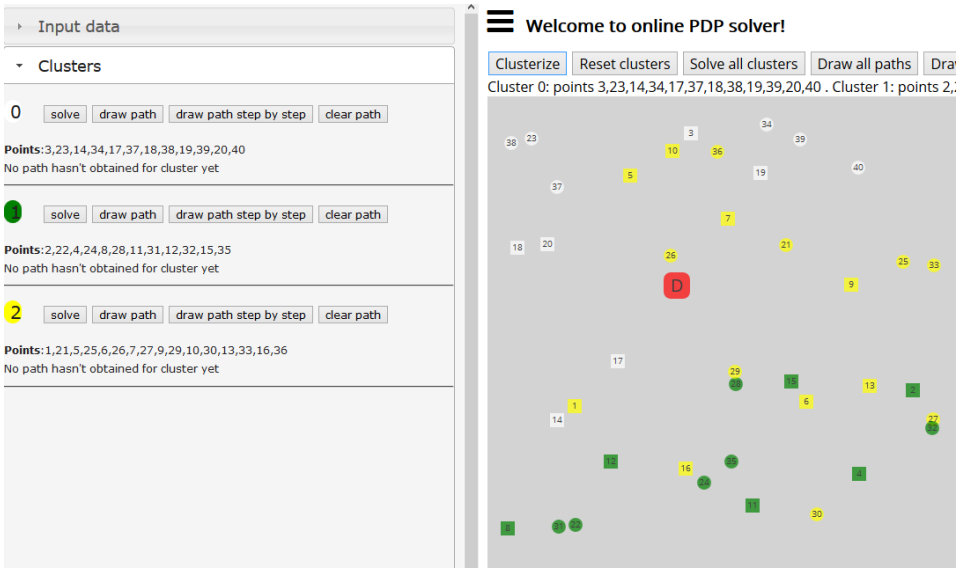


Fig. 5. A screenshot of clustering of 20 pickup-delivery pairs (squares are pickups and circles are deliveries; the big rounded red square is a depot)

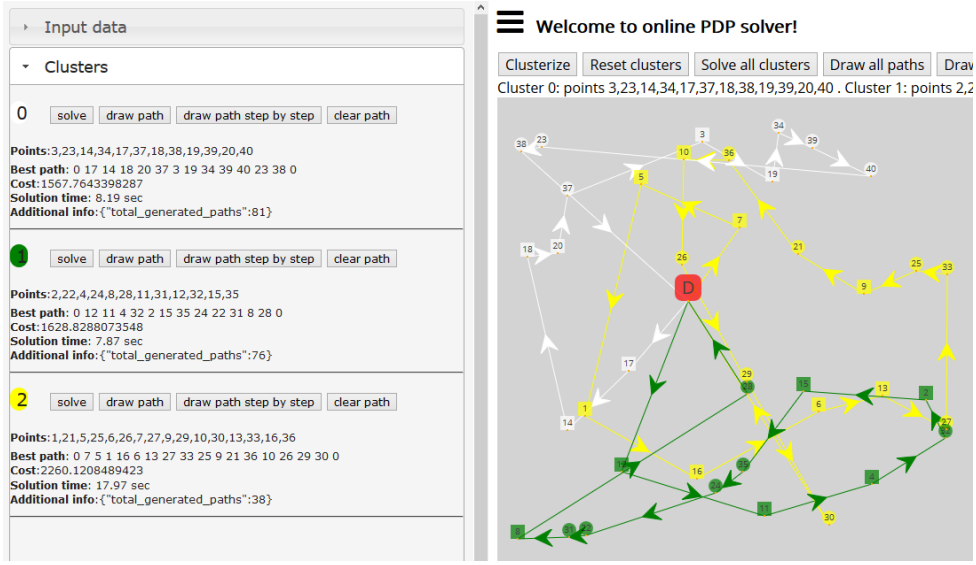


Fig. 6. A screenshot of path generated for each cluster from the example above

5. Web application for solving problem of scheduling freight trains in rail-rail transshipment yards with train arrangement

Article [15] considers problem of scheduling freight trains in rail-rail transshipment yards. In addition to solving problem of scheduling the service slots of trains considered in original paper [16], article [15] additionally solves the problem of train arrangement, i.e. assigning each train to a certain railway track. Mathematical model which uses apparatus of combinatorial sets and solution method which uses beam search heuristic are given there.

Solution algorithm from [15] was implemented in Python 2.7 as a web application which is available online at http://rebrand.ly/tsy-app. Screenshots of example input data and solution results are given on Fig. 7-10.

6. Application for optimization of linear function on set of cyclic permutations

In article [10], problem of optimization of linear function on set of cyclic permutations was described. Mathematical model and two solution methods of considered problem were given: exact method which uses branch and bound method and heuristic method which modifies original branch and bound method to obtain feasible solution in less period of time.

Both exact and heuristic algorithms was implemented using Java 7.

In table 1, results of comparing solutions obtained by exact and heuristic methods are given.

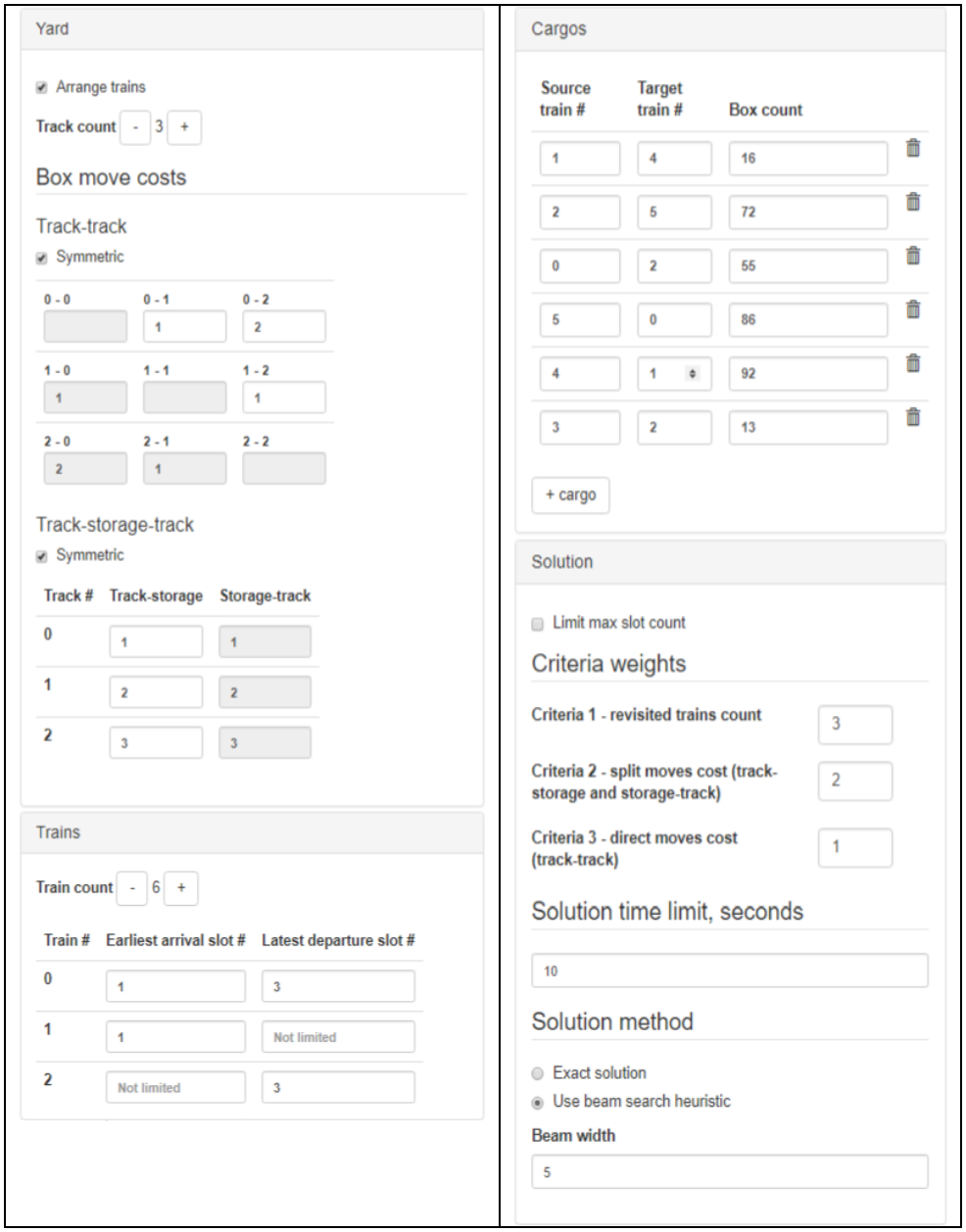


Fig. 7. Screenshot of developed application (input data)

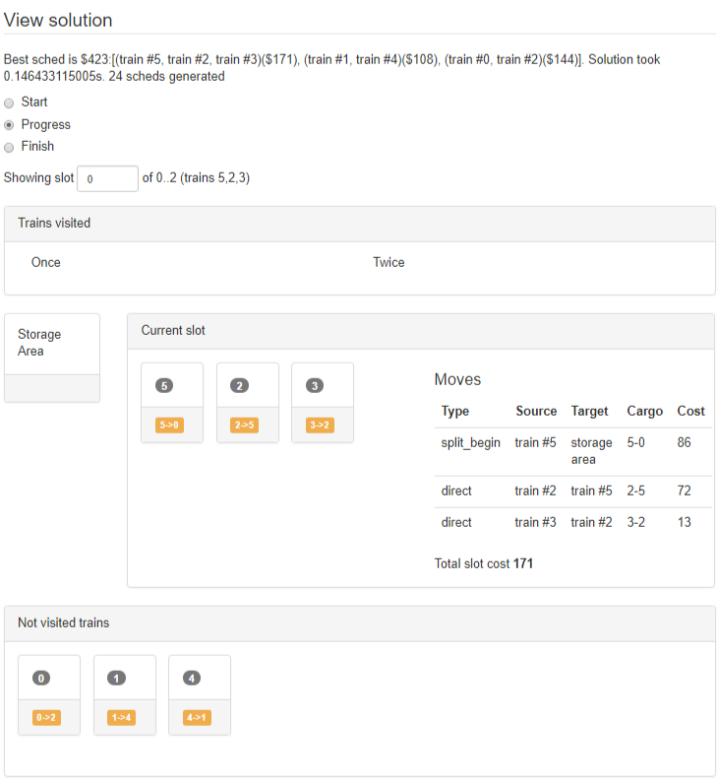


Fig. 8. Screenshot of developed application (solution, first slot)

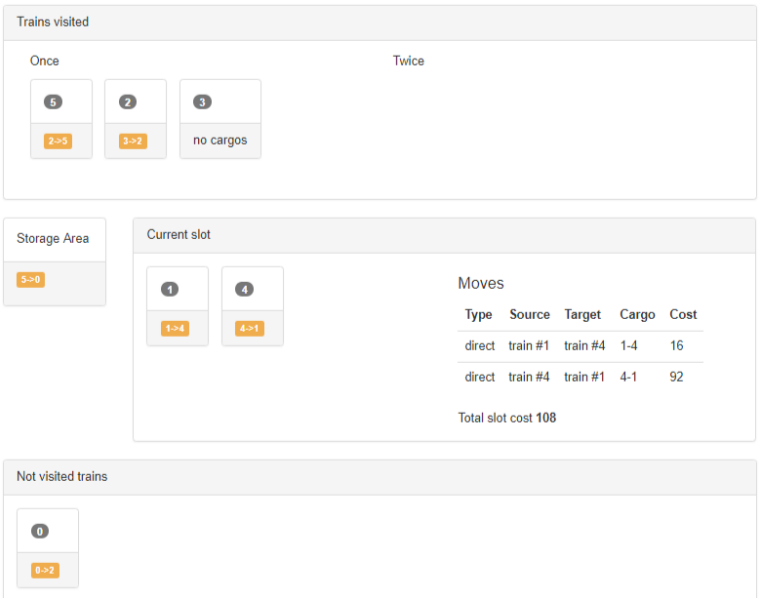


Fig. 9. Screenshot of developed application (solution, second slot)

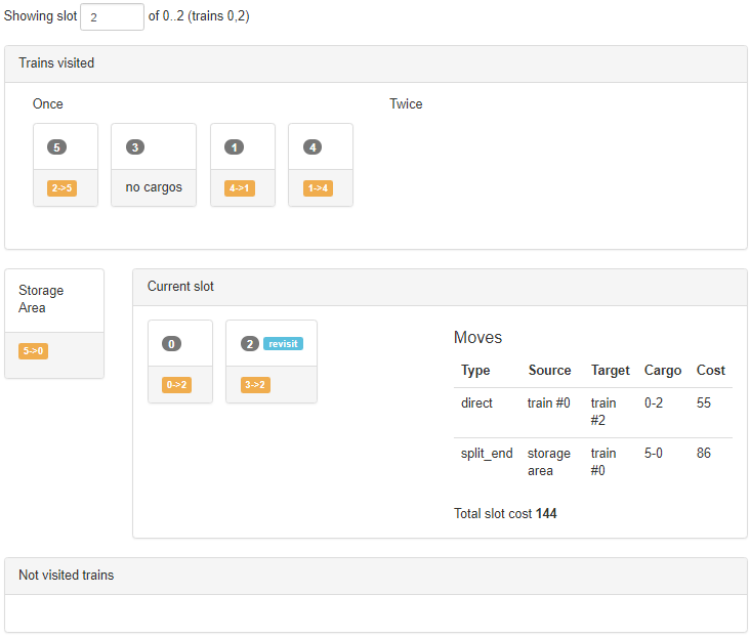


Fig. 10. Screenshot of developed application (solution, third slot)

Table 1. Comparison of exact and heuristic solutions for problem of optimization of linear function on cyclic permutations set

n	Exact solution			Heuristic solution			Relative difference between objective function value
	Value of objective function	Vertex count	Solution time	Value of objective function	Vertex count	Solution time	
10	169.2	12290	6 s	172	1782	16 ms	1.65%
15	309.3	33990	12 s	319.3	4642	47 ms	3.23%
20	525.2	523760	102 s	571.3	3817	62 ms	8.78%
30	804.5	1600350	244 s	915.8	21540	485 ms	13.83%
40	1621.1	6105360	1074 s	1889.2	6662	203 ms	16.54%

7. Conclusion

In this article, software for solving various combinatorial generation and optimization problems were given.

Algorithms for generating classical combinatorial sets k-compositions of combinatorial sets were implemented in Delphi 7. Also, algorithm for generation of permutations with partially fixed order of elements which are generalization of well-known permutations with given ups and downs was implemented as a module for software for generating k-sets.

Programmatic implementations of algorithms of solving three various combinatorial optimization problems were also considered. For the pickup and delivery problems with 3D

loading constraints and for the problem of scheduling freight trains in rail-rail transshipment yards with train arrangement, web applications which are available online were developed.

Finally, software solving the problem of optimization of linear function on cyclic permutations set were considered. Comparison of results obtained with exact algorithm (which uses branch and bound method) and with heuristic algorithm was given.

Developed software has friendly interface and allows to set input data combinations in a quite flexible way.

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How Digital Technologies are Changing the Process of Personnel Management Civil Service

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Abstract: The subject of this research is the formulation of principles for competence management of civil service personnel in terms of digitalization of Economics and management and the transition to the knowledge society. In the work, the peculiarities of project management in the public service of Russia are highlighted. The authors recommend adapting flexible methods of project management to the work of civil servants. This work proposes tools for monitoring processes in the civil service, the ways of automation of such tools.

Keywords: Civil service, Project management, Agile, IT, dashboard.

1. Introduction

A new strategy for information society development was approved by the decree of the President of the Russian Federation in May 2017 [1]. In June 2017, the Program of the digital economy was adopted for the implementation of this strategy [2]. In this program, among the objectives of raising awareness and digital literacy, availability of digital services, the importance of creating conditions for the development of the knowledge society was highlighted.

The digital economy needs employees, that have a broad competence. Staff in the digital economy of the future must be fluent in information technology, multitasking skills and manage information in large volumes. Today Universities have to train specialists who are capable of flexible adaptation to rapidly changing due to the explosive nature of changing process conditions.

The role of the state in the development of society is significant. The state is in the transition to a digital economy, globalization and the complex political situation feels a high need in improvement of the quality of state civil service management, its competent staff.

2. The demand for knowledge and digital technologies in the Russian practice of the public administration

Nowadays, the problems of personnel management civil service are in high priority and are critical. Capacity development of civil servants is aimed to the efficient development and the ability of public administration to adapt to the new environment of digital society. Public administration must have the necessary number of workers with certain qualifications, with expertise in a given time period and future strategic objectives.

The authors conducted a research of current situation in the management of the civil service in 2015 and 2016, the research Results were obtained in the performance of the State task of the Financial University. More than 365 civil servants, in positions from specialist to head of the Department, were interviewed.

Only 9.5% of the surveyed civil servants said that professional knowledge is enough to work with. 75% were not sure, 11% of respondents acknowledged the insufficiency of their professional knowledge to work.

Usually the knowledge acquired individually is applied for one's personal use, for sharing with colleagues in the Department. 15% of respondents noted that knowledge sharing takes place verbally at conferences and seminars. And 5% said that the new information is not stored electronically. Therefore, the access to this part of knowledge in the future is limited. Knowledge was rarely used by employees throughout the organization and reported to all the seminars.

The majority of respondents as an evaluation tool praised the certification as an effective tool for assessing the competence of civil servants (76%). In their opinion, the most important factors in the selection and promotion of personnel in a leadership position in the organization are professional and personal qualities, and work experience (60% and 50.5%, respectively). But they appreciated very low credibility in the team (25%) and personal desire (23%).

The analysis showed that in organizations, as a rule, the workflow is automated only (official correspondence with higher and lower authorities, subordinate agencies, citizens and organizations, correspondence between departments).

The interaction with the Federal Treasury and banks, suppliers of goods, works and services in the process of signing government contracts, the interaction with the Multifunctional centers providing state and municipal services to citizens, is partially automatic. Respondents also noted that apply the tools of process automation control projects. Processes, such as internal coordination, of the project contract staff management (planning of training, performance assessments), maintenance (repair of equipment, furniture, air conditioners, etc.), innovation management (submission of proposals, evaluation, monitoring) are not automated or partially automated.

3. Project management in the civil service

Among the characteristic problems of the Russian system of execution of state functions, it is possible to distinguish the complexity and opacity of processes, redundancy of documents, unclear distribution structure, and overlapping responsibilities. Statistics indicate that the number of civil servants is constantly increasing. Between 1999 and 2015, the number of employees of state bodies and bodies of local self-government and election commissions of municipal formations of the Russian Federation has increased 2 times and achieved 2176,4 thousand people [3]. And he most important is the problem of interaction between staff inside the civil service.

The implementation of ambitious and innovative task in the area of governance requires new forms of project organization the work of public servants. Feature innovative development of the state in the digital age is that the project objectives can be explained accurately, and the problem should be corrected in the course of their execution. Therefore, the application of agile methods of project management becomes the right decision.

Modern approaches to reform the state apparatus and mechanisms of its functioning are considered within the concept of New Public Management (NPM). The principles of the concept of NPM lie in the basis of administrative reform in modern countries. This concept declares the possibility of the applicability and adaptation successful management of the technology used in a business environment, to the system of public administration.

The introduction of NPM principles in our country is also carried out through the inclusion of design technologies. As a rule, they are considered only through the classical approach of the PMBOK. The PMBOK guide is a standard for managing most projects in

many cases in all fields of activity [4]. Today, PMBOK is the most sophisticated project management technology that is supported by the Microsoft Project program.

We can give examples of the implementation of the project approach in the civil service. This reorganization and establishment of project offices in regions (Perm Krai, Belgorod oblast, etc.). Council on the implementation of project management in the Federal bodies of Executive power and bodies of state power of subjects of the Russian Federation are created. The competition "Project Olympus" (project management in the public sector) was conducted for three consecutive years [4]. In the Tomsk region a large-scale project "Inotask'2020" in coordination authorities, universities, big business and state corporations is being realized on the basis of the design approach. Project offices are created at level of subjects of Federation and municipal formations. However, their number is rather telling about the pilot testing of this approach.

Our research of the current state of the situation showed that especially acute is the problem of project management in the civil service. The survey results showed that information about the project generally does not intend, and electronic archives are maintained at 45.6% of cases. Only in 34% of cases, a history of the project is created. The project folder on the portal forms even less (20,16%). Information about people involved in the project shall be stored only in 47% electronic and 30% stays on the paper. This means that employees understand the importance of saving intermediate information about the project, but do not have adequate tools for collecting, storing and sharing the current and future use.

The problems remained even after the implementation of the principles of PMBOK of the civil service. This means that we cannot restrict the approach to reorganize the system of state management by the application of the classical methodology. Note that in the implementation of the project for the execution of public functions purpose, the number and complexity of tasks, priorities can change. In these circumstances, the management principles should be replaced with a new one. Different tasks require different approaches, sometimes in combination, based on the specifics of the subproblems. Different conditions of implementation of the project also necessitates the use of various tools. Where tasks are large-scale, technology is known, and resources are defined, the classical design techniques are flawless. If placed innovative objectives, there is a high risk of going beyond budgets and time, it is necessary to consider expediency of application of flexible technologies (in combination with rigid or separately).

In addition, the participation of civil servants in the projects should correspond to their competencies. Some employees work better on a rigid, the other are flexible with technologies, and the third find it generally easier to use only in processes involving the implementation of one-time orders – not difficult, but, nevertheless, a priority. Therefore, we formulated the need for the development of new principles, taking into account the flexibility of the project management and the requirements of liability on the part of the civil service, including best practices of management principles of PMBOK and Agile methodology for flexible project team management of the civil service in the context of maintaining strict requirements for accountability and the formalization of processes.

The study of the peculiarities of project management in the civil service and to assess the possibility of adaptation of agile methods of project management to the organization of work of civil servants of the Russian Federation has allowed us to formulate principles GovAgile – flexible project management in the civil service. Table 1 shows the successive steps of the transition from Agile in development to Agile business and Agile in the civil service.

Table 1. Methodology GovAgile (fragment) [5]

	Features of civil service	GovAgile Principles
1	In the civil service the customer and sponsor is always linear head	Employees that are linearly obey the sponsor and the sponsor should be included In the project team members
2	In the civil service goals often change, but they should be monitored	The objectives of the project can change the leader but change must come
3	The reported performance should be at all stages	The project should be divided into stages, each of which has value for the customer
4	The civil service conducts regular reports, usually no more than once a week	The Manager should get weekly reports about the project
5	Team members should be motivated and have the relevant competence	Team members should be motivated and be selected according to their competences
6	Regular meetings of team members required	The team members should meet in person at least 2 times a week
7	Control is very important for the civil service	The stages of the project and the value of their results should coincide with the measured parameters
8	The regularity of the records dictates the pace of work	The project phases should be of similar duration to be short (no more quarters)

4. Digital "Dashboard" monitoring of execution of state functions

Dashboard for monitoring of the execution of state functions to civil servants is one of the topics to be discussed today in Russia. The existing system of control orders does not match the new realities and either inhibits innovation, or makes to imitate a high performing discipline by the decision of simple tasks. New integrated tools for monitoring processes required in the civil service.

Dashboard monitoring the performance of public services can be built using the data exploration tool of data discovery, which allows you to create statements to employees, without having any special technical knowledge. Research data and build a dashboard implemented using the discovery tool's data table to the software.

For the dashboard we propose the following performance regulation of civil servants in the execution of public functions.

The first group of indicators will assess the process from the point of view of the regulation of organization and conducting of projects on execution of the state functions. The dashboard indicators should monitor four key parameters: effectiveness, team and leadership just-in-time without overtime. Evaluation of results should be carried out on such key parameters as the deviation of the real performance of the organization design work of the plan.

The second group of indicators consists of assessment of effective organization processes of execution of the state functions. The effectiveness of the organization processes of public service can be assessed by using key indicators such as adaptability, continuous improvement, customer focus. On the dashboard, this can be rendered as:

- The level of regulation of work of civil servants.
- The level of automation of the time management process (electronic diaries, communication, email and calendar), a common information space for government employees.
- The level of organization, including the optimal number of involved employees to perform work depending on concurrent tasks and even distribution of assignments and responsibilities for each member of the project team.

The third group are key indicators of competency assessment must assess the levels of competency, continuity of learning, intellectual activity. The level of knowledge management shows co-ordination environment of knowledge sharing.

It is important to know the options of obtaining new professional knowledge (training courses, official web-site, distance learning, seminars and / or conferences, information systems, community professionals (associations, expert groups), saving and sharing independently obtained new knowledge (for personal use, for use by colleagues on your unit (expert group) for use by all employees of the organization are reported at seminars and / or conferences and / or training courses are not retained in electronic form), receipt and exchange of colleagues new knowledge at seminars, conferences or refresher courses (on the web site, knowledge library, in person, etc.).

The fourth group of indicators monitor activities of public administration (competence). To monitor all the activities of the state service can also be used such indicators as:

- The percentage of turnover of public service, including the percentage of dismissed workers with experience less than 3 years, more than 10 years; from among the personnel reserve.
- The average age of the employees. Currently, there is an age crisis of the public service against the background of an ageing staff there is a tendency to transition the most capable in the business structure.
- The average length of service, including the characteristics of career growth (within what time and how many times the employee was promoted), the percentage of appointments of employees from the personnel reserve.
- The level of training, including the percentage of passed additional training, a number of measures to improve qualification and their direction per employee, the percentage of professionals who have the qualification category as a result of additional training and the percentage certified.
- Timing of career advancement depending on experience and completed design task.
- The increased loyalty of the civil servant in the eyes of citizens and society (quality of implementation of projects related to public services).

5. Conclusion

In the field of project management subject-oriented approach is important, as it takes into account special capabilities of the employee. The project approach should be customer-oriented, to include tools for continuous improvement, what needs to be motivated employees. In the project approach it is necessary to expand the standards of performance of civil servants based on the inclusion of agile methods of project management where the outcome is

innovative. The time management system should include provisions for execution priority orders.

In the study, we identified areas of concern activities of public civil servants in the implementation of state functions in managing the knowledge and maintaining high qualification and competence level of employees in the public service. For problem solving we note the importance of conducting regular evaluation of personnel important to the organization parameters: to define the area of staff development, teaching methods. And methods of motivation to the development of competencies required currently and in the future, play an important role.

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Model of the Formation and Development of Intellectual Teams

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Abstract. The work is devoted to the task of intellectual team's management, namely the problem of their formation, adaptation and training. The paper presents a mathematical model of the multifactor estimation of intellectual team, allowing to choose the best of its composition from a plurality of possible options. To formalize the problem using utility theory, candidates in the team are assessed for their professional, profile and personality characteristics. The model also takes into account the requirements for the competence of the performers. Various options for the formation of the optimality criteria are considered. The paper also considers the process of motivating the members of the intellectual team for their development, namely, adaptation and training.

Key words: Theory of utility, Attractiveness of the applicant, Adaptation, Training, Motivating the members of the intellectual team.

1. Introduction

The increasing pace of technology improvement, the creation of new products, the growing competition create conditions for the use of project management not only in the IT sphere, but also in other kinds of intellectual activity. In the field of information technology, the command form of the organization is the main or the only type of organization of the technological process and performance of works. As an organizational form of professional activity, the teams of performers also operate in other spheres of society: economic, industrial, social, intellectual, cultural.

The system of working with intellectual project teams has its own specifics and consists of interconnected subsystems: team formation, its evaluation, adaptation and team training. The concepts of management and development of the organization's intellectual team are based on the knowledge of the employee's motivational skills, the ability to form and guide them in accordance with the tasks that are necessary for the organization. Intellectual teams can be formed both for a long time, and for a while to solve a specific problem. The longer the team will exist, the higher will be its level of harmony and professionalism, and the more successfully and efficiently it will act. When forming intellectual teams, it is necessary to take into account the level of competence of the team members regarding the requirements for competencies.

2. Analysis of Research and Publications

Earlier, in project management in an organization, employees were viewed as an element of a technical system, and the task of managing a team was reduced to the task of managing the company's human resources. In modern conditions, more and more attention is paid to the personality of the employee, and the company's employees are regarded as its intellectual capital, which determines the relevance of project management and directly affects

the effectiveness of project management and the success of its implementation, which are impossible without the formation of an effective team. A lot of scientific and practical developments of domestic and foreign authors are devoted to the research of mathematical models and methods of formation and functioning of teams. Recently, in the literature, the competence approach and decision-making methods are increasingly used in the formation and management of teams [1-3]. More and more attention is paid to interpersonal relations in the team [4, 5].

The analysis of scientific publications has shown that the existing methods and approaches to the task of managing the teams of performers are not always applicable or effective and cover not a full range of factors that need to be taken into account when in project management. This is due to possible changes in the conditions for the functioning of teams due to political, social or labor conflicts, changes in the timing of the project or a number of other reasons. Unfortunately, most sources give only general recommendations on the choice and use of a particular approach and method.

In general, the problem of formation of the team are considered as assignment tasks that cover a wide class of optimization tasks: the formation of the composition of teams, the distribution of functions (roles) in heterogeneous teams, and the tasks of allocating workloads. Existing approaches to the solution of such problems allow to designate the applicant for one and only one position and do not take into account all possible characteristics of the applicant, therefore they require development and improvement, which determines the relevance of the issue under study.

3. Formulation of the Problem

Teams can be divided into two large classes: homogeneous and heterogeneous. Intellectual teams refer to heterogeneous teams, where its members perform various functions, and each member of the team is generally characterized by certain efficiency of implementing certain functions. Therefore, when forming a heterogeneous team, the main task is the distribution of roles and activities among performers.

Each team member has two roles: functional and command. A functional role is determined by professional competencies that describe the level of knowledge, skills and competences that determine the level of orientation in the environment, understanding of technologies and trends, knowledge of business processes and the specifics of working in a given field of activity. The level of competence of professional and profile characteristics of applicants for different functional roles will be different. Functional roles are defined by job responsibilities [6].

The command roles reflect the way in which the team member performs his work, they are determined by innate and acquired personal qualities, which include the degree of responsibility, the ability to make decisions independently, to work in a team, in tight schedule, in conditions of risks and uncertainties, systemic and strategic thinking, leadership skills, organizational and motivational skills, discipline and organization, analytical approach, ability to communicate effectively (oral and written), creativity. For different team roles, a different level of competence is required for the personal characteristics of applicants [7]. Examples of team roles are "ideas generator", "resource researcher", "coordinator", "organizer" and others.

The role of a particular participant is determined by his contribution to the work of the team and the relationship between the team members, so the team can have several performers with the same role. From the point of view of the competence approach, such an allocation of roles is considered effective, under which the responsibility of each role does not exceed the skills of a member of the team to whom this role was given [1]. In this case, it is necessary to ensure the composition of the team composition to the task for which it is created.

Consider the task of forming an intellectual team in this setting. For the implementation of the project you need a team in which the team members are assigned a number of different functional roles (positions) $Y = \{y_j\},\ j = \overline{1,m}$. The quantitative composition of the team is determined by the scope of work envisaged by the project. We assume that the amount of work shared between functional roles. The project manager for each project determines the role composition of the team and the number of performers of each role. Several specialists can perform one role. But, in turn, one and the same specialist can combine different roles.

There are also known the sets of applicants $X_j = \{x_i\},\ i = \overline{1,n}$ for every *j*-th role. However, some elements x_i can be included in several sets of applicants (claiming different roles in the team). Each applicant x_i from the sets X_j is described by the set of professional $K_f(x_i) = \{k_f(x_i)\},\ f = \overline{1,F}$, profile $K_r(x_i) = \{k_r(x_i)\},\ r = \overline{1,R}$ and personality $K_l(x_i) = \{k_l(x_i)\},\ l = \overline{1,L}$ qualities (characteristics). For definiteness, we assume that the values of $K_f(x_i)$, $K_r(x_i)$ and $K_l(x_i)$ are known and given in the form of quantitative estimates. These values can be obtained by human resources specialists during interviews using methods accepted in the given subject area, for example, as a result of processing of psychological tests, tests for professional knowledge and skills, etc.

For each role $y_j,\ j = \overline{1,m}$ in the intellectual team, the value of the criteria from the set of professional $K_f^*(y_i) = \{k_f^*(y_i)\}$, profile $K_r^*(y_i) = \{k_r^*(y_i)\}$ and personality $K_l^*(y_i) = \{k_l^*(y_i)\}$ competencies are known and can be given by quantitative estimates. Each applicant x_i for the role y_j has many characteristics $K_f(x_i) = \{k_f(x_i)\},\ f = \overline{1,F},\ K_r(x_i) = \{k_r(x_i)\},\ r = \overline{1,R}$ and $K_l(x_i) = \{k_l(x_i)\},\ l = \overline{1,L}$. If the applicant has the required competencies, then x_i participates in the selection. If at least one of the conditions is not satisfied, then x_i is excluded from consideration for the execution of this role.

Considering the set of applicants X_j as a set of alternatives that are characterized by some set of partial criteria $K(x_i)$, the task of forming the optimal command can be attributed to the decision making problem. The ultimate goal of the overall decision-making task is to choose the only best solution from the admissible set of solutions X_j , i.e. extreme of the selected particular criteria. By the optimal performer x_j^0 of the role y_j we will understand such an applicant x_i from the set X_j, which has the best characteristics [3]:

$$x_j^0 = \arg \underset{x_i \in X_j}{\text{extr}} \{K_f(x_i), K_r(x_i), K_l(x_i)\}, j = \overline{1,m}.$$

4. Development of the Method for Solving the Problem of Forming the Intellectual Team

The problem of multi-criteria optimization (2) is incorrect, since in the general case it does not ensure the determination of a unique optimal solution from $x_i \in X_j, j = \overline{1,m}$, therefore it is necessary to transform it into a one-criterion one with a scalar criterion.

The main methods for transforming multi-criteria optimization problems into single-criterion ones are: the selection of the main criterion and the transfer of all other criteria to restrictions; functional and cost analysis; sequential optimization; the formation of a generalized scalar criterion that takes into account all the heterogeneous partial criteria [3].

To form an optimal team, i.e. selection of the best candidates for the team and evaluation of the team's effectiveness we use functional-cost analysis and the formation of a generalized scalar criterion based on the theory of utility. Taking into account the merits and

demerits of possible functions of convolution of particular criteria [3], we use the additive function of the form:

$$P(x) = \sum_{i=1}^{n} a_i p_i(x),$$

where a_i – the dimensionless weight coefficients of the importance of particular criteria satisfying conditions:

$$\sum_{i=1}^{n} a_i = 1, \qquad 0 \le a_i \le 1,$$

and $p_i(x)$ – normalized, i.e. reduced to a dimensionless form, to the same interval of variation, and to the direction of dominance of particular criteria:

$$p_i(x) = k_j^{\text{Н}}(x) = \left(\frac{k_j(x_i) - k_j^{\text{НХ}}(x_i)}{k_j^{\text{НЛ}}(x_i) - k_j^{\text{НХ}}(x_i)}\right)^{\alpha_i},$$

where $k_j^{\text{НХ}}(x_i)$, $k_j^{\text{НЛ}}(x_i)$ - respectively, the worst and best values of particular criteria on the entire set of applicants X_j, α_i – the nonlinearity parameter realizing a linear dependence for $\alpha_i = 1$, for $\alpha_i < 1$ – is a convex upward dependence, for $\alpha_i > 1$ – is a convex-down dependence [7].

In general, in different projects the significance of the qualities of applicants $k(x_i)$ of the corresponding competencies is different, therefore the attractiveness (usefulness) of the *i*-th applicant for the *j*-th functional role in professional $P_j^f(x_i)$, profile $P_j^r(x_i)$ and in personality $P_j^l(x_i)$ characteristics are defined as:

$$P_j^f(x_i) = \sum_{f=1}^{F} q_f k_f^{\text{Н}}(x_i),$$

$$P_j^r(x_i) = \sum_{r=1}^{R} q_r k_r^{\text{Н}}(x_i),$$

$$P_j^l(x_i) = \sum_{l=1}^{L} q_l k_l^{\text{Н}}(x_i),$$

where the weight coefficients q_f, q_r, q_l satisfy the requirements (4).

1. *Generalized evaluation of the attractiveness of the i-th applicant for the j-th functional role*

The attractiveness $P_j(x_i)$ of each applicant x_i to the *j*-th role takes into account the presence and the degree of development of his professional $K_f(x_i)$, profile $K_r(x_i)$ and personality $K_l(x_i)$ characteristics required for the position in question y_i, as well as requirements $K_f^*(y_i)$, $K_r^*(y_i)$ and $K_l^*(y_i)$ to these characteristics. Then

$$P_j(x_i) = a_f \sum_{f=1}^{F} q_f k_f^{\text{Н}}(x_i) + a_r \sum_{r=1}^{R} q_r k_r^{\text{Н}}(x_i) + a_l \sum_{l=1}^{L} q_l k_l^{\text{Н}}(x_i), \qquad (9)$$

where the weight coefficients a_f for the professional group, a_r or the profile group and a_l for the group of personality characteristics, satisfy the conditions of the form (4). And the task of choosing the optimal performers has the form:

$$x_j^0 = \arg\max_{x_i \in X_j} P_j(x_i), j = \overline{1,m}, \quad (10)$$

with restrictions

$$K_f^*(y_i) \le K_f(x_i), \quad K_r^*(y_i) \le K_r(x_i), \quad K_l^*(y_i) \le K_l(x_i). \quad (11)$$

2. Functional-cost analysis

The mathematical model (9) does not take into account the desired salary level $C(x_i)$ of applicant x_i for performing the role y_i. We use the method of functional-value analysis, which allows us to determine the quality-cost ratio. The use of the cost factor in absolute terms in the problem of selecting the performers of the work is incorrect, so we use the relative cost in the form of a value normalized by formula (5). Then the mathematical model for choosing the optimal performers is:

$$G(x_i) = \frac{P_j(x_i)}{C(x_i)} \to \max_{x_i \in X_j, j}, \quad (12)$$

with restrictions (11).

The disadvantage of the method of functional and cost analysis is the possibility of a situation when the team will recruit applicants who do not have sufficient functional characteristics, but have a small value of the desired salary.

3. Generalized evaluation attractiveness considering costs

In the utility function (9) we introduce the value of the particular wage criterion $C^{\text{H}}(x_i)$, normalized by formula (5) with the weighting coefficient a_s. Then the generalized evaluation of the attractiveness of the *i*-th applicant to the *j*-th functional role of $P_j^C(x_i)$ taking into account the salary $C(x_i)$ is defined as:

$$P_j^C(x_i) = a_f \sum_{f=1}^{F} q_f k_f^{\text{H}}(x_i) + a_r \sum_{r=1}^{R} q_r k_r^{\text{H}}(x_i) + a_l \sum_{l=1}^{L} q_l k_l^{\text{H}}(x_i) + a_s C^{\text{H}}(x_i). \quad (13)$$

The method of selection of applicants for the intellectual team is selected by the project manager, depending on the project requirements, organizational capabilities and team characteristics. If the utility of the applicant and the desired salary have the same importance for the organization, then it is expedient to use the method of functional and cost analysis (12). In other cases, it is necessary to apply a generalized method of assessing the applicant's attractiveness to the position (13).

5. Development of Intellectual Team through Motivation

After the project is completed, a situation may arise where it is not advisable to dissolve the formed cohesive team, and to recruit a new team for the next project. This will entail unnecessary financial costs and may adversely affect the interpersonal relationships that have developed in the team. At the same time, members of the existing team may not be competent enough in the sphere of the new project or do not have sufficient experience, knowledge and skills to implement it. In this case, it is necessary to pay attention and efforts of the organization to the development of the intellectual team, namely, its adaptation and training.

Adaptation of the intellectual team is the process of adapting the collective to the changing conditions of the external and internal environment of the organization. It has a complex structure and represents a unity of professional, socio-psychological, socially organizational and cultural-domestic adaptation [8]. The successful implementation of the project is an indicator of a successful process of adapting an intellectual team, selecting candidates and their introduction into the post.

The training of an intellectual team is designed to ensure that the professional knowledge and skills of employees correspond to the current level of production and management. In accordance with the urgent needs and perspectives of the organization, the development of an intellectual team is a complex, multifaceted process of training an employee for the performance of new production functions, the employment of new posts, the solution of new tasks [9]. More perspective is the attitude to learning as to the investment of material resources in the intellectual capital of the organization.

The success of the organization's adaptation and training of an intellectual team is based on motivating its members to develop. At the core of the concepts of management and development of the intellectual team lies the increasing role of the employee's personality, the knowledge of his motivational attitudes, the ability to form and guide them in accordance with the tasks facing the organization.

Motivation is the internal process of a person's conscious choice of one or another type of behavior, determined by the complex effect of external (incentives) and internal (motives) factors [9]. For each member of the team, these factors may differ: some may be more focused on the meaningfulness and social significance of labor, others - on salary and status values. As factors of motivation for members of an intellectual team, high salaries, bonuses, career and professional growth, education, development and self-improvement, the ability to travel, a flexible work schedule, life insurance, recognition in the team, etc. Motivating is an external impact on a person's work behavior for achieving personal, group and social goals [9].

But if significant advances have been made in the understanding of motivation and its qualitative nature, there are many theories that provide adequate descriptions of the process of motivating, then with a quantitative tool for managing the process of motivating, there are great difficulties. Since at present very few mathematical methods are known for modeling and predicting the motivation of employees, and especially taking into account the characteristics of intellectual teams.

A feature of motivating intellectual teams is that intangible factors that are difficult to manage come to the fore. Since the motivation of an individual depends on the psychic-moral moments, such as values, attitudes, aspirations, on the basis of which its preferences are formed, the task of developing and adapting the team can be considered as a management task, first, preferences, and secondly the professional qualities of the members intellectual team. Resources are needed to manage them. Therefore, the task of further research is the study of existing theories of motivation and the development of a mathematical model and a method for managing the motivation of members of an intellectual team.

There is content theories of motivation are based on the fact that there are internal motivations (needs) that make a person act and process motivation theories that determine not only the needs but also come from the person's perception and expectations associated with the given situation and the possible consequences chosen type of behavior. Content theories of motivation are based on the identification of those internal needs that cause people to act this way, and not otherwise. This group includes theories of Maslow, Herzberg, McClelland. Process theories of motivation (more modern) are based on models of people's behavior with regard to their perception and cognition (Vroom theory, justice theory and Porter-Lawler motivation model, McGregor theory).

For motivating the members of the intellectual team, it is necessary to go through five stages. The first stage is the assessment of the needs of employees, determining their working behavior, attitude to work and tasks. The second is the definition of those factors that affect the labor motivation of workers, determining their attitude to work, the degree of interest in the results and the willingness to work with full efficiency. The first and second stages relate to the identification problem. The third stage is the development of such measures of influence, the construction of such a motivating working environment, which contributes to high interest in the results. At this stage, a model of motivation management is being built. The fourth is the impact on labor motivation, taking into account the individual characteristics of the employee, which is the realization of the task of managing motivation. And the fifth is to evaluate the effectiveness of the selected measures of influence, and to correct them if necessary, i.e. evaluation of management results.

6. Conclusion

Based on the analysis of the problem and the existing methods of forming teams, a new model was proposed that allows to form of an intellectual team for the duration of the project, taking into account both professional and economic factors. Also, the process of motivating the members of the intellectual team was considered and the importance and expediency of their adaptation and training was shown, as the development of an effective intellectual team contributes to the creation of a favorable climate in the organization, increases the efficiency and motivation of the employees of the organization: employees become more competitive and receive additional opportunities for professional growth, which is especially important in the current conditions of rapid obsolescence of professional knowledge. This directly affects the effectiveness of the project, and therefore contributes to improving the financial performance of the organization.

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Modeling of Dynamic Objects and Systems Using Petri Evaluation Networks in an Interactive Environment

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Abstract. The approach to modeling of dynamic objects and systems by means of Petri evaluation networks is described. As a tool, it is proposed to use the E-NETSIM simulation environment. A formal description of the modeled object is proposed to be performed in terms of discrete-event modeling. An example of a model based on the sequence diagram of a universal modeling language is considered.

Keywords. Simulation modeling, Evaluation networks, Petri nets, Discrete-event modeling, Tool environment.

1. Introduction

Investigation of complex distributed dynamic objects and systems is impossible without a deep study of the processes of interaction between individual components in such systems. Typical features of the systems are deep parallelism, mutual uncertainty of states, absence of unambiguous dependence between events and conditions of their generators, variety of options for possible development of each process and the system as a whole.

The use of modern modeling tools can significantly reduce the complexity of analyzing the systems being designed, and in some cases replace the laborious design process with automated synthesis from existing prototypes. The proposed graphical approach to solving the problem of automation of project development is based on the idea of attracting visual forms of representing objects and systems with the help of graphic models. Visualization of development can be understood as a set of methods for using graphics and human-machine interaction tools used to better understand the concepts of construction and effective operation of the elements of the system under study.

2. Evaluation Networks as a Modeling Tool

Currently, there are a number of modeling tools and a graphical representation that allow to perform a description of the projected object at the initial stage of its design. Such tools include such software systems as BPWIN, Power Designer, Designer 2000, IBM Rational Rose, Borland Together, Gentleware Poseidon, Microsoft Visio, Telelogic TAU G2 [1]. Their main disadvantage is the static description of the modeled object. In the above systems, object models are represented in the form of static notations, which makes it impossible to analyze the system in dynamics and to assess the behavioral and temporal indices of the system under study. The simulation environment based on the graphical description of E-NETSIM aimed at solving these problems is proposed for consideration. The basis of the formal description and analysis of objects and processes occurring in them in the E-NETSIM environment is the apparatus of the Petri evaluation networks.

As a universal tool for discrete-event modeling, the mathematical apparatus of Petri nets can be used as well as its expansion - evaluation networks [2]. It has several advantages, such as graphical representation of the model, a wide range of developed methods for modeling and evaluating the characteristics of networks, a high level of formalization of the model, the possibility of accounting and analysis of parallel processes [3].

Petri net is a tool for modeling dynamic systems. The Petri net theory makes it possible to model the system based on its mathematical representation in the form of a Petri net, the analysis of which helps to obtain important information about the structure and dynamic behavior of the modeled system [3,4].

There are several possible ways of practical application of Petri nets in the design and analysis of systems. In one approach, Petri nets are considered as an auxiliary analysis tool. For the construction of the system, general design methods are used, then the constructed system is modeled by the Petri net, and the model is analyzed.

In another approach, the entire design and characterization process is carried out in terms of Petri nets. In this case, the task is to transform the representation of the Petri net into a real information system.

Modeling in Petri nets is carried out within the framework of the event approach. It determines what actions take place in the system, what states precede these actions and what states the system will take after the action is performed. The analysis of the results of implementation can tell about the states in which the system was or did not stay, which states are in principle not achievable. However, such an analysis does not give numerical characteristics that determine the state of the system. The development of Petri net theory led to the appearance of so-called "colored" Petri nets. The concept of chromaticity in them is closely related to the concepts of variables, data types, conditions and other constructions more closely related to programming languages. Petri nets are a powerful tool for studying simulated systems due to their ability to describe many classes of discrete, asynchronous, parallel, distributed, nondeterministic systems, thanks to the visibility of their work, developed mathematical and software analysis apparatus [3,4].

The extension of classical Petri nets is the evaluation networks (Evaluation networks, E-networks) [4]. Unlike Petri nets, they allow to take into account the response time of transitions, assign markers to property sets, change the properties of markers according to predetermined functions in the modeling process, flexibly change the logic of the development of processes in the network, taking into account the given logical functions.

E-networks are used as a means of describing simulation models of systems structured as event networks. Formally, they are defined by a tuple of 8 sets:

$$E = ((P, B, R), A, (I(A), O(A)), Z, V, Q, \Psi, M_0)$$

P – finite non-empty set of network positions, $P = \{p_i\}; B = \{b_k\} \subset P$ is a set of peripheral (not internal) positions; $R = \{r_m\} \subset P$ is a set of decisive positions. Positions $p_i \in P \setminus R$ play the same role in E-networks as in Petri nets. Are indicated graphically in a circle. Peripheral positions $b_k \in B$ are used to model the relationships of the system with the external environment. The decisive positions of *R* do not have direct analogs in Petri nets. With their help, E-networks provide conflict resolution and synchronization of events. With each deciding position there is a certain list of predicates used for a formal description of the conditions for performing the transitions. These positions are displayed by hexagons.

In each network state, positions may or may not have a token. The presence of a marker in the position is marked by a dot.

$A = \{a_n\}$ is finite non-empty set of transitions, which are displayed by rectangles.

I(A), O(A) are the sets of arcs associated with the transitions through the input (*I*) and the output (*O*). Pairs $(p_i, a_i) \in I(A) \times A$ and $(p_i, a_i) \in O(A) \times A$, composed of adjacent positions and transitions, correspond to arcs of the network.

In order to build an E-network describing the object under investigation, in which some processes occur, the following is necessary.

1. Identify all possible actions that can occur in the system under investigation at a given level of detail, as a result of which to determine the set of transitions of the network *A*.

2. Formulate conditions that determine the possibility of performing each action ("preconditions" for possible actions). Thus, set the elements of the set *P* of input positions for transitions and determine the set of input transition arcs $I(A)$.

3. Formulate the conditions arising from the execution of actions ("postcondition" for the performed actions) to set the elements of the set P of output positions for the transitions and to determine the set of output transition arcs $O(A)$.

4. On the set of possible actions A determine the set of decision positions R, that is, select actions that perform conditional selection and conditional branching.

5. Arrange actions taking into account the formulated conditions, that is, to link actions on the basis of "preconditions" and "postconditions" and to construct the structure of the E-network.

6. Define a set of properties (attributes) of markers that reflect the conditions for the execution of events.

7. Set a set of transition procedures Ψ, changing the values of the marker attributes when events occur.

8. Set the execution time of each action using the function $Z : A \to R^+$.

9. Define the set of decision procedures defined on the set of decision positions R and specify rules for conditional branching and conditional selection.

3. Construction of the model object in the form of E-network based on the sequence diagram

The basis for structuring the system under investigation can be one of the universal modeling languages. The transition from the description of the object in the form of a model presented in the Rational Rose environment to the description in the form of an E-network model, let's look at an example.

It is necessary to describe the process of user interaction with file hosting. File hosting is a collection of technical and software tools that allows users to upload files to the hosting as well as to their computer.

This example does not set the task of comprehensively describing file hosting, but only to show the possibility of implementing a sequence diagram in the form of an E-network.

Figure 1 shows a sequence diagram showing the interaction of the user with various elements of file hosting. The arrows show the names of the functions and the parameters passed by them.

To go to the E-network, you need to determine which network elements will correspond to the elements of the interaction diagram. The objects of the diagram will be represented by the positions, while the messaging process will be represented by a more complex position and transition system, which will be described later.

Figure 2 shows a network that implements a diagram of user interaction with file hosting.

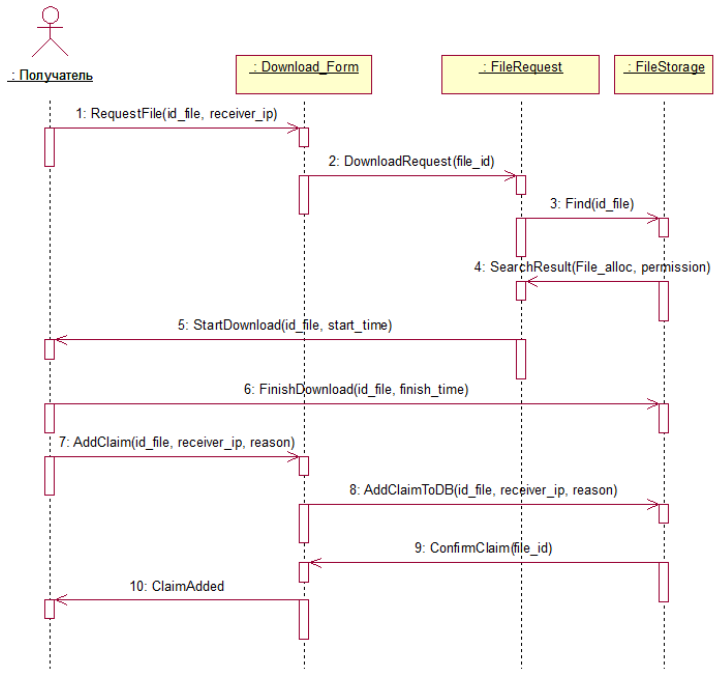

Figure 1- Diagram of user interaction with file hosting

One marker with one attribute is circulating in the network. The key is to find the marker in positions P1, P2, P3 and P4. The sequence of the marker passing through these positions corresponds to the sequence of message exchange between objects in the diagram. When moving between these positions, the marker attribute is incremented by one. As mentioned above, the E-NETSIM environment performs a logical AND action when the conditional branch is executed when conditions are added. Therefore, additional transitions T2, T3, T4, T5 are introduced that will ensure the uniqueness of the transition conditions.

Positions P1, P2, P3 and P4 correspond to the objects of the diagram "User", "Download_Form", "FileRequest", "FileStorage".

Positions P5, P6, P7, P8 are necessary for the direction of the markers in positions P1, P2, P3 and P4. Transitions T5, T6, T7, T8 perform only the direction of the markers from positions P1, P2, P3, P4 to position P5.

Transition T1 distributes the marker depending on the stage of network execution.

Transitions T2, T3, T4 distribute the marker between the positions P1, P2, P3, P4, depending on the value of the marker attribute.

The transition time for T1, T2, T3, T4 is set to zero, so when simulating the network, the sequence of the marker's passage of positions P1, P2, P3, P4 is easily monitored.

In addition to dynamically modeling the transition sequence, the program allows to specify the variables that define the execution time of the transition, which will allow to simulate the timing features of the sequence diagram.

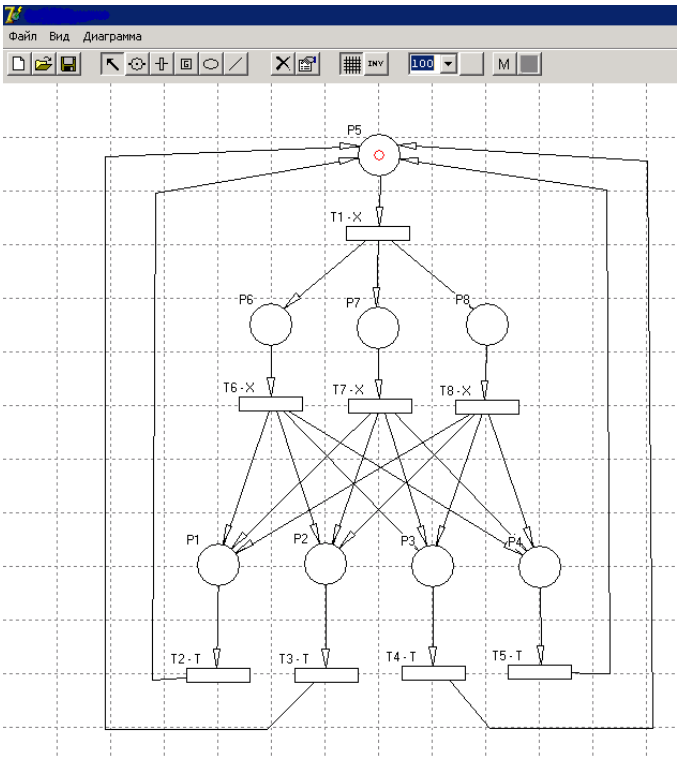

Figure 2 - Network illustrating the process of user interaction with file hosting

4. Conclusion

An interactive environment for simulation modeling of dynamic objects and systems based on the Petri E-net apparatus is proposed. The system allows creating and analyzing simulation models of dynamic objects and systems using Petri evaluation networks in an interactive environment. In this case, the ideology of discrete-event modeling is used. The described system can be used to implement simulation experiments and analyze models of a wide class of problems that are formally described using valuation networks. Examples of problems solved in the environment are simulation and analysis of queuing systems, telecommunication networks and data transmission networks, analysis of the correctness of algorithms, analysis of distributed systems.

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Binarization Based Minutiae Extraction

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Abstract. New minutiae extraction method is proposed in this paper. Reliable minutiae is very important for both fingerprint recognition and fingerprint based cryptographic key generation. Minutiae point is not change during the person life. However, there are many false minutiae points occurred during image processing by noise and various effects. We can easily remove false minutiae points by this proposed method.

Keywords. Binarization, Segmentation, Thinning, Minutia detection, Filtering.

1. Introduction

Biometry, as the science of studying mathematical or statistical properties in physiological and behavioral human characteristics, is widely used in forensic and non-forensic applications in security field such as remote computer access, access control to physical sites, transaction authorization etc.

Fingerprint authentication (identification) is one of the most well-known and publicized biometrics. Because of their uniqueness and consistency over time, fingerprints have been used for identification for over a century, more recently becoming automated (i.e. a biometric) due to advancements in computing capabilities. Fingerprint authentication is popular because of the inherent ease in acquisition, the numerous sources (ten fingers) available for collection, and their established use and collections by law enforcement and immigration.

In this paper, we proposed new minutiae points' extraction method, which address the problem of false minutiae points. Besides that, analysis of previous works address this problem are given.

2. Some Previous Work on Minutiae Based Feature Extraction

Most of the proposed methods require the fingerprint gray-scale image to be converted into a binary image. Some binarization processes greatly benefit from an a priori enhancement; on the other hand, some enhancement algorithms directly produce a binary output, and therefore the distinction between enhancement and binarization is sometimes faded. The binary images are usually submitted to a thinning stage, which allows the ridgeline thickness to be reduced to one pixel, resulting in a skeleton image. A simple image scan then allows the detection of pixels that correspond to minutiae.

In [2] reference, authors divide minutiae extraction approaches two types:

- Binarization-based methods;
- Direct gray-scale extraction.

Based on first method, fingerprint image is convert to binary image and then got thin image by thinning process. Thinning fingerprint image enters to minutiae extraction process. Leung et al [6] extract minutiae points from thinning images using a three-layer perceptron

neural network. Besides that, in [7, 8], authors proposed new minutiae extraction algorithm based on special ridge tricking algorithms.

Second method does not include binarization and thinning process due to the problem related with them and using gray-scale images. First, Maio and Maltoni [9] proposed a direct gray-scale minutiae extraction technique. In this method, basic idea is to track the ridgelines in the gray-scale image. This work is improved by Jiang, Yau and Ser [10] due to dynamically adapted to the change of ridge contrast and bending level.

Proposed method in this paper is belong to first method that includes binarization, segmentation, thinning, minutiae detection and post – processing stages. For each stages, full information is given below.

3. Extraction of Minutiae Points from Fingerprints

It is presumed that the fingerprints of every individual are distinct and in each individual it varies between his/her own fingers. As most of the available fingerprint authentication systems are on the basis of minutiae points, we have also made use of minutiae points in our proposed approach. The minutiae points are the feature points extracted from a raw fingerprint image. A fingerprint is formally defined as a pattern of ridges and valleys on the index of the finger. The local ridge characteristics that materialize either at the ends of the ridge or ridge bifurcations is called as Minutiae points. The significant steps involved in the extraction of minutiae points are given in Fig.1.

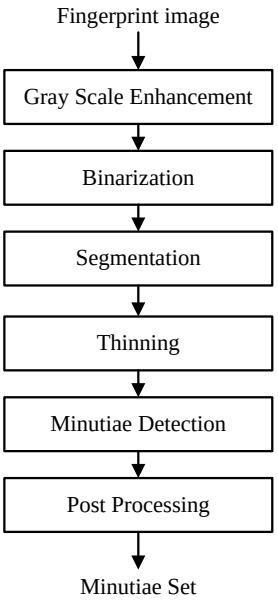


Fig. 1. Block diagram for minutiae based feature extraction

Gray Scale Enhancement. The acquirement stage is based on scanning, capturing and features registration processing to detect a high resolution image with enough gray levels, in most cases 256 levels (8 bits/pixel). However, converting to gray level must done in case of image is different color systems. For example, image is in RGB (red, green, blue) model, converting to gray scale is done by following equation [1]:

$$Gray_{ij} = 0.3 \cdot R_{ij} + 0.59 \cdot G_{ij} + 0.11 \cdot B_{ij} \quad (1)$$

Alternatively, $Gray_{ij} = \frac{R_{ij}+G_{ij}+B_{ij}}{3}$ where, $Gray_{ij}$ is gray level value for *i ,j* position, R_{ij}, G_{ij}, B_{ij} – are values respectively red, green and blue color.

Binarization. Nearly most of the minutiae point's extraction algorithms make use of binary images, which possess only two levels of interest: The black pixels that indicate ridges and the white pixels that signify valleys. During binarization, the grey level image is translated into a binary image with the purpose of improving the contrast between the ridges and valleys in a fingerprint image and thereby performing minutiae points' extraction. The grey-level value of each pixel in the enhanced image is investigated in the binarization process. Subsequently, if the grey-level value is greater than the global threshold, the pixel values are set to one, or else zero. Usually, to get threshold value image histogram is used:

a) median value *T* is defined by image illumination;
b) calculate weight centers, *m1*, *m2* for two sides of histogram;
c) threshold *T* is calculated as $T = (m1 + m2)/2$;
d) if new value of *T* is differ from first value, 2-3 stages are done until difference is equal zero.

Alternative method is to calculate mean value for selected section is calculated as following:

$$T = \frac{1}{M \cdot N} \sum_{i=1}^{M} \sum_{j=1}^{N} G(i,j) \quad (2)$$

Besides that, *T* value is can calculated as following equation:

$$T = (G_{min} + G_{max})/2 \quad (3)$$

Resulted images that got above binarization methods are given in Fig. 2.

gray scale image | Binary image by (2), T=117 | Binary image by (3), T=102 | Binary image by (1)

Fig 2. Binary images

Segmentation. The segmentation process is chiefly used to extract the region encompassing the fingerprint without noise by segmenting the input fingerprint image from the background. There are many segmentation algorithms and we choose one of the robust among them from [2]. In this process, binary images are needed and following stages must done:

1. Select such *C* point of the fingerprint image that is in fingerprint. (This point is usually in fingerprint).
2. From C move to right, left until only white space, and find two points, *R* and *L* respectively (one is right site and other is left site).
3. Find middle point, C', on line that through *R* and *L* points. This point is lien on center of fingerprint horizontal axes. Through C' point move to top, bottom until only white and find two points, *T* and *B*.
4. Done three time again above stages and find new three point for each site of image (top, bottom, left, right).
5. Segmented image is got as following boundary (Fig. 3.).

$$Seg_{image} = Org\_image(top: bottom, left: right) \quad (4)$$

where

top – is point among three top points where *y* coordinate is minimal;
bottom - is point among three bottom points where *y* coordinate is maximal;
left - is point among three left points where *x* coordinate is minimal;
right - is point among three right points where *x* coordinate is maximal.

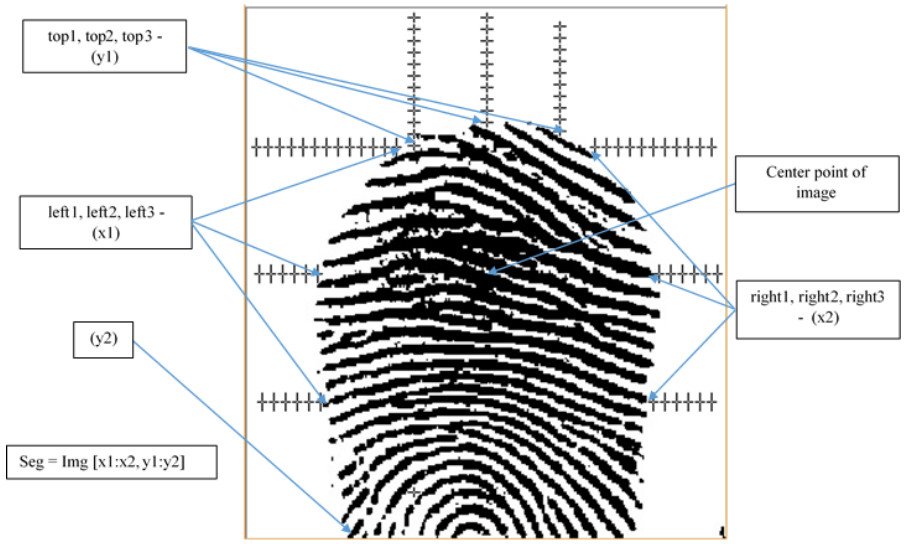


Fig. 3. Define boundary of fingerprint

By this method, we got following segmented fingerprint image (Fig.4).

Thinning. Even segmented image is not suitable for minutiae extraction. Thinning process must done to remove noise part of images and leave width of only one pixel line [3]. There many publication in this fields at last 3 decades [3, 5]. Classification of thinning algorithms are following (Fig. 5.) [4].

Gray scale image Binary image Segmented image

Fig. 4. Segmented fingerprint image

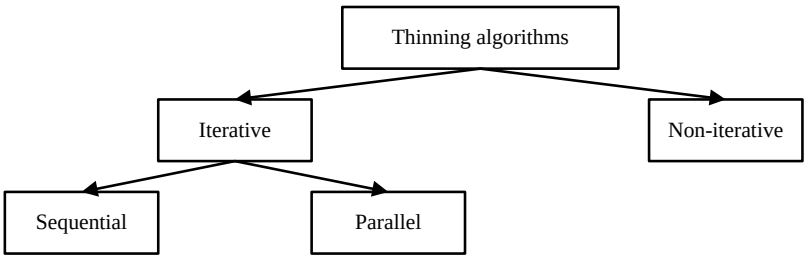


Fig. 5. Classification of thinning methods

Among these algorithms, parallel method is more robust and fast one. We use Zhang-Suen et. el [5] method for thinning. For this, binary image is describe as two-dimensional matrix that consist only zero and one. There are one is line and zero is background. Among this image, we get following 3x3 matrix as following:

$P9(i-1,j-1)$	$P2(i,j-1)$	$P3(i+1,j-1)$
$P8(i-1,j)$	$P(i,j)$	$P4(i+1,j)$
$P7(i-1,j+1)$	$P6(i,j+1)$	$P5(i+1,j+1)$

Algorithm:

Each pixel of full images is checked following two stages and if result is true then this pixel is removed.

Stage 1:

a) $2 \leq N(P) \leq 6$, *N(P)* – is number of movements from 0 to 1 of side by side pixels;
b) *S(P)=1,* selected pixel is black;
c) *P2*P4*P6=0,* at least one of them is 0;
d) *P4*P6*P8=0,* at least one of them is 0;

Stage 2: case of a and b are not changes

*c) P2*P4*P8=0,* at least one of them is 0;
*d) P2*P6*P8=0,* at least one of them is 0;

When selected pixel is done above case, then this pixel changes to zero. Simple example for this method is given in Fig. 6 and Fig. 7.

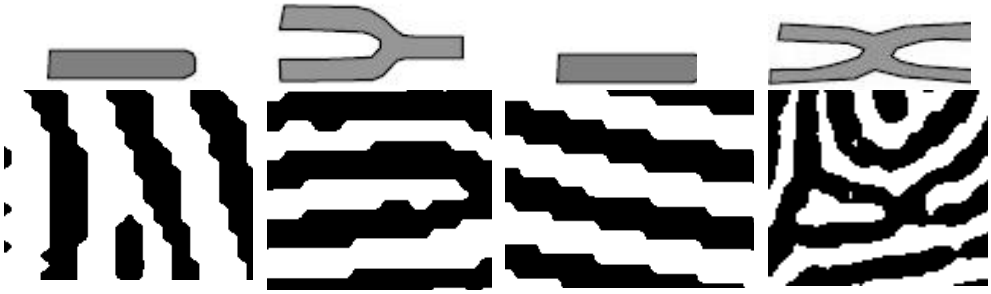
before	after
[0, 0, 0, 0, 0, 0, 0, 0, 0]	[0, 0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 1, 1, 1, 1, 1, 1, 1]	[0, 0, 0, 0, 1, 1, 1, 1, 1]
[0, 0, 1, 1, 1, 1, 1, 1, 1]	[0, 0, 0, 1, 0, 0, 0, 0, 1]
[0, 0, 1, 1, 1, 0, 0, 1, 1]	[0, 0, 1, 1, 0, 0, 0, 0, 1]
[1, 1, 1, 1, 1, 0, 0, 1, 1]	[1, 1, 1, 0, 1, 0, 0, 0, 1]
[0, 0, 0, 0, 1, 0, 0, 0, 0]	[0, 0, 0, 0, 1, 0, 0, 0, 0]

Fig. 6. Thinning process by Zhang-Suen's method

Binary image	Thinned image

Fig. 7. Thinning image by Zhang-Suen's method

Minutiae Detection. By this process, we can get most important point of images. Most automatic systems for fingerprint comparison are based on minutiae matching. Reliable minutiae extraction is an extremely important task and a substantial amount of research has been devoted to this topic. Usually, when we move 3x3 matrix over thinning fingerprint image, there are three case would be *intermediate ridge*, *ridge ending*, *bifurcation* and in some case *crossover (*Fig. 8*)* [2].



a) ridge ending b) bifurcation c) intermediate ridge d) crossover

Fig. 8. Types of minutiae points

To check these points we get following 3x3 matrix:

$P8(i-1,j-1)$	$P1(i,j-1)$	$P2(i+1,j-1)$
$P7(i-1,j)$	$P(i,j)$	$P3(i+1,j)$
$P6(i-1,j+1)$	$P5(i,j+1)$	$P4(i+1,j+1)$

White and black color is defined as zero and one. Line is one (black), background is zero (white). In this case, number of movements from white to black among matrix elements:

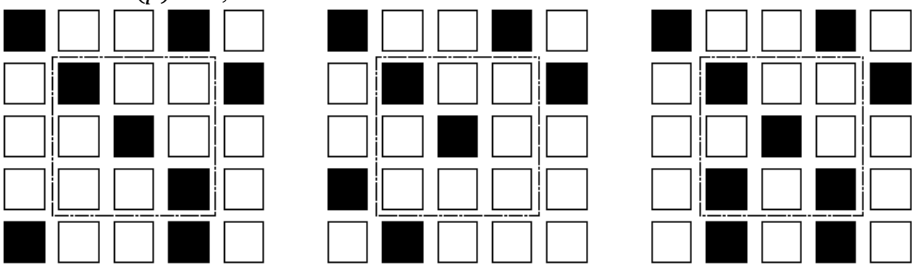
$$n = p1 + p2 + \cdots + p8 \qquad (5)$$

$$cn(p) = \frac{1}{2}\sum_{i=1\ldots8}|val(p_{i\ mod 8}) - val(p_{i-1})| \qquad (6)$$

Where: p_i – is value (0 or 1) index of i, $cn(p)$ - number of movements from white to black, $val(p_i)$ – value of p index of i.

Then, based on values of $cn(p)$ we can define types of minutiae (Fig. 9):

- If $cn(p) = 2$, then intermediate ridge;
- If $cn(p) = 1$, then ridge ending;
- If $cn(p) = 3$, then bifurcation;
- If $cn(p) > 3$, then crossover.



a) $cn(p) = 2$ b) $cn(p) = 1$ c) $cn(p) = 3$

Fig. 9. Defined minutiae point's types

Resulted fingerprint image after processing with minutia detection like as following (Fig. 10).

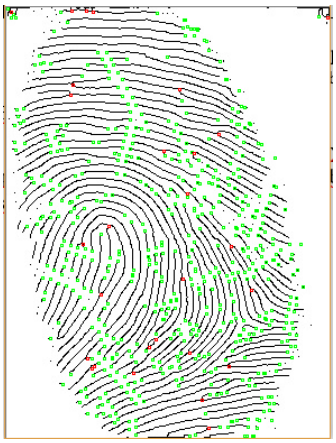


Fig. 10. Fingerprint image after minutiae detection

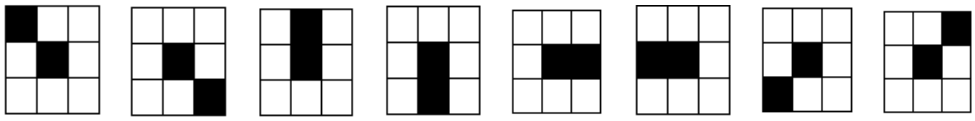
Post Processing. As you can see in Fig. 10 image, there are many false minutiae points. Therefore, we need robust post processing method. During post processing two tasks are done (Fig. 11).

- Remove false unconnected lines;
- Remove ridge-ending points that situated boundary of fingerprint.

a) false unconnected lines b) ridge endings at top right side c) ridge endings at top left side

Fig. 11. False minutiae points

Remove false minutiae points is difficult task in image processing. However, we proposed following method that is reliable in most cases. For all ridge endings, define angles as following (Fig. 12).



a) α = 135 b) α = 315 c) α =90 d) α =270 e) α =0 f) α =180 g) α =225 h) α = 45

Fig. 12. Ridge endings types and it's angle

Then, $alfa = |p_i(\alpha) - p_j(\alpha)|$ and $d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$. Where, *alfa* – is angle between two ended points and *d* – is the distance between two point in two-dimensional space.

To detect false minutiae points that lies on unconnected lines, following two cases must be done: *alfa=180* and *d>=10.* Then, two minutiae points passed.

To remove false minutiae points that are boundary of fingerprint, there are four different situations, particularly, four corners of images. For all situation, we check minutiae point is not near to white space. If there are not any black space (this is line), then this minutiae is passed (Fig. 13).

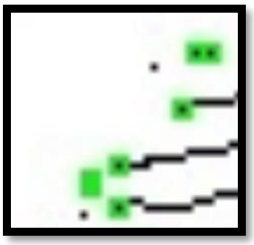


Fig. 13. Check minutiae points is in boundary of fingerprint

Finally, overall fingerprint image with minutiae points is like following (Fig. 14).

Fig. 14. Overall minutiae points

4. Conclusion

In the literature, many minutiae detection methods are proposed and up to date is creating continuously. Proposed minutiae extraction method is based on binarization approach.

After minutiae detection process, there are many false minutiae points. To remove them, we check each minutiae point whether it is in boundary of fingerprint or in unconnected line. Result of them, we can remove many false minutiae.

True and reliable minutiae points is important for strong fingerprint authentication (identification) and fingerprint based cryptographic key generation.

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Personnel Competitiveness and Its Impact on Sales of the Company

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Abstract. The present article deals with the influence of personnel factors on sales performance of the company. In modern conditions of the development personnel competitiveness serves as the best form of social protection of employees at the company and into the job market. In the article were observed that the employee competitiveness is not only one of the key factors influencing on growth of sales of goods and serves, but also on enterprise competitiveness as a whole. Basic theoretical foundations of employee competitiveness were investigated. Determined that the employee competitiveness is a combination of knowledge, abilities, skills and personal traits that enable employees to fulfill their responsibilities in the company. The main components and types of employee competitiveness are elucidated; a variety of factors that influencing on it are analyzed. The basic tools of employee competitiveness and the special features of its evaluation are investigated.

Kew words: Competitiveness, Personnel competitiveness, Management of competitiveness, Sales.

1. Introduction

Target setting

On condition of competition intensification between economic subjects at all levels, the employee competitiveness serves as the best form of social protection of workers at the plant and in the labor market. This effect is achieved through the implementation of economic (a permanent job, a good job, high variability of wages) and social (a choice of work, self-confidence and confidence in the future) benefits that underlie this complex and multifaceted phenomenon.

Competitive employee due to high quality of work and his ability to implement his competitive advantages meets not only his needs but also the needs of the relevant company. As a result, competitive products that are in demand both domestically and abroad enter the market. These businesses provide stable sales and high incomes, the saturation of the market with competitive goods, worthy compete with foreign producers.

Analysis of recent research and publications on the issue

Problems of personnel competitiveness were researched in the scientific works of domestic and foreign economists such as F. Taylor, A. Fayol, G. Emerson, L. Urwick, M. Weber, C. Ardzerries, R. Licart, R. Blake, J. Basiluk , D. Bogin, N. Glevatskaya, O. Grishnova, N. Dudina, G. Krisina, E. Libanova, L. Lisogor, M. Semikina, C. Tsimbalyuk, V. Shapoval and others.

Formation objectives of the research

The objective of the article is to analyze personnel competitiveness and its impact on sales and total competitiveness of an enterprise.

2. Presentation of the main results and their justification

In modern developing conditions the development of the competitiveness of an enterprise is largely effected by employee competitiveness. Nevertheless, new technology implementation in a company and positive influence of surrounding factors on the performance of an organization, cannot be compared with an impact of highly qualified personnel, which is ready for changes, otherwise the company cannot achieve the desired results. In economic literature there is no single definition of the term of the personnel competitiveness.

A peculiar characteristic of the term personnel competitiveness is given by A. Marshall: "when a person is capable enough and knows everything about the market of related work, he will not remain at lower ranks of workers categories for a long time" [1].

A. Shatokhin defines the term of the personnel competitiveness as the relation between utility of worker labour qualities in the labour market and a potential buyer, namely an employer [2].

S.V. Kravtsevych describes the personnel competitiveness as "a comparative characteristics of a worker, which determines the effectiveness of present worker's potential which is implemented through his labour behaviour" [3].

S.I. Sotnikova defines the personnel competitiveness as staff ability to individual achievements in labour, contributing to the achievements of organizations [4].

According to O.A. Grishnova, competitiveness of an employee is an accordance of labour market needs, the ability to win in the competitive job market, with better performance than other candidates, meeting of the requirements to employers in terms of their knowledge, skills and personal traits [5].

V.N. Lazarev defines the personnel competitiveness as a complex of personal and professional characteristics of the personnel that is able to perceive and analyze the situation quickly, make the best decisions, enabling them to fulfil their responsibilities, and implement in the labour market effectively [6].

In our opinion, *employee competitiveness is a combination of knowledge, abilities, skills and personal traits that enable employees to fulfil their responsibilities in a company and be demanded in labour market.*

The studying of the personnel competitiveness as an integrated characteristic and complex systems involves the need to study and analyze some components of labour potential, among which there are: physiological, vocational and qualification, and status components.

Thus, **physiological component of labour potential** is defined according to psycho-physiological characteristics of personnel and it includes the elements such as gender, age, health status, personal staff qualities (activity, creativity, initiative, motivation type, needs, etc.).

Vocational and qualification component of labour potential is determined by such vocational and qualification characteristics of personnel as its degree of education and qualifications, work experience in the profession, professional mobility.

Status component of labour potential is determined by social status and the assessment of the prestige of the profession by the employee, his family, colleagues and friends.

Each of these elements of work potential of a particular individual may create either competitive labour advantage, or vice versa it may obstruct him in competitive job market.

Therefore, we consider it reasonable to study the features of the competitive advantages of employees as the basis of their competitiveness. Thus, in the economic literature there are following types of competitive advantages: inherited and acquired.

Inherited competitive advantages include the aptitudes (cleverness, talent, genius, ability for this type of activity), temperament, and physique [7].

Acquired competitive advantages include: business skills (education, specialist knowledge, skills and abilities); intelligence and culture; purposefulness of the work motivation (ability to set personal goals and team goals); character (attitude to work, to others, to oneself, to things); emotionality (ability to control ones emotions, will, stress resistance, etc.); sociability, communication skills, organized character; age and so on.

The classification of the personnel competitiveness into inherited and acquired ones is conventional. For example, the ability to a particular type of work is accumulated as the experience gained in this branch. But other aspects of the abilities - cleverness, genius, talent are mostly determined by inherited. Physique is mainly people's hereditary factor that can be improved by means of individual training or in other ways.

Competitive advantages of employees, depending on the availability of documentary evidence are: **subjective** (personal qualities, professional mobility, prestige estimation) and **objective** (gender, age, health, education, qualifications and work experience).

The formation and development of the personnel competitiveness is affected by the factors which are divided into two groups according to their source of impact: **internal** (factors that impact due to the personnel and organization) and **external** (factors of micro-and macro environment of the organization) [8].

The factors affecting the competitiveness of the personnel are also the determinants of the employment potential components (psycho-physiological, professional qualification, status). The effect of the organization on competitiveness is determined by created organizational, social and psychological conditions that form and contribute to the development of employee competitiveness [9]. These include such groups of factors as work team, salary, workplace, company management, professional career, social security and social welfare.

External factors of the personnel competitiveness are a complex of acting individuals and forces outside the organization that affect the maintenance and development of the personnel competitiveness. These include: mediators, suppliers, competitors, consumers, demographics, economics, environment, technology, politics, culture, etc. [10]. Basic components of the employee competitiveness are presented in Fig. 1.

The concept of employee competitiveness can be classified according to various criteria, thereby determining its basic types.

1.Depending on the achieved level there is **the personnel competitiveness of high, medium and low level.**

The high level of the competitiveness provides a combination of competitive advantages of personnel on the basis of its characteristics (professional qualification, physiological, motivational, corporate, etc.) that fully meet the requirements of production.

The average level of the competitiveness is typical to the personnel imparted partial matching of the characteristics of the labour potential (all or several) to the proposed requirements and according to the evaluation results these workers are less confident in the stability of their employment both within the enterprise and beyond it. The low level of the competitiveness is peculiar to the employees having unacceptably low estimation rate on one or several characteristics in comparison with the required ones [11].

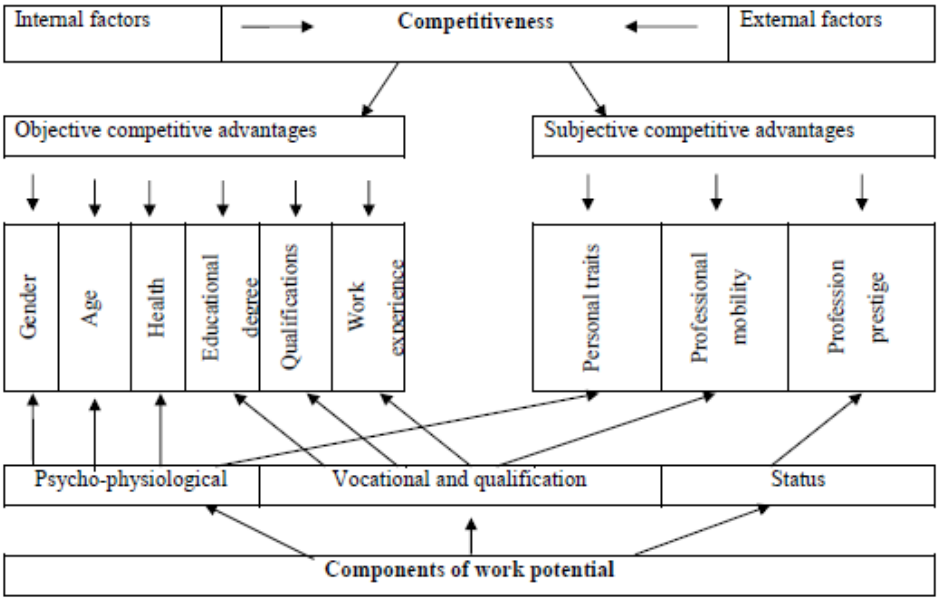

Fig. 1. The key elements and factors of the personnel competitiveness
[*Source: prepared by the author*]

2. Depending on the number of evaluated characteristics there can be distinguished **an element-based** (it is defined by any one of the characteristics of the work potential (e.g., work experience)) and **general competitiveness** (it provides a comprehensive analysis of the development of employee work potential) [12].

3. Depending on the tested individual there can be distinguished: **individual** (it describes the level the development of the characteristics of labour potential of a particular employee) and **group or competitiveness of groups** (it studies the competitiveness of certain age and gender workers, professional and qualification or other groups of different categories of personnel, and of the whole enterprise).

4. Depending on the site of labour application there are **internal** (the competitiveness of the personnel within the enterprise) and **external competitiveness** (the competitiveness outside the enterprise).

5. Depending on the type of prevailing competitive advantages there are **absolute and relative competitiveness.** The absolute competitiveness allows the personnel to reproduce itself continually, to rise professionally, and improve itself. Such personnel respond to social and economic changes with flexibly that allows it to maintain its competitiveness at a sufficient level. Relative competitiveness is connected with the fact that to a greater degree its level is less supported by the staff itself, but by external conditions, such as relations, acquaintances, etc., which are usually of a temporary nature. At any time, regardless of employees the characteristics can shift from a competitive advantage to a factor of non-compliance with presented requirements.

6. Depending on the causes influencing the dynamics of competitiveness there can be distinguished: **factor, structural and situational competitiveness.**

The factor competitiveness is associated with changes within the personnel, namely its level of certain characteristics of the work potential. Thus, the external conditions related to the personnel may remain unchanged, or they may be evolutionary in nature, that is associated with ongoing, daily changes (industrial, economic, social and other) in the life of the enterprise.

Structural competitiveness is associated with a sharp change in personnel in terms of compliance of its certain characteristics of the work potential to the required regulations because of some independent on its (personnel) reasons.

Situational competitiveness is associated with regional (including natural, climatic, geographic) characteristics of the production, but also it is determined by the status of a particular company in the region [13].

As companies have different levels of technological and technical development, unequal financial status, level of management, corporate culture and requirements are different for employers to set competitive skills of employees and a reasonable valuation of labour services workforce. Of course, the last affects the equilibrium price of such services on the labour market, especially in a particular area or a particular segment of the labour market, as well as general trends such as the increasing demand for the ability to work with information, professional mobility, adaptability and so on.

It is important to emphasize that attempts to assess the competitiveness of the staff always include a conformity assessment of certain components of the labour potential indicators of competitiveness.

Let us consider some methodological approaches to the assessment of the competitiveness of workers. Thus, evaluating the competitiveness of a particular category of staff according to Fatkhutdinov R.A. is recommended as follows:

$$K_n = \sum_{i=1}^{n} \sum_{j=1}^{7} \frac{(6_i \cdot B_{ij})}{5 \cdot n} ,$$

where K_n - the competitiveness of specific categories of staff, n - number of experts, 7 - quantity of quality of staff to be considered, a_i - importance of quality, b_{ij} - experts estimation of personnel competence according to five point scale: 1 - no quality, 2 - appears quite rarely, 3 - not very evident and mild, 4 - appears often, 5 - appears systematically [7].

Comprehensive assessment of the competitiveness of K_{ij}, proposed by Petrova I.L [14], is built using the points a_{ij} and b_{ij} of significance criteria used for it:

$$K_i = \text{å } a_{ij} \times b_{ij.}$$

Methodological approaches developed by Grishnova O. and Shpyrko O. are based on the fact that competitiveness is a function of the personnel of its quality and price [15], and the method provides for application method and magnitude involving weights to determine the validity of certain indicators of competitiveness.

Designated methodological approaches Grishnova AA, Petrova IL and other scientists have significant advantages, allowing the selection of the most competitive workers in the labour market positively be put on improving the quality of the labour potential of individual employees and the company as a whole.

Designated methodological approaches by Grishnova O.A, Petrova I.L. and other scientists have significant advantages, allowing the selection of the most competitive workers in the labour market positively improving the quality of the labour potential of individual employees and the company as a whole.

3. Conclusions

In modern developing conditions the working out and the introduction of the personnel competitiveness management system by each enterprise is regarded as one of its main competitive advantage which enhances the its sales of goods or services and total competitiveness of the enterprise. In this context, the effective personnel competitiveness management is one of the most important tasks of modern enterprise management.

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The Use of Crypto Currencies and the Development of Crypto Economy as Threats to the Financial Security of the State

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Abstract. The paper reviews current trends in use of crypto currency. The threats to the financial security of the country that are provoked by the spread of crypto currencies and the growth of the crypto economy are identified. The possibilities of minimizing the threats and risks of using crypto currencies in financial relations are determined. The role of the central banks and regulators of the financial markets in the process of controlling the use of crypto currencies is emphasized. Promising direction for future research is outlined.

Keywords. Crypto currency, Crypto economy, Threat, Risk, Financial security.

1. Introduction

The concept of crypto currency became into a lexicon of economists in 2009, when its first version, Bitcoin, was created. Since then, Bitcoin is the first product of crypto economy that represents the use of cryptographic tools in accordance with economic laws and under the influence of economic incentives allow to realize the interests of the crypto-currency owner (primarily financial and economic). In informational Internet resources, you can find the following definition: crypto currency is any type of digital unit used as a medium of exchange or a form of digital retention value. It is important that this concept excludes the domestic currency of computer games; digital units that can be exchanged for goods, services, discounts or purchases within customer loyalty programs; as well as digital units that are used as part of a debit card system.

Functioning and developing in the information environment, the crypto-economic system is exposed of numerous threats inherent in digital resources and objects that are the products of computer systems and Internet resources. At the same time, the very fact of the existence and popularization of crypto currencies and other forms of the evolution of the crypto economy is a modern threat to the financial security of the state - both at the global level and at the level of individual countries of the world, which allows us to assign crypto economy the status of a national threat to Ukraine's financial security.

At the beginning of its use the crypto currency contributed to the mediation of settlements between persons who were not familiar and had no reason to trust each other. But now the crypto currency is an instrument for mediating financial flows in the shadow economy, an instrument of transferring financial assets to pay for smuggling and financing terrorist activities, conducting financial transactions bypassing fiscal services and other public authorities and monitoring. The rapid development of crypto economy on a global scale in general and in Ukraine in particular distorts data from monitoring of the state of real and financial markets, as it does not allow to accurately assess the level of their capitalization through the execution of financial transactions outside officially recognized trading platforms.

The problem of regulation of economic relations mediated by the use of crypto currencies is also acute. At the global level, crypto currencies are not officially recognized as legal currencies, and that raises some questions about the legality of their use by individuals and entities.

2. Threats of Using Crypto Currency for Financial Security of the State

Problems and perspectives of using crypto currencies in the system of economic relations are studied by modern foreign scientists, in particular, some aspects of this process are presented in publications [1] (Cryptocurrencies: Are Disruptive Financial Innovations Here), [2] (An Analysis of Cryptocurrency, Bitcoin, and the Future), [3] (Legal and Economic Analysis of the Cryptocurrencies Impact on the Financial System Stability), [4] (Bitcoin and Beyond), [5] (Risks and Threats of Cryptocurrencies) and in many others.

The aim of this study was to determine the list of the threats to financial security of the state arising from active use of crypto currency within the economic system for the mediation of financial calculations for various forms of economic relations. So, first of all use of crypto currency is a threat to the proper functioning of the financial system and its participants, as it intensifies development and provides the ability to finance the illegal production and trade. The second block of threats associated with the state tax security system of financial security because it allows entities of crypto economy fully or partially evade taxes. The cripto currency actualizes inflationary threats to the economy, as it increases the amount of funds available in circulation. The issuance of various types of electronic money is beyond the control of banking systems and their regulators. In particular, in Ukraine, the National Bank of Ukraine, which is the main subject for guarantee bank security, has no means and instruments for influencing processes of emission and using crypto currencies. In fact, these processes take place entirely outside the banking system, and totally reduce the role and significance of banking institutions in the process of servicing financial transactions, limits the ability to receive income from them as customers pay for financial services, reduce the amount of financial resources available to professional sub- objects of the banking sector and can be used to lend to the activities of business entities.

Calculations in cripto currency are convenient for use when buying and selling illegal goods, paying for illegal works and services. With crypto currency people buy narcotic drugs, forbidden drugs, organs for transplantation. Krypto money are using for paying for weapons, sexual services, orders for killers, gangsters to eliminate competitors, and so on. Money laundering using crypto currency threat assessment shows that criminal organizations can use virtual currency for access to "legal cash".

The use of virtual currencies allows organized criminal groups to receive anonymous access to cash and hide the chain of transactions. They can receive secret keys from electronic purses or withdraw cash at an ATM. Because of the inability to trace who owns the crypto currency, it is popular with hackers, arms dealers. Crypto currency simplifies the flow of funds between criminal groups. In August 2017, hackers began to demand a ransom from the HBO television company for the abducted script of the series "The Game of the Thrones". Redemption in the amount of $ 6 million was due to pay in crypto currency Bitcoin. Crypto currencies are often used by members of the "darknet" - a private network whose users are difficult to trace through non-standard communications protocols.

Instability in Ukraine and new restrictions that appear for money transfers for Ukrainians (the Russian government recently banned transfers of money to Ukraine through the instant money transfers), stimulate non-standard investment decisions. One of them was

an investment in crypto currency. However, at the moment, crypto currencies are very high risk assets with high volatility. Crypto currency has no single course. For example, the Bitcoin rate may vary several times a day. In the markets of crypto currencies there is a chaotic trade. For a long time, known "safe" coins get serious blows, little-known coins seem to fall into the top 10 overnight, almost neglected projects suddenly become expensive and popular.

Also, the crypto currency is used to store financial assets. The lack of oversight of operations in crypto currencies leads to the fact that government structures can not monitor investments in crypto currency. According to co-founder of Bitcoin Foundation in Ukraine Andriy Dubetsky, in 2016 demand for Bitcoin in Ukraine has grown at once five times (the weekly volume of trading has increased from 500 thousand UAH to 2.5 million UAH), and continues to grow in 2017. In the current year, the hryvnia exchange rate crippled from 26 thousand UAH up to 34 thousand UAH for one Bitcoin. In response to the growing demand for crypto currencies, the semi-legal financial offices that provide services for exchanging them for legal currency and conducting payments with a conversion when purchasing goods or services began to appear. In Ukraine, the number of points where people can pay for goods with crypto currencies is increasing: tickets booking services, online stores, restaurants, and more.

Robert Schiller, Economic Nobel Prize winner 2013, believes that Bitcoin is a good example of a speculative bubble. A financial bubble occurs when too much money is behind a small amount of assets, which results in overestimating these assets. This, in his opinion, is happening with crypto currencies.

Anonymity of transactions, lack of control of any regulators, lack of security, algorithmically specified limited emissions, the impossibility of cancellation of transactions - this is an incomplete list of characteristics of crypto currencies. Specific feature of crypto currency is the irreversibility of operations with it. They can not be canceled or moved: complex cryptography is used for this. Owners of crypto currencies can count on them without the participation of banks and other intermediaries. To do this, you only need to know the wallet number. But the name, country or phone number is not required. However, due to anonymity, it is impossible to return lost Bitcoins or to prove ownership of them. Experts note that the crypto currency is easy to steal. Experts estimate that theft amounts are around 20% of the world's crypto currencies.

In the scale of the financial system of the country, an increase in the number of anonymous transactions can lead to an increase in the shadow economy. The risks of mass use of crypto currency ovalite by individuals are also present due to the low level of financial literacy of the population. The owner of crypto currency can give it as a loan to someone and, if the borrower turned out to be a fraud, to get currency back is impossible. In order to use crypto currencies, the financial and technological literacy of the population should be very high.

In theory, the growth of the scale of the crypto currencies use can ruin the banking world system, on condition that all of the world's most commonly used to calculate in crypto currency. However, moderate use of the digital currency will not lead to the collapse of the banking system, but for banks it will be seriously shaky, forcing them to revise the policy of obtaining "easy" revenues - from money transfers, commissions for operations of private individuals and so on. Thus, banks will have to compensate the loss of income, using a more risky credit policy, adhering to high-risk trading strategies.

3. Directions of Minimization the Threats of the Existence of Crypto Currency in Financial System

At the end of 2014, the National Bank of Ukraine emerged on the path of a crypto-currency war. Bitcoins have received a "money surrogate" stamp, and all potential users have been warned that using Bitcoin, they pose in a deadly threat. True, it was not announced what exactly this deadly threat was. Now, in 2017, the National Bank of Ukraine intends to carefully study the principles of crypto currency and only then to introduce a mechanism for it regulation, which depends on whether NBU consider it simply as a digital asset or will take into account its currency nature. The NBU worries about the key point - the regulator can not control a currency such as Bitcoin, its rate and volume of investments.

The practical aspects of using crypto currencies are in attention by the heads of central banks of different countries of the world. For example, Jens Widman, chairman of the German Bundesbank, announced that Bitcoins and other digital assets pose a potential threat and could worsen the effects of future financial crises.

Vedman believes that central banks will sooner or later create their own crypto currency in order to demonstrate to ordinary citizens the security and stability of this form of money, but this may increase the risk of crises.

Activating of use crypto currencies is a challenge for regulators in all countries, since Bitcoin does not exist within any existing jurisdiction and can not be changed by anyone directly/ Bitcoin is a social tool that is developed and used by society. But representatives of the legal Ukrainian business are facing difficulties when using Bitcoin in their calculations, primarily due to the lack of a legislative framework. Even a mechanism that would allow paying VAT and other taxes in crypto currency is missing now.

The Ministry of Finance in Russia in the fall of 2015 offered to criminalize the issuance and circulation of crypto currencies. In the opinion of the department, the maximum punishment for these acts was 4 years of imprisonment, but after six months it was proposed to increase this term for another three years. The ministry was concerned about anonymity, the lack of state control, and the possibility of violating the rights of entrants in the turnover of conscientious participants in market relations. The Central Bank of Russia also initially supported the ban on the use of crypto currencies, which by its nature are close to the money surrogates, denominated in Russia. However, this position has changed now. For the accounting and control of crypto currencies, the Central Bank of Russia expressed the assumption that digital currency should be officially recognized as assets, cash or securities.

In 2015, the Financial Services Department of New York City adopted the world's first regulatory act, detailing Bitcoin. In April 2017, the Japanese government passed a law on virtual currencies, which legalized the crypto currency of Bitcoin and Ethereum. Due to this, these virtual money in Japan can be used for mutual settlements. Crypto trading is subject to licensing, and all crypto currency exchanges, payment service providers will have to work on the same rules.

The authorities of Japan in April 2017 adopted a law on virtual currency, reports. Thanks to the new law in the country now legalized crypto currency Bitcoin and Ethereum. These virtual money in Japan can be used for mutual settlements. Companies and individuals can buy these virtual money as goods that are not subject to mandatory 8 percent consumer tax. But despite the adoption of the law, crypto currency in Japan did not become legal circulating medium.

In the European Union, transactions in Bitcoin are classified as currency transactions, and are excluded from taxable assets.

In September 2017, the prime minister of Malta, Joseph Muscat, created a special group, whose responsibilities include working out schemes for the adoption and use of crypto currencies. According to the politician himself, he wants to see Malta as the first country that will be able to regulate the circulation of crypto currencies.

In Ukraine, at present, there is no legislation that strictly prohibits the use of crypto currencies as a means for payment. This fact highlights the need to develop at the national level the strategies and concepts for the regulation of virtual currencies in order to maintain the level of financial security of the country.

Activity related with crypto currencies should be licensed. This applies to the business activities of legal entities engaged in the sale or purchase of crypto currencies in the interests of the client, receiving it for money transfer, trust management on behalf of third parties, etc. That is, the license will have to receive Biction-exchanges and similar bidding organizers.

US authorities in the near future will oblige electronic money operators to disclose information about the large postings of funds and report about the exchange of virtual currency for cash. Officials explain the increased regulation as the fight against drug trafficking and laundering of illegal proceeds. Companies that provide the ability to exchange electronic money for cash will be subject to additional checks.

Legalization of crypto currency is a long process. In the world of digital calculations, there is a change in the philosophical paradigm. What was created to avoid state regulation is now recognized as a sovereign regulator. Central banks are looking for ways if not to get total control over the terra incognita of financial markets, then at least include it in the legal field.

Central banks around the world should seriously think about their attitude to the growing market of crypto currencies, according to the Bank for International Settlements (BIS). IMF chairman Christine Lagarde does not rule out the possibility of using the block-chain technology by the International Monetary Fund. Lagarde said that the crypto currency, despite the high risks for depositors, the lack of transparency and lack of real security does not pose a threat to the world's central banks. The shortcomings of crypto currencies are due to technical problems that can be resolved over time.

The BIS argue that central banks should consider confidentiality and effectiveness according the valuation of digital currencies as well as the implications of using them for global financial stability.

4. Conclusion

The existence of crypto currencies and their active use have generated the phenomenon of crypto economics. The greatest problem of the existence of economic relations, which is mediated by the turnover of crypto currencies, is their lack of control and their unregulatedness.

For financial security of Ukraine, the use of crypto currencies has the following threats:

- expansion of the boundaries of the shadow economy and shadow cash flows;
- simplification of the procedure for laundering of proceeds from crime actions;
- reduction of tax revenues to the budget;
- increase of inflation and increase of inflationary fluctuations;
- refusal of traditional banking services and other types of financial intermediaries;
- destabilization of the monetary sphere;
- decrease in the level of trust of the population and business entities to the financial system and its professional participants;
- the emergence and distribution of new unlicensed types of financial services that do not have standards;
- lack of guarantees during cash payments with crypto currencies.

For these reasons the development of the concept of regulating the circulation of crypto currencies in Ukraine is a promising area for future research.

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The Optimisation Problem of Packing Ellipsoids in a Convex Container

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Abstract. We consider the problem of optimal packing of a given collection of unequal ellipsoids into a convex container of minimal sizes. To describe non-overlapping, containment and distance constraints we derive phi-functions and quasi-phi-functions. We formulate the packing problem in the form of a nonlinear programming problem and propose a solution strategy that allows us to search for local optimal packings. We provide computational results illustrated with figures.

Keywords. Packing, Ellipsoids, Convex container, Non-overlapping, Containment, Quasi-phi-functions, Nonlinear optimisation.

1. Introduction

The optimal ellipsoid packing problem is NP-hard problem and has multiple applications in modern biology, medicine, mineral industries, molecular dynamics, nanotechnology, as well as in the chemical industry, power engineering etc. For example, the formation and growth of crystals, the structure of liquids, crystals and glasses, the flow and compression of granular materials, the thermodynamics of liquid to crystal transition and other.

The 3D Modeling software product family is a set of scientific tools for three dimensional modeling of granular structures and substances. It provides comprehensive visual and quantitative analysis of structural characteristics, such as spatial density, spatial porosity, spatial distribution, grain and pore structure.

Robotics: a robot arm and other elements in a scene are approximated by three-dimensional ellipsoids and it allows the authors [1] to explore the relation between the overlapping of ellipsoids and the overlapping of free-form objects.

A problem related to the chromosome organization in the human cell nucleus and that falls between ellipsoid packing and covering is considered in [2].

2. Related works

Many works have tackled the optimal ellipsoid packing problem.

In [3] is analysed the density of three-dimensional ellipsoid packings. Technique that considered in [4] allow to statistically explore the geometrical structure of random packings of spheroids. In [2] the problem consists in minimizing a measure of the total overlap of a given set of ellipsoids arranged within a given ellipsoidal container. In [5] consider the problem of packing ellipsoids within rectangular containers of minimum volume. The non-overlapping

constraints are based on separating hyperplanes. Nonlinear programming models are proposed and tackled by global optimisation methods. Instances with up to 100 ellipsoids.

Analytical description of placement constraints (non-overlapping, containment and distance constraints) for ellipsoids with continuous rotations to produce NonLinear Programming models (NLP-models) of ellipsoids' packing problems is of paramount importance.

3. Problem formulation

We consider here a packing problem in the following setting.

Let n be the number of ellipsoids to be packed. And let Ω be a given convex container of variable sizes p. The objective of the problem is to find ellipsoids $E_i(u_i)$, $i \in I_n = \{1,2,\dots,n\}$, such that $\operatorname{int} E_i \cap \operatorname{int} E_j = \varnothing$, for each j, $i \in I_n$ with $i \neq j$; $E_i \subset \Omega$ for each j, $i \in I_n$;

and the volume of the container will be minimized.

Ellipsoid E is given by semi-axes a, b and c, $u = (v,q)$ is a variable vector of placement parameters, $v = (x,y,z)$ is a translation vector, $q = (q^1,q^2,q^3)$ is a vector of rotation parameters, where q_i^1, q_i^2, q_i^3 are Euler angles. Let $M(q)$ be the rotation matrix of the form

$$\begin{pmatrix} \cos q^1 \cos q^3 - \sin q^1 \cos q^2 \sin q^3 & -\cos q^1 \sin q^3 - \sin q^1 \cos q^2 \cos q^3 & \sin q^1 \sin q^2 \\ \sin q^1 \cos q^3 + \cos q^1 \cos q^2 \sin q^3 & -\sin q^1 \sin q^3 + \cos q^1 \cos q^2 \cos q^3 & -\cos q^1 \sin q^2 \\ \sin q^2 \sin q^3 & \sin q^2 \cos q^3 & \cos q^2 \end{pmatrix}$$

Within the research as a container Ω we consider a convex 3D region bounded by surfaces which described by infinitely differentiable functions, in particular, a sphere, a cylinder, a cuboid, an ellipsoid of variable sizes.

4. Tools of mathematical modeling

To describe non-overlapping and containment constraints we use quasi-phi-functions and phi-functions. To describe distance constraints we apply adjusted quasi-phi-functions and adjusted phi-functions. Let us consider clear definitions of a phi-function [6] and a quasi-phi-function[7].

Definition. A continuous and everywhere defined function $\Phi^{AB}(u_A,u_B)$ is called a phi-function for objects $A(u_A)$ and $B(u_B)$ if (Fig. 1)

$\Phi^{AB} < 0$, if $\operatorname{int} A(u_A) \cap \operatorname{int} B(u_B) \neq \varnothing$;

$\Phi^{AB} = 0$, if $\operatorname{int} A(u_A) \cap \operatorname{int} B(u_B) = \varnothing$ and $fr A(u_A) \cap fr B(u_B) \neq \varnothing$;

$\Phi^{AB} > 0$, if $A(u_A) \cap B(u_B) = \varnothing$.

a b c

Fig.1. Definition of phi-function

Let r be a given minimal allowable distance between objects $A(u_A)$ and $B(u_B)$: $\text{dist}(A,B) \geq r$

Definition. A continuous and everywhere defined function $\Phi^{AB}(u_A,u_B,u')$ is called a quasi-phi-function for two objects $A(u_A)$ and $B(u_B)$ if $\max_{u' \in U} \Phi^{AB}(u_A,u_B,u')$ is a phi-function for the objects. The general property of a quasi-phi-function is: if $\Phi^{AB}(u_A,u_B,u') \geq 0$ for some u', then $\text{int}\,A(u_A) \cap \text{int}\,B(u_B) = \varnothing$.

A function defined by

$$\Phi^{AB}(u_A,u_B,u) = \min\{\Phi^{AP}(u_A,u), \Phi^{BP^*}(u_B,u)\},$$

is a quasi-phi-function for the pair of convex objects A and B.

$\Phi^{AP}(u_A,u)$ is a phi-function for $A(u_A)$ and a half-space $P(u)$ and $\Phi^{BP^*}(u_B,u_P)$ is a phi-function for $B(u_B)$ and $P^*(u) = R^3 \setminus \text{int}\,P(u)$.

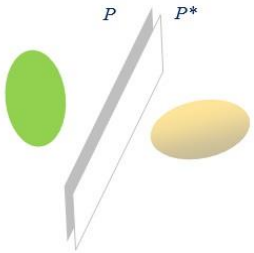

Fig. 2 Definition of a quasi-phi-function

5. Mathematical modeling of placement constraints

5.1 Nonoverlapping constraints

A function defined by

$$\Phi(u_1,u_2,u) = \min\{c(q_1,q_2,u), c_1^+(u_1,u_2,u), c_1^-(u_1,u_2,u),$$

$$c_2^+(u_1,u_2,u), c_2^-(u_1,u_2,u)\}$$

is a quasi-phi-function for ellipsoids $E_1(u_1)$ and $E_2(u_2)$, where $u = (t_1,g_1,t_2,g_2)$ is a vector of parametric variables of ellipsoids,

$$c = -\left\langle N_1^{'}, N_2^{'} \right\rangle = -a_1^{'}a_2^{'} - b_1^{'}b_2^{'} - g_1^{'}g_2^{'}$$

$$c_k^{\pm} = a_1^{'}(x_{2k}^{\pm} - x_1) + b_1^{'}(y_{2k}^{\pm} - y_1) + g_1^{'}(z_{2k}^{\pm} - z_1) - 1$$

$$(x_i^{'}, y_i^{'}, z_i^{'}) = v_i + M(q_i) \times (x_i^t, y_i^t, z_i^t), i = 1,2$$

$$(x_{22}^{\pm}, y_{22}^{\pm}, z_{22}^{\pm}) = v_2 + M(q_2)(a_2 \cos t_2, b_2 \sin t_2, \sqrt{2a_2})^T$$

$$a_i = \frac{\cos t_i}{a_i}, b_i = \frac{\sin t_i \cos g_i}{b_i}, g_i = \frac{\sin t_i \sin g_i}{b_i}, i = 1,2$$

$$(a_i^{'}, b_i^{'}, g_i^{'}) = M(q_i)(a_i, b_i, g_i), i = 1,2$$

$(x_{2k}^{+}, y_{2k}^{+}, z_{2k}^{+})$ is a vector of coordinates of point g_{2k}^{+} and $(x_{2k}^{-}, y_{2k}^{-}, z_{2k}^{-})$ is a vector of coordinates of point g_{2k}^{-}.

5.2 Containment constraints

In order to obtain the containment constraints of an ellipsoid in a region, a construction of the phi-function is required. When constructing this function, essential difficulties arise that are associated with the appearance of equations of more than four degree. In this regard, we propose an approach related to constructing a phi-function for an object approximating the ellipsoid with a required accuracy. At the first step, an approximation of the ellipsoid with the circumscribed polyhedron is constructed. Starting with, e.g., a parallelepiped we sequentially choose the vertex most distant to the ellipsoid. Then we find its projection to the ellipsoid. In the projection point on the ellipsoid surface we construct the tangent plane and then section the polyhedron with this plane.

We do so till required accuracy is achieved. Projection may be found as a solution of an appropriate optimisation problem using IPOPT optimisation package. Since the simplest form of phi-function is in case the included object is a sphere, an outer approximation of the obtained polyhedron with the spheres is applied using the method described in [8].

Within the research we assume that each ellipsoid $E_i(u_i)$ is approximated by a collection of spheres $E_i(u_i) \subset \bigcup E_i(u_i) = \bigcup_{k=1}^{n_i} S_{ik}(u_i)$.

To describe the containment constraint $E_i \subset W(p)$ we use a phi-function for $\bigcup E_i(u_i)$ and $W^* = R^3 \setminus \operatorname{int} W$ that may be defined in the form

$$F(u_i, p) = \min\{F_1(u_i, p), ..., F_{n_i}(u_i, p)\},$$

where $F_k(u_i, p)$ is a phi-function for sphere S_{ik} and W^*.

6 Mathematical model

Mathematical model of the ellipsoid packing problem can be presented in the form

$$\min_{u \in W \subset R^s} F(u), \tag{1}$$

$$W = \{u \in R^s : g_{ij}(u) \geq 0, g_i(u) \geq 0, i = 1,\dots,n, j = 1,\dots,n, j > i\} \tag{2}$$

$F(u)$ is the volume of the container W.

$u = (l, w, u_1, u_2, \dots, u_n, t) \in R^s$ is the vector of all variables

p denotes the variable metrical characteristics of the container W

$u_i = (x_i, y_i, q_i)$ is the vector of placement parameters for E_i, $i \in I_n$

t is the vector of additional variables for quasi-phi-functions

g_{ij} is a phi-function (quasi-phi-function) for E_i and E_j

$g_i(u)$ is a phi-function for approximated ellipsoid E_i and the object W^*

Problem (1)-(2) is NP-hard nonlinear programming problem (exact, non-convex and continuous NLP-model).

7 A solution strategy

Our solution strategy consists of three major stages:

- Generate a number of starting points from the feasible set of the problem (1)-(2). We employ a fast starting point algorithm described in [7].
- Search for a local minimum of problem (1)-(2) starting from each point obtained at Step

  We employ a special local optimisation procedure described in [7].

  Choose the best local minimum from those found at Step 2.

Here we present a number of examples to demonstrate the efficiency of our methodology. We have run our experiments on an AMD Athlon 64 X2 5200+ computer, and for local optimisation we used the IPOPT code (https://projects.coin-or.org/Ipopt).

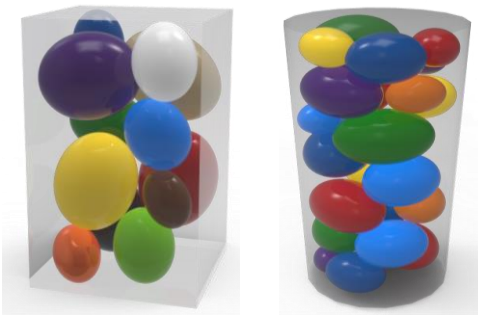

Fig. 3. Instances of local optimal placement of ellipsoids

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Mathematical Model of Finding the Point Values of Decision Maker Preferences

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Abstract. The present report aims to develop a mathematical model of parametric identification of additive multi-factor evaluation models and to develop a method of choosing a solution for interval model parameterization. The model is based on the theory of interval mathematics and the model of comparator identification.

Keywords. Decision maker, multi-factor evaluation, parametric (comparator) identification of multi-factor evaluation models, interval mathematics.

1. Introduction

Any determined effort, as a means of goal achievement, must contain decision making procedure which is aimed to make an informed choice of a specific method of goal achievement (realization) out of many possible alternatives. At the same time, most often every alternative is characterized not by one but by a number of factors (criteria). Therefore, the main difficulty is to solve the problem of parametric identification of multi-factor evaluation models, this is further complicated by interval model parameterization. There are two main approaches to solve the problem of multi-factor evaluation: introspective (to induce decision maker to understand, structure, formalize their knowledge) and formal (based on the ides of comparator identification). Comparator identification model was used in this paper [1].

The general statement of the comparator identification of evaluation model can be formulated in the following way:

Let's assume there is a multitude of alternatives A, each of them is characterized by n particular criteria $k_j(x)$, $j = \overline{1,n}$ which allow objective quantitative measurement. In this case decision maker (DM) evaluates alternatives, i.e. there exists mapping A to a multitude of individual assessments B

$$F : A \to B \tag{1}$$

Then F is operator and $B = F(A)$ is a model of alternatives multi-criteria evaluation. Values of elements of multitude B are not available for quantitative measurement, but can be analyzed qualitatively.

For multitude *B* two assumptions must be fulfilled:

- multitude *B* must not contain incomparable elements, this is achieved by the correct specification of the multitude *A*;
- there is preorder relation for multitude *B*. This means that reflexivity and transitivity axioms are fulfilled. In this case multitude B analysis allows to form factor-multitude B^* on it by combining $u, v \in B$ elements in one class for which conditions $u \geq v$,

$v \geq u$ are fulfilled simultaneously which means that $u = v$. At the same time, some or all classes of factor-multitude B^* in general case can contain one element each. As we know [1], preorder relation for multitude B induces order relation on factor-multitude B^*. This means that taking into account assumptions made B^* could well be put in order, i.e. specify the order of element precedence and extreme elements (the best and the worst) in the chain.

2. Problem Solving

Initial data for the comparator identification model is a multitude of alternatives $X = \{x_j\}$, $j = \overline{1, m}$, which is characterized by particular criteria values and preference of each alternative. Alternative with maximum value is chosen among the whole multitude of alternatives.

Based on the above information comparator identification standard model of weight coefficients a_i is synthesized

$$\begin{aligned} &P(x_l) \geq P(x_j), \quad \forall j = \overline{1, m-1}; \\ &0 \leq a_i \leq 1; \qquad \sum_{i=1}^{n} a_i = 1, \end{aligned} \tag{2}$$

where the values of utility are determined using formula

$$P(x_j) = \sum_{i=1}^{n} a_i \, k_j^{н}(x), \tag{3}$$

$k_j^{н}(x)$ - normalized values of particular criteria.

The system of inequalities (2) is transformed to the following

$$\begin{aligned} &P(x_l) - P(x_j) \geq 0, \quad \forall j = \overline{1, m-1}; \\ &0 \leq a_i \leq 1; \qquad \sum_{i=1}^{n} a_i = 1. \end{aligned} \tag{4}$$

The system excludes all agreed solutions, i.e. solutions where all coefficients are non-negative or non-positive, and the remaining solutions form Pareto multitude X^*.

Mathematical model (4) can be interpreted in the following way.

Equality $\sum_{i=1}^{n} a_i = 1$ describes n - dimensional hyperplane in in the positive octant of the coordinate system where inequalities in the model form a convex polyhedron. The borders of this polyhedron determine the intervals of possible (admissible) values of variables a_i satisfying the model constraints.

The indicated intervals for each coefficient a_i are determined by solving the following optimization problems.

$$\begin{aligned} & a_i \to \max \\ & P(x_l) - P(x_j) \geq 0; \quad \forall j = \overline{1,m}; \\ & a_i \geq 0; \qquad a_i \leq 1; \\ & \sum_{i=1}^{n} a_i = 1; \end{aligned} \tag{5}$$

$$\begin{aligned} & a_i \to \min \\ & P(x_l) - P(x_j) \geq 0; \quad \forall j = \overline{1,m}; \\ & a_i \geq 0; \qquad a_i \leq 1; \quad . \\ & \sum_{i=1}^{n} a_i = 1; \end{aligned} \tag{6}$$

Since all the relations in (5) and (6) are linear this is the standard problem of linear programming. As a result, interval values of weight coefficients of relative importance are determined $\lfloor a_{i\min}; a_{i\max} \rfloor$, $\forall i = 1, n$. Based on these values interval values $P(x_i)$ [2] can be calculated according to the formula (3). In this case alternatives $x \in X$ should be ranked according to the interval values $[P_{\min}(x_i); P_{\max}(x_i)]$.

To compare the intervals of utility functions it is necessary to use the theory of interval mathematics. According to [3], interval numbers are compared in the following way. Let's assume $\tilde{a}_1 = \lfloor a_{1\min}; a_{1\max} \rfloor$ and $\tilde{a}_2 = \lfloor a_{2\min}; a_{2\max} \rfloor$ are random interval numbers. According to existing principles of interval mathematics the operations of $\vee$ (disjunction) and $\wedge$ (conjunction) over intervals are determined according to the formulas

$$\begin{aligned} & \tilde{a}_1 \vee \tilde{a}_2 = \lfloor a_{1\min}, a_{1\max} \rfloor \vee \lfloor a_{2\min}, a_{2\max} \rfloor = \lfloor a_{1\min} \vee a_{2\min}, a_{1\max} \vee a_{2\max} \rfloor; \\ & \tilde{a}_1 \wedge \tilde{a}_2 = \lfloor a_{1\min}, a_{1\max} \rfloor \wedge \lfloor a_{2\min}, a_{2\max} \rfloor = \lfloor a_{1\min} \wedge a_{2\min}, a_{1\max} \wedge a_{2\max} \rfloor. \end{aligned} \tag{7}$$

The inequalities of the intervals are defined similarly to the ratios of the inequalities of real numbers.

$$(\tilde{a}_1 \geq \tilde{a}_2) \Leftrightarrow (\tilde{a}_1 \vee \tilde{a}_2 = \tilde{a}_1, \tilde{a}_1 \wedge \tilde{a}_2 = \tilde{a}_2);. \tag{8}$$

However, the problem is that not all intervals can be compared in such a way. To make intervals $\tilde{a}_1 = \lfloor a_{1\min}; a_{1\max} \rfloor$ and $\tilde{a}_2 = \lfloor a_{2\min}; a_{2\max} \rfloor$ comparable in relation to $\geq$ and in the ration of $\tilde{a}_1 \geq \tilde{a}_2$ it is necessary and sufficient for the system of inequalities to be fulfilled $\tilde{a}_{1\min} \geq \tilde{a}_{2\min}$, $\tilde{a}_{1\max} \geq \tilde{a}_{2\max}$ [4].

Therefore, the problem of alternatives ranking according to interval values can only be solved in particular cases [4], when intervals coincide (fig. 1a), or are shifted relative to each other along the numerical axis (fig. 1b). In this case, the interval shifted to the right left) is larger (smaller). It is not possible to compare the intervals in such a way if one interval overlaps the other (fig. 1c)

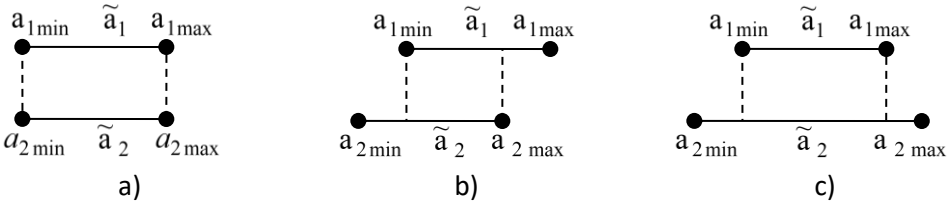

Fig. 1. Variants of interval location

Theorem. For two random intervals $\tilde{a}_1 = \lfloor a_{1\min}; a_{1\max} \rfloor$ and $\tilde{a}_2 = \lfloor a_{2\min}; a_{2\max} \rfloor$ to be in one of the ratios $>, \geq, =$, it is necessary and sufficient for their centers $M_{a1} = \left(a_{1\min} + a_{1\max}\right)/2$ and $M_{a2} = \left(a_{2\min} + a_{2\max}\right)/2$ to be in the same ratio as real numbers [4].

As this theorem shows, comparison of random intervals comes down to a comparison of the interval centers. (3) follows that interval centers $\left[P_{\min}(x_i); P_{\max}(x_i)\right]$ are defined by the interval center $\lfloor a_{i\min}; a_{i\max} \rfloor$. That is, interval centers $\tilde{a}_i$ can be considered as point values a_i

$$a_i = \left(a_{i\min} + a_{i\max}\right)/2, \; i = \overline{1,n}. \tag{9}$$

For the condition $\sum_{i=1}^{n} a_i = 1$ to be fulfilled it is necessary to apply the following normalization function

$$a_i = \frac{a_i}{\sum_{i=1}^{n} a_i}, \; i = \overline{1,n}. \tag{10}$$

3. Model Verification

We will use methodology based on the comparison of values calculated according to the comparator model (2) with test values [5] to analyze accuracy and adequacy of the a_i point values identification model.

As a test situation, we will consider the selection case taking into account five particular criteria. We will generate a set of 20 alternatives.

We will generate a vector of test weight coefficients $\left\langle a_2^T > a_5^T > a_4^T > a_3^T > a_1^T \right\rangle$, satisfying the condition $\sum_{i=1}^{n} a_i^T = 1$, and the set of weight coefficients will look like $\langle 0{,}1;\ 0{,}3;\ 0{,}15;\ 0{,}2;\ 0{,}25 \rangle$.

We will generate a set of particular criteria from 20 alternatives, build the system of inequalities (2) and based on it we will solve ten optimization problems (5) and (6) respectively. Calculation of the exact values of weight coefficients is carried out sequentially according to the formulas (9) and (10). In this case model will look like $\langle 0{,}097;\ 0{,}245;\ 0{,}18;\ 0{,}237;\ 0{,}241 \rangle$.

4. Conclusion

Comparison of the order ratios of standard and calculated coefficients shows that they coincide:

$$\begin{matrix} \left\langle a_2^{\text{T}} > a_5^{\text{T}} > a_4^{\text{T}} > a_3^{\text{T}} > a_1^{\text{T}} \right\rangle \\ \left\langle a_2^{\text{M}} > a_5^{\text{M}} > a_4^{\text{M}} > a_3^{\text{M}} > a_1^{\text{M}} \right\rangle \end{matrix}, \tag{11}$$

and consequently, the preference of particular criteria coincides

$$k_2 \succ k_5 \succ k_4 \succ k_3 \succ k_1 . \tag{12}$$

In this regard, we can make a conclusion that the results obtained during the computational experiment, confirmed the efficiency and effectiveness of the proposed model of point values identification of DM's preferences.

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Estimation of Economic Efficiency of Investment Decisions Information Support in the System of Economic Security of Enterprises

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Abstract. The article is focused on the formation of methods of estimation the economic efficiency of using information technologies by making investment decisions in the system of economic security of enterprises. It was established that determination the efficiency of information security systems usage for investment decisions it is more appropriate to use probabilistic characteristics - the functions of distribution of probabilities of causing harm. The integrated indexes for estimating the effectiveness of information support with use for appointment the weight categories under the Fishburn's rule, was formed. The system of indicators of efficiency and risk was defined in order to calculate this index. Promising directions for future research are outlined.

Keywords: Information support system, Investment, Economic security, Fishburn's rule.

1. Introduction

An important area of information technology (IT) application is the provision of analytical information about the company's activities in the system of its economic security. In market conditions, developed analytical infrastructure provides the necessary competitive advantages, while its absence creates threats to the proper development of the enterprise and the preservation of market positions.

The main object of this article is to review the methods of estimation the economic efficiency of using information technologies by making investment decisions in the system of economic security of enterprises. This task is conditioned by the large-scale growth of IT use by making investment decisions. In this case, for investing in analytical tools, the issue of economic efficiency estimation is particularly relevant, since it requires significant costs, and it is not always possible to follow the benefits of classical indicators of enterprise activity.

The foregoing determines the significant practical value of the research and construction of the model of evaluation within its limits, since in order to substantiate the investment decisions in the system of economic security of enterprises, high-quality methods of economic efficiency of information analytical systems' implementation are required.

2. Definition of Economic Efficiency and Use of Information Support Systems

Formation of the strategy of enterprise development should include the cost of construction and ensuring the functioning of the information support system of investment decisions in the system of economic security. Information assets circulation, links between information resources, the functioning of the information systems in which they are processed, ultimately affect the financial indices of enterprises.

Publications of A. Butov, A. Gorbunov, E. Efimov, S. Simonov, E. Zinder are devoted to the evaluation of the economic efficiency of information systems. However, these works focus more on estimating the risks of breaking the work of information systems.

It is believed that the costs for information provision of investment decisions are effective if they meet the requirements of normative documents, as well as the concept of economic security of the enterprise. This is due to the fact that for the objective estimation of economic efficiency no universal methods are established.

Economic efficiency, as a rule, is considered as an excess of cost estimates of the results of the events carried out, over the total costs of their implementation in the estimated period [1, 3].

In accordance with the theory of system efficiency assessment, the quality of any object, including information support system, is manifested only in the process of its target function, therefore the objective is to evaluate the effectiveness of use [4]. In addition, the adoption of investment decisions is associated with uncertainty in the future, primarily as a result of the achievement of the results of the measures taken. The beginning of the investment project implementation in most cases is accompanied by uncertainty. In the process of project implementation its level is reduced, but the effectiveness of information systems can never be adequately expressed and described by deterministic indicators.

Certification, licensing and compliance with security conditions are not able to completely eliminate the uncertainty of information systems' characteristics and their individual elements, and do not allow prediction of accidental elements in decision making. Accordingly, only the probabilistic indicators can serve as an objective characteristic of the quality of information security systems, the degree of their suitability to achieve the desired level of economic security of the enterprise under the influence of random factors. The ability to achieve the objectives of economic security under given conditions, for example, with the use of the information support system is characterized by a certain degree of probability. Probability in this way should be based on a set of indicators and criteria for evaluating the effectiveness of information support systems for investment decisions in the system of economic security of enterprises. In this case, the evaluation criteria serve the concepts of suitability and optimality. Suitability means the fulfillment of all requirements of the information security systems, and optimality means to achieve one of the characteristics of extreme value with respect to the constraints and conditions of other properties of the system.

Usually, when developing information systems, there is a multicriteria task of comparing different variants of the structures of these systems. Among the indicators considered in the task are indicators of efficiency, which have probabilistic-time character of distribution functions. In particular, they include the probability of overcoming the system of protection of information for a certain time [2].

Thus, to evaluate the cost-effectiveness of the use of information systems for investment decisions most applicable probabilistic methods were used, according to which levels of security are transformed into confidence intervals of probabilities of the corresponding values of indicators. Estimation of the optimal level of enterprise economic security largely depends on the prevention of damage. To obtain a set of risk values you must know the distribution of random variables of damage. In most cases such estimates can be obtained, for example, with simulation modeling or by the results of active auditing [1].

So, at first, the determination of the efficiency of the use of information support systems for investment decisions can not be based on deterministic estimates. Secondly, to determine the effectiveness of the above measures, it is more appropriate to use probability characteristics - the function of distributing the probability of causing harm.

3. Current Approaches to the Evaluation of Costs for Information Support of Investment Decisions

Economic security of the company in general is a complex and specific process influenced by many external and internal factors. One of the main factors in the process of construction, organization and implementation of economic security of the enterprise is investment. The strategy of a high-level protection system can only be built in case if you conduct a preliminary analysis and estimation of the effectiveness of investment decisions.

By making investment decisions in the system of economic security of the enterprise, it is necessary to use a separate methodology, which allows conducting effective costs for the implementation of appropriate information support. However, not all approaches to estimating the cost of information provision of investment decisions can distribute funds in such a way that investment in the construction of the system economic security has become effective. According to statistical data, the cost of information security in the system of economic security is 30% of all costs of the enterprise spent on information systems, and the cost of protection of information systems should be about 20% of the cost of information resources of the enterprise [5]. However, only 10% of enterprises properly finance the information systems, 40% are exposed to significant risks of breaching the protection of information systems [6].

Thus, the problem of effective information support of investment decisions in the system of economic security of the enterprise has not yet been resolved. The results of conducted analysis show that such question as: the estimation of the effectiveness of information support of investment decisions, adaptation of such estimation to the current time, decision-making on the organization of investment turnover company in the absence of statistical data and parametric estimates, comparing the assessment of possible risks to new threats to economic security, are still actual.

The analysis of the approaches to estimating the cost of information provision for investment decisions has shown that they are limited only to the assessment of net discounted value and the assessment of the risks of violating the company's economic security. The main disadvantages of these approaches are that efficiency can be achieved by using them in combination.

Most of the existing approaches to estimation are oriented towards enterprises of economically developed countries, while the peculiarities of transformational economies (Figure 1) should include the calculation of the risks of economic security violations, which provides the assessment of the continuity of the operation of enterprise information processes.

By using the specifics of the approach to estimating the costs of information provision of the enterprise, used in transformational economies, practically different levels of risk are determined, such as: acceptable, critical, inappropriate, stable.

Determination of the acceptable level of risk in this case is based on such indicators: short-term information assets, security, justification of the cost of information resources. Estimates of each risk are different. Therefore, depending on the category of risk, the assessment of the risk of information security violation in the proposed model will be determined in different ways.

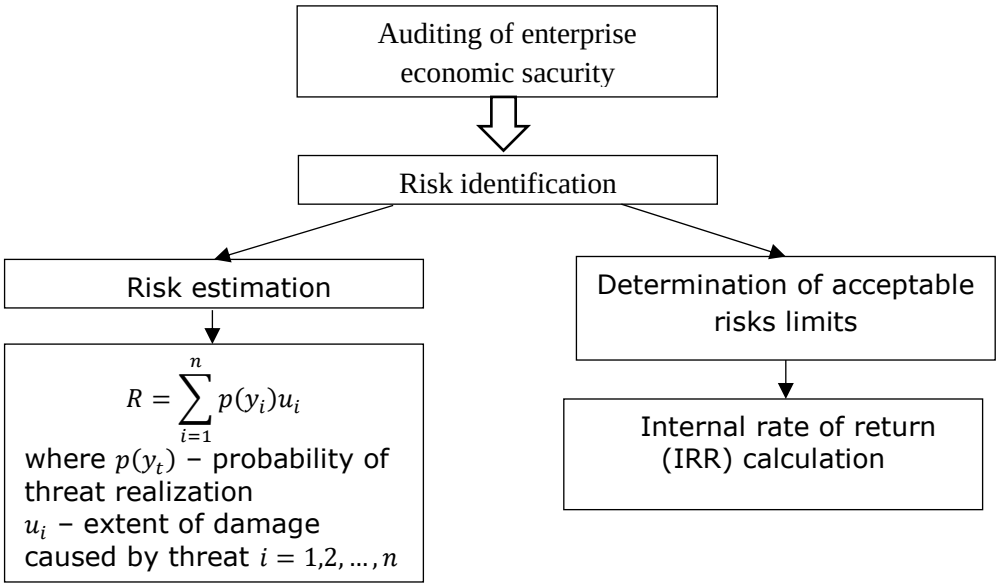

Fig. 1. Peculiarities of estimation of the information systems effectiveness in transformational economies

Thus, such approach to estimating the cost of investment decisions information support in the system of economic security of the enterprise provides an assessment of information risks in the form of calculating the amount of risks inherent in certain information system and system of economic security, taking into account not only the internal and external factors, but also certain conditions inherent in the system.

4. Model of estimation of economic efficiency of investment decisions information support in the system of economic security of enterprises

In the efficiency calculations, as a rule, there are two main components, namely: the result obtained from the implementation of the event and the costs necessary for its implementation. The final result of the implementation of information security measures is usually considered the loss prevention value. The loss prevention value P_i can be calculated, based on the probability of occurrence of the 1-st incident (i = 1, 2, ... n) and possible economic losses from it before and after the implementation of information security measures:

$$P_i = P'_i - P''_i, \quad (1)$$

P'_i, P''_i - losses from the realization of threats before and after the implementation of information support measures, respectively.

Then the total loss prevention value in all incidents is defined as:

$$P = \sum_{i=1}^{n}(P_i + R_i), \quad (2)$$

R_i – direct return of losses, for example, compensation by a third party, guilty of the economic security incident, funds received as a result of the application of penal sanctions to employees, guilty of incidents, insurance indemnity, etc.

After generalizing the conditions of the effectiveness of information support, let's define the integral criterion of the efficiency of information support of investment decisions in the system of economic security of enterprises, using the formula:

$$G = \sum_{i=1}^{N} w_i C \quad (3)$$

w_i - is the Fishburn's weight index for the parameter of the estimation of the efficiency of information support of investment decisions in the system of economic security of the enterprise,

M - total cost of eliminating the consequences of the threat implementation and other reasons for the damage of the company's information support system.

Thus, the model of the efficiency of information support of investment decisions in the system of economic security of enterprises may be in different states S, which can be described as the following set of values:

$$S = \{s_1, \dots, s_m\}, \quad (4)$$

S – set of possible states of the model,

s_1 – initial state of the model,

s_m – final state of the model.

Each parameter has its own weight categories under the Fishburn's rule. This rule is defined by the formula:

$$w_i = [2/(N - n + 1)]/(N + 1)N \quad (5)$$

w_i – Fishburn's weight index for the criterion of estimation the information support efficiency,

N – the total number of parameters of integral criterion of the efficiency of information support of investment decisions in the system of economic security of enterprises,

n – serial number of the parameter,

$i = \overline{1,8}$

Thus, the system of Fishburn's weight coefficients is formed. The conditions satisfying the system of Fishburn's weight coefficients are given by the equations:

$$W_i \in [0; 1] \quad (6)$$

$$W^{\Phi} = \sum_{i=1}^{N} w_i = 1 \quad (7)$$

where $i = \overline{1, N}$.

The obtained model may include the following parameters: NPV, return on investments, revenue from the use of the information system and risks.

The basis of the first two parameters is a unique mathematical model of estimation. Thus, the NPV approach is based on the NPV model with an equivalent annuity, and the ROI is based on the PI model.

Income D from the use of the information system can be estimated by the formula:

$$D = Cost_1 P_{\sigma} - Cost_2(1 - P_{\sigma}) \quad (8)$$

P_{σ} – the probability of income provision,

$(1 - P_{\sigma})$ – probability of losses,

$Cost_1$, $Cost_2$ – the units of information asset value.

The single risk of enterprise information security violation R is estimated by the formula:

$$R_i = p_i u_i \quad (9)$$

p_i – probability of the threat *i* of economic security,

u_i – damage, caused by the threat *i*.

The subjective rist (*risk*) is determined in the following way:

$$risk = \frac{E}{M} \tag{10}$$

E – total number of risks,

M – number of all possible risks.

Total risk Q is determined by the formula:

$$Q = \sum_{i=1}^{n} R_i + risk \tag{11}$$

n – the number of threats to the economic security of the enterprise.

5. Conclusion

The developed model of economic efficiency of information support of investment decisions in the system of economic security of enterprises is different from other models that solve similar problems, in that:

1) it is completely formalized;

2) it is meant to be used at the enterprises with centralized document circulation, located in countries with a transformation economy;

3) it makes a comprehensive estimation of the cost of information support of investment decisions in the system of economic security of enterprises;

4) it allows you to determine the time intervals between changes of the amounts of costs intended for the information support system;

5) it increases the economic efficiency of information support of investment decisions in the system of economic security of enterprises.

For these reasons, the described model is a promising area for future research.

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Modeling and Coding of the Spatial Object with the Using of Cubic Splines

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Abstract. A new model of a spatial object, which is represented by its two three-dimensional projections from a four-dimensional space is proposed. Also the coding of such spatial object using its cross-sections is considered, where the object is described by pairs of control surfaces of the form and parameter.

Keywords. Spatial object, Images, Splines, Surfaces.

1. Introduction

There are areas of activity where it is necessary to describe a spatial object together with the distributed parameters of the material that forms this spatial object, or by other parameters of interest.

In such a problem, it is required to select some spatial function $f(x, y, z)$, which in an acceptable way determines the parameter $p(x, y, z)$ on the set of points belonging to the object. It is assumed that the distribution of the parameter p is described by a continuous function.

This paper considers the method for modeling and coding a spatial object. It is assumed that such an object is bounded by pieces of simple surfaces (hereinafter - surfaces) (Fig.1), which are the single-valued functions with respect to x, y.

In the described model, the spatial object and the parameter variation inside it are determined by control regular surfaces. In the example given in the article, a mechanism for using regular surfaces for determining the value of a parameter at the points of each column of an object and constructing a cross-section from such columns is described [4].

This paper also considers the method for obtaining analytical description of a spatial object using the grayscale images of its cross-sections [5]. It is assumed that the change in brightness levels within the images allows its approximation of a continuous function. The description of a spatial object in this case is formed by sequential coding of grayscale images of cross-sections with help of cubic splines [1].

Since the value of the parameter p is added to the spatial coordinates of the object points, we assume that any point has 4 dimensions.

2. Description of a spatial object by pairs of control surfaces of the form and parameter

A spatial object with a distributed parameter can be represented by its two three-dimensional projections from the four-dimensional space *Oxyzp* in two three-dimensional subspaces formed by the coordinate axes *Oxyz* and *Oxyp*.

Such spatial object can be described by several fragments of surfaces [3]. All fragments of surfaces are bounded by equal simple forms. For simplicity of exposition, we assume that three fragments of surfaces are sufficient to describe the object. Each of these three fragments

can be defined by a pair of control surfaces - the control surface of the form and the control surface of the parameter. The form control surface is the projection of the spatial object in the three-dimensional subspace formed by the coordinate axes *Oxyz*, and the parameter control surface is a projection in the three-dimensional subspace formed by the *Oxyp* coordinate axes. Herewith the form control surfaces and associated with them the parameter control surfaces are fragments of some regular surfaces that are bounded by equal contours (Fig. 1). All three pairs of control surfaces are represented by halftone images. Control surfaces are coded by cubic splines [1]. Thus, the analytical description of a spatial object consists of control points of cubic splines.

Having an analytical description, it is possible to construct any cross-section of a spatial object, i.e. determine the value of the parameter at each point of object. For this it is necessary to plot the traces of all pairs of control surfaces. The trace of the form control surface is a function of *z(x)* and is formed by the intersection of this surface by a plane parallel to *Oxz* for some fixed value of the coordinate *y*. Similarly, the trace of the parameter control surface is a function of *p(x)* and is formed by the intersection of this surface by a plane parallel to *Oxp* for some fixed value of the coordinate *y*. Traces of control surfaces have the form of a single-valued curve with respect to *x* (Fig. 2b, 2c).

The construction of the cubic spline by three control points obtained from the traces of the corresponding parameter (Fig. 2c) and form (Fig. 2b) control surfaces, describing the values of parameter p in one of the columns of the section of the object, is shown in Fig.2d. From such columns a cross-section of the spatial object is formed (Fig. 2a). The procedure for constructing such cross-section is described in [4].

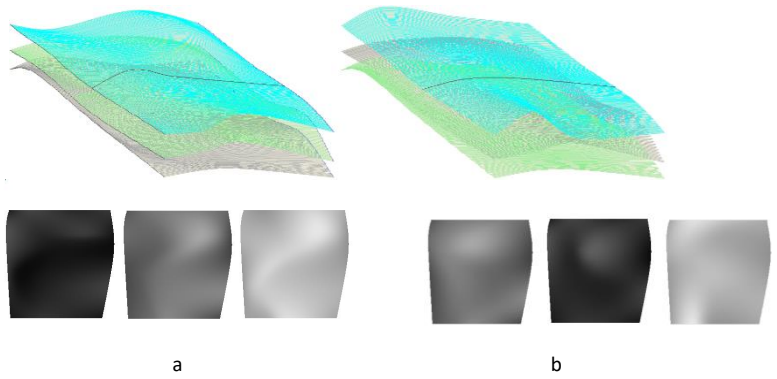

Fig.1. Drawing control surfaces of the form (a) and control surfaces of parameter; (b) and their visualization by grayscale images

In general, representing a spatial object by *n* pairs of control surfaces, each of which can be defined by *m* cubic splines having *k* control points, we obtain a complete description containing *2 * n * m * k* control points. With help of this description, you can calculate the value of the parameter *p* at each point of a spatial object, and also construct any of its cross-sections, vertical or horizontal (Fig. 3).

3. Encoding the spatial object by its cross-section

Let us describe the inverse problem: how, having cross sections of a spatial object with a variable parameter, make its analytical description, i.e. get all the pairs of its control surfaces.

For example, consider the vertical cross-sections of a spatial object, i.e. sections perpendicular to the *xOy* plane. Theses cross-sections are represented by halftone images whose brightness level corresponds to the value of the parameter *p* (Fig. 2a). We will consider these images as a surface the third coordinate of which is the value of the parameter *p*. We also assume that the brightness function of points and its derivatives within a contour that limits each such image of a cross-section are continuous. So, each section image can be encoded using cubic splines that successively approximate the columns of these images [1]. In this example, the number of control points of the cubic spline that approximates one column of the image is three. Three-dimensional sequences of column points can be represented as projections on the *xOz* and *xOp* planes and approximated by cubic splines. These projections are traces of control surfaces: the projections onto the *xOz* plane are traces of the form control surfaces (Fig. 2b), and the projections on the *xOp* plane are traces of the parameter control surfaces (Fig. 2c). Having processed all the cross-sections of the spatial object, we obtain a set of pairs of traces of control surfaces from which control surfaces can be constructed. As a result, to each surface of the form corresponds certain parameter surface, and for the description of the spatial object we have three pairs of control surfaces. The order of coding of a spatial object with use of its cross-sections is described in work [5].

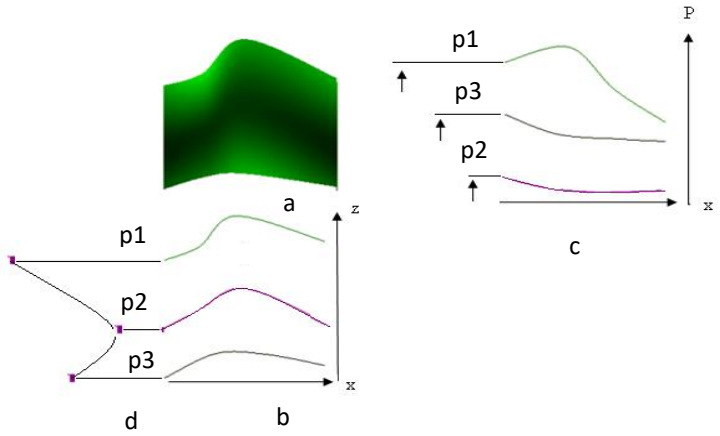

Fig.2. Halftone imaging of the object cross-section and traces of three pair of control surfaces управляющих поверхностей: a) Representation parameters of all points of the cross-section as brightness levels of halftone image. b) Traces of all three surfaces of form as a result of their sectional plane parallel xOz. c) Traces of all three surfaces of parameter as a result of their sectional plane parallel xOz (y=1). d) Cardinal spline graph used to determine the parameter value for all the points of the first column belonging to the cross-section of the object.

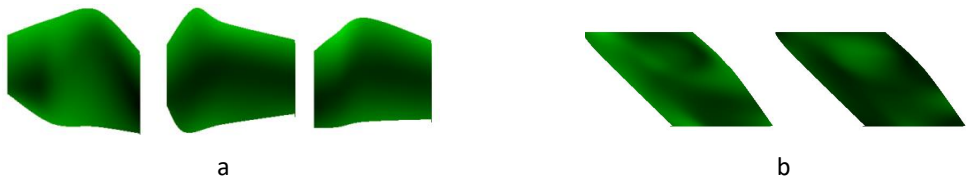

Fig.3. a) Result of constructing several images of vertical cross-sections of a spatial object. b) Result of plotting images of horizontal cross-sections of a spatial object

Thus, the complex problem of describing a spatial object with a variable parameter can be reduced to describing a certain number of pairs of the form and parameter control surfaces. Each of these surfaces is described by a number of control curves specified in a parametric form, the shape of which depends on the coordinates of their control points. In Fig. 4 such a sequence is shown: from the description of a complex spatial object with the help of control surfaces to parametric splines, by means of which this description is carried out.

4. Substantiation of the using of control surfaces in the description of a spatial object

Papers [1, 2, 4, 5] demonstrate how the method developed from the encoding of a halftone image by cubic splines to the encoding of a spatial object with a variable parameter by the pairs of control surfaces of the form and parameter. And if for the analytical description of a halftone image represented as a surface, where the third coordinate described the brightness level of the points of this image, it was sufficient to use control cubic splines [1], then for the description of a spatial object with a changing parameter it is already necessary to use the control surfaces [4, 5].

Due to such description, it is possible to calculate the value of the changing parameter at any point of the spatial object. It is also possible and the reverse action - the obtaining an analytical description of a spatial object with a variable parameter by sequentially coding its cross-sections, represented in the form of halftone images (Fig. 5).

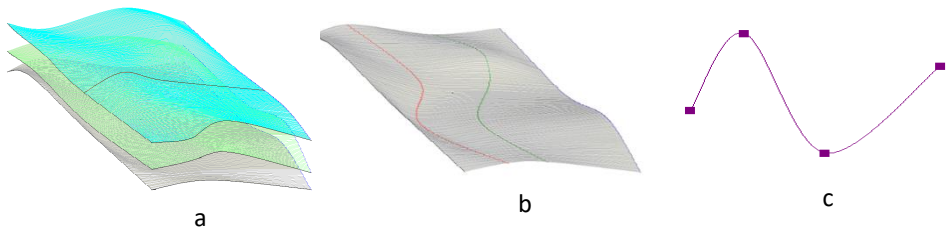

Fig.4. From control surfaces to control points:
a) the form of the spatial object and the characteristics of each of its points depend from the control surfaces and their parameters;
b) the form of the surface depends on the governing spatial curves;
c) the shape of the curve depends on the control points.

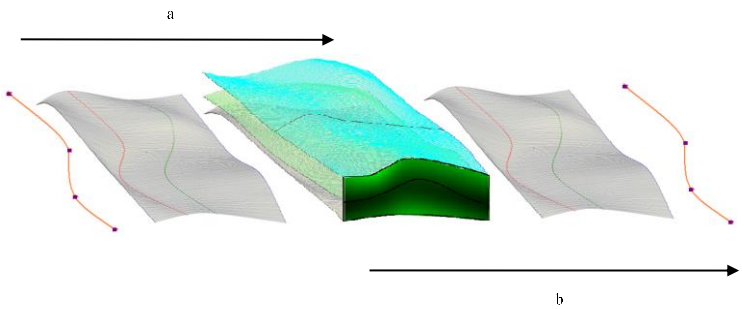

Fig.5. Illustration of two tasks realization:
a) reconstruction of a spatial object by its analytical description;
b) obtaining an analytical description of a spatial object by encoding its cross-sections.

5. Conclusion

Coding a parameter that changes in a certain spatial object in pairs of control surfaces of the form and parameter gives a compact format for its description, stored in files. Such a description contains *2 * n * m * k* control points of cubic splines, where *n* is the number of pairs of control surfaces, *m* is the number of cubic splines describing one such surface, and *k* is the number of control points in each spline.

Having an analytical description, it is possible to calculate the parameter values at each point of any cross-section of the spatial object, both vertical and horizontal, and visualize such a cross-section in the form of a halftone image.

If the object is described in the form of its cross-sections represented by halftone images, it is also possible to calculate the value of the parameter at each point of this object, therefore to obtain its compact analytical description in the form of pairs of control surfaces of the form and parameter.

The computer code that implements the described algorithm allows you to change any control surface, which makes it possible to obtain a description of a new spatial object, i.e. to carry out modeling of the object.

In the proposed description of a spatial object, any of its points has 4 dimensions: three spatial coordinates and one parameter. It is possible to extension the proposed analytical representation to spatial objects that have more than one variable parameter.

The proposed analytical representation of spatial objects is invariant to certain affine transformations, which significantly simplifies the processing of such objects.

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Integration of Information Systems in the Management of Public Projects

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Abstract: The paper examines the problems of the integration of computer information systems in the management of public projects. The subject is relatively broad and complex. The root causes lie in the complexity of stakeholder engagement in public projects, as well as the aspirations to achieve a public result. All of this provides reasonable grounds to seek methodological approaches to the integration of existing information solutions to obtain timely and accurate management information. At last, the conclusions are drawn.

Keywords: Software integration, software platform, public projects

1. Basic information problems with the integration of software applications

Implementing public projects is a complex and responsible task. It cannot be realized without proper information provision. In most cases, using specialized software is important in making the key decisions of managing such a project.

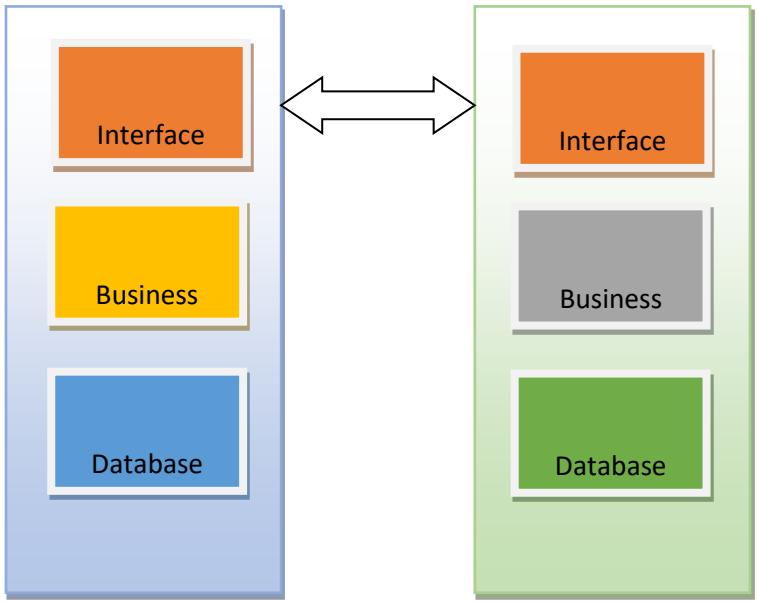

Fig. 1. Architectures of unintegrated software applications

Fig. 1 illustrates the need for the use of various software applications in making a management decisions. It is normal and logical for these software applications to be designed and implemented with a different architecture, a different data model and a different business logic. In most cases, it is necessary to use systems that are internal to the organization, systems that are part of national data registers, systems that are specifically designed for project management.

2. Issues of the information provision in the management of public projects

The management of public projects has some features that can be summarized as:

- These are projects that are mainly aimed at achieving a public result;
- The effectiveness of these projects is mainly measured by cost and benefit analysis;
- Management is associated with the participation of a significant number of participants;
- Such projects involve workflows from different institutions;
- In most cases the implementation of the project requires reengineering of some of the work processes or modernization of services [1];
- Requires the use of multiple computer information systems, etc.

These peculiarities of public projects also impose the corresponding requirements for the information systems used. They can be summarized as:

- Computer information systems should ensure the delivery of reliable and timely information;
- Right and on-time online information is available in web-based systems, among which the most important are web portals for news, blogs, message boards and social networks [2];
- Computer information systems have common architectural components in view of the possibilities of their integration;
- Software gadgets should have components to export data to external systems;
- The integration of software applications should create conditions for building thematic data warehouses, etc.

All these requirements to software applications that are used in public project management require the search for technological capabilities to integrate applications.

3. Integration of software systems in the management of public projects

The integration of software systems in public project management should be carried out taking into account the following three main sources of data:

- Source of quantitative data;
- Source of quality data;
- Source of poorly structured data.

The use of these three heterogeneous sources of data is presented graphically in fig. 2.

Different methodological approaches can be applied to the integration of software applications. From the point of view of the particularities in the management of public projects, the present study will show the advantages of applying an integration layer at the data level (fig. 3).

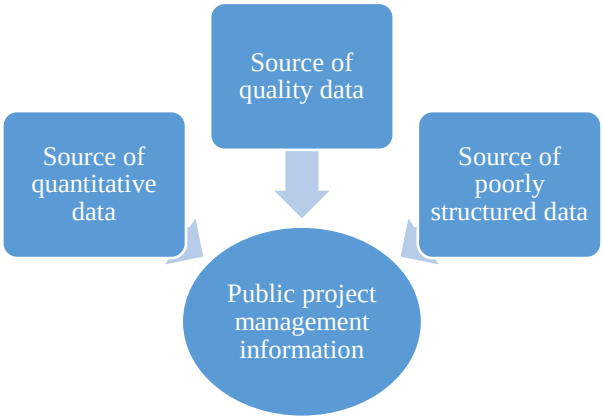

Fig. 2. Using heterogeneous data sources

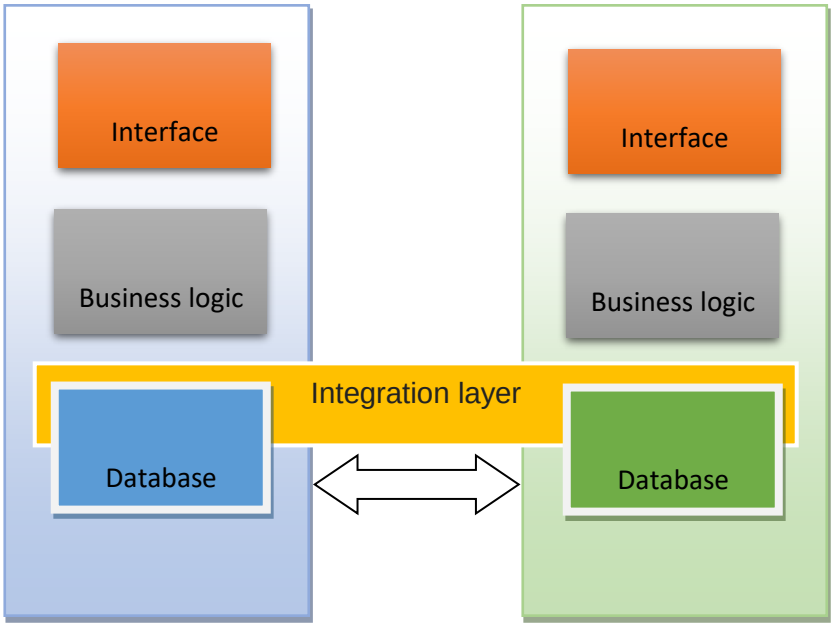

Fig.3. Building an integration layer

The process of creating the integration layer should go through the following stages:

- Structural analysis of existing databases;
- Defining metadata;
- Defining the structure of the common data repository;
- Creating integration procedures;
- Integration layer (fig. 4).

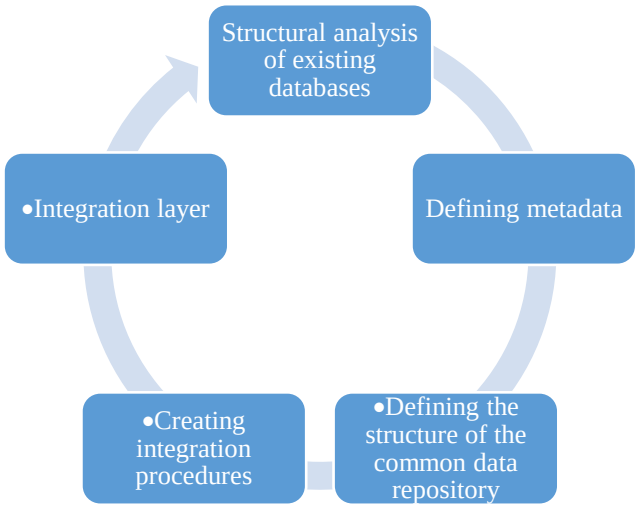

Fig.4. Steps of the process of creating an integration layer

The five stages mentioned are exemplary and conditional. They reflect some of the specifics described in public project management. Given the wide variety of such projects, additional stages in the integration process of software applications can be defined.

4. Conclusion

Because of the research we can draw the following conclusions:

- The integration of software applications and used information registers is key to the successful management of public projects;
- Building a data layer integration layer is one of the ways to develop specific application integration methodologies;
- In practice, other methodologies can be applied to the integration of applications with various stages and sequences of actions.

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Investment Alternatives Choice to Prevent Natural Disasters using Decision Tree and Influence Diagrams Approaches

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Abstract. The report examines the peculiarities of making investment decisions aimed at implementing projects to reduce the risks of natural disasters. This type of decisions is perceived as a specific type of managerial decision. The strategic framework in which decisions are taken is studied. The documents on which these strategic decisions can be based are strategically systematized. The peculiarities of the stakeholders concerned by the decisions and their possible attitude to risk are analyzed. The specificity of the evaluation of possible damages in the event of natural disasters has been identified. The possible benefits of implementing projects to reduce the risks of natural disasters are outlined. The prospects for choosing an investment alternative using the "Decision Tree" and "Influence Diagrams" are analyzed.

Keywords. Investment Decisions, Disaster Risk, Stakeholders, Decision Tree, Influence Diagrams

1. Introduction

Taking investment decisions to implement projects to reduce the risks of natural disasters is a specific type of managerial decision. On the one hand, it is subject to the general logic and decision-making methodology. On the other hand, it has a certain specificity to be taken into account. To make such a decision, it is necessary to identify specific alternatives, to evaluate each alternative according to a specific system of criteria and to choose the best alternative according to that system of criteria. Decision-making takes place in a defined strategic environment and is based on the adoption of a number of strategic documents of an international and national nature.

2. Characteristics of decisions to invest in projects to reduce the risk of natural disasters

The type of decisions under consideration has some features that have a significant influence on their logic, methods, algorithm and criteria in taking:

1. The aim of such decisions is at providing security that is a public good. The level of security is difficult to quantify and compare with the amount of resources spent on its production.

2. Projects are usually long-term. There is a significant lag between the decision making and the start of the investment process and between the start of the investment process and the moment when the first beneficial effects of the project are realized. The time horizon during which the advantages or shortcomings of the decisions is significant. One can expect that accidental and unpredictable factors will impact the results of the projects.

3. Decisions are typically risky. The implementation of investments to reduce the risk of natural disasters is carried out in highly uncertain environment. Risk assessment and risk management should be of particular importance.

4. The implementation of decisions requires spending of a large amount of resources. In essence, in most cases it is about implementing large infrastructure projects. The value of the assets acquired is significant. At the same time, concomitant and related investment costs are needed.

5. Decisions are often taken not by a single decision maker but by a decision body. Each of the decision-makers has his own value system, a set of criteria, interests, and a specific attitude to risk.

6. The market structure in the area of implementation of projects to reduce the risk of natural disasters is specific. Typically, the state, in the person of the ministries involved in the projects, is the only buyer, and the potential supplier is one or more (but limited) companies. As a result, public procurement in the area under examination cannot rely on market mechanisms for pricing and other conditions for the conclusion of the contract.

7. Part of the information required for decision-making is classified. It cannot be provided to a sufficiently wide circle of persons to ensure transparency and accountability when spending public funds.

8. The decision-making process is based on a set of strategic and programming documents from which it is possible to define objectives, priorities and criteria for assessing alternatives.

3. Strategic framework

When assessing investment alternatives in a particular situation, it is important first to examine the context in which the evaluation will be carried out. It is necessary to analyze some strategic documents in order to identify important details that are necessary in the context of the assessment of investment alternatives to reduce the risk of natural disasters.

The international scientific community and practitioners with an obligation to assess and manage the risk of natural disasters have a long-term interest in strategic issues. A number of strategic documents have been developed at different levels – internationally, regionally and nationally, which form a specific strategic framework.

In 1994, the first UN World Conference on Disaster Reduction was held. A Yokohama Strategy and Action Plan have been developed. These documents are seen as the first policy guidelines for reconciling world-wide efforts to reduce disasters that are both socially oriented and to select technical solutions to reduce disaster risk.

Another important international strategic document was adopted shortly after the 2005 Indian Ocean catastrophic tsunami – the Hyogo Framework for Action (HFA) 2005-2015. The Hyogo Framework for Action was created to stimulate the global community for actions to support the International Framework of Action during the International Decade of Natural Disaster Reduction of 1989 and the Yokohama Safer World Strategy. [1]

In 2015, the United Nations Office for Disaster Risk Reduction (UNHCR) developed its Global Assessment Report on Disaster Reports on Disaster Risk Reduction (GAR), the Risk Reduction Making Development Sustainable: future of disaster risk management. A strategic framework for reducing the risk of natural disasters has also been developed.[11]

The document outlines the vision of the organization to significantly reduce the risks of natural disasters and losses in order to ensure a sustainable future, as well as three strategic objectives – to strengthen the global monitoring, analysis and coordination of the implementation of the Sendai Framework; supporting the regional and national implementation of the Sendai Framework and activating actions by Member States and

partners. The Sendai Framework is considered to be a crucial change from the Disaster Management approach to Risk Management and Risk reduction and Sustainability establishment as a common denominator on the 2030 agenda.

In Bulgaria, a series of strategic and programming documents have also been developed and are in force, which contain some important elements to be considered in the selection of an investment alternative. The National Security Strategy of the Republic of Bulgaria was adopted by decision of the National Assembly on 8 March, 2011 and has a time horizon up to 2020. The document contains important information that can be used to make strategic decisions to reduce the risk of disasters. It defines national interests by dividing them into vital and other important interests. In making a decision these interests must be ranked by priority.

A key strategic document at national level is the Strategy for Disaster Risk Reduction 2014-2020. The document was adopted by the Council of Ministers. The strategy defines the main natural hazards – seismic hazard, flood hazard, landslide hazard, forest fires, danger of adverse meteorological phenomena such as drought, strong winds and tornadoes, heavy snowfalls, snow storms, icing and extreme temperatures, hailstorm danger. The main strategic objective in the field of research – prevention and / or reduction of the adverse effects on human health, socio-economic activity, the environment and the cultural heritage in Bulgaria due to natural and man-made disasters is formulated. Four priorities for action have been identified to achieve this goal.

4. Stakeholders

The identification and analysis of stakeholders and interested groups is another important element of looking at the context when choosing an investment alternative. The term "stakeholders" is a broadly applied term in the field of strategic management. These are all those individuals and groups who may be affected (positively or negatively) by the processes under investigation or that may affect the process. Risk assessment, including the assessment of the risks of natural disasters, should be done not "in principle" but from the point of view of certain stakeholders.

An important feature of stakeholders and groups is their attitude to risk. This feature has a strong impact on risk assessment and on how to make decisions in a risky situation. Another important feature of stakeholders who may suffer damage in the event of a natural disaster is their vulnerability.

The term "vulnerability" is often explored in connection with concepts such as "threat", "risk", "safety", "security". The magnitude and nature of the damage that people may suffer will depend on many factors but also on those that are characteristic of the person or group of persons, for example: location, age, gender, physical and mental abilities, education, experience, skills, availability of resources (physical, technological, financial, social, personal), ethnicity, presence of construction and other infrastructure elements, flexibility / adaptability / ability to deal with problem situations, ability / intuition, access to information, exposure to danger.[1]

5. Assessment of possible damage in the event of natural disasters

Any type of natural disaster can lead to different types of damage. At the same time, the disaster damages can lead consecutively to other damages or combine with damage from other disasters. Therefore, the damage assessment is a complex problem from a methodological and technical point of view. However, in order to be able to make rational decisions regarding the prevention and reduction of the risks of natural disasters, it is necessary to assess as accurately as possible the potential damages from them.

Worldwide there are long-standing traditions in collecting, summarizing and analyzing statistical information on natural disasters. Various databases are considered in the world literature. Detailed information on such bases is represented in Regional Analysis of Disaster Loss Databases in Arab States. The databases there are divided into two broad categories – open global and national disaster loss databases and disaster recovery databases related to the reinsurance industry. The following categories can be assigned to the first category: Disaster Inventory System, or DesInventar [14] , International Disaster Database – or Emergency Database – EMDAT [15], Global Disaster Identifier Database (GLIDE) [13] , The Global Risk Identification Program (GRIP) [17]. The following databases can be assigned to the second category: Munich Reinsurance database (NatCatSERVICE) [16] , Swiss Reinsurance database (Sigma) [12]. Very detailed analyzes of the information on damage from natural disasters are presented in a World Bank publication [7] .

In the practice of Bulgaria, serious consideration is also given to the assessment of the damage caused by natural disasters and their analysis. The Disaster Risk Reduction Strategy provides a detailed analysis of the main natural hazards that can lead to disasters.[2]

The National Statistics Institute maintains statistics on so-called crisis events, many of which can be attributed to natural disasters – landslides, earthquakes, droughts, floods, storms, tornadoes, tornadoes, windstorms, hailstorms, snowstorms, frosts, frostbite. Both the number of natural disasters and the damage caused by them, the means required for recovery and the cost of rescue and emergency are taken into account.

6. Assessment of the possible benefits of implementing projects to reduce the risks of natural disasters

The economic benefits of activities to reduce the risks of natural disasters can be divided into two categories - direct and indirect benefits. Direct benefits are directed at controlling the very risk for which they are designed. Indirect benefits can result in different beneficial effects for a group of people or the entire population as a result of a reasonably planned project. For example, a flood protection project can be designed to provide drinking water or irrigation water for the local population.

7. Opportunities for choosing an investment alternative using the "Decision Tree" model

The Decision Tree is a method of taking rational managerial decisions in the presence of risk. In applying this method, a tree graph is developed that reflects consecutive and interrelated decisions and their results. The method is suitable for use when a series of successive decisions is required when designing the project.

When selecting an investment alternative to reduce the risk of natural disasters, it is necessary to take consecutive decisions – to allocate the available public resources to deal with the various types of natural disasters, to choose from various portfolios of projects to address the risk of a particular natural disaster, to select concrete projects to prevent the risk of a natural disaster.

A specific Decision Tree model, which presents consecutive choices for selecting an investment alternative, is presented in Fig. 1.

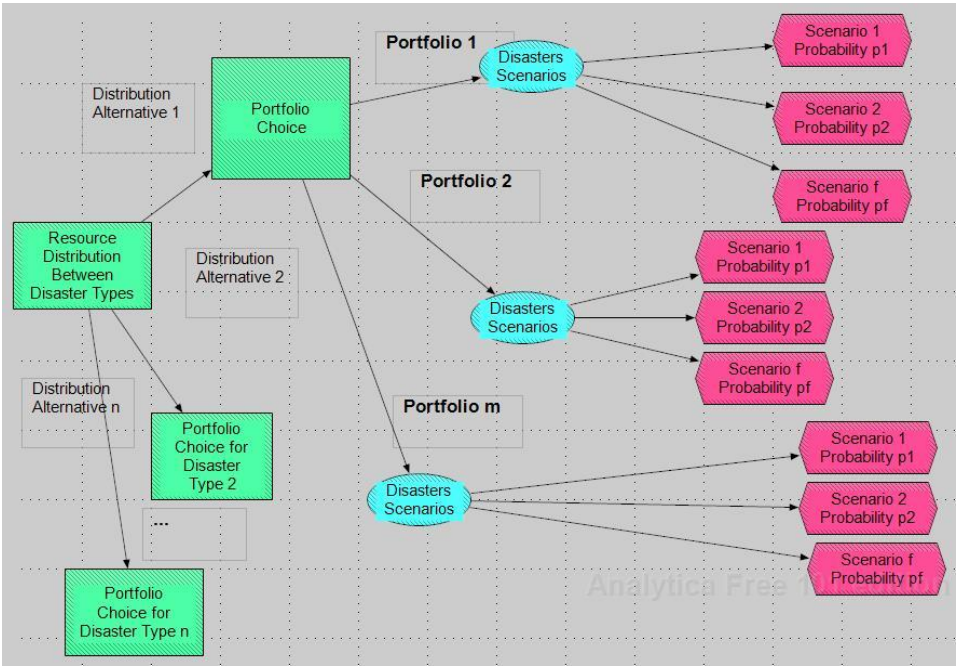

Fig. 1. Decision Tree Model for selecting an investment alternative

If the functionalities of the Analytica, version 5.1 software are used, the model can be presented in a simpler way. However in this model one cannot see graphically important details (Fig. 2).

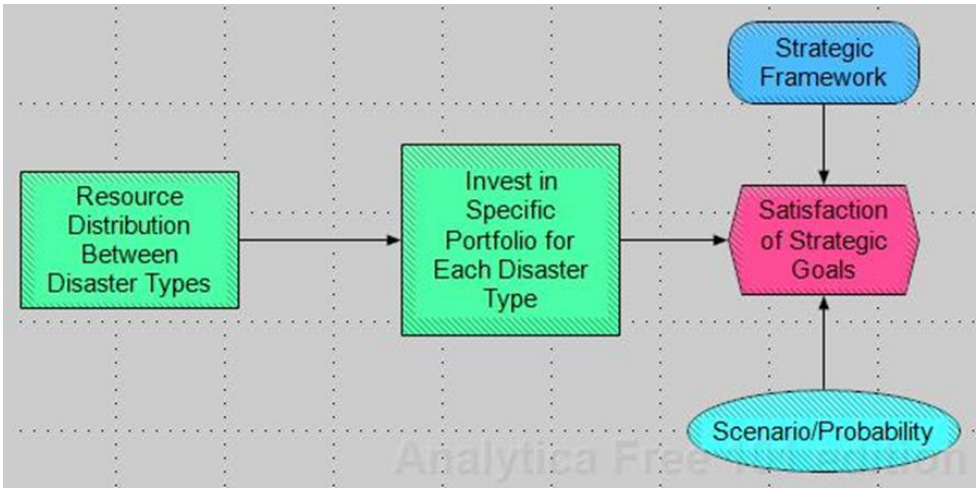

Fig. 2. Decision Tree Model for selecting an investment alternative using the Analytica, version 5.1 software

8. Opportunities for choosing an investment alternative through the "Influence Diagram" model

"Influence Diagram" is a tool that somewhat resembles the decision tree. An influence diagram is a graphical image consisting of nodes and arrows that connect nodes.

The nodes can represent decisions, chance events, and values. Strength of the Influence Diagrams is that they can present a problem at different levels – more generally or more specifically. This report explores the possibilities offered by Analytica, version 5.1 for development and computation with Influence Diagrams. Such a model is shown in Fig. 3.

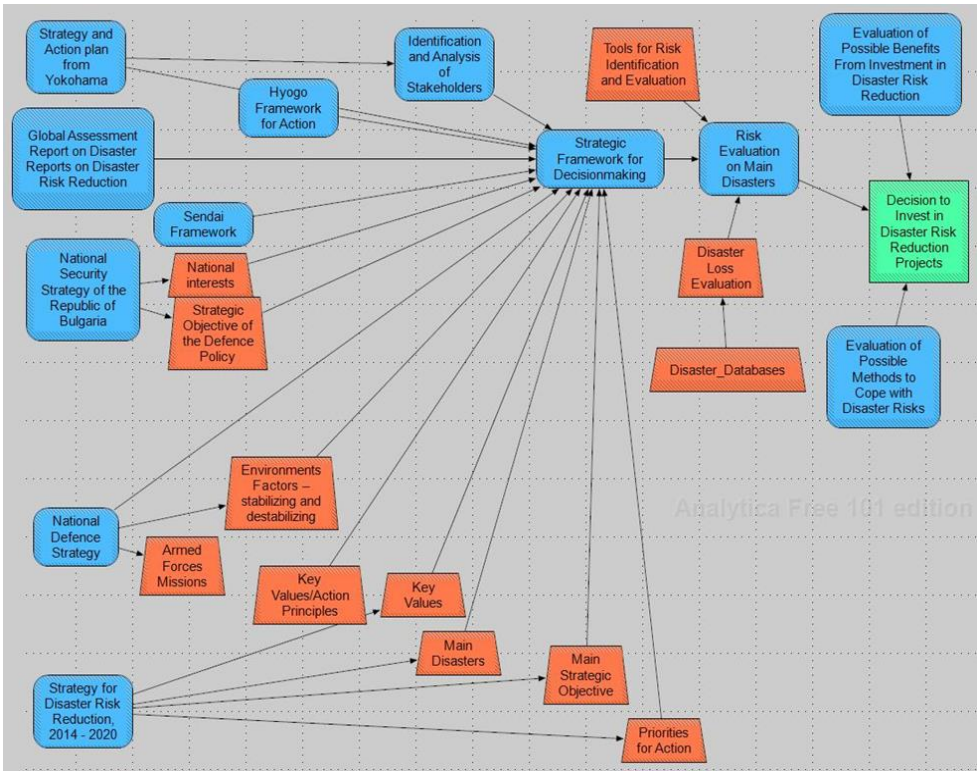

Fig. 3. Influence Diagram Model for Investment Alternatives Choice to Prevent Natural Disasters

The software used has many advantages, the main ones being: it is possible to use it for free, with certain limitations (models can not contain more than 101 items). Once created the model allows for simulations and exploration of multiple scenarios. In this way, the decision-maker will be able to identify the possible outcomes of choosing one or another alternative if several scenarios come true.

The model can be built at multiple levels and analyzed at each individual level. This allows for a more general view of the problem situation as well as concentrating in more or less details about the situation.

Acknowledgment

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Applications of Modern ICT in Risk Assessment from Natural Disasters

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Abstract. There is a natural trend to combine Social Media, Big Data and Cloud Computing by rescue organizations to find value in and insight from both structured and unstructured data from internal and external sources, generated in large volumes during and after Natural Disasters. The purpose of this paper is to analyze the relation between Natural Disasters and Social Network, Big Data and Cloud Computing.

Keywords. Social Network, Big Data, Cloud Computing, Modern ICT Applications, Natural Disasters, Risk Assessment

1. Introduction

Natural disasters come without warning and takes lives of tens, hundreds and thousands of people. Natural disasters can destruct entire cities if precaution is not taken. The types of natural disasters are earthquakes, floods, tornadoes, hurricanes, tsunamis, wildfires and thunderstorms. The effects of natural disasters are very serious and the destruction caused may take a very long time to recover. The damage caused by natural disaster is severe and may cause damage of billions of dollars. The natural disasters cause severe damage and after the disasters the destruction continues with outbreak of epidemic diseases, undernourishment, sickness and other diseases.

With the increase of natural disasters that have occurred in the past years, it is expected their frequency will continue to increase in the coming years. From a business point of view, the evaluation of the risk of a natural disaster occurring comes in when talking about investing in a large in-house infrastructure. However, the idea of having everything at the same physical location is not reasonable since all could be destroyed in a flash.

In order to find alternatives to this problem, a lot of technology experts turn to modern ICT in a hope to solve this issue. They could permit to have redundancy spread across the world to make sure that even if a part of the world is touched by such disasters, that everything can stay in operating order.

The aim of the recent research is to analyze the integration of Social Media, Big Data and Cloud Computing as the most viable solution today for the Risk Assessment from Natural Disasters

Organizations are looking for ways to find value in and insight from both structured and unstructured data from internal and external sources. This is expected to complement but not to replace long-standing information management programs and investments in data

warehouses, business intelligence suites, reporting platforms and relational database experience. The concept of information known as Big data is not only managing large volumes of data, but also controlling the velocity and variety of data that exists nowadays. The ability to extract data from different sources to perform a specific task and the ability to provide information in real-time with the right context is essential.

Information is stored everywhere. Social, mobile and cloud make information accessible, shareable and consumable at anytime and anywhere. The knowledge to capture the right information and utilize the smaller subsets applicable to a specific problem will be critical for avoiding risks.

Risk assessment as a service is a new paradigm for measuring risk as an autonomic method that follows the on-demand, automated, multitenant architecture of the cloud – a way to get a continuous risk score of the cloud environment with respect to a given tenant, a specific application or more generally, for use by new tenants and applications. Risk assessment provides a significant value in increasing trust in a commercial service, and thus appear particularly beneficial to the adoption of cloud computing. Traditional assessments developed for conventional IT environments do not readily fit the dynamic nature of the cloud [1].

The proposed approach is envisaged to be implemented as an instance of the "nexus of forces" paradigm in a cloud environment that allows:

- Using the computing cloud to rapidly converge geographically dispersed global experts at the start of an international incident, deploy a foundation of guidance in accordance with community leaders in a manner that empowers community members through education and smart technologies to support mitigation, response, recovery, and a resumption of societal normalcy at a level of functioning an order of magnitude higher than existed before;
- Using mobile communication devices for rapid threat/damage assessment of occurring events, as well as damage to critical infrastructure inland that necessitates mass sheltering of displaced community members;
- Using the power of nongovernmental organizations, rapidly responding government and corporate groups, social networking communities and other online social networks to locate and gather information, as well as to send help.

2. Social Network in Risk Assessment from Natural Disasters

Social media includes web-based and mobile technologies used to turn communication into interactive dialogue. Social media is defined as a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, a nd that allow the creation and exchange of user-generated content [2]. In Web 2.0 terms this would be a website that does not just give information, but interacts with users while giving them information. Social media is media for social interaction as a super-set beyond social communication.

Online social networking services and social media like Facebook, Twitter, Google+, Etc. can act and try to solve many problems during natural disasters [3]. During disasters all the conventional communications generally stop functioning at this time interval while social media or networking services stay active. Online social networks allow the establishment of global relationships that are domain related or can be based on some need shared by the participants. They have investigated whether or not the social network paradigm can be used to enable individuals and organizations to collaborate in mutually beneficial ways, in all stages of emergency management: mitigation, preparedness, response and recovery.

Conducted research has found that though the use of mobile phones and email did predictably increase in the immediate aftermath of the earthquake the use of social networking

sites also increased and even surpassed the use of more conventional methods of communication such as fixed phones [4]. Apart from the use of major public social networking services, many companies actively used their own secured corporate social networking services after disasters to confirm the safety of employees As with any new technology, there remain many hurdles between current use and optimal exploitation of social media [5]. Although these media are used by people of both sexes and an expanding range of ages, it is important to recognize and explore the technology's limitations in reaching at-risk, vulnerable populations.

It is not always possible to know whether social media users are who they claim to be or whether the information they share is accurate. Although false messages that are broadcast widely are often rapidly corrected by other users, it is often difficult to separate real signals of a health crisis or a material need from background noise and opportunistic scams. Careful consideration must also be given to issues of privacy and the question of who should monitor data from social media [6].

Most of the commentary about social media during natural disasters has centered on its role as a news source. Certainly this is invaluable with instantaneous information available across multiple devices, critical with power outages shutting down TV stations and landlines. People need advice and information, not only in the wake of a disaster but also for ensuring in advance that they are prepared. Disasters bring risk into the mainstream conversation as people have heightened concerns about their loved ones, and not just the ones in the path of a disaster. During these periods, there are sharp increases in the information shared about claims, preparedness tips and how-to insure for the future. Social media is a critical sharing vehicle because it already connects people and it is very easy [7].

Emergency service agencies are utilising the power of social media and SMS to instantly broadcast and amplify emergency warnings to the public [8]. The multi-channel communication approach incorporates mainstream media. They monitor and actively crowdsource localised information from community agencies and the public, which they relay with geospatial information to emergency personnel on the scene. The public are directly receiving and acting on localised, real-time emergency warning information via SMS alerts and messages to their social networks as well as the traditional channels of radio, TV and online. They are directly accessing links to online information via a number of platforms including websites, mobile friendly sites, smartphone apps and video sharing sites as well as social networking sites. They are actively forwarding emergency agency messages to their social networks and amplifying the warnings.

The role of social media in the wake of natural disasters is still unclear, but sites like Facebook, Twitter and YouTube can be of great value when tsunamis, earthquakes, floods and other natural disasters strike. Social media [9]:

- Provides valuable information to those in a disaster area pre and post disaster (via Internet, if available, or SMS updates;
- Drives awareness to those outside the affected areas, generating volunteers and/or donors;
- Connects displaced family & friends;
- Provides information about unclaimed property, and in worst case scenarios, bodies;
- Offers information about aid, centers and other resources available to those affected.

A study by the American Red Cross shows more people are turning to sites like Facebook and Twitter to learn about emergencies, get information and check on friends and family [10]. Facebook, Youtube, MySpace and Twitter were the most popular social network sites when nature strikes.

Research and reviews of different casea has identified the four primary ways that citizens use social media technologies during natural disasters [11]:

Family and Friends Communication - To connect with family members between affected and unaffected communities/areas (or within affected communities) for situation updates and planning responses. This is the most popular use. Primary tools used are Twitter, Facebook and/or a blog.

- Situation Updates - Neighbours and communities share critical information between each other such as; road closures, power outages, fires, accidents and other related damages. ;
- Situational/Supplemental Awareness - in a number of cases citizens rely less and less on authority communication, especially through traditional channels (television, radio, phone.);
- Services Access Assistance - Citizens would use social media channels to provide each other with ways and means to contact different services they may need after a crisis. ;

Before a natural disaster social media can help people better prepare for a disaster and understand which organizations will help their communities [12]. During the disaster social media helps users communicate directly to their families, reporters, volunteer organizations and other residents and immediately share information. It also controls rumors because it's easier for organizations to validate facts. After the disaster, social media helps bring the community together to discuss the event and share information, coordinate recovery efforts and get information about aid.

The use of social media for disaster preparedness has two components [13]:

- As an effective means for providing updated information about a crisis, proactive steps must be taken prior to disasters in order for effective communications to occur;
- As a part of crisis observation, managers should be monitoring social media platforms and channels that may be relevant to their organization. Observing can be as simple as conducting regular searches and analyses of media platforms for keywords and phrases that may imply an emerging crisis or disaster. Monitoring of social media should extend into the crisis response and post-crisis phases to check how crisis management efforts are being received.

Many researchers propose three ways to use social media for risk assessment during natural disasters [14-16]:

- Preparing for a natural disaster - though no one can predict an earthquake days in advance, social networks such, email and text messaging could help people prepare for the emergency. ;
- Responding during and immediately after the natural disaster - this is especially the case for SMS messages and other communications that can be received through cellphones. ;
- Recovering from the natural - communication is done through social media. ;

Nevertheless, the tendency to sensationalize news that is inherent in human nature, basic information may get disproportionately misconstrued as a result of which rumors are created, misleading people with regard to ongoing activities. In the process, there is a loss of confidential information and victims may fail to be notified about revised safety measures. Eventually the lack of constant flow of communication can result in chaos and confusion.

Critical tasks that can be implemented by social media [16]:

- Prepare citizens in areas likely to be affected by a disaster;
- Broadcast real-time information both for affected areas and interested people;

- Receive real-time data from affected areas;
- Mobilize and coordinating immediate relief efforts;
- Optimize recovery activities.

Concerns such as the threat of technology failure, hackers, stalkers, viruses, flaming, and usability issues will have to be addressed in the development of emergency online networks [3]. Current social networks have limitations in terms of the collaborative tools available to users that might be repurposed for emergency use, especially given as they were generally designed with socializing rather than emergency efforts in mind.

Nevertheless, within a short time, even the most enhanced system will seem primitive as user requirements mature and develop in all areas. Systems will ultimately emerge that allow true collaboration and have complete user control. When developing the use of online social networks, it is essential to engage emergency management personnel and their organizations in dialog to determine their concerns, needs and how to serve them in the best feasible manner.

3. Big Data in Risk Assessment from Natural Disasters

Big Data is a broad term for data sets so large or complex that traditional data processing applications are inadequate [17-19]. Challenges include analysis, capture, search, sharing, storage, transfer, visualization, and information privacy [20, 21]. The term often refers simply to the use of predictive analytics or other certain advanced methods to extract value from data, and seldom to a particular size of data set. Scientists, practitioners of media and advertising and governments alike regularly meet difficulties with large data sets in areas including Internet search, finance and business informatics. Scientists encounter limitations in e-Science work, including meteorology, genomics, complex physics simulations, and biological and environmental research.

Big Data is tightly connected with the Internet of Things (IoT). It is a network of physical objects or "things" embedded with electronics, software, sensors, and connectivity to enable objects to exchange data with the production, operator and/or other connected devices The Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure.

A big part of any Big Data use in a disaster relief operation is going to come through the use of crowdsourcing and with the advent and large scale adoption of social media [22-24]. Having the ability to search through the huge amount of data on social media to find this kind of information is where Big Data has given a real advantage to the first responders.

Use of Big Data in disaster response is still fairly new [25-27], but Big Data can create a clear picture of a disaster's regional effects [24].

A big part of any Big Data use in a disaster relief operation is going to come through the use of crowdsourcing and with the advent and large scale adoption of social media [13, 23, 24]. Having the ability to search through the huge amount of data on social media to find this kind of information is where Big Data has given a real advantage to the first responders.

While developers work to create innovative approaches for disaster management by using data culled from social media, others have focused on creating meaning from the disparate databases used for responder training, certification and crisis planning. Aggregated data can provide law enforcement and public safety departments with the information they need to make better decisions during an emergency. Fusing information about individual

responders, their assigned equipment and what tasks they are authorized to perform can have a significant impact on the quality of the response. By aggregating data, individuals are better able to make strong decisions that are appropriate for the situation [28, 29].

When sensing earthquakes, one of the most important aspects to being able to track them and quickly find out where the epicenter was then warn those in surrounding areas. At present one of the only ways to do this is through the use of dedicated networks of sensors that allow seismologists to be able to see where the tremors have started from [30]. The problem with these systems is that they are not only expensive to buy in the first place, but the maintenance of them is also incredibly expensive. The truth about these networks though, is that despite the sensors needing to have special treatment and calibration, they have a lot in common with the sensors that many find in their smartphones, which gives scientists the possibility of crowdsourcing a sensor network.

The problem that many people have in disaster areas is that they lose access to some of the most basic services like food and water, let alone access to the internet. Hence the importance of these services come from their ability to have information uploaded through SMS, which requires far less infrastructure. There are thousands of such reports and analysis on the usage and statistics of social media [31, 32]. For whatever reasons people use social media two things that do not change are:

- People are very active on social media;
- Social media generates enormous amount of data.

Making sense of the big data by processing and analyzing them has been one of the biggest revolutions of the century. One such achievement is the role social networking sites plays in society during a crisis. During such times social media networks provide an instant view of conditions on the ground. Generally social media is used in 4 ways during a disaster [33, 34]:

- Sharing information and spreading awareness;
- For relief operations - building communities, volunteering etc;
- For collecting funds;
- Monitoring and providing insights to the whole situation.

Social media has emerged as a new way through which natural or man-made disasters are dealt with. While the first responders to a crisis are almost always members of affected communities such as neighbours and local authorities, social media may motivate provincial and federal governments to mobilize resources and act on impending crises [35, 36].

Additionally 11 kinds of Big Data datasets useful in Natural Hazards Management have been also identified [24, 37]:

- Satellite imagery
- Elevation and surface models
- Meteorological data
- Transportation networks data
- Demographics and population density data
- Country and urban borderline data
- Use of land and buildings
- Utility networks
- Critical infrastructures
- Hospitals, schools, and other vulnerable locations and last but not least
- PoI data, which is data practically about any point of interest (PoI) directly or indirectly related to natural hazards management.

It is evident these sets add to the vast volumes of data that could describe the situation in a disaster case. Then the question of the fullness and trustfulness of data arises [38, 39]. Big Data, mostly sourced from self-reporting, cannot be the only source of information and accessing data is not necessarily straightforward [24, 40]. The existence of large-scale human behavioral data that could be extremely useful to help fight the consequences of natural disasters. Digital data and new technology, including satellite technology, is far from the best solution for humanitarian and development problems and can actually threat people's lives.

Big Data can help build the big picture [28, 41, 42], but it must never be forgotten that behind every dataset, behind every map, behind every message, there are people striving to save their lives. Data is usually analyzed in a highly secure and protected environment by authorized personnel and no analysis should be undertaken that would ever identify individuals. In addition, only the resulting aggregated, non-sensitive analyses would be made available to relevant aid or government agencies. Another challenge arises from the lack of expertise to carry out such analyses in a technically sound way. Finally, there are regulatory barriers and legal uncertainties that would need to be addressed [42, 43]. In particular, standards, practices and regulation would need to incorporate trust mechanisms for giving access to data for social good purposes and in specific conditions.

4. Cloud Computing in Risk Assessment from Natural Disasters

Cloud Computing is a model for providing on-demand Internet-based access to a shared pool of virtualized computing resources, including networks, storage and applications. The user of cloud services never has to buy or upgrade computing hardware, not to worry about disaster recovery and significantly simplifying business continuing planning. Cloud computing can provide data-communication-as-a-service solution to emergency management. A cloud computing disaster management system could provide for a dedicated platform to enable users (workers, first-responders, local disaster-related non-profit organizations, volunteers, and local residents) to access information, communicate, and collaborate in real-time from all types of computing devices, including mobile handheld devices, such as smartphones, tablets, iPads, etc. Such a system could help for the establishment of a community-based, effective and self-scalable cloud computing environment in which a diverse set of organizations and personnel can contribute their data, knowledge, experience, storage and computing resources to deal with natural disasters

Natural disasters may severely damage Internet access and communications which makes it difficult to access cloud-based servers, applications and data storage. The interruption of network availability is usually temporary, while companies that relied purely on local infrastructure may find their servers completely destroyed and their backup totally lost [44]. When a disaster occurs, telephone lines in disaster areas are overloaded with calls. Using cloud computing for the emergency management could also improve the computer database by providing government agencies with detailed, real-time disaster information. Recovering data after as disaster costs typically twice as much as replacing compromised hardware and software. In the case of cloud computing, recovery costs are considerably lower since only local computers used to access the Internet are at risk and user data and cloud servers are protected far from the disaster site.

In the case of a disaster striking a cloud computing data center, user data will not be lost since suppliers of cloud infrastructure replicate user data and cloud servers across multiple data centers. If a city that uses cloud computing to manage its community development department had the misfortune to lose all its IT equipment in a hurricane or tornado, it could start the task of rebuilding the next day from any location using laptops and an Internet connection [45].

A common concern about using a cloud computing application is that data will be less secure. In practice, however, entrusting information assets to a recognized cloud computing provider generally increases the safety of those assets since on premise IT security practices are often sub-standard. Given that smaller IT departments struggle to design, fund and maintain secure systems while cloud computing providers deliver IT infrastructure as their primary business and competence, moving to cloud computing and SaaS will almost certainly increase security for the majority of IT users [45].

One of the benefits of cloud computing is that information and operations are hosted in well protected data centers. Top cloud providers keep information on thousands of systems and in numerous locations.

Redundancy, availability and reliability are hallmarks of cloud computing, so that users can access your information quickly, no matter where they are located. For example, Amazon and Microsoft have data centers all over the world, with tens of thousands of processing units and storage. They have miles of cables, generators and batteries to run these systems for days or even weeks in the event of power disruptions. Many are located in places less susceptible to harm from natural disasters. Some service providers build data centers underground inside massive concrete buildings. All these precautions ensure that you have access to services and data 24 x 7.

The location of a data center can have a significant impact on the performance of applications running in a cloud computing environment. If a cloud computing provider's primary data center is in country that is to far away from the current location of the natural disaster, the performance of that application will be adversely affected by the prorogated time needed for the messages to travel between the data center and the users in disaster condition.

5. Conclusions

Combining Social Media, Big Data and Cloud computing is the best solution to the needs and requirements of the government, organizations and individuals responding to catastrophic disasters. The availability, scalability, cost, speed of communication and potential security offer solutions to current dilemmas within the emergency response and relief work community are considered. The combined computing services are more readily available for a response to a catastrophic event. Analyzing Big Data generated through social media can help understand the identity and activity of people in these networks and examine the possibility of recruiting them as volunteers in recovery processes. Big Data generated by IoT device could bring up to additional clarification of the damages caused. Since the cloud applications are hosted at geographically dispersed locations, they are not at risk of going down if one of the facilities fails. Cloud computing provides the ability for users to communicate between those in the field with those coordinating efforts outside the field. Evidently putting together Social Media, Big Data and Cloud Computing is a winning solution.

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Geographic Information Systems and Disaster Protection

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Abstract. In the recent years the catastrophic natural disasters have often occurred, becoming a serious threat to people's lives and property. The rapid development of spatial information technologies is widely applicable to natural disasters and they have become a powerful disaster mitigation tool. This report analyzes spatial information technology in Bulgaria in connection with investigation and identification, dissemination and law, risk assessment and zoning, loss estimation, forecasting and dynamic monitoring of application in natural disasters.

Keywords: natural disasters, spatial information technologies, disaster mitigation tool

1. Introduction

During the last year the process of harmonious development and interactions between humans and nature is constantly affected by natural disasters such as global earthquakes, landslides, storms, floods and droughts, hail and snow, freezing temperatures, soil erosion, desertification, dust storms, pests and diseases, forest fires, typhoons, tsunamis, floods and other natural disasters.

Monitoring and early warning are one of the ways for a better outcome for the state and society. Natural disasters are a serious threat to people's lives and property in recent years and have hindered social and economic sustainable development [1].

That is why the use of modern high-tech instruments such as spatial information technology used in assessment and zoning, monitoring, prevention and control of natural hazards has unique advantages in this regard. An important guideline is the assessment of damage and other aspects related to the legal framework so that the objective is to help prevention and mitigation of natural hazards.

2. Based Definitions

Geographic Information Systems (GIS): GIS is a computer-based information system designed for capturing, storing, analyzing, managing, and displaying spatial data representing human and natural phenomena from the real world. It may include applications to Remote Sensing, land surveying, mathematics, and geography.

Natural Hazard: Any natural phenomenon that poses a threat to human life or properties. [2]

Spatial Information Technology is now seen as the third fastest growing new technology globally, following biotechnology and nanotechnology. Geospatial information technologies include the Geographic Information System (GIS), Remote Sensing (RS) and Global Positioning System (GPS) [2]. Spatial information is the digital link between location, people and activities. This information can graphically illustrate what's happening (where, how, and why) to show the insight and impact of the past, present and (possibly) future.

One of the main applications of SIT (Spatial Information Technology) is in a system of monitoring, acquisition, processing, analysis, application of terrestrial information, but in terms of purpose, the main objective of spatial information technology is to study and support the sustainable development of society and to make decisions about the economic development. Spatial information reflects spatial ownership, which has natural, humanitarian, economic, social, historical, cultural and other, comprehensive, multifunctional, heterogeneous, multidimensional, dynamic, informative and massive through various acquired methods for macro and global levels.

Spatial information technology is essential in protecting national economic and social development as well as in the access to critical information and resources for national security. It is an example of the national development of high technology and is a powerful tool for the study of natural disasters.

3. Application of Spatial Information Technologies in Case of Natural Disasters from GIS Perspective Science

Also known as geospatial data or geographic information it is the data or information that identifies the geographic location of features and boundaries on Earth, such as natural or constructed features, oceans, and more. Spatial data is usually stored as coordinates and topology, and is data that can be mapped. Spatial data is often accessed, manipulated or analyzed through Geographic Information Systems (GIS**).**

Example: The aapplication of geographic information systems and software applications for flood modeling are particularly necessary in their application in terms of their impact mitigation capability, allowing for the identification of various alternatives that can be compared on the basis of the costs and benefits they bring. The economic assessment is the result of the identified alternatives they represent flood prevention activities - model of concrete or bulk dyke construction, model for cleaned river bed and adjacent gullies. These models form the cost estimates for the individual alternatives where one can analyze how the damage values are changed to change prevention [4].

3.1. Study and identification

Remote sensing, which is of a unique importance for the monitoring of natural disasters, especially geological hazards, has also benefits for the effectiveness and visualization of results in disaster information extraction. We can provide qualitative and quantitative assessment of relational data for the disaster area through spatial information technology. Spatial data managed by the GIS can provide detailed and comprehensive information to control various natural disasters, but it can also provide a scientific basis for disaster-modeling of a development trend.

Currently, remote sensing technology is used to investigate geological hazards. Remote sensing information sources are used, mainly through visual interpretation, complemented by computer image processing and interpretation results of key region remote monitoring combined with field tests and the use of other data that does not allow remote monitoring, access to reliable research results with comprehensive information analysis [3]. By remote sensing to investigate geological hazards, we can direct this detailed field to exploring and identifying the hazards of geological disasters and their spreading characteristics. This is an important theoretical basis for the prevention of geological disasters.

In bad weather conditions in rain and snow, it is difficult to make accurate real-time observations. If spatial information technology is used to investigate disasters, this could lead to more awareness and promptitude.

In particular, radar remote sensing also has the advantage in case of clouds and fog, and the real-time information on unexpected natural disasters is accurate.

3.2. Spatial distribution and legal prerequisites

Image data can be analyzed and interpreted by remote sensing using RS and GIS technologies, not only to identify the number, distribution and characteristics of disaster-stricken areas, but also to connect with a disaster information database and analyze and explore the characteristics of the distribution and the development of a large number of secondary disasters.

For example, in case of an earthquake remote sensing images could be used to reveal the spatial location and distribution of earthquakes as well as to control geological factors and development through GIS spatial analysis, as well as clear possible impacts: site, scope, earthquake rate and points for hazards for which technical assistance is provided after the disaster as well as a scientific recovery [3].

Through vector-based geographic data and basic geological data combined with remote sensing data and spatial analysis of geological disasters of the earthquake or landslide, we can explore the links between the hazard and the violation of laws.

(*Example* there are illegal constructions in the landslide zones).

3.3. Risk assessment and zoning

With the rise of the natural disaster losses and the rapid development of the theory and technologies associated with them, disaster risk assessment has increased its importance over the last decades, especially with GIS technologies. By integrating risk assessment and spatial data, the analysis is easier, faster and more accurate.

By using GIS, which is a powerful tool for maintaining and processing spatial data, a proper visualization of the territory of the country is also could be carried out. An advantage in this aspect is that by using GIS technology could be selected the functional areas [3].

For example, by the combination of GIS technology and natural disaster management methods, one could take advantage of powerful GIS spatial data and attribute data capabilities, and in combination with software development technology, to implement effective data management of the geological disasters and on this basis to use the correct reliable mathematical model for disaster analysis and assessment. Zoning will thus help decision-makers and decision-makers to effectively control and prevent natural disasters and provide scientific data that is the basis for decision-making to reduce disaster losses.

3.4. Loss valuation

Estimated incidents and economic losses in natural disasters [1] are one of the key disaster prevention and mitigation technologies that could help decision-making and providing information on post-disaster reconstruction.

Through the use of advanced communication technology, GIS technology and information processing technology, it is possible to quickly and dynamically assess the loss of natural disasters as well as choosing the right model for risk assessment. This also makes it possible to select indicators and methods for the implementation of population data management, economic data and disaster statistics data from on-site disasters (video, still images and pictures) and a variety of remote exchange information. Particularly through the powerful GIS spatial data processing functions, zoning disaster and displaying and processing a variety of information on economic losses, victims and other spatial analysis, show further evaluation of data together with automatic generation of evaluation reports, etc. Most of the

assessment data is related to the spatial position, the use of spatial information technology to assess the damage caused by natural disasters, not only to improve the visibility of information and to facilitate emergency decision making, but also to improve the accuracy and the effectiveness of the assessment.

3.5. Warning

Spatial information technologies have a very high value in all aspects of the natural disaster warning system. The creation of a forecasting and warning platform has become possible with the benefits of mass spatial data on natural disasters in acquisition, storage, management, spatial analysis and other GIS and combining theoretical models and methods of hazard warning [3]. For example, remote sensing information can be collected through RS technology. Images and spatial data on disaster and additional monitoring and surveillance identifying disaster incentives, the use of GIS technology can analyze related spatial data and spatial analytical factors and disasters disaster mechanism combined with remote sensing and spatial data and further dissemination of public information disasters through WebGIS technology to reduce disaster losses caused by opaque information. Using GPS technology, the subject of a key monitor in disaster areas can be found and explored to improve the effectiveness of disaster information collection. We can also build SIT-based early-warning systems for natural disasters to ensure the accuracy of system information from sources as well as scientific information on decision-making, timely distribution of warnings and pre-screening and disclosure. The goal is to assist managers in timely decision-making and pre-screening, maximizing disaster risk reduction and possible negative outcomes to improve the capacity and efficiency of the disaster.

4. Examples of application of geodata in local government in Bulgaria

Dobrich Municipality is the first Bulgarian municipality with a developed geographic information system (GIS) of the underground pipelines and all the related facilities. It is the only municipality that can manage the integrated systems of the water supply, sewerage, electricity distribution, telecommunication and gas transmission networks throughout the city. The Geographic Information System was developed under the "Future" Plan - Improving the Human Resources Capacity in the Municipality of Dobrich for Better Urban Management, Planning and Development ".

The project is worth EUR 302,000 and it is implemented with the financial support of Iceland, Liechtenstein and Norway through the European Economic Area Financial Mechanism. Its partners are operating companies - EON AD, Dobrich, WIC EOOD, Dobrich, Alcatel Lucent Bulgaria EOOD and Black Sea Technology Company AD.

The geographic information system of the Dobrich municipality is based on real data obtained through surveying on the territory of the entire city with an area of 1401 hectares, comprising two industrial zones - North and West, as well as 16 residential areas. More than 250 16 points of the working geodetic base and 1100 km of underground pipelines and facilities, including plumbing, sewerage, low-voltage, high-voltage and gas pipelines, street lighting and a trolley network, were captured. The data are digitized and processed in order to produce a specialized cadastral map and registers of underground pipelines and facilities to them.

The developed geographic information system allows the filing of reports, the drawing of sketches and the making of analyzes in order to facilitate the making of informed management decisions and provide information to citizens and investors. By introducing this

innovation to help local governments, the practice of digging up without the necessary information on available underground infrastructure will cease. The project will allow the extension of the scope of e-services provided to citizens, in particular the cadaster services. The sustainability of the project is ensured by maintaining and updating the newly built system of trained for this purpose 30 experts from the municipal administration and the operating companies.

5. Conclusions

In the recent years, spatial information technology has been widely and extensively applicable in various areas related to natural disasters. GIS, RS and GPS, have replaced many traditional tools and have become an important support and a basis for modernizing disaster prevention and mitigation. With the advent of the information age, thanks to its characteristics of a sophisticated and an effective tool, spatial information technology will become an indispensable for tackling of the natural disasters.

Acknowledgment

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Physio-geographical and Meteorological Prerequisite for Floods in the Aydarovska River (South-West Bulgaria)

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Abstract. Physiographic conditions for occurrence of river floods and inundation in small watersheds of southwestern Bulgaria on the example of Aydarovska River, a left affluent of Struma River, are considered. Some measurements of water quantity are made and the weather conditions in river floods during the winter of 2015 are analyzed. The presented own data show that this type of processes are widely spread and often accompanied by debris flows.

Keywords. Catchment area, morphometric parameters, torrential rainfall, Digital elevation model, GIS, weather conditions.

1. Introduction

River flowing are a characteristic feature of the river's regime in Bulgaria. They are determined by the following rainfall patterns - frequencies, heavy rainfall or intense snow melting, and also they are a major factor in river degradation. River flowing and floods depend also of the morphometric characteristic of river basins (drainage density, slope, aspect), of the nature of the geological base and the soil and land cover. Last but not least, human activities also influence the occurrence of these types of hazards River flowing make and modify various geomorphological forms - alluvial and alluvial-proluvial deposits and congestion cones, generate landslides and collapses, cause riverbed changes, enhance erosion, and destroy the soil cover.

In the middle stream of the Struma River there are good prerequisites for river flowing. Very often, they are characterized by a large flow density know as debris flow, due to the presence of a large amount of leeward rock masses caused by intensive erosion.

Especially hazardous are small rivers, tributaries of Struma in the region of the Kresna and Zheleznitsa gorges. They form deep-buried and steep river valleys with highly steep slopes with intense weathering.

Many hydrologists, geologists and geomorphologists are involved with the problems of the frequency of river debris, debris lows and the formed new forms of relief and they investigate the negative influence of these processes on the economic activities. For the region of Middle Struma publications have [1-4]. The abnormal rain, floods and the erosional processes associated with them were subject of investigation by [5] and [6]. According the last, over 2000 catchment areas in Bulgaria are associated with flash flood character of the river discharge. [7] also worked on debris flows around Struma river drainage basin. In our previous publication [8] we look at the morphometric indicators of Aydarovska's catchment as a prerequisite for the formation of river flowing.

The subject of the study is the Aydarovska River, a left tributary of Struma. Its catchment area is elongated in the direction East-West 10 km long, average width 2.6 km and maximum width up to 4 km. The catchment area is 26.24 km². The average altitude is 704 m,

with a maximum of 1180 m and a minimum of 320 m altitude. The length of the main river is 11.93 km [8].

The purpose of this article is to analyze the episodic torrential floods of the Aydarovska River, observed in January and February 2015, and geographic and meteorological factors, and to determine the risk for settlements, technical infrastructure and landscape changes.

2. Materials and methods

For the purposes of the study, the synoptic conditions of three cases of intensive precipitation - 23-24.01., 31-01.2. and 6-7.02. Synoptic maps have been used [9]. The monthly newsletters of NIMH-BAS [10] serve also for the analysis of the weather situation.

The meteorological conditions are traced according to the data of three amateur weather stations situated in the region of Blagoevgrad - Riltsi (377 m a. s. l.), Ezerets (380 m a. s. l.) and Blagoevgrad center (383 m a.s.l.) [10]. The data from the meteorological network of the support stations of NIMH-BAS - Blagoevgrad, Sandanski, Musala peak [11, 12], as well as data from the Institute's rainfall stations [13] were also used.

For torrential rainfall, rainfall with intensity greater than 0.180 mm / min is acceptable [7], which are risky for river flowing.

The water quantity of the river and the determination of the parameters of the river runoff was carried out in Izgrev district at bridge 4 (fig.1). Here the river has an easy to define rectangular profile of the live section. The speed of the river is determined by swimmers. The determination of the water quantity is performed according to the standard requirements when using floats [14, 15].

In our previous publication, we have determined the morphometric parameters of the catchment based on the obtained digital model of relief (DMR) with a cell size of 30 at 30m. [8].

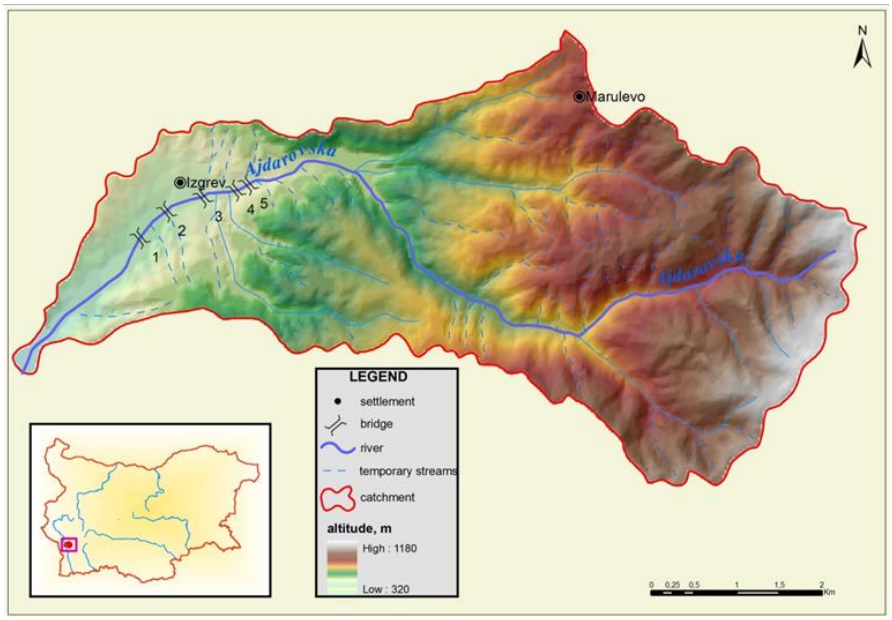

Fig. 1. General geographic map

The research is also supported by field observations, which determine the type of brook processes and sediments, the type and condition of the vegetation.

An attempt has been made to determine the risk of flooding for the population and technicians. Infrastructure of the Izgrev district (Blagoevgrad).

3. Results and discussion

After a prolonged dry period, during the period 23.01-8.02.2015 a precipitation situation environment was created over the Balkan Peninsula and the country. The reason is that a series of cyclones formed over the Mediterranean basin, which in their eastward movement affects the territory of the country. Under their influence over Southwest Bulgaria and the area under consideration there are significant rainfalls mainly from rain and wet snow, in the mountains - from snow. The sum of the precipitation for this 17-day period for the Blagoevgrad region is: Riltsi 141 mm, Blagoevgrad - center 130 mm (Figure 2), Ezerets - 169.2 mm. In Sandanski - the measured total quantity reaches 109.3 mm and Musala peak 88.9 mm. These significant rainfalls, combined with relatively low (winter) temperatures and lack of evaporation, lead to over-wetting of the soil layer and formation of river springs.

	RILTSI						BLAGOEVGRAD-TSENTAR					
Data	Temperature			Pressure	Precip. Ac.		Data	Temperature			Pressure	Precip. Ac.
	High	Avg	Low		Sum			High	Avg	Low		Sum
23	14,5	9,8	5,6	1006,0	21,8		23	15,1	10,4	5,8	1000,0	18,0
24	9,5	6,2	3,9	1003,0	8,4		24	9,4	6,2	4,7	997,0	6,3
25	6,1	5,1	3,6	1008,0	9,1		25	5,9	4,6	3,5	1002,0	8,6
26	6,4	3,7	2,0	1015,0	1,5		26	5,8	3,4	1,9	1009,0	1,0
27	3,7	2,3	0,6	1011,0	7,1		27	3,9	2,4	0,6	1006,0	3,3
28	5,6	3,6	2,6	1008,0	0,0		28	4,9	3,6	2,6	1003,0	0,0
29	10,1	4,3	1,0	1006,0	0,0		29	9,6	5,1	1,3	999,0	0,0
30	10,3	7,7	4,0	992	0		30	10,4	7,8	5,3	987	0,5
31	10,9	7,4	1,4	988	17,5		31	10,2	7,2	0,6	982	14
1	11,7	4,7	0,7	989	33,8		1	11,9	5,1	0,3	983	37,6
2	11,8	6,4	2,7	995	2,8		2	10,4	6,2	3,1	990	4,6
3	9,5	3,7	-1,0	1003	1,5		3	6,6	3,8	0,4	998	1,8
4	7,9	3,3	-2,7	1008	0		4	9,0	4,9	-0,6	1003	0
5	14,3	8,7	0,9	1009	0		5	14,1	9,4	4,1	1004	0
6	11,5	5,8	1,1	1005	35,8		6	13,3	6,1	0,9	998	30,7
7	4,1	2,4	1,2	1011	1,5		7	3,6	2,4	0,9	1006	2
8	3,9	1,6	-0,1	1007	0		8	3,7	1,6	0,1	1001	1,8
Average	8,9	5,1	1,6	1003,8	140,8		Average	8,7	5,3	2,1	998,1	130,2

Fig. 2. Weather data from Riltsi and Blagoevgrad –center stations for the period 23.01-8.02.2015г. [10]

Table 1. Rainfall in some stations measured at 1.02.2015 г.[10, 12]

№ Station	Name	Precipitation mm	Snow cover, cm	№ Station	Name	Precipitation mm	Snow cover, cm
AMS	Elenovo	63,3	Н.д.	AMS	Blagoevgrad -center	51,6	
AMS	Riltsi	51,3		61010	Blagoevgrad	48,3	3
61040	Bansko	49,0	10	61100	Sandanski	29,7	
61111	Parvonaj	30,5		61420	Yakoruda	35,4	9
61570	Satovcha	50,0		61600	Gajtaninovo	50,0	
61631	Polena	51,9		61695	SeloPirin	46,8	
64215	Musala peak	8,3		62050	Dupnitsa	37,0	4

On 23 January, a Mediterranean cyclone with a center above the southern part of the Apennines began to influence the weather over the country (Figure 3). Initially the Balkan Peninsula falls into the front of the cyclone and hot air is exported from the southeast. In the area, where the warm wind effect also occurs, the temperatures reach 14.5° (Riltsi) and 15.1° (Bl.-Center).

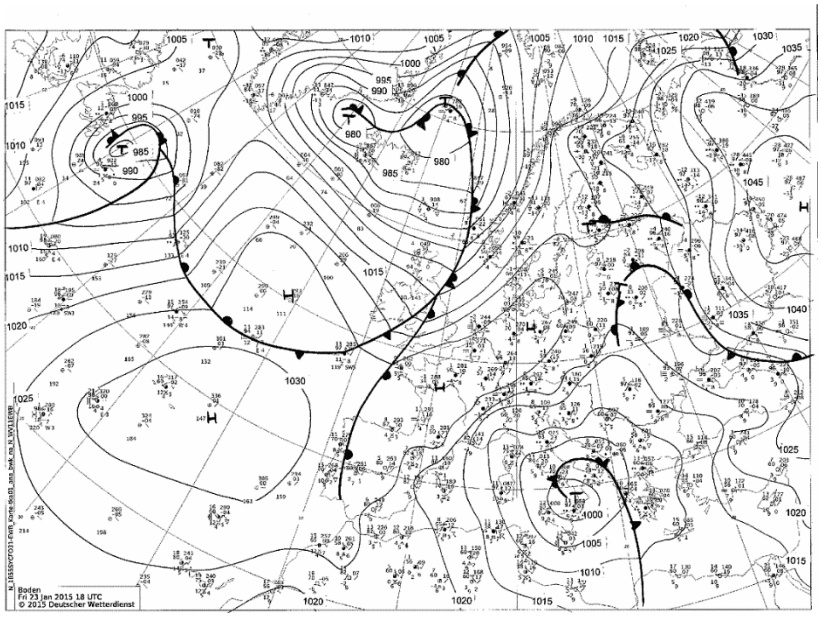

Fig. 3. Weather conditions on 23 Jan 2015 18 UTC [9]. Cyclone over the Apennine peninsula is moving in the eastern direction through the territory of Southern Bulgaria and Northern Greece

The wind is pulsing at a speed of 4-6 m /s in the more orographically closed valley of the village of Riltsi and 10-12 m /s in Blagoevgrad. Precipitation starts about 17 o'clock. Until 20 o'clock falls in Rilci 19 mm, in Blagoevgrad-center 15 mm, Ezerets - 18,3 mm. With interruptions it rains until midnight with a total value of 21.8 mm (Riltsi). Overnight precipitation continues with less intensity and stops until 5 o'clock on 24.01 - 8.4mm (Station Riltsi). Atmospheric pressure decreases, and after a short-lived increase on the cold front, it drops again. Temperatures are lowered to approx. 5° - the region of Blagoevgrad and 7° at Sandanski, but remain relatively high.

Similar is the meteorological situation on 31-1.02. Above the country there is an increase in the transport of air masses from the southwest. A Mediterranean Cyclone passes through the peninsula through the peninsula. It has a frontal zone [11] connected with heavy rainfall. They last about 10-12 hours. Along with that at night on 31.01. temperatures fall and the rain passes into snow, over 500 m above sea level. a snow cover is formed. At 1.02. starts a noticeable rise in temperatures, the snow cover quickly melts throughout the catchment and the river flows. The measured total precipitation amounts at 1.02. are about 50 mm in the region of Blagoevgrad. Rainfall is significant in all Southwestern Bulgaria, the Rhodopes and Southeastern Bulgaria (in Kirkovo - 210 mm) [10, 12] (Table 1).

A new rainy setting is set at 6.02. under the influence of a sequential cyclone from the south and a ridge from the northwest. New rainfall starts. In Blagoevgrad the precipitation starts in 14 hours and up to 20 hours the rainfall between 20 and 35 mm - Riltsi 31.7 mm; Bl. center - 25.5 mm, Ezerets - 37.2 mm. Temperatures decrease from about 8 degrees at the start of the rain to 3 degrees around 20 hours. Again a snow cover is formed that quickly melts. The total rainfall according to the data of the NIMH network [13] reaches Blagoevgrad – 38.3, mm, Musala-33.9 mm, Dupnitsa 30.5 mm, Polena 36.6 mm.

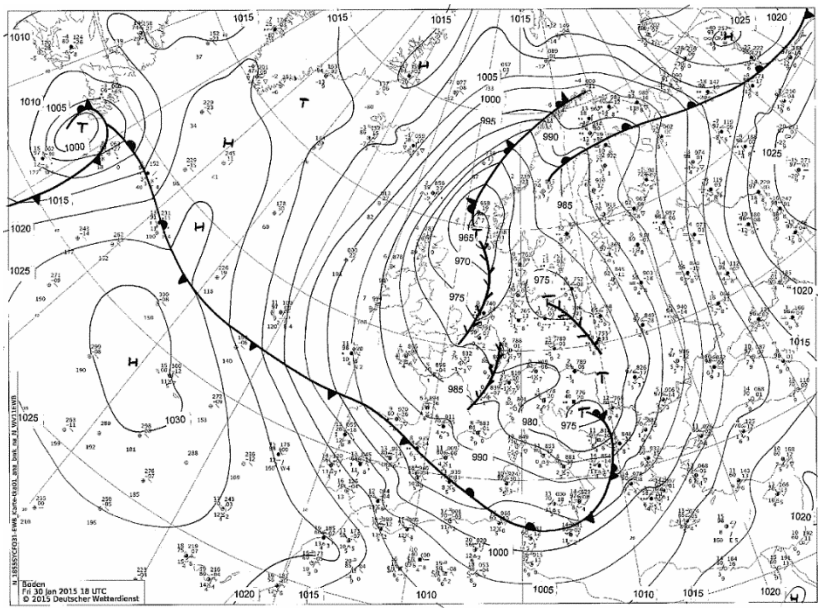

Fig. 4. Weather conditions on 30 Jan 2015 18 UTC [9]. The center of the cyclone is located over South Hungary and a occluded frontier passes through the country

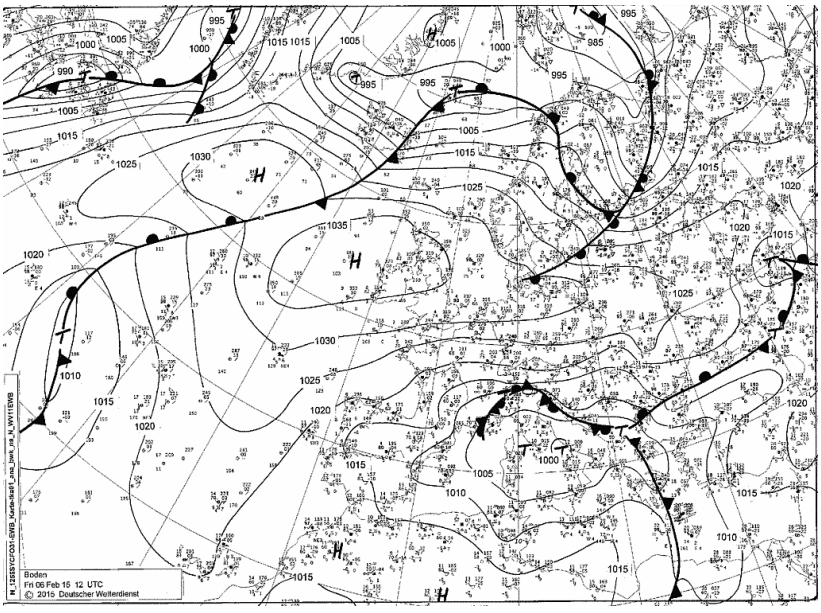

Fig. 5. Weather conditions on 06 Feb 2015 12 UTC [9].
A hydrometer station on bridge 4 is equipped to measure the water quantity (fig. 6).

Fig. 6. Bridge 4 – 01.02.2015 и 15.05.2015

Here the river has an easy to define rectangular profile of the live section. The catchment characteristic to bridge 4 is as follows (Table 2).

Table 2. Morpfometries of the drainage basin

Average alt.,m	Max. altitude, m	Min. altitude, m	length of main river, km	Average slope, degrees	Max slope, degrees	Area, km^2
777,68	1180	420	11,92	16,71	40,74	19,59

The speed of the river is determined by swimmers. According to the adopted methodology, the following values were obtained (Table 3).

Table 3. Quantitative characteristics of the river runoff

№	Data	Precipitation, mm	Q, m^3/sek	Mo l/sek/km^2
1	24.01. – 12 h	20-25	0,834	42,6
2	1.02. – 14 h	50	3,315	169,2
3	6.02. – 12 h	30-35	3,689	188,3

After the second and third rainfall, the river flows and leaves its bedside. It causes local floods in yards, houses and streets, some of the bridges are damaged, the water supply and power supply are interrupted due to a broken water pipe and a fallen electric pole.

The main causes of river flowing and floods can be grouped into three groups: physiographic, meteorological and human activities.

The physio-geographical prerequisites detailed in [8] firstly indicate the highly eroded rock base and soil cover, the significant slope of the water catchment and the deforestation of the terrain, a particularly important factor in the winter.

The analysis of weather conditions shows that local floods can be observed in precipitation over 30 mm falling for about 3 hours (intensity 0.167 mm/min) and over-wetting of the surface soil layer.

Infrastructure in the neighborhood district is in poor condition. The river bed is not fortified, but only one of the five bridges is in good technical condition.

Above Izgerv neighborhood, the river canal is artificially narrow by huge depo for industrial waste with hight of 8-10 m above the canal and inclination of the slope up to 60º. This represent a real danger during a high river discharge a disintegration of the depo slope to occur and potential bent of the river to be formed, which can have disastrous consequences for the nearby village down the river.

4. Conclusion

Reduces the negative effect of physio-geographical factors on river degradation. It is expressed in increasing the afforestation of the catchment and reducing the share of arable land. Local floods, caused by precipitation over 30 mm, combined with snow melting and over-wetting of the soil, are possible. To reduce the flood damage in the neighborhood, it is necessary to correct, deepen and strengthen the river bed and repair the bridges.

Acknowledgment

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Approaches of the Memory Usage in Databases

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Abstract: The growth of data volumes and need for fast analytical data processing lead to significant efforts to answer effectively these major challenges. It is known that Data Processing plays key role and is the leading trigger for the research and development in software and hardware technologies. Facing the new challenges the companies have designed new hardware and software concepts for Database processing. To these enhancements belong intelligent caching high speed memory devices, database appliances and in-memory databases. The In-Memory functionality leads to new approaches in the data processing algorithms and database architecture. The paper observes also the big improvements in the hardware: complex engineered database machines and even special enhancements in the processor architecture.

Keywords: Big Data, Large Data, In-Memory Databases, Analytical Data Processing, Transactional Data Processing.

1. Introduction

The growth of the volumes of data processed in the big industries in the world is a significant challenge in the data processing because the speed of the delivery of expected results is seriously hurt. This phenomena influences both online transactional data processing and also the online analytical data processing (data warehouses and data marts).

There are many new ideas and solutions how to speed up both types of data base processing. One Approach is to concisely cache the frequently used blocks of the data base in special cache devices. The difference between the classical cache and the cache devices is that cache devices are separated from the common RAM of the computers and is used only to cache data base data. This caching is governed and used by the data base software and not by the operating system. Other approach is to use special designed data base appliances that have autonomous intelligence delivered by separate dedicated processors and can independently search data in big disk arrays.

Another way of facilitating analytical processing of data is to use in-memory computing, which relies primarily on a computer's main memory (RAM) for data storage. In contrast the conventional DBMS use disk storage systems. Users access data stored in system primary memory, thereby eliminating bottlenecks from retrieving and reading data in a traditional, disk-based database and dramatically shortening query response times. In-Memory processing makes possible fast to analyze very large sets of data, allowing data marts or small data warehouses, to reside entirely in memory or to use big amounts of memory. Complex business calculations that used to take hours or days are able to be completed within seconds.

Now there are advances in contemporary computer hardware technology that make In-Memory processing possible, such as powerful high-speed processors, multicore processing, and falling computer memory prices. These technologies help companies optimize the use of memory and accelerate processing performance while lowering costs.

Leading commercial products for In-Memory computing include SAP HANA and Oracle In-Memory option. Each of them provides a set of integrated software components, including In-Memory database software and specialized analytic software, run on hardware optimized for In-Memory computing work.

2. Basic Concepts in In-Memory Technology

In-Memory means that the data (or the most frequently accessed data) reside in the main memory (RAM) of the database server. The basic idea is that memory is much faster than disk, actually it is times faster. A 2014 CPU has a memory bandwidth of 10GByte/sec and higher, a single disk around 150MByte/sec – difference by factor 70. If the program is using the same memory frequently, it is cached inside the CPU's L1 or L2 cache, speeding up the memory bandwidth by another factor of 10. On the contrary the disk speed of 150MB/sec is for sequential read access only, random access is times worse for a disk system whereas has no negative impact on the RAM.

The downside of memory is the costs of the memory chip itself (7USD/GByte for RAM compared to 0.05USD/GByte for disks as of 2014) and the hardware platform you need, in order to cope with more memory, is getting increasingly more expensive also.

On the other hand, if the company need 1TB of RAM that would be 7000 USD. While this is much money compared to a single 100 USD disk, it is not much in terms of absolute numbers.

So from expenses point of view the hard disk memory is preferable, but from the data processing speed point of view the RAM based data have preference. Nothing new – this is known fact in the computer science! The only news is that nowadays the big amounts of RAM are affordable for the shops.

3. Alternative Variants of In-Memory

The system administrators and designers always has tried to use the RAM for keeping of data (caching).

All UNIX-like systems analyse the unused portion of the RAM and store data about size and location of the free RAM extents. If such free extents exist the OS are placing there temporarily the most frequently accessed blocks from the disks without to distinguish blocks needed for the OS and blocks needed for the applications. So the number of the physical read and write operations decrease. But if there are need of RAM this area is emptied and the blocks are stored back to the disk without any possibility to manage this process. Nevertheless the RAM is used in the whole extent and the physical access to the disks decreases which increases the speed of the data processing.

Another approach used in the databases is to keep the frequently used data files in the RAM (if there are enough free extents). The association of the files to the applications (the so called table spaces) allows to distinguish the files belonging to different applications and open the possibility to place some files in the RAM instead on disks.

On table level of the databases it is possible the frequently used tables to be placed in the RAM (in Oracle this is the SGA - System Global Area). Additionally in the RAM is possible to keep the results of the data processing (in Oracle – Result Sets). So if the data in the tables after the last processing are not changed the application is provided with the last result of the data processing instead of repeating the slow and expensive process of data retrieval.

4. New Challenges in Data Processing, New Ways

Small business works with small volume of data, the big business – big volume of data, the continental or global business – an ocean of data and gigantic data processing. To be compliant the needs of the big businesses the supplier of the data bases are trying to develop adequate software tools, in some cases also with hardware appliances in which are united all hardware and network components for the data processing.

These appliances comprises processors, RAM, disk memory with enhanced advanced architecture, some network circles (one for superfast inter component communication, another for the applications access), integrated storage chips (cache) with very fast access (approaching the speed of the RAM) for caching the most frequently used disk blocks. In these appliances the notion disk is replaced with the notion "intelligent cell" – a set of 12 classical disk devices, which works as one unit and poses intelligence provided by two powerful Intel Xeon processors. The intelligence has many functions (automatic compression of the disc data, automatic indexing of part of the tables and automated support of different indexes over different parts of a single table, automatic caching in the in the cache memory the most frequently read disk data blocks).

The most important advantage of these appliances is that the data processing is done in the disc cells from the mentioned processors. So is avoided the transfer of the data via the network the disk blocks to the RAM and main processors. Instead a special selective protocol is used (known as iSQL) and the data base is provided with retrieved data and results. This significantly lowers the data transfer by the processing (from one hand because the work of additional processors in the disc cell, from other hand because the parallel usage all the discs in one cell). This technology is implemented in Oracle Exadata, but it is used from other hardware providers. The big disadvantage of such appliances is the big price and that it is hard to expand such systems.

Another approach are the In-Memory databases. The basic ideas here are many, but some of them are important. The In-Memory databases give the possibility to place in the RAM whole tables (and in some cases part of the columns of some tables) and to leave other tables (in some cases other table columns) on the discs. This choice is a new challenge to the system administrators because they need to know in details the application, the data structure and the data processing. From other side they need to know in details the hardware landscape.

The paper presents some features of the In-Memory database HANA of the German Company SAP and Oracle In Memory option. Other providers like IBM и Microsoft have also In-Memory Data Bases but SAP HANA and Oracle are the most common Go Live and Support (productive start and maintenance) - data migration from the old system, activation of the system and support period.

5. SAP HANA In-Memory Database

The SAP HANA database supports two types of table: those that store data either column-wise (column tables) or row-wise (row tables). SAP HANA is optimized for column storage.

Conceptually, a database table is a two dimensional data structure with cells organized in rows and columns. Computer memory however is organized as a linear sequence. For storing a table in linear memory, two options can be chosen as shown below. A row store stores a sequence of records that contains the fields of one row in the table. In a column store, the entries of a column are stored in contiguous memory locations.

In the SAP HANA database, tables that are organized in columns are optimized for high-performing read operations while still providing good performance for write operations.

Efficient data compression is applied to save memory and speed up searches and calculations. Furthermore, some features of the SAP HANA database, such as partitioning, are available only for column tables. Column-based storage is typically suitable for big tables with bulk updates. However, update and insert performance is better on row tables. Row-based storage is typically suitable for small tables with frequent single updates.

The approach to highlight the criteria to be used to decide whether a table should be a colon or a sequence is as follows:

- Column type storage – when to use: Calculations are typically executed on individual or a small number of columns; The table is searched based on the values of a few columns; The table has a large number of columns; The table has a large number of rows and columnar operations are required (aggregate, scan, and so on High compression rates can be achieved because the majority of the columns contain only a few distinct values (compared to the number of rows).
- Row type storage – when to use: The application needs to process only one single record at one time (many selects and /or updates of single records); The application typically needs to access the complete record; The columns contain mainly distinct values so compression rate would be low; Neither aggregations nor fast searching are required; The table has a small number of rows (for example, configuration tables).

It is important to note, that the SAP HANA database allows row tables to be joined with column tables. However, it is more efficient to join tables of the same storage type. It is possible to change an existing table from one storage type to the other (ALTER TABLE ALTER TYPE).

SAP HANA supports history tables which allow queries on historical data (also known as time-based queries).

History tables are special database tables that only allow inserts. Write operations on history tables do not physically overwrite existing records. Instead, write operations always insert new versions of the data record into the database. The most recent versions in history tables are called current data. All other versions of the same data object contain historical data. Each row in a history table has timestamp-like system attributes that indicate the time period when the record version in this row was the current one. Historical data can be read by requesting the execution of a query against a historical view of the database (SELECT ... AS OF time).

Memory management – the column store is the part of SAP HANA database that manages data organized in columns in memory. Tables created as column tables are stored here.

The column store is optimized for read operations but also provides good performance for write operations. This is achieved through 2 data structures: main storage and delta storage.

The main storage contains the main part of the data. Here, efficient data compression is applied to save memory and speed up searches and calculations. Write operations on compressed data in the main storage would however be costly. Therefore, write operations do not directly modify compressed data in the main storage. Instead, all changes are written to a separate data structure called the delta storage. The delta storage uses only basic compression and is optimized for write access. Read operations are performed on both structures, while write operations only affect the delta.

The purpose of the delta merge operation is to move changes collected in the delta storage to the read-optimized main storage. After the delta merge operation, the content of the main storage is persisted to disk and its compression recalculated and optimized if necessary.

A further result of the delta merge operation is truncation of the delta log. The delta storage structure itself exists only in memory and is not persisted to disk. The column store creates its logical redo log entries for all operations executed on the delta storage. This log is called the delta log. In the event of a system restart, the delta log entries are replayed to rebuild the in-memory delta storages. After the changes in the delta storage have been merged into the main storage, the delta log file is truncated by removing those entries that were written before the merge operation. As only data in memory is relevant, the load status of tables is significant. A table can have one of the following load statuses:

- Unloaded, that is, none of the data in the table is loaded to main memory;
- Partly loaded, that is, some of the data in the table is loaded to main memory, for example, a few columns recently used in a query;
- Fully loaded, that is, all the data in the table is loaded into main memory.

The SAP HANA database aims to keep all relevant data in memory. Standard row tables are loaded into memory when the database is started and remain there as long as it is running. They are not unloaded. Column tables, on the other hand, are loaded on demand, column by column when they are first accessed. This is sometimes called lazy loading. This means that columns that are never used are not loaded and memory waste is avoided.

This is the default behaviour of column tables. In the metadata of the table, it is possible to specify that individual columns or the entire table are loaded into memory when the database is started.

The database may actively unload tables or individual columns from memory, for example, if a query or other processes in the database require more memory than is currently available. It does this based on a least recently used algorithm.

The Delta Merge operation - Write operations are only performed on the delta storage. In order to transform the data into a format that is optimized in terms of memory consumption and read performance, it must be transferred to the main storage. This is accomplished by the delta merge operation.

Before the merge operation, all write operations go to Delta 1 storage and all read operations read from Main 1 and Delta 1 storages.

While the merge operation is running, the following happens:

- All write operations go to the second delta storage, Delta 2.
- Read operations read from the original main storage, Main 1, and from both delta storages, Delta 1 and Delta 2.
- Uncommitted changes in Delta1 are copied to Delta 2.
- The content of Main 1 and the committed entries in Delta 1 are merged into the new main storage, Main 2.

After the merge operation has completed, the following happens:

- Main 1 and Delta 1 storages are deleted.
- The compression of the new main storage (Main 2) is reevaluated and optimized. If necessary, this operation reorders rows and adjust compression parameters. If compression has changed, columns are immediately reloaded into memory.
- The content of the complete main storage is persisted to disk.

With this double buffer concept, the table only needs to be locked for a short time: at the beginning of the process when open transactions are moved to Delta2, and at the end of the process when the storages are “switched”.

The minimum memory requirement for the delta merge operation includes the current size of main storage plus future size of main storage plus current size of delta storage plus

some additional memory. It is important to understand that even if a column store table is unloaded or partly loaded, the whole table is loaded into memory to perform the delta merge. The performance of the delta merge depends on the size of the main storage. This size can be reduced by splitting the table into multiple partitions, each with its own main and delta storages.

The standard method for initiating a merge in SAP HANA is the **auto merge**. A system process called mergedog periodically checks the column store tables that are loaded locally and determines for each individual table (or single partition of a split table) whether or not a merge is necessary based on configurable criteria (for example, size of delta storage, available memory, time since last merge, and others).

If an application powered by SAP HANA requires more direct control over the merge process, SAP HANA supports a function that enables the application to request the system to check whether or not a delta merge makes sense now. This function is called **smart merge**. For example, if an application starts loading relatively large data volumes, a delta merge during the load may have a negative impact both on the load performance and on other system users. Therefore, the application can disable the auto merge for those tables being loaded and send a "hint" to the database to do a merge once the load has completed.

The database can trigger a **critical merge** in order to keep the system stable. For example, in a situation where auto merge has been disabled and no smart merge hints are sent to the system, the size of the delta storage could grow too large for a successful delta merge to be possible. The system initiates a critical merge automatically when a certain threshold is passed.

The delta merge operation for column tables is a potentially expensive operation and must be managed according to available resources and priority. This is the responsibility of the **merge monitor**.

The system uses cost functions to decide which table to merge, when, and in which order. There are also cost functions that control how many tables are merged at the same time and how many threads are used to merge a single table.

The merge monitor is responsible for controlling all merge requests for all column tables on a single host. In a distributed system, every index server has its own merge monitor.

Data compression in the column store - The column store allows for the efficient compression of data. This makes it less costly for the SAP HANA database to keep data in main memory. It also speeds up searches and calculations. Data in column tables can have a two-fold compression:

- Dictionary compression - This default method of compression is applied to all columns. It involves the mapping of distinct column values to consecutive numbers, so that instead of the actual value being stored, the typically much smaller consecutive number is stored.
- Advanced compression - Each column can be further compressed using different compression methods, namely prefix encoding: run length encoding (RLE), cluster encoding, sparse encoding, and indirect encoding. The SAP HANA database uses compression algorithms to determine which type of compression is most appropriate for a column.

Advanced compression is applied only to the main storage of column tables. As the delta storage is optimized for write operations, it has only dictionary compression applied. Compression is automatically calculated and optimized as part of the delta merge operation.

Table partitioning - The partitioning feature of the SAP HANA database splits column-store tables horizontally into disjunctive sub-tables or partitions. In this way, large

tables can be broken down into smaller, more manageable parts. Partitioning is typically used in multiple-host systems, but it may also be beneficial in single-host systems. When a table is partitioned, the split is done in such a way that each partition contains a different set of rows of the table. There are several alternatives available for specifying how the rows are assigned to the partitions of a table, for example, hash partitioning or partitioning by range. The following are the typical advantages of partitioning:

- Load balancing in a distributed system - Individual partitions can be distributed across multiple hosts. This means that a query on a table is not processed by a single server but by all the servers that host partitions.
- Overcoming the size limitation of column-store tables - A non-partitioned table cannot store more than 2 billion rows. It is possible to overcome this limit by distributing the rows across several partitions. Each partition must not contain more than 2 billion rows.
- Parallelism - Partitioning allows operations to be parallelized by using several execution threads for table.
- Partition pruning - Queries are analyzed to determine whether or not they match the given partitioning specification of a table. If a match is found, it is possible to determine the actual partitions that hold the data being queried. Using this method, the overall load on the system can be reduced, thus improving the response time.
- Improved performance of the delta merge operation which depends on the size of the main index. If data is only being modified on some partitions, fewer partitions will need to be delta merged and therefore performance will be better.
- Explicit partition handling - Applications may actively control partitions, for example, by adding partitions to store the data for an upcoming month.

Disadvantages of SAP HANA – it has traditionally been a "pure" In-Memory database, which limited HANA to databases that could be fully loaded into memory. This meant that HANA could not support very large databases where the size exceeded the amount of memory available. This has been a source of a large number of complaints from HANA customers over the need for a smooth transition within HANA to non-volatile storage. SAP partially addressed this problem with the dynamic tiering option and support for "extended tables" released in late 2014. Extended tables are disk-based structures that allow HANA to access data on disk as well as in memory but currently there is no concept of partitioning, and extended tables are discrete objects from in-memory tables, which must be managed by applications.

More recently, their Data Lifecycle Management (DLM) tool can be used for moving data between memory, disk and Hadoop/SybaseIQ based on specified rules and policies. This solved the large database problem, but introduced other issues. Besides the issue that extended tables will be very slow to access, use of extended tables is also not transparent to the application. The logic to manage data tiering and access for extended tables may need to be added to every application that accesses data in a large database.

HANA does have support for row based tables, but the performance emphasis is on columnar based tables and this is the format that all of HANA's performance features operate on. This is a significant issue in HANA, as a table is either row based or it is column based; it cannot be both simultaneously.

So although row based tables are supported, HANA is primarily a columnar database and SAP emphasizes that most tables should be columnar based. This implies that a single data format is suitable for both OLTP and analytics.

Organizations can deploy HANA on premise after purchasing an SAP-certified hardware appliance, or on a public cloud from SAP, Amazon, Microsoft, IBM, and several

other cloud providers. The processors used are Intel Xeon. The OS is Linux. So it is not possible to claim that SAP Hana is a multiplatform DB.

6. Oracle Database In-Memory Option

Oracle database In-Memory is available in Oracle database 12c Enterprise Edition as additionally paid option. This means that the database can be also used without the In-Memory feature. The Oracle database 12c has variants for almost all industrial used operating systems and processor types and do not need special certified appliance to be run. The only exception is the option to use the so called "SQL in Silicon": the SPARC M7 microprocessor, specifically engineered for optimal performance for the database In-Memory.

Dual-format architecture – Oracle database In-Memory optimizes analytics and mixed workload OLTP, delivering outstanding performance for transactions while simultaneously supporting real-time analytics, business intelligence, and reports.

This breakthrough capability is enabled by the "dual-format" architecture of Oracle database In-Memory. Up to now, databases have forced users to store data in either column or row format. Column format is highly efficient for analytics, but imposes very large overheads when used in OLTP environments. Similarly, row format enables extremely fast OLTP, but is less optimized for analytics. The only way to optimize for both OLTP and analytics has been to copy data from OLTP systems to analytic systems using complex ETL processes that add a great deal of expense and latency.

The dual-format architecture of Oracle database In-Memory eliminates this tradeoff by representing tables simultaneously using traditional row format and a new in-memory column format.

The Oracle SQL Optimizer automatically routes analytic queries to the column format and OLTP queries to the row format, transparently delivering best-of both-worlds performance. Oracle database 12c Release 2 (12.2) automatically maintains full transactional consistency between the row and the column formats, just as it maintains consistency between tables and indexes.

The new column format is a pure In-Memory format. Tables are stored on disk using

Oracle's existing row-based or hybrid columnar formats. Since there is no persistent columnar storage format, there are no additional storage costs or storage synchronization issues. Changes to the purely In-Memory column format are very fast because they don't need expensive persistent logging.

Having both a column and a row-based In-Memory representation does not double memory requirements. Oracle uses its highly optimized buffer cache management algorithms to keep only actively accessed row data in memory. Decades of experience has shown that caching a small percentage of data blocks in memory eliminates the vast majority of storage I/Os, and flash caching eliminates virtually all the rest. Therefore most of the memory capacity in a database server can be allocated to the column format.

Oracle's In-Memory column format uses sophisticated compression to expand memory capacity and improve query performance. Compression ratios vary from 2X – 20X, depending on the option chosen and redundancy in the data. The compression method may be different across columns, partitions or tables. For example, some table partitions can be optimized for scan speed, others for memory footprint, while others may be optimized to efficiently handle frequent DML operations.

Comprehensive In-Memory optimizations – Oracle implements state-of-the-art algorithms for In-Memory scans, In-Memory joins, and In-Memory aggregation. Tables are logically split into sections, and minimum and maximum values of every column are

maintained for every section of a table. This allows queries to quickly skip table sections that only contain data outside of the range of data needed by the query. Modern microprocessors support SIMD (Single Instruction for Multiple Data values) vector processing instructions to accelerate graphics and scientific computing. Oracle can use these SIMD vector instructions to process multiple column values in a single CPU clock cycle. In-Memory table joins take advantage of the new columnar compressed format by converting join conditions into filters applied during very fast data scans or by executing the join on the compressed values within the join columns. Analytic workloads typically spend a considerable amount of time on expression evaluation for each row returned by a query. In-Memory expressions enable frequently evaluated expressions to be materialized into the In-Memory column store. Once in the column store, all In-Memory optimizations seamlessly apply to the expressions: vector processing, storage index pruning, etc. The expression columns are also maintained automatically as the underlying table columns are updated. In-Memory aggregation algorithms leverage the column format to speed up analytic queries and reports that aggregate large amounts of data.

Cost effective In-Memory processing for any database size - Oracle database In-Memory does not require all database data to fit in memory. Users can choose to keep only performance sensitive tables or partitions in memory. Less performance sensitive data can reside on much lower cost flash or disk. Queries execute transparently on data residing on all three tiers - memory, flash and disk - enabling Oracle database In-Memory to be used with databases of any size.

7. Conclusion

In the second decade of this century, the database got significant improvements in their functionality. Even more – there are new trends in the balance of the usage of RAM and hard disk memories. The attempt to place massive parts of the databases in the RAM mature and is now almost standard feature of the databases implemented in thousands of shops. These leads to new approaches in the design of the applications and rise new challenges for hardware, operating systems and database administrators. The architectural and functional changes are significant and need knowledge to operate them successful.

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Divided Differences and One Problem from International Competition for University Students

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Abstract. The aim of this paper is to introduce divided differences and to prove their properties. A problem from International Competition in Mathematics for University Students related to divided difference is considered.

Keywords. Divided differences, Function approximation, Interpolation, Mathematical Analysis.

1. Introduction

Divided differences are approximations to derivatives. They have important application to various areas of numerical analysis as in polynomial interpolation formulas, definition of a class of functions called B-splines [2, 3, 4]) and etc. An important application of divided differences is Newton's interpolation formula. The definition of B-splines is based on divided differences. Splines provide us a tool to deal with the rate of best approximation, direct and inverse theorem. Related results appeared recently in [1, 5].

For a function f defined on $[a,b]$ and points $x_0, x_1, \ldots, x_n, \ldots$ from $[a,b]$ we define the *first divided difference of* f by

$$[x_i, x_{i+1}]f = \frac{f(x_{i+1}) - f(x_i)}{x_{i+1} - x_i}, \; x_{i+1} \neq x_i; \qquad (1)$$
$$[x_i, x_i]f = f'(x_i),$$

if this derivative exists $i = 0,1,2,\ldots$ For $x_0 \neq x_n$ we define the *n-th divided difference of* f by the recurrence relation

$$[x_0, x_1, \ldots, x_n]f = \frac{[x_1, x_2, \ldots, x_n]f - [x_0, x_1, \ldots, x_{n-1}]f}{x_n - x_0}$$

and if the multiplisity of the point x_0 is $n+1$ then $[x_0, x_0, \ldots, x_0]f = f^{(n)}(x_0)/n!$.

2. Properties of differences

Lemma 1. *If all* x_i *are different*

$$[x_0, x_1, \ldots, x_n]f = \sum_{k=0}^{n} \frac{f(x_k)}{(x_k - x_0)\ldots(x_k - x_{k-1})(x_k - x_{k+1})\ldots(x_k - x_n)} = \sum_{k=0}^{n} \frac{f(x_k)}{\omega'_{0,n}(x_k)} \qquad (2)$$

where

$$\omega_{i,k}(x) = (x - x_i)(x - x_{i+1})...(x - x_{i+k}).$$

Proof. Indeed, (2) can be proved by induction on n. For $n = 1$ equality (2) is true:

$$[x_0, x_1]f = \frac{f(x_1) - f(x_0)}{x_1 - x_0} = \frac{f(x_0)}{x_0 - x_1} + \frac{f(x_1)}{x_1 - x_0}.$$

Asume that (2) is true for n and prove it for $n+1$. By the recurrence relation we have

$$[x_0, x_1, ..., x_{n+1}]f = \frac{[x_1, x_2, ..., x_{n+1}]f - [x_0, x_1, ..., x_n]f}{x_{n+1} - x_0}.$$

But by inductive supposition

$$[x_1, x_2, ..., x_{n+1}]f = \sum_{k=1}^{n+1} \frac{f(x_k)}{(x_k - x_1)...(x_k - x_{k-1})(x_k - x_{k+1})...(x_k - x_{n+1})} = \sum_{k=1}^{n+1} \frac{f(x_k)}{\omega'_{1,n}(x_k)}$$

and

$$[x_0, x_1, ..., x_n]f = \sum_{k=0}^{n} \frac{f(x_k)}{(x_k - x_0)...(x_k - x_{k-1})(x_k - x_{k+1})...(x_k - x_n)} = \sum_{k=0}^{n} \frac{f(x_k)}{\omega'_{0,n}(x_k)}.$$

Then

$$[x_0, x_1, ..., x_{n+1}]f = \frac{[x_1, x_2, ..., x_{n+1}]f - [x_0, x_1, ..., x_n]f}{x_{n+1} - x_0}$$

$$= \frac{1}{x_{n+1} - x_0}\left(\sum_{k=1}^{n+1} \frac{f(x_k)}{\omega'_{1,n}(x_k)} - \sum_{k=0}^{n} \frac{f(x_k)}{\omega'_{0,n}(x_k)}\right)$$

$$= \frac{1}{x_{n+1} - x_0}\left[\sum_{k=1}^{n}\left(\underbrace{\frac{f(x_k)}{\omega'_{1,n}(x_k)} - \frac{f(x_k)}{\omega'_{0,n}(x_k)}}_{\omega'_{0,n+1}(x_k)}\right) + \frac{f(x_{n+1})}{\omega'_{1,n}(x_{n+1})} - \frac{f(x_0)}{\omega'_{0,n}(x_0)}\right]$$

$$= \frac{1}{x_{n+1} - x_0}\left[\sum_{k=1}^{n}\left(\frac{f(x_k)(x_k - x_0) - f(x_k)(x_k - x_{n+1})}{(x_k - x_0)...(x_k - x_{k-1})(x_k - x_{k+1})...(x_k - x_{n+1})}\right)\right]$$

$$+ \frac{1}{x_{n+1} - x_0}\left(+\frac{f(x_{n+1})}{\omega'_{1,n}(x_{n+1})} - \frac{f(x_0)}{\omega'_{0,n}(x_0)}\right)$$

$$= \frac{1}{x_{n+1} - x_0}\left[\sum_{k=1}^{n} \frac{f(x_k)(x_{n+1} - x_0)}{\omega'_{0,n+1}(x_k)}\right] + \frac{1}{x_{n+1} - x_0}\left(\frac{f(x_{n+1})}{\omega'_{1,n}(x_{n+1})} - \frac{f(x_0)}{\omega'_{0,n}(x_0)}\right)$$

$$= \sum_{k=1}^{n} \frac{f(x_k)}{\omega'_{0,n+1}(x_k)} + \frac{f(x_{n+1})}{\omega'_{0,n+1}(x_{n+1})} + \frac{f(x_0)}{\omega'_{0,n+1}(x_0)} = \sum_{k=0}^{n+1} \frac{f(x_k)}{\omega'_{0,n+1}(x_k)}.$$

Corollary 2. $[x_0, x_1,...,x_n]f$ *is symmetric in* $x_0, x_1,...,x_n$.

Proof. Follows from Lemma 1 $[x_0, x_1,...,x_n]f = \sum_{k=0}^{n} \frac{f(x_k)}{(x_k - x_0)..(x_k - x_{k-1})(x_k - x_{k+1})..(x_k - x_n)}$.

Corollary 3. *If* $k < n$, $[x_0,...,x_k]x^n$ *is homogeneous polynomial of the variables* $x_0,\ldots,x_k$ *of degree* $n-k$ *; if* $k = n$ *coincides with* 1 *, i.e.* $[x_0,...,x_n]x^n = 1$ *, and if* $k > n$ *is zero,i.e.* $[x_i,...,x_{i+k}]x^n = 0$.

Proof. The polynomial x_j^n is homogeneous of degree n and

$(x_j - x_0)\ldots(x_j - x_{j-1})(x_j - x_{j+1})(x_j - x_k)$ is homogeneous of degree k and hence $[x_i, \ldots, x_{i+k}]x^n$ is homogeneous of degree $n-k$. It is easy to see, that it is a polynomial. Indeed,

$$[x_0, x_1]x^n = \frac{x_1^n - x_0^n}{x_1 - x_0} = x_1^{n-1} + x_1^{n-2}x_0 + \cdots + x_0^{n-1}$$

i.e.

$$[x_0, x_1]x^n = \sum_{\alpha_0+\alpha_1=n-1} x_0^{\alpha_0} x_1^{\alpha_1}$$

is a homogeneous polynomial of degree $n-1$,

$$[x_0, x_1, x_2]x^n = \frac{[x_1, x_2]x^n - [x_0, x_1]x^n}{x_2 - x_0}$$

$$= \frac{\sum_{\alpha_0+\alpha_1=n-1} x_1^{\alpha_0} x_2^{\alpha_1} - \sum_{\alpha_0+\alpha_1=n-1} x_0^{\alpha_0} x_1^{\alpha_1}}{x_2 - x_0} = \frac{\sum_{\alpha_0+\alpha_1=n-1} x_2^{\alpha_0} x_1^{\alpha_1} - \sum_{\alpha_0+\alpha_1=n-1} x_0^{\alpha_0} x_1^{\alpha_1}}{x_2 - x_0}$$

$$= \sum_{\alpha_0+\alpha_1=n-1} x_1^{\alpha_1} \frac{x_2^{\alpha_0} - x_0^{\alpha_0}}{x_2 - x_0} = \sum_{\beta_0+\beta_1+\beta_2=n-2} x_0^{\beta_0} x_1^{\beta_1} x_2^{\beta_2}$$

is also polynomial, because $x_2^{\alpha_0} - x_0^{\alpha_0}$ is divided by $x_2 - x_0$. Moreover, one can prove by induction that $[x_0,...,x_k]x^n = \sum_{a_0+\ldots+a_k=n-k} x_0^{a_0}\ldots x_k^{a_k}$.

In the general case, when $x_0,...,x_n$ are arbitrary points, the following properties are true.

Proposition. $[x_0, x_1,...,x_n]f$ is symmetric in $x_0, x_1,...,x_n$.

Proposition. $[x_0, x_1,...,x_n]f$ is constant if f is a polynomial of degree $\leq n$, and is zero for a polynomial of degree $< n$.

3. Connection with Hermite interpolation.

In *Hermite interpolation,* not only the value of the polynomial

$$P_n(x) = a_0 + a_1 x + \frac{a_2 x^2}{2!} + \cdots + \frac{a_n x^n}{n!}$$

but also the values of some of its successive derivatives are prescribed. Let

$$y_1, y_2, \ldots, y_p$$

be distinct real *interpolation points,* which are equipped with multiplicities $m_j > 0$, $j = 1,2,...,p,$ with $m_1 + m_2 + ... + m_p = n+1.$ Let $c_{j,l}$ be given constants. We look for a P_n which satisfies the equations

$$\begin{aligned} &P_n^{(l)}(y_j) = c_{j,l} \\ &l = 0,...,m_j - 1, \quad j = 1,2,...p. \end{aligned} \tag{3}$$

In particular, for some function f we may take $c_{j,l} = f^{(l)}(y_j).$ Then the polynomial $P_n = P_n(f,x)$ *interpolates the function* f.

Sometimes a slightly different point of view is preferable.

Let $X : x_0,...,x_n$ be the interpolation points, with possible repetitions. For each j, the multiplicity m_j of x_j is the number of $x_i = x_j$, while l_j is the number of $x_i = x_j$ with $i \le j$.

For example for points

$$x_0, x_1, x_1, x_2, x_3, x_3, x_3$$

$$m_0 = 1, l_0 = 1, \; m_1 = m_2 = 2, l_1 = 1, l_2 = 2,$$
$$m_3 = 1, l_3 = 1, \; m_4 = m_5 = m_6 = 3, l_4 = 1, l_5 = 2, l_6 = 3.$$

Then equations (3) are replaced by

$$P_n^{(l_j - 1)}(x_j) = c_j, \; j = 0, \ldots, n$$

with properly chosen c_j. In particular, for some function f we may take $c_j = f^{(l_j - 1)}(x_j)$. The interpolation polinomial $P_n(x) := P_n(f, X)(x) := P_n(f, X; x)$ depends on the $(n+1)$ - tuple $X : x_0,...,x_n$. It can be obtained by means of Newton's method:

Theorem 4. *There exist unique constants* $A_0,...,A_n$ *for which the polynomials*

$$\begin{aligned} &P_0(x) = A_0 \\ &P_1(x) = A_0 + A_1(x - x_0) \\ &... \\ &P_n(x) = A_0 + A_1(x - x_0) + ... + A_n(x - x_0)..(x - x_{n-1}) \end{aligned} \tag{4}$$

are the solutions of the Hermite interpolation problems for the sets of interpolation points $X_0 := \{x_0\},..., X_n := \{x_0,...,x_n\}$ *and given data* $c_0,\ldots,c_n.$

Proof . We proceed by induction on k. Certainly $P_0(x) := A_0$ is uniquely defined by the condition $P_0(x_0) = c_0$.

Suppose that our assertion is true for $P_0, \dots, P_{k-1}$ and $X_0, \dots, X_{k-1}$. The additional point x_k in X_k is associated with the condition $P_k^{(l_k-1)}(x_k) = c_k$ for the polynomial

$$P_k(x) = P_{k-1}(x) + A_k(x - x_0) \dots (x - x_{k-1})$$

To define A_k uniquely from the condition

$$c_k = P_k^{(l_k-1)}(x_k) = P_{k-1}^{(l_k-1)}(x_k) + A_k\big((x - x_0) \dots (x - x_{k-1})\big)^{(l_k-1)} | x = x_k$$

we need that the $(l_k - 1)$ - st derivative of $(x - x_0)..(x - x_{k-1})$ is non-zero at x_k. This defines A_k uniquely. Indeed, recall that l_k is the number of $x_i = x_k$ with $i \le k$ and we have $l_k - 1$ points before x_k equal to x_k. Then in the product

$$(x - x_0)..(x - x_{k-1}) = (x - x_0)..(x - x_s)(x - x_k)^{l_k-1}, \quad s = k - 1 - (l_k - 1) = k - l_k.$$

The points $x_0,\dots,x_s$ are different from x_k. From Leibniz's formula it follows that the $(l_k - 1)$-s derivative of $(x - x_0)..(x - x_{k-1}) = (x - x_0)..(x - x_s)(x - x_k)^{l_k-1}$ is non-zero at x_k . This defines A_k uniquely. The other conditions $P_k^{(l_i-1)}(x_i) = c_i$, $i = 0,\dots,k-1$ for P_k and $i < k$ are satisfied because they are satisfied for P_{k-1} and because the $(l_i - 1)$ - st derivative of $(x - x_0)..(x - x_{k-1})$ is zero at x_i. Certainly for $i < k$ in the product

$$(x - x_0)..(x - x_{k-1}) = (x - x_i)^{l_i} Q_1(x).$$

Then from Leibniz's formula it follows that the $(l_i - 1)$-st derivative of $(x - x_0)..(x - x_{k-1}) = (x - x_i)^{l_i} Q_1(x)$ is equal to $(x - x_i)Q_2(x)$ and is zero at x_i. This completes the proof of theorem.

Extreme cases of Hermite interpolation are Lagrange interpolation, when all x_i are different and Taylor interpolation, when $x_0 = x_1 = \dots = x_n$. In the latter case, if $c_k = f^{(k)}(x_0)$ $k = 0,\dots,n,$ P_n is the Taylor polynomial

$$P_n(x) = f(x_0) + f'(x_0)(x - x_0) + \dots + f^{(n)}(x_0)(x - x_0)^n / n!$$

When all $x_0,\dots,x_n$ are different $P_n(f, X; x)$ is called Lagrange interpolation polynomial $L_n(f; x)$. For it all $l_j = 1$, $j = 0,\dots,n$ and $L_n(f; x)$ satisfies the equations

$$L_n(f; x_k) = f(x_k), \; k = 0,\dots,n.$$

The Lagrange interpolating polynomial is given by

$$L_n(f, x) = \sum_{k=0}^{n} f(x_k) \frac{(x - x_0) \dots (x - x_{k-1})(x - x_{k+1}) \dots (x - x_n)}{(x_k - x_0) \dots (x_k - x_{k-1})(x_k - x_{k+1}) \dots (x_k - x_n)}$$

Theorem 5. *For a function* f *and points* $X: x_0, x_1, ..., x_n$ *with possible repetition we have*

$$[x_0, x_1, ..., x_n]f = A_n$$

where A_n *is the coefficient of* x^n *of the Hermite polynomial* $P_n(f, X; x)$ *which interpolates* f *at* $x_0, x_1, ..., x_n$. A_n *is given by (4).*

Proof . For the proof we proceed by induction on n. Certainly for

$$P_0(x) = A_0$$

$$P_1(x) = A_0 + A_1(x - x_0)$$

in case of different interpolation points x_0, x_1 we have $A_0 = f(x_0),\ f(x_1) = f(x_0) + A_1(x_1 - x_0)$ hence $A_1 = [x_0, x_1]f$; in case $x_0 = x_1$ we have $A_0 = f(x_0),\ f'(x_0) = P_1'(x_0) = A_1$ i.e. $A_1 = [x_0, x_0]f$. Suppose that our assertion is true for $P_0, P_1, ..., P_{n-1}$ and $X_0, X_1, ..., X_{n-1}$. Let S, T be polynomials of degree $\leq n-1$, which interpolate f at the points $x_0, x_1, ..., x_{n-1}$ and $x_1, x_2, ..., x_n$ respectively. Then

$$\frac{x - x_0}{x_n - x_0} T(x) + \frac{x_n - x}{x_n - x_0} S(x) \tag{5}$$

is a polynomial of degree $\leq n$, and an application of Leibniz's formula shows that it interpolates f at $x_0, x_1, ..., x_n$ with the required multiplicities. The leading term of (5)

$$\frac{[x_1, x_2, \dots, x_n\ ]f - [x_0, x_1, \dots, x_{n-1}\ ]f}{x_n - x_0} = [x_0, x_1, \dots, x_n\ ]f$$

is the coefficient A_n of x^n of the polynomial P_n which interpolates f at $x_0, x_1, ..., x_n$.

This comletes the proof of theorem.

Let a function f and points $X: x_0, ..., x_n$ be given . Let the polynomial of degree n $P_n(x) = P_n(f, X; x)$ satisfies the conditions $P_n^{(l_j - 1)}(x_j) = f^{(l_j - 1)}(x_j)$, $j = 0, ..., n$. From Theorem 4

$$P_n(x) = A_0 + A_1(x - x_0) + ... + A_n(x - x_0)..(x - x_{n-1}).$$

The coefficients A_k are divided differences $[x_0, ..., x_k]f$ for $k = 0, 1, ..., n$ .This leads to Newton's formula for the interpolating polynomial:

$$P_n(f, X; x) = \sum_{k=0}^{n} (x - x_0)..(x - x_{k-1})[x_0, ..., x_k]f.$$

If we adjoin an additional point y to X and put $Y: x_0, ..., x_n, y$, we will have $P_{n+1}(f, Y; y) = f(y)$. We obtain a formula with remainder

$$f(y)=P_n(f,X;y)+(y-x_0)..(y-x_n)[x_0,...,x_n,y]f.$$

Lemma 6. *If* $f\in C[a,b]$, $a\le x_i\le b$, $i=0,...,n$, *then*

$$[x_0,...,x_n]f=\frac{f^{(n)}(\xi)}{n!} \qquad \textit{for some } \xi\in[a,b].$$

Proof. If $P_n(x)=P_n(f,X;x)$, then the function $f(x)-P_n(x)$ has $n+1$ roots - at the points $x_0,...,x_n$ (with corresponding multiplicities m_j , $j=0,...,n$). Then by Rolle's theorem, the first derivative $f'(x)-P_n'(x)$ has n roots, $f''(x)-P_n''(x)$ has $n-1$ roots, etc. $f^{(n)}(x)-P_n^{(n)}(x)$ has a root $\xi\in[a,b]$, i.e. $f^{(n)}(\xi)-P_n^{(n)}(\xi)=0$ for some $\xi\in[a,b]$. But $P_n(f,X;x)=\sum_{k=0}^{n}(x-x_0)..(x-x_{k-1})[x_0,...,x_k]f$ and only the last term $(x-x_0)..(x-x_{n-1})[x_0,...,x_n]f$ has degree n, the other terms have degree less than n . Since the coefficient in x^n is $[x_0,...,x_n]f$, we obtain, that $\frac{d^n}{dx^n}P_n(x)=n![x_0,...,x_n]f$ $\forall x\in\mathbf{R}$, which shows that $f^{(n)}(\xi)-n![x_0,...,x_n]f=0$ for some $\xi\in[a,b]$. The lemma is proved.

4. Problems

Problem 1. If $f(x)=\frac{1}{x}$ and $0<x_0\le...\le x_n$, then $[x_0,...,x_n]f=\frac{(-1)^n}{x_0...x_n}$.

Solution. For $n=0$, $[x_0]f=f(x_0)=\frac{1}{x_0}$, for $n=1$ and $0<x_0<x_1$, $[x_0,x_1]f=\frac{f(x_1)-f(x_0)}{x_1-x_0}=\frac{1}{x_1-x_0}\left(\frac{1}{x_1}-\frac{1}{x_0}\right)=\frac{x_0-x_1}{(x_1-x_0)x_0x_1}=-\frac{1}{x_0x_1}$, when $0<x_0=x_1$, $[x_0,x_0]f=f'(x_0)=-\frac{1}{x_0^2}$. Assume, that the assertion is true for $[x_0,...,x_{n-1}]f$. Then, when not all $x_i, i=0,...,n$ coincide,

$$[x_0,...,x_n]f=\frac{[x_1,...,x_n]f-[x_0,...,x_{n-1}]f}{x_n-x_0}=(-1)^{n-1}\frac{\frac{1}{x_1...x_n}-\frac{1}{x_0...x_{n-1}}}{x_n-x_0}=(-1)^{n-1}\frac{\frac{1}{x_1...x_{n-1}}}{x_n-x_0}\left(\frac{1}{x_n}-\frac{1}{x_0}\right),$$
$$=(-1)^{n-1}\frac{\frac{1}{x_1...x_{n-1}}}{x_n-x_0}\frac{x_0-x_n}{x_0x_n}=(-1)^{n-1}\cdot\frac{(-1)}{x_1...x_{n-1}}=\frac{(-1)^n}{x_0x_1...x_{n-1}x_n}$$

when $0<x_0=...=x_n$, then $[x_0,...,x_0]f=\frac{\left(x^{-1}\right)^{(n)}(x_0)}{n!}=\frac{(-1)..(-n)x_0^{-n}}{n!}=\frac{(-1)^n}{x_0^n}$.

Problem 2. Prove that if $f:\mathbf{R}\to\mathbf{R}$ is three times differentiable, then there exists a real number $\xi\in(-1,1)$ such that $\frac{f'''(\xi)}{6}=\frac{f(1)-f(-1)}{2}-f'(0)$. (12^{th} International Mathematics Competition for University Students Blagoevgrad, July 22 - July 28, 2005).

Solution 1. Let

$$g(x)=-\tfrac{f(-1)}{2}x^2(x-1)-f(0)\left(x^2-1\right)+\tfrac{f(1)}{2}x^2(x+1)-f'(0)x(x-1)(x+1)\ .$$

It is easy to check that $g(\pm1)=f(\pm1)$, $g(0)=f(0)$ and $g'(0)=f'(0)$. We apply Rolle's theorem for the function $h(x)=f(x)-g(x)$ and its derivatives. Since $h(-1)=h(0)=h(1)=0$, there exists $\eta\in(-1,0)$ and $\theta\in(0,1)$ such that $h'(\eta)=h'(\theta)=0$. We also have $h'(0)=0$, so there exists $\rho\in(\eta,0)$ and $\sigma\in(0,\theta)$ such that $h''(\rho)=h''(\sigma)=0$. Finally, there exists a $\xi\in(\rho,\sigma)$ where $h'''(\xi)=0$. Then

$$f'''(\xi)=g'''(\xi)=-\tfrac{f(-1)}{2}.6-f(0).0+\tfrac{f(1)}{2}.6-f'(0).6=6\left(\tfrac{f(1)-f(-1)}{2}-f'(0)\right)\ .$$

Solution 2. The expression $\frac{f(1)-f(-1)}{2}-f'(0)$ is the divided difference $[-1,0,0,1]f$ and by Lemma 6 there exists a number $\xi\in(-1,1)$ such that $[-1,0,0,1]f=\frac{f'''(\xi)}{3!}$.

We calculate $[x_0,x_1,x_1]f=\frac{[x_1,x_1]f-[x_0,x_1]f}{x_1-x_0}=\frac{f'(x_1)(x_1-x_0)-f(x_1)+f(x_0)}{(x_1-x_0)^2}$ for $x_0\neq x_1$. Then $[-1,0,0]f=f'(0)-f(0)+f(-1)$, $[0,0,1]f=f(1)-f(0)-f'(0)$, $[-1,0,0,1]f=\frac{1}{2}(f(1)-f(-1)-2f'(0))$.

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Misstatements Caused by Fraudulent Financial Reporting: Overview on the Main Ways of Committing Financial Statement Fraud

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Abstract: This paper gives an overview of the main ways by which financial statement fraud can be committed in organizations. The article goes over revenue manipulation, inventory manipulation, and asset and liability manipulation as ways of perpetrating financial statement fraud giving examples where appropriate. Financial statement fraud can be committed using various ways by manipulating the financial statements.

Keywords: Fraud, Financial statements, Revenue manipulation

1. Introduction

The Institute of Certified Public Accountants (AICPA) [1] and more precisely the Statement on Auditing Standards 99 define two main possible misstatements in relation to the financial statements that constitute fraudulent activity: the first one is fraud due to fraudulent financial reporting and the second is fraud due to misappropriation of assets. Each of the two categories consisting of a variety of ways for their perpetration. It has to be noted that generally the consequences from fraudulent financial reporting are considered of much bigger magnitude due to their effect on the organization and even society.

2. Misstatements that are caused by fraudulent financial reporting

Fraudulent financial reporting incorporates actions designed to deceive the users of such information, usually with the purpose of indirect benefits for the individual committing the fraud. The primary objective of such reporting is usually to show a better financial position of the entity and one way is to overstate the revenue and/or income. The same effect can be achieved by understating the expenses and cash outflows of the entity. A representation can be found in figure 1. The Securities and Exchange Commission (SEC) [2] sees fraudulent financial reporting as the use of tricks in order to achieve a specific result by manipulating the financial information (performance) of an organization. The literature discusses two types of fraudulent financial reporting that result in direct or indirect manipulation of the profits and losses of organization (Dooley, [3]). The first one is inclusive meaning that misstatements in the financials arise from overstatements of revenues assets and or understatement of liabilities. The second one is exclusive and it involves an intentional omission of liabilities and/or other obligation from the company's financials.

According to the statement on auditing standards No. 82. of the AICPA financial statement misrepresentation arising from fraudulent financial reporting may involve:

- Intentional misapplication of the relevant accounting principles and policies in regards to amount estimation, classification and disclosure.
- Intentional omission of material information from the financials

- Alteration of accounting records and the respective supportive documents in order to conceal the fraudulent action.

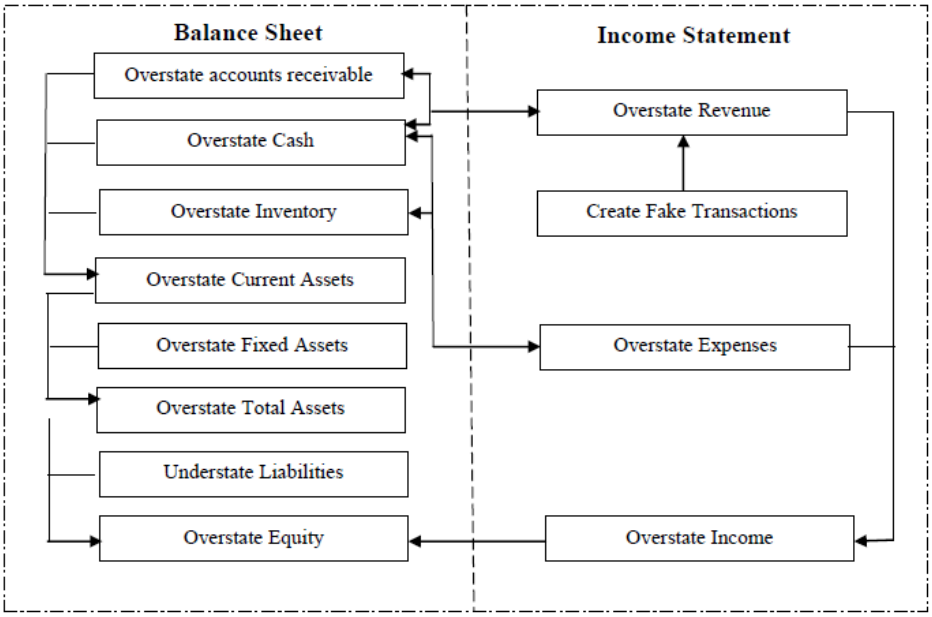

Fig. 1. Profit manipulation

In many cases financial statement manipulation is done in order to report a constant, steadily increasing income which creates an impression of minimization of the unpredictability of the operations of the company and influencing the value of the organization.

Reliable financial reporting on the other hands characterizes itself as one that has met the financial reporting objectives, has used the applicable financial reporting framework and has complied with relevant laws and other regulatory requirements.

The schemes that can result in financial statement fraud can reach hundreds thus a summary of the most popular and general categories as described by the AICPA will be discussed next.

3. Revenue Manipulation

The most popular way of manipulating the financial statements is via the revenues (the largest item on the financial that was involved in 38% of fraud schemes associated with the financial statements (Deloitte, [4]) and/or accounts receivable. Hunt [5] argues that the number associated with fraud associated with revenue recognition is over 50%. By increasing the accounts receivables the income and assets are inflated and higher revenue is reported. Since the accounts receivable are viewed as the second best thing to cash this creates the illusion that the activity and capacity of the organization have increased. It is estimated that the bulk of the revenue recognition schemes is comprised of fictitious and premature revenue schemes. Such schemes include timing differences manipulation where revenues and their corresponding expenses are recorded in different accounting periods. The Financial Accounting Standards

Board has set explicit rules that try to fight this by outlining four criteria for recognizing revenue:

i) Persuasive evidence of an arrangement exists;

In many cases companies engage in fraud by trying to circumvent this and acknowledging the revenue even thought.

- The company has no written or verbal arrangement for the business dealing.
- The order is conditional on some other factors such as a right of return or on consignment.
- There exists a side latter that alters the terms of the arrangement.

ii) Delivery has occurred or services have been rendered

Here the organizations try to acknowledge revenue without delivering or providing the service to completion. Situations include cases when:

- Shipment delivery is not considered complete until installation, customer testing and customer acceptance have passed.
- Some of the components that are required for the operation of the shipment are not delivered or with wrong specification.
- Not meeting other appropriate criteria or applying principles in situations where they should not be applied such as "bill and hold" transactions.
- Services in the contract have not been provided yet or are provided over an extended period are recognized in the current period.

iii) The seller's price to the buyer is fixed (or can be determined);

Example of situations where the price cannot meet the requirement but applied by organizations include:

- A situation where the price of the sale is contingent on future events;
- Fees or other commissions are subject to cancellation at any time during the contract period;
- There is an option in the contract that allows the exchange of the good for other goods;
- Payment terms that include and extension of the period and additional discounts (upgrades) which might be required for the buyer to continue his payment and usage of the products.

iv) Collectability of the payment is reasonably assured.

Organizations are in violation of this principle when they assume that the payment is reasonable but in reality:

- The sale payment is contingent on some future events beyond the control of the organization such as resale or litigation from the buyer.
- The buyer has no means to pay for the sale.

The general fraud schemes related to revenue are summarized in Table 1.

Some authors consider revenue manipulation as a subclass of the so called earnings management which includes a purposeful intervention in the financial reporting and disclosure process with a specific intent (Shipper, [6]). Moreover earnings management can be defined as making decisions that might lead to the achievement of specific accounting goals but be accompanied by destruction of economic value in the process (Graham et al., [7]). The Committee on Sponsoring Organizations [8] further lists some schemes that are considered

part of the illegitimate ways of recognizing revenue and manipulating the earnings of the organization:

i) Bill and Hold Transactions

Bill and Hold transactions refer to a situation where the organization keeps the sold inventory in order to meet the needs of the buyer. Fraudulent behavior occurs when the entity recognizes the revenue generated from the goods before the goods are delivered as the revenue is commonly recognized. Rezaee [9] gives this way of revenue manipulation as an example of substance over form and emphasise the ability to distinguish how the revenue is recognized in different transactions.

Table 1. Revenue related fraud schemes

Type of Fraud Scheme(s)	Accounts used in the fraud	Type of Procedure involved
1) Understate the allowance for doubtful accounts (indirectly overstating receivables)	Bad debt expense and allowance for doubtful accounts	Estimating the uncollectible receivables
2) Record fictitious (non-existing, illegitimate) sales – including related party transactions, sales with conditions etc.); recording sales with fictitious customers **3) Recognizing revenue too early (improper cutoff, % of completion etc);** **4) Overstate real sales (inflate amounts, change contracts, disguised consignment sales etc.)**	Accounts receivable, revenue accounts (sales revenue)	Selling goods/services to customers and other parties
5) Not recording returned goods from customers **6) Recording returned goods in next periods, keeping the books open beyond the period**	Sales returns, accounts receivable	Accepting returned goods
7) Not writing off uncollectible receivables **8) Writing uncollectible receivables in wrong period**	Allowance for doubtful accounts, accounts receivable	Writing off receivables from the financials
9) Recording bank transfers as cash **10) Manipulating cash received from related partiers**	Accounts receivable and cash accounts	Collecting wrong transactions
11) Not recognizing discounts given to customers, manipulation of customer incentives	Sales discounts, accounts receivable, cash	Collecting cash in a discount period

ii) Other timing of revenue schemes

The most common timing of revenue schemes involves keeping the accounting records open more than the corresponding period thus inflating the earnings for the current period. A special situation occurs when leasing transaction is in a place where the organization misstates its upfront revenue from different types of leases such as sales type lease.

iii) Side arrangements

Side arrangements exist in order to add to or alter the terms and conditions of different sales transactions with the goal of motivating the consumer to engage in the transaction. Usually they are in a form of special contingencies such as a right for a refund, prolonged financing or some sort of customization. Some sectors such as the services or technology ones provide many opportunities for side arrangements, which might not be clear and result in revenue misstatement.

iv) Improper Related party Transactions

Improper related transactions are commonly used revenue manipulation due to their ability to remain out of sight and difficult to identify without a provision of proper disclosure. Pesaru [10] sees them as a relationship or other link (financial) between an organization and a customer. An example of how such relationship can result in earnings management is the trading and/or reselling of the same inventory over and over again between the entity and a customer which could be immaterial in the beginning but add to a material misstatement of the financials overtime.

v) Channel stuffing (also known as trade loading)

Channel stuffing involves selling more goods to distributors that they are able to resell in the current period. The usual way of motivating distributors to buy bigger quantifies is via the offer of deep discounts or warning of losing business with the entity. This practice makes related revenue recognition more unclear by delaying the exact pricing of the merchandise until the end of the period resulting in a fluctuating volume of sales. Channel stuffing usually results in returns due to the surplus of goods that the distributors are unable to resell. Without proper disclosure and estimation channel stuffing results in an overestimation of earning in the period because of the extra revenue has been recognized without taking into account the possibility of sales returns afterwards.

4. Inventory Manipulation

The second most common method for committing fraud in the financials is by manipulating the inventory. With inventory manipulation, higher ending inventory can be produced as well as higher income for the period. Typical schemes are found in Table 2.

5. Liability manipulation financial statement fraud

Liabilities are the third most often used method to commit financial statement fraud. They are schemes in which the financial statements are misstated by improperly recording the liabilities and/or other obligations. Moreover the liabilities could be understated by improperly classifying liabilities as equity or recording shot term debt as long term. Missing transactions can be harder to detect than misclassification because of the lack of an audit trail. Here the characteristic schemes are grouped into three main categories: Liability/expense omissions; Capitalized expenses and failure to disclose warranty costs and liabilities. Examples are:

- Not recording accounts payable;

- Not recording accrued liabilities;
- Understatement of expenses;
- Recording unearned revenues as earned;
- Not recording warranty/service liabilities;
- Not recording loans;
- Keeping liabilities off the books;
- Not recording contingent liabilities;
- Ignoring monetary legal judgmental against the organization.

Table 2. Inventory Manipulation Schemes

Fraud Scheme	Accounts Involved	Type of procedure
1) Under-recording purchases **2) Recording purchases in a wrong period** **3) Not recording purchases at all**	Accounts payable, inventory	Purchasing of inventory
4) Overstating returns **5) Recording returns in wrong period**	Accounts payable, inventory	Returning goods to suppliers
6) Overstating purchases	Accounts payable, cash	Paying vendors
7) Overstating discounts **8) Not reducing inventory's cost**	Accounts payable, cash, inventory	Paying vendors
9) Recording at a lower amount of cost **10) Not recording the cost of goods sold or inventory**	Cost of goods sold, inventory	Selling inventory, recognizing cost of goods sold
11) Not writing off/down obsolete inventory **12) Over-Estimating inventory**	Inventory write down, inventory	Estimating inventory quantities, estimating obsolete inventory
13) Over-counting Inventory	Inventory shrinkage, inventory	Counting of inventory quantities
14) Using incorrect costs **15) Recording fictitious inventory**	Inventory, cost of goods sold	Determining inventory costs

6. Asset manipulation in financial statement fraud

Assets are the fourth most common method in fraud in the financials. They could be increased artificially by not booking the accounts receivable or not acknowledging the expense for impairment. Assets manipulation schemes include falsifying the value of the organization's

assets with the intended goal in mind typical schemes include:

- Overstatement of current assets – cash, securities etc.
- Including assets that are not under reporting control and ownership of the entity
- Overstating pension assets
- Capitalizing instead of expensing assets
- Not recording depreciation or amortization expenses
- Extending the useful lives of assets
- Overstating assets via the creation of complex entities, mergers and acquisitions
- Overstating inventory counts and receivables
- Failure to record impairment losses (book value of assets is greater than its fair value or net realizable value)
- Recording fake unrealized gains
- Keeping insufficient reserves for uncollectible receivables

Inclusive/ Exclusive fraud categorization

If categorization is made via the inclusive and exclusive categories the inclusive fraud can involve either the creation of fictitious assets, an omission of present liabilities or in some cases inappropriate timing of transactions:

In the fictitious assets case the most common techniques are: recording of fictitious revenues and their corresponding receivables and recording of fictitious inventory thus influencing the cost of goods sold. Both of this techniques require the creation of a debit account which has to be matched with a credit to either revenues or an expense account making the earnings misstated as well.

Inappropriate timing of transactions can include a variety of scenarios ranging from:

- Premature recognition of receivables and other revenue (before they can be considered realizable or realized).
- Accruals not recognized in a timely manner skewering the recognition of any related expenses.
- Allowances (account, sales returns) and reserves (liability, litigation) and other contingencies not recognized when probable or estimable delaying the related expenses.
- Deferring cost of goods sold associated costs instead of accruing them either by overstating the value of the current inventories or deferring the recognition of any purchases and other costs (labor, materials etc.).

On the other hand the category of exclusive fraud focuses on the omission of liabilities and other expenses and obligations (guarantees, commitments) from the financials. The effects involve:

Underestimation of items that influence the financials like:

- Clean up and other related expenses
- Failure to properly account for litigation reserves and estimation of liabilities due
- Losses with debt and other liabilities
- Reserves associated with impairments and investment losses
- Interest expense

Moreover exclusive fraud typically results in an overstatement of financial ratios relating to liquidity of the company due to their understating effect of liabilities.

7. Conclusion

Financial statement fraud has been an important focus of research due around the world due to its negative impact on organizations, regulators and other stakeholders. This article has provided the different ways financial statement fraud can be perpetrated in organizations. Knowing the ways fraudster can commit such fraud is only the first step out of many towards combating the phenomenon. It establishes the basis which should be used by the relevant parties that play key a role in preventing this type of fraud to reduce the risk of its occurrence.

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Developing Information Technologies and Digital Transformation to Answer Modern Educational and Security Challenges

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Abstract: This report examines the international experience and the new trends for digital transformation in the field of education as well as possibilities of the Internet of Everything application for building the next generation digital university and education of personnel in the sphere of national and coalitional security and defense in the era of globalization.

Keywords: Information technologies, digital transformation, education, career opportunities in cyber security field.

1. Introduction

In today's globalization and informatization environment, all industries have the tendency for digital transformation. That is happening no matter whether we talk about manufacturing, infrastructure, logistics, transport or related industries. Previously, in all these industries, Information Technologies (IT) were "one piece of the cake", while today they are considered to be a major factor in the development of all businesses. All Information Technologies offer amazing opportunities for the development of digital strategies. [2]

Digital transformation is in fact a complete change in business processes, the way of thinking, the behavior of the organization as a result of the application of the latest technologies. Digital transformation is related, on the one hand, to technology and its accessibility, and, on the other hand, to the attitudes of people. The fact that a technology is available does not infer that there are consumers who are ready to use it, and even less - people who are ready to use it actively. Today's students who are formed as individuals under the influence of technologies and their attitudes towards them are naturally very different - they expect to be surrounded by them, they look for them and will continue to look for them.

2. Digital transformation in the field of education as a trend

The trend that exists today is that universities, colleges and academies around the world are getting more digitized or digital, taking advantage of the unprecedented opportunities provided by the use of the Internet of Everythong (IoE) as a technology. It is expected that by 2020, 75% of organizations will have become digital or will be preparing to become digital. Digitization is a phenomenon on which all institutions and organizations have focused. Actually, the digitization of education stems from the need for academic institutions to be more effective in today's competitive environment and to result in better educational outcomes.

According to a UNESCO survey of 2015, 57% of all mobile students are found in North America and Western Europe. The term "mobile students" comprises those students who are enrolled in distance or online training courses. With regard to another study - what should be identified as the number one priority for educational institutions worldwide, answers vary from the improvement of educational outcomes, increasing the efficiency of management and administrative processes as well as raising the level of security and protection [1].

The survey's results show that all these factors are important, but the highest priority is given to the improvement of the educational outcomes. This means making the level of education better and higher, using the potential of collecting and applying the best teaching approaches for modern students. The issue of improving data security and storage is a critical area problem that is being addressed by educational institutions nowadays because more and more links are being established with the introduction of the IoT's, and hence the number of vulnerabilities and potential interruptions is growing. It is also worth studying the percentage of IT spending on education as well as finding out who takes the decision about the IT budget - whether it is mainly the management of the educational institution together with the Chief Information Officer (CIO) or mainly a necessity for improving the business (LOB-Line of Business).

Answers indicate that in the past the CIO decisions were taken and proposed by the management, for example, introducing new networks, video conferencing technologies, etc., but in the current educational environment a large part of the solutions are developed and offered by the participants in the training process. This becomes possible because nowadays technologies are introduced and "support" all sectors or components of the public sector, organizations and the trend is for the heads of relevant units to make decisions on new technologies. This means that the proposals come from different sectors within the institution, for example they could come from the human resources, the finance, the marketing departments or the service sector. For an educational institution this could be the rector of the university or the dean of a faculty or department, chair, center, laboratory, etc. Consequently, the following key ideas can be identified: understanding the historical context of education; outlining the current trends affecting education; identifying the possibilities and ways in which the IoE changes many aspects of the educational process – an investigation how technologies address a number of issues in educational institutions around the world. For example, e-books are presented as the most widespread in Mexico. Mexican educational institutions have the largest e-Textbook program in the world. In Mexico, a million electronic textbooks are distributed to students, starting from Monterey in Mexico. This requires a solid network infrastructure to deliver the books. The Department of Education in São Paulo, Brazil, uses in some of its the teachers' colleges various video technologies to develop a stronger professional environment for teachers across the country. The City of Glasgow College works with the University of San Francisco, which applies the IoE technology to realize a safer and more secure area. It is really exciting to see world examples of what institutions do and the fact that they are sometimes limited only in their imagination.

3. The Historical Perspective of the Digital Transformation

With regard to exploring the historical aspect of development, examples of predictions about the future of education can be considered. One of them represents one of the futuristic paintings of the French painter Jean Kote "At School", from the late 1890s painted on the occasion of the World Exhibition in Paris in 1900. These paintings present how the different professions would look like in the "distant" future, such as future: aviation police, barber, housewife, farmer, theater, home on wheels, future of transport, etc. These paintings were not

published until 1986 in a book where Isaac Asimov was a co-author: Future Days: A Nineteenth Century Vision of the Year 2000 [1].

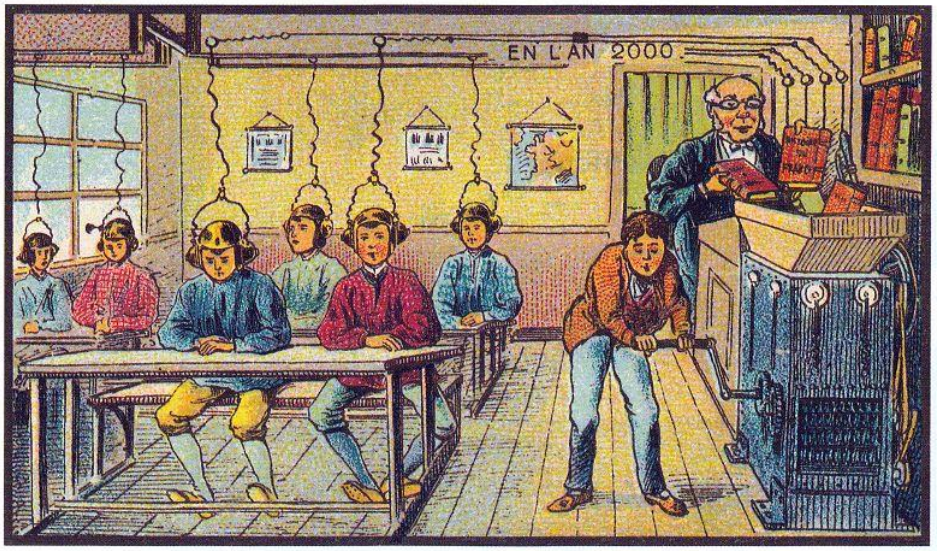

Fig. 1. Jean Kote, "At School" [1]

In the Picture of the Future of Learning, the artist predicts the advent of digitization more than a hundred years ago. It goes without saying that many classrooms in the world still have the old classical look.

Regarding the development of the industry the following main stages can be mentioned: pre-industrial - connected with the early rural economy and society. At that time life goes slowly, socialization takes place mainly in classrooms and in coffee shops. In practice, this must have been the social networking before the advent of the Internet. People just went to bars and clubs to communicate. Nowadays there are people who go to a cafe in order to access a wireless connection. This fact shows the real change in the way people communicate.

The next important stage is the industrial revolution with steam and hydropower and the analog technology, tapes and cassettes for listening to music compared to the modern digital technologies. In 1971, Intel developed the first programmable microprocessor chip. This chip literally changed the world. The world we have now is social, global and video-oriented. From the analysis of the world Global Gross Domestic Product (GDP) per capita, 1550-2000, it is seen that GDP has been dramatically increasing after the invention of the chip This huge jump could only be explained by the higher production levels after the discovery and the implementation of the chip.

Another trend is the amount of information and the enormous number of interactions which people start making around the world. For example, it might be interesting to note that 168 million e-mails are sent per minute all over the world nowadays (Figure 2) [4].

Fig. 2. The amount of information and interactions between people for one minute worldwide [4]

Some of the technologies illustrated in Figure 2 are already considered outdated. Another impressive aspect noticeable in the figure is the fact that in just one minute, 695,000 upgrades of Facebook status are made, which turns Facebook into the largest photographic company in the world. At the same time there is a reverse trend in all paper editions, which have lost some of its importance. They are getting fewer in number, too. Technologies also change the type of media.

There is also a tendency in business to link the field of activity of a firm to another in order to achieve a common goal and a synergical effect. For example, Expedia, which is one of the largest online carriers today, is being displaced by the "Hotel Tonight" company. The latter one uses the digitization to manage and control the supply and demand of hotels, comparing prices accordingly and performing the service "last minute booking". There is also a trend new companies to be created that "destroy" the business of larger ones. Likewise, the created in 2014 social network without ads Ello is an alternative to Facebook. Accordingly, the personal betting system Depop is an alternative to eBay. A similar trend exists in education. For example, for faculty and academic staff in universities and colleges, in order to be more relevant and adequate to the ever-increasing learners' needs, they need to be flexible with regard to the development of new competences related to the future careers of the students. For example, different variants of certification can be offered through various online specialized courses. For example, the network academy's program enables you to acquire a certificate and start work in the field of IT and networking.

It is a fact that a huge amount of data is generated daily in the world - more than two exabytes per day. Big Data can be used for analysis and decision making. In the context of education, data from the use of information infrastructure (devices, computers, mobile devices) used by learners could serve to analyze the network traffic in the area of the university for different periods of the day, i.e to establish its so called baseline. For example, if at a certain

time of the day the students are in the online library, then it will be necessary to create more points to access it. Teachers can also get an idea of how students are progressing in their training, whether they need more assessment, more help or more information, and how they can individually guide them.

Considering that the new millennium generation is growing with visual, virtual, social and mobile features, we can say that they also affects the workforce. Challenges lurk in this situation because for the first time in history we have witnessed four generations of workforce at the same time. We have a lot of elderly people because life expectancy is increasing; we also have the Baby Boomers or the so-called post-war generation, who were born between 1946 and 1964. They are the ambitious goal-oriented type of employees who are dedicated to their work to a great extent. The so-called X generation - born from the 1960s to the 1980s and the millennium generation or the generation Y. They are bringing the change. They are rapidly adapting to technologies, and, therefore, it is necessary to apply new technological approaches of presenting knowledge apart from the classical form of lectures.

Modern students are interested in the opportunity to use a flexible learning environment. For example, the lecturer can record a video lecture and then discuss the content of the lecture in class. In fact, homework can partially be done in class rather than being done late at home at night. Another advantage is the team or group work, which is proven to be more productive in many cases.

The idea of enabling learners to gain knowledge in the way they want will undoubtedly lead to changes. Sometimes watching a lecture on video, the ability to repeat the recording can often be more effective. The conclusion that naturally comes is that flexibility is what is needed but it requires the introduction of modularity of learning. For example, the University of Pennsylvania intends to have a campus (branch) in the silicon valley, but without making their teachers commute. They have installed "hi definitions telepresence" in their campuses in San Francisco and Pennsylvania. Students go to the telepresence room and gain a visual image of their teacher. They can also use applications like webex to take part in seminars with professors from all around the world. The trend is to learn at any time, everywhere, on every device. The University of San Francisco uses the Internet technology of the IoE to create a more secure environment in the university area.

4. The relation between the current security environment and education in the Republic of Bulgaria

In the cold war times the secondary education system included an obligatory basic military training for students in the tenth grade and they obtained minimal skills and knowledge in guns handling. What has remained from this period is only a series of classes conducted by a military officer who has the task to introduce some of the major challenges in the security environment, too. Nowadays with the increasing number of terrorist attacks and security threats worldwide, it is getting more and more important early, initial and adapted to age of learners training to be introduced. It is generally known that pupils are some of most vulnerable part of modern society. Children should be given a chance to learn how to react when they come across suspicious objects or people, which in real situations can save human lives and/or critical infrastructure. Currently such modules for security threats education do not exist in the Bulgarian secondary and higher state educational institutions, but there are some trainings programs on safer internet which protects young people from online threats.

A secure cyber environment requires strong labor force, and it is a fact that more specialists are needed to adequately protect computer networks. Developing competent labor force in the field of cyber security is a crucial factor to guarantee global economic stability and

the security of all states. So, as a possible solution, universities and the business should react quickly by facilitating more people's access into this specific profession sphere. Industries and educational institutions should promote the subject area of cyber security as an attractive option for career development. Educational experts and teachers need to find a way to cooperate in carrying out cyber threat courses, giving sufficient information about the specifics and the responsibilities of this career field. So, to summarize, by providing the necessary information on cyber security, the young generation will choose this specific field of expertise as a main employment area.

Another challenge that is worth discussing is to develop a "safe" campus. That should include technologies for protecting IP protocols, students, data, and the campus as well as securing research funding and resources. The digital campus should comprise a physical security platform for campus surveillance, access control, and unified communication systems. The digital campus ensures better cost control and higher campus safety and security.

5. Conclusion

In conclusion, it can be pointed out that digitization is a prerequisite for the realization of the necessary transformation in many methods of education and training. The application of modern technologies and digitization are both the method and the instrument of this transformation. Therefore, digitization influences the educational process in the field of security and defense and its participants, too - learners, trainers, consumers and others. It will also facilitate the development of their competencies. It is necessary to summarize that modern education institutions should alter not only the way they present the knowledge and information but also its content, first because the contemporary security environment has dramatically changed and second, because the world is getting hyper connected in the era of "Industry 4.0".

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Some Estimates Bellow the Modulus of Some Integrals in the Complex Plane Using Symmetric Polynomials for n=7

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Abstract. In this paper, we make some estimates bellow the modulus of some integrals in the complex plane. Here we apply essentially some symmetric polynomials.

Keywords. Modulus, Integral, Complex plane, Increasing function, Decreasing function, Homogeneous polynomials, Symmetric polynomials.

1. Introduction

The lemmas and the theorem, which are presented here, related to the inequalities

$$\left|\int_0^{e^{i\varphi}} \prod_{k=1}^{n} (x+a_k)dx\right| \geq \frac{1}{n+1},$$

for arbitrary natural n, where, $\varphi \in \left[0, \frac{\pi}{2}\right]$, $0 \leq a_1 \leq a_2 \leq ... \leq a_n$, $n \in N$.

The results related with this conjecture we observe in Theorem1, Theorem2 and Theorem3.

We can see the results of Theorem1 in [8], [9], and [11]. Such ones of Theorem2 and Theorem3 could be seen in [10].

For the proof of Theorem4, we use essentially symmetric polynomials and two lemmas related with them.

Many authors use some modulus of some integrals in the complex plane for various estimates in their works. For example we can see how Bojanov and Rahman in [13] use this method. These estimates are explored for the localization of the zeros of some polynomials.

These results could be applied to many areas of mathematics. Especially in the complex analysis and algebra: In these areas of mathematics, inequalities of integrals are very important part. For example, we could be applied to these results for some localization of the zeros of some entire functions or some polynomials, like [1-4]. These results could be applied to many polynomial surfaces like [5-7]. The results are useful in the (open) problems of [14-17].

2. Preliminaries

Definition 1: If $m, k, n \in N$, $a_k \in R$, $a_k \geq 0$, $k = \overline{1,n}$, we put

$$\sigma_m = \sum_{1 \leq k_1 < k_2 < ... < k_m \leq n} a_{k_1} a_{k_2} ... a_{k_m}$$

Definition 2: Let $n \in N$, $a_k \in R$, $a_k > 0$, $k = \overline{1,n}$. Let $f = \sum_{k=1}^{i} a_k g_k$, where g_k are symmetric homogeneous polynomials: $g_k = \sum a_{i_1}^2 a_{i_2}^2 ... a_{i_s}^2 a_{j_1} a_{j_2} ... a_{j_m}$, $s, m \in N$, $2s + m \le n$.

Here $\{a_{i_1}, a_{i_2}, ..., a_{i_s}, a_{j_1}, a_{j_2}, ..., a_{j_m}\}$ is a combination from set $G = \{a_1, a_2, ..., a_n\}$.

If we note the number of terms in g_k with $|g_k|$, then we will note with $n(f) = \sum_{k=1}^{i} a_k |g_k|$.

Definition 3: Let all conditions of Definition2 are satisfied. We will consider some polynomial $h(a_1, a_2, ..., a_n)$. Then we will note the index of f relevant to h with $i(f)$, and this will mean $i(f) = \sum_{k=1}^{i} a_k |g_k|_h$, where $|g_k|_h$ is the number of terms of h which belong to g_k.

3. Related results

The development of tools to enhance corporate sustainability remains an important

Theorem 1. *Let* $k = 1,2,...,n$, $n \in N$, $a_k, \varphi \in R$, $a_k \in [0,1]$, $\varphi \in \left[0, \frac{\pi}{2}\right]$. *Then the function* $\left| \int_0^{e^{i\varphi}} x \prod_{k=1}^{n} (x + a_k) dx \right| \ge \frac{1}{n+2}$, for $n = 1,2,3$.

Theorem 2. *Let* $k \in N$, $a \in R$, $a \ge 0$. *The function* $\left| \int_0^{e^{i\varphi}} (x + a_k) dx \right| \ge \frac{1}{k+1}$, where $\varphi \in \left[0, \frac{\pi}{2}\right]$

Theorem 3. *Let* $k \in N$, $a \in R$, $a \in [0,1]$. *Then the function* $\left| \int_0^{i} x(x + a_k)^k dx \right| \ge \frac{1}{k+2}$.

4. Main Results

Lemma 1: Let $m, k, n \in N$, $a_i \in R$, $a_i > 0$, $l = \overline{1,n}$. *Let,* $S = \frac{(m+1)(m+2)}{k(n-k-m)}$, *where* $2k + m \le n$. *Let* g *and* h *are symmetric homogeneous polynomials:*

$$g = \sum a_{i_1}^2 a_{i_2}^2 ... a_{i_k}^2 a_{j_1} a_{j_2} ... a_{j_m}$$

$$h = \sum a_{i_1}^2 a_{i_2}^2 ... a_{i_{k-1}}^2 a_{j_1} a_{j_2} ... a_{j_m+2}$$

where $\{a_{i_1}, a_{i_2},..., a_{i_k}, a_{j_1}, a_{j_2},..., a_{j_m}\}$ *and* $\{a_{i_1}, a_{i_2},..., a_{i_{k-1}}, a_{j_1}, a_{j_2},..., a_{j_{m+2}}\}$ *are some combinations from the set* $G = \{a_1, a_2,..., a_n\}$. *Then* $|g| \geq S.|h|$.

Proof: The number of terms of g and h are respectively $\binom{n}{k}\binom{n-k}{k}$ and $\binom{n}{k-1}\binom{n-k+1}{m+2}$.

Therefore $\dfrac{\binom{n}{k}\binom{n-k}{k}}{\binom{n}{k-1}\binom{n-k+1}{m+2}} = \dfrac{(m+1)(m+2)}{k(n-k-m)} = S$

Theorem 4. Let $a_k \in (0,1)$, $k = \overline{1,7}$. Then $\left|\int_0^i \prod_{k=1}^{7}(x+a_k)dx\right| \geq \frac{1}{8}$.

Proof: Let us σ_k, $k = 1,2,...,n$ are elementary symmetric polynomials(definition 1):

$$\sigma_0 = 1$$
$$\sigma_1 = a_1 + a_2 + ... + a_n$$
$$\sigma_2 = a_1a_2 + a_1a_3 + ...$$
$$...$$
$$\sigma_{n-1} = a_1a_2...a_{n-1}$$
$$\sigma_n = a_1a_2...a_n$$

Then we have

$$A = (n+1)\int_0^{e^{i\varphi}} \prod_{k=1}^{n}(x+a_k)dx = (n+1)\int_0^{e^{i\varphi}} \left(x^n + \sum_{k=1}^{n}\sigma_k x^{n-k}\right)dx =$$

$$= \left(x^{n+1} + \sum_{k=1}^{n}\frac{n+1}{n+1-k}\sigma_k x^{n+1-k}\right)\Bigg|_0^{e^{i\varphi}} =$$

$$= e^{i(n+1)\varphi} + \sum_{k=1}^{n}\frac{n+1}{n+1-k}\sigma_k e^{i(n+1-k)\varphi} =$$

$$= e^{i\varphi}\left(e^{in\varphi} + \sum_{k=1}^{n}\frac{n+1}{n+1-k}\sigma_k e^{i(n-k)\varphi}\right)$$

Then we obtain

$$|A|^2 = A\overline{A} = \left(e^{in\varphi} + \sum_{k=1}^{n}\frac{n+1}{n+1-k}\sigma_k e^{i(n-k)\varphi}\right)\left(e^{-in\varphi} + \sum_{k=1}^{n}\frac{n+1}{n+1-k}\sigma_k e^{-i(n-k)\varphi}\right) =$$

$$= 1 + \sum_{k=1}^{n} \sigma_k \sigma_{n+1-k} \frac{(n+1)^2}{k(n+1-k)} \cos(n+1-2k)\varphi .$$

If we put $\varphi = \frac{\pi}{2}$, $n = 7$, i.e. $e^{i\varphi} = i$ we obtain

$$|A|^2 = A\overline{A} = 64\left(\sum_{k=0}^{7} \frac{e^{k\varphi i}}{1+k} \sigma_{7-k} \right)\left(\sum_{k=0}^{7} \frac{e^{-k\varphi i}}{1+k} \sigma_{7-k} \right) =$$

$$= 64\left(\sum_{k=0}^{7} \frac{i^k \sigma_{7-k}}{k+1} \right)\left(\sum_{k=0}^{7} \frac{i^k \sigma_{7-k}}{k+1} \right) = \sum_{k=0}^{7} T_k ,$$

where

$$T_8 = 64\sigma_7^2 ,$$

$$T_7 = 64\left[\frac{\sigma_6^2}{4} - \frac{2}{3}\sigma_5\sigma_7 \right],$$

$$T_6 = 64\left[\frac{\sigma_5^2}{9} - \frac{1}{4}\sigma_4\sigma_6 + \frac{2}{5}\sigma_3\sigma_7 \right],$$

$$T_5 = 64\left[\frac{\sigma_4^2}{16} - \frac{2}{15}\sigma_3\sigma_5 + \frac{1}{6}\sigma_2\sigma_6 - \frac{2}{7}\sigma_1\sigma_7 \right],$$

$$T_4 = 64\left[\frac{\sigma_3^2}{16} - \frac{1}{12}\sigma_2\sigma_4 + \frac{2}{21}\sigma_1\sigma_5 - \frac{1}{8}\sigma_6 \right],$$

$$T_3 = 64\left[\frac{\sigma_2^2}{36} - \frac{2}{35}\sigma_1\sigma_3 + \frac{1}{24}\sigma_4 \right],$$

$$T_2 = 64\left[\frac{\sigma_1^2}{49} - \frac{1}{24}\sigma_2 \right],$$

$$T_1 = 1 .$$

Let us calculate

$$B = (k+1)\int_0^t \left(x + e^{i\varphi}\right)dx = t^{k+1} + \frac{k+1}{k} te^{ki\varphi} + \ldots + \frac{t^2 e^{(k-1)\varphi i}}{2} + te^{k\varphi i}$$

$$B\overline{B} = x + e^{i\varphi}\Big|_0^t \left(x + e^{-i\varphi}\right)^{k+1}\Big|_0^t =$$

$$= \left[\left(t + e^{i\varphi}\right)^{k+1} - e^{i\varphi(k+1)} \right]\left[\left(t + e^{-i\varphi}\right)^{k+1} - e^{-i\varphi(k+1)} \right] =$$

$$= \left(t^2 + 2\cos\varphi t + 1\right)^{k+1} - \left[\left(t + e^{i\varphi}\right)^{k+1} e^{i\varphi(k+1)} + \left(t + e^{-i\varphi}\right)^{k+1} e^{-i\varphi(k+1)}\right] =$$

$$= \left(t^2 + 2\cos\varphi t + 1\right)^{k+1} - \left[\left(t + e^{i\varphi}\right)^{k+1} e^{-i\varphi(k+1)} + \left(t + e^{-i\varphi}\right)^{k+1} e^{i\varphi(k+1)}\right],$$

where k belongs to N. (*)

If we put $k = 7$, $\varphi = \frac{\pi}{2}$ we get

$|B|^2 = \left(t^2 + 1\right)^8 - \left[(t+i)^8 + (t-i)^8\right] = p(t) - q(t)$, where

$$p(t) = \left(t^2 + 1\right)^8 = t^{16} + 8t^{14} + \binom{8}{2}t^{12} + \binom{8}{3}t^{10} + \binom{8}{4}t^8 + \binom{8}{5}t^6 + \binom{8}{6}t^4 + \binom{8}{7}t^2 + 1$$

$$q(t) = (t+i)^8 + (t-i)^8 = 2t^8 - 2\binom{8}{2}t^6 + 2\binom{8}{4}t^4 - 2\binom{8}{6}t^2 + 2\binom{8}{8}$$

If we note the sum of coefficients of $p(t)$ whit $Sump(t) = \sum_0^8 \binom{8}{k}$, and respectively

$Sumq(t) = 2\sum_0^4 \binom{8}{2k}(-1)^k$.

But $\sum_0^8 \binom{8}{k} - 2\sum_0^4 \binom{8}{2k}(-1)^k \geq \sum_0^8 \binom{8}{k} - 2\sum_0^4 \binom{8}{2k} =$

$$= \sum_0^8 \binom{8}{k}(-1)^k = 0 \qquad (**).$$

The polynomials $h_k = \sum a_1^{\,2} a_2^{\,2} \ldots a_k^{\,2} a_{k+1} a_{k+2} \ldots a_s$ (where $2k + s = l$), which consist to T_l we will count by the coefficients of the t^m in the polynomial $p(t) - q(t)$. Therefore it is obvious the next

Lemma 2: $h_0 \supset h_1 \supset h_2 \supset \ldots \supset h_k$, and besides $h_k \geq 0$, where k belongs to N.

Since $a_k \in (0,1)$, $k = \overline{1,7}$, and according to (*) T_1, T_2, T_3, T_4 are positive, we have $T_1 / n(T_1) \geq T_2 / n(T_2) \geq T_3 / n(T_3) \geq T_4 / n(T_4)$.

If all others coefficients are negative we will obtain that

$$T_1 + T_2 + T_3 + T_4 + T_5 + T_6 + T_7 \geq \left(\sum_0^8 \binom{8}{k} - 2\sum_0^4 \binom{8}{2k}\right)p + 1 = 1,$$

according to (*) and (**). Here we have put $p = T_4 / n(T_4)$. This confirms the assertion.

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An Application of Some Analytic Techniques for Solving of Nonlinear Differential Equations

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Abstract: Finding a nonlinear differential equations' analytic solution in rare cases can be obtained mostly by the help of some special functions. The existing of a small parameter in the equations help us to find the solutions in the form of series by the powers of the small parameter known as asymptotic series. In this paper we consider some modeling problems which clearly show the significant use of the asymptotics' methods.

Keywords: nonlinear differential equations, asymptotic methods, dynamic systems

1. Introduction

The description of a specific process is usually achieved by using of some mathematical techniques. The most common approach is the mechanism of the differential equations' systems. It is known that for given initial conditions the problem that we have to solve has only one solution that is guaranteed by the Cauchy's problem. Finding an analytic solution for nonlinear equations and systems is a difficult task. Sometimes it is good if we can bring the solution to some special functions (see [3] and [4]).

Another approach suggested by Poincare is the method of using the asymptotic series. These series are not convergent in the common case but in given boundaries when time is changing they give an adequate description of the given processes, see [3].

In this paper we consider some analytic solutions of two dynamic systems. In the first example we consider a dissipative system which is under a coulter friction. In the second one we consider a conservative system which is described by two nonlinear differential equations. The solutions' methods are chosen in a way that they can clearly and shortly reach the solution with the accuracy we need.

2. An application of the harmonious balance's method used for the analytic solution of a differential equation with a cubic nonlinearity under the action of the coulter friction

Example 1:

In general, we have to find a solution of the following Cauchy's problem for the nonlinear differential equation of second order:

$$\ddot{q} + \omega_0{}^2 q + \varepsilon \omega_0{}^2 q^3 - \alpha = 0 , \tag{1}$$

with initial conditions:

$$q(0) = A,$$
$$\dot{q}(0) = 0,$$

where $\alpha, \omega_0 \in R$, $|\varepsilon| << 1$ and ε is a small parameter.

Taking into account the Cauchy's problem's initial conditions it can be figured that it is appropriate to search the solution to third harmonica in the form [3, 5]:

$$q = C_1 \cos(\omega t + \delta) + \varepsilon C_2 \cos(2\omega t + 2\delta) + \varepsilon C_3 \cos(3\omega t + 3\delta) + \gamma, \quad (2)$$

For the equation (2) we find the first and second derivative in time and substitute the obtained expressions in equation (1). After that the equation (1) gets the form:

$$\left[C_1\left(-\omega^2 + {\omega_0}^2\right) + \varepsilon \frac{3}{4} {\omega_0}^2 {C_1}^3 + \varepsilon 3 {\omega_0}^2 \gamma^2 C_1 \right] \cos(\omega t + \delta) +$$
$$+ \left[\varepsilon C_2 \left(-4\omega^2 + {\omega_0}^2\right) + \varepsilon \frac{3}{2} {\omega_0}^2 \gamma {C_1}^2 \right] \cos(2\omega t + 2\delta) +$$
$$+ \left[\varepsilon C_3 \left(-9\omega^2 + {\omega_0}^2\right) + \varepsilon \frac{1}{4} {\omega_0}^2 {C_1}^3 \right] \cos(3\omega t + 3\delta) +$$
$$+ {\omega_0}^2 \gamma + \varepsilon \frac{3}{2} {\omega_0}^2 {C_1}^2 \gamma + \varepsilon {\omega_0}^2 \gamma^3 - \alpha = 0 \quad (3)$$

To be fulfilled the equality (3) is necessary that the coefficients before each of the trigonometric functions and the free coefficients to be equal to zero. We start the solution of the obtained expressions by starting from the free coefficient:

$$\omega_0^2 \gamma + \varepsilon \frac{3}{2} {\omega_0}^2 {C_1}^2 \gamma + \varepsilon {\omega_0}^2 \gamma^3 - \alpha = 0. \quad (4)$$

Let the small parameter be zero. Then we obtain a zero approximation of the coefficient γ.

$$\gamma_0 = \frac{\alpha}{\omega_0}. \quad (5)$$

We search the first approximation in the form:

$$\gamma = \frac{\alpha}{{\omega_0}^2} + \varepsilon \gamma'.$$

Substituting in equation (4) finally, we obtain:

$$\gamma = \frac{\alpha}{{\omega_0}^2} - \varepsilon \left(\frac{3\alpha}{2{\omega_0}^2} {C_1}^2 + \frac{\alpha^3}{{\omega_0}^6} \right). \quad (6)$$

Finally, we can find the solution of the equation:

$$C_1\left(-\omega^2 + {\omega_0}^2\right) + \varepsilon \frac{3}{4} {\omega_0}^2 {C_1}^3 + \varepsilon 3 {\omega_0}^2 \gamma^2 C_1 = 0. \quad (7)$$

As we take the fact that the coefficient C_1 will be determined by the initial conditions then the equation **(7)** gives us the connection between the frequency of oscillation and the amplitude:

$$\omega^2 = {\omega_0}^2 + \varepsilon \frac{3}{4} {\omega_0}^2 {C_1}^2 + \varepsilon 3 \frac{\alpha^2}{{\omega_0}^2} . \tag{8}$$

Let us consider the following equations:

$$C_2 \left(-4\omega^2 + {\omega_0}^2\right) + \frac{3}{2} {\omega_0}^2 \gamma {C_1}^2 = 0 \tag{9}$$

$$C_3 \left(-9\omega^2 + {\omega_0}^2\right) + \frac{1}{4} {\omega_0}^2 {C_1}^3 = 0 . \tag{10}$$

From the equation (9) we obtain an expression for the amplitude C_2:

$$C_2 = -\frac{3}{2} \frac{\alpha {\omega_0}^2 {C_1}^2}{\left(-4\omega^2 + {\omega_0}^2\right)}. \tag{11}$$

Similarly we solve the equation (10) from which we obtain an expression for the amplitude C_3:

$$C_2 = -\frac{1}{4} \frac{{\omega_0}^2 {C_1}^3}{\left(-9\omega^2 + {\omega_0}^2\right)}. \tag{12}$$

As we consider the problem's initial conditions:

$$q(0) = C_1 \cos(\delta) + \varepsilon C_2 \cos(2\delta) + \varepsilon C_3 \cos(3\delta) + \gamma = A , \tag{13}$$

$$q(0) = -\omega C_1 \sin(\delta) - \varepsilon \omega C_2 \sin(2\delta) - \varepsilon \omega C_3 \sin(3\delta) = 0 . \tag{14}$$

From the equation (14) we can conclude that $\delta = 0$.

$$C_1 + \frac{\alpha}{{\omega_0}^2} - \varepsilon \left[\frac{3}{2} \frac{\alpha {\omega_0}^2}{\left(-4\omega^2 + {\omega_0}^2\right)} + \frac{3\alpha}{2{\omega_0}^2} \right] {C_1}^2 - \varepsilon \frac{1}{4} \frac{{\omega_0}^2 {C_1}^3}{\left(-9\omega^2 + {\omega_0}^2\right)} - \varepsilon \frac{\alpha^3}{{\omega_0}^6} = A . \tag{15}$$

Finally, for the solution we obtain the following:

$$q=\left\{A-\frac{\alpha}{\omega_0^{\,2}}+\varepsilon\left[\frac{3}{2}\frac{\alpha\omega_0^{\,2}}{\left(-4\omega^2+\omega_0^{\,2}\right)}+\frac{3\alpha}{2\omega_0^{\,2}}\right]\left(A-\frac{\alpha}{\omega_0^{\,2}}\right)^2+\varepsilon\frac{1}{4}\frac{\omega_0^{\,2}\left(A-\frac{\alpha}{\omega_0^{\,2}}\right)^3}{\left(-9\omega^2+\omega_0^{\,2}\right)}+\varepsilon\frac{\alpha^3}{\omega_0^{\,6}}\right\}\cos(\omega t)-$$

$$-\varepsilon\frac{3}{2}\frac{\alpha\omega_0^{\,2}\left(A-\frac{\alpha}{\omega_0^{\,2}}\right)^2}{\left(-4\omega^2+\omega_0^{\,2}\right)}\cos(2\omega t)-\varepsilon\frac{1}{4}\frac{\omega_0^{\,2}\left(A-\frac{\alpha}{\omega_0^{\,2}}\right)^3}{\left(-9\omega^2+\omega_0^{\,2}\right)}\cos(3\omega t)+\frac{\alpha}{\omega_0^{\,2}}-\varepsilon\frac{3\alpha}{2\omega_0^{\,2}}\left(A-\frac{\alpha}{\omega_0^{\,2}}\right)^2-\varepsilon\frac{\alpha^3}{\omega_0^{\,6}} \tag{16}$$

where

$$\omega=\omega_0\sqrt{1+\varepsilon\left[\frac{3}{4}\left(A-\frac{\alpha}{\omega_0^{\,2}}\right)^2+3\frac{\alpha^2}{\omega_0^{\,4}}\right]}.$$

The solution of the equation (16) has an accuracy to the first degree of the small parameter and it depends entirely from the initial conditions. For finding a correct solution we suppose that the denominators in the expression are not equal to zero for the given values of the parameters and the initial conditions.

3. A conservative system of two differential equations of second order with a nonlinear member which is existing in the one of the given equations

Example 2:

Let us consider an ordinary differential equations' system with the following constant coefficients:

$$w_1^2, w_2^2, \alpha_1^2, \alpha_2^2, \varepsilon \quad \text{and} \quad |\varepsilon| << 1.$$

We also consider that $n \in \mathbf{R}$ and that the system has the following form:

$$\begin{cases}\ddot{x}+w_1^2x+\varepsilon\alpha_1^2y^n=0\\ \ddot{y}+w_2^2y+\alpha_2^2x=0\end{cases} \tag{17}$$

The initial conditions for this system are:

$$\begin{cases}x(0)=A_0\\ y(0)=B_0\end{cases} \tag{18}$$

and

$$\begin{cases}\dot{x}(0)=0\\ \dot{y}(0)=0\end{cases}.$$

We search the solution of (17) in first approximation of the form [3]:

$$\begin{aligned}x_1&=a_1.\cos\Omega t+\varepsilon.\xi\\ y_1&=b_1.\cos\Omega t+\varepsilon.\eta\end{aligned}. \tag{19}$$

Taking into account the initial conditions then the formulas (19) get the form:

$$\begin{aligned} x_1 &= [A_0 - \varepsilon.\xi(0)].\cos\Omega t + \varepsilon.\xi \\ y_1 &= [B_0 - \varepsilon.\eta(0)].\cos\Omega t + \varepsilon.\eta \end{aligned}, \tag{20}$$

where

$$\begin{aligned} \dot{\xi}(0) &= 0 \\ \dot{\eta}(0) &= 0 \end{aligned}.$$

As we take $\varepsilon = 0$ then for A_0 and B_0 we can say that they satisfy the nonlinear algebraic system:

$$\begin{vmatrix} (w_1^2 - \Omega^2).[A_0 - \varepsilon.\xi(0)] = 0 \\ \alpha_2^2.[A_0 - \varepsilon.\xi(0)] + (w_2^2 - \Omega^2).[B_0 - \varepsilon.\eta(0)] = 0 \end{vmatrix}. \tag{21}$$

From (21) it follows that:

$w_1^2 = \Omega^2$, and $[B_0 - \varepsilon.\eta(0)] = -\alpha_2^2.\dfrac{[A_0 - \varepsilon.\xi(0)]}{w_2^2 - w_1^2}$

which means that the periodic solution we have found doesn't give the chance to choose the initial conditions independently.

Without interfering the community of the consideration we take that $\xi(0) = \eta(0) = 0$. Then for the equations which describe the movement in first approximation we get the following system:

$$\begin{vmatrix} \ddot{\xi} + w_1^2.\xi = -\alpha_1^2.B_0^n(\cos w_1 t)^n \\ \ddot{\eta} + w_2^2.\eta = -\alpha_2^2.\xi \end{vmatrix}. \tag{22}$$

Let $n = 2$.

Then the first equation from system (22) is transformed to the following equation:

$$\ddot{\xi} + w_1^2.\xi = -\frac{\alpha_1^2.B_0^2}{2} - \frac{\alpha_1^2.B_0^2}{2}.\cos(2w_1 t). \tag{23}$$

We search the solution of equation (23) in the form

$$\xi = a.\cos(2w_1 t) - \frac{\alpha_1^2.B_0^2}{2w_1^2}.$$

After substituting in (23) we obtain that

$$a = \frac{\alpha_1^2.B_0^2}{6w_1^2}.$$

We solve the second equation from system (22) and obtain:

$$\ddot{\eta} + w_2^2.\eta = -\frac{\alpha_1^2.\alpha_2^2.B_0^2}{6w_1^2}.\cos(2w_1 t) + \frac{\alpha_1^2.\alpha_2^2.B_0^2}{2w_1^2}. \tag{24}$$

We search the solution of equation (24) in the form:

$$\eta = b.\cos(2w_1 t) + \alpha.\frac{B_0^2.\alpha_1^2}{2w_1^2.w_2^2}$$

and find the coefficient b in the form:

$$b = \frac{\alpha_1^2.\alpha_2^2.B_0^2}{6w_1^2.(4w_1^2 - w_2^2)}.$$

Finally for the solutions we obtain:

$$x_1 = \left(A_0 + \varepsilon.\frac{\alpha_1^2.B_0^2}{3w_1^2}\right).\cos(w_1 t) + \varepsilon.\frac{\alpha_1^2.B_0^2}{6w_1^2}.\cos(2w_1 t) - \varepsilon.\frac{\alpha_1^2.B_0^2}{2w_1^2}$$

$$y_1 = B_0^0.\cos(w_1 t) + \varepsilon.\frac{\alpha_1^2.\alpha_2^2.B_0^2}{6w_1^2}.\cos(2w_1 t) + \varepsilon.\frac{\alpha_1^2.\alpha_2^2.B_0^2}{2w_1^2.w_2^2}$$

where

$$B_0^0 = B_0 - \varepsilon.\frac{\alpha_1^2.\alpha_2^2.B_0^2}{6w_1^2.(4w_1^2 - w_2^2)} - \varepsilon.\frac{\alpha_1^2.\alpha_2^2.B_0^2}{2w_1^2.w_2^2}.$$

4. Conclusion

The examples, which we considered in this paper, demonstrate the possibilities of approaching a solution for nonlinear differential equations. In many of the cases the numeric solution although it can be found easily than the analytic one doesn't give an information about the system's behavior in nonlocal aspect.

Of course, the using of the small parameter's method sometimes has some disadvantages. The main disadvantage of this method is that it can't describe adequately the transition processes. In this paper, we choose examples, which don't assume such type of system's behavior.

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Microeconomic Nature of the E-commerce Market

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Abstract: The main objective of this scientific report is to study and analyze the e-commerce market and to draw its microeconomic characteristics. Special emphasis is placed on the similarities of the e-commerce market with the structure of the classical market. The research interest is focused on the studying the functioning of the e-commerce market and the ways for achieving market equilibrium. Depending on the quantitative ratio of demand and supply as the main market forces driving the market mechanism, the necessary conditions that enable the e-commerce market to use resources rationally and generate economic efficiency, are brought out.

Keywords: E-commerce market, Demand, supply, Microeconomic market equilibrium.

1. Introduction

For decades, people have used different electronic means to do business deals. Financial institutions have used telecards, and in recent years also Electronic Funds Transfer (EFT) in order to improve their operations. Businesses introduce electronic networks to make sure their processes work efficiently and use POS devices for retail or electronic data interchange in production and marketing. In turn, consumers use electronic means of contact with their banks, such as an Automated Teller Machine (ATM).

With the distribution and use of computers with Internet access, the Internet connection provides new means of conducting an online business, namely e-commerce. This means that e-commerce is not only effective with its timely and accurate operations, but is also available to anyone who engages in the sale and or buying of business by individual users. E-commerce represents an effective way to speed up business operations and for others - it is the basis for a new industry [1].

The term e-commerce is used to designate online shopping, especially on the World Wide Web. Other researchers use the term e-business (or e-business) to include a range of business activities other than online shopping [2]. In this report these two terms are used interchangeably. The main purpose of the report is to examine the market structure and the functioning of e-commerce from a microeconomic point of view. Microeconomic theory argues that a balance in the e-commerce market can be achieved if supply and demand converge to a level that maximizes both company revenue and consumer utility. Consequently, convergence will ensure an efficient allocation of economic resources, which is a prerequisite for achieving aloof efficiency.

2. The market structure as main category in the classical microeconomics

Classical microeconomic theory links the structure of the market with all the characteristics that can influence behaviour and efficiency of firms operating in one country and forming its own industry. Market competitiveness shows the degree of individuality of the

firm and its ability to influence the market price or the conditions under which its product is sold [3]. Typical of a perfectly competitive market is the presence of many companies with a small market share that prevents an individual company from having dominant market behaviour and sets out the rules and conditions under which other competitors will develop. Consequently, each company accepts the price determined by the forces of market demand and market supply, therefore, firm accepts the price as the market demands.

Ceteris paribus, the demand for a good in terms of perfectly competitive market depends on the different quantities that consumers buy on the market. The amount used by consumers is influenced by factors such as the price of the good, tastes and preferences of consumers, the number of consumers in the relevant market, consumer incomes, the prices of related goods - the nomenclature and the assortment of complementary and substitute commodities [4]. In general, the quantity sought of product is inversely proportional to its price. In this line of thought, if the price of the main good is increased, it can stimulate consumers to switch to consumption of substitute goods. Therefore, increasing the consumption of a product may lead to an increase in the consumption of additional products [5].

In the classical economic analysis, considering the demand curve of product, the demand elasticity of the price reflects the propensity of consumers to change the demand for a product under the influence of changes in its market price. If the quantity corresponds to the price changes, the price reduction can increase the total amount of money spent on the good. If the quantity is not accepted in response to price changes, lowering the price may reduce the total amount of money spent on the good.

The main factor influencing the elasticity of demand is the availability of commodity substitutes of the main commodity [6]. The availability of substitute products is the most important factor influencing the consumption of a good. The more substitute goods a product has, the product is more elastic. In this case, cross-demand elasticity is used to measure the extent to which different goods are interconnected. When the goods are substitutes, the cross-elasticity between them is positive. Increasing the cost of one commodity will increase the consumption of others, and the demand will be redirected to the substitute. When the goods are complementary, the cross-elasticity is negative. Increasing the cost of a good will reduce its consumption and will positively affect the consumption of additional products.

Supply is a market process that relates to the maximum quantity per unit of time that companies will put on sale at different prices. In principle, the higher price will cause companies to put more products on the market and attract new companies in the industry. Classical microeconomics differentiates the demand curve according to the type of market competition that creates the conditions under which the company operates. The market classification is based on the importance of individual companies for the whole market in which they sell and whether the products sold on this market are homogeneous or heterogeneous. Depending on the above-mentioned indicators and a number of others defined by microeconomic theory, there are four types of markets - pure perfect competition, pure monopoly, oligopoly and monopolistic competition.

E-commerce research can be viewed from different perspectives [7]. From the point of view of communication, e-commerce is the supply of information products and services and their payment over telephone lines, computer networks or other electronic means. From a business point of view, e-commerce is the application of technology to the automation of business and workflow. From a service point of view, e-commerce is a tool for reducing service costs, while improving the quality of goods and increasing service speeds and, ultimately, shortening the delivery times of products. From the point of view of the online market, e-

commerce provides the opportunity to buy and sell products and information on the Internet [8].

In this context, e-commerce can be considered as a process of buying, selling or exchanging products, services and information from various agents via a computer with an Internet connection. In e-commerce, the new market order has already been implemented. From the characteristics of the perfectly competitive market, many similarities in the structure of this new electronic market with those of the purely competitive market described in microeconomic theory can be recognized. Competition ensures that the supply and demand of a good or service interact in an effective manner. Competition requires the rules of the market game to be respected, which in turn would guarantee fairness for all market participants. Competition principles are in fact a condition that guarantees a fair development of the game market.

These rules basically prohibit two things: agreements and/or unfair practices between competitors that violate the perfect mechanism of market functioning (what the theory calls a collusion), as well as the abuse of market influence characteristic of monopolists and oligopolists (especially cartels agreements). The purpose of the bans is to ensure that the success or failure of the market participant depends exclusively on its ability to compete and compete on established market principles. The rules of market competition do not apply in the abstract. They always operate in those markets that are characterized by precise and clear boundaries. These established principles include the following conditions: who is competing with; what is the purpose of the competitive game; what product or service they are competing with, and in which geographic area companies are competing.

At present, the internet can be seen as a global-based communication system, World Wide Web. This system can be used in many ways and for many purposes by different people. From an economic point of view, it can be seen as a market that allows companies to compete, offer, sell, buy and (sometimes) distribute goods and services - in a different way [1]. These are concepts like e-commerce or e-business. In order to be able to ascertain whether fair and fair competition is taking place in markets based on or connected to the Internet, it is first necessary to determine the relevant product and geographic market. As more and more business operations move to the internet, an increasing number of separate markets will emerge in the new environment.

Using the Internet for doing business is not only a technological innovation that dramatically changes an industry's production parameters. Technological innovations are permanent in almost all economic sectors, including those that are developing at a rapid technological pace. Antitrust rules have been applied consistently over the last forty years in the field of high tech industries [9]. Based on recent years in which electronic markets have increased their size and generally accepted short-term expectations in this area, the following key features of the Internet-based markets can be identified:

- The Internet can transform market functions.
- The Internet reproduces traditional markets.
- The Internet is a cheap production factor available to all industries.
- Investor uncertainty is constant in Internet markets.
- Competition in Internet markets leads to concentration of resources.
- Internet-based products use (or suffer) network effects.
- Internet markets require common protocols and standards across the industry.

The essence of the information system that builds the internet leads to ever greater transparency about the opportunities for buying and selling remote locations. This feature - the achievement of almost perfect transparency conditions can in itself upset traditional markets. Moreover, these characteristics are the basis of services for which demand and supply do not

exist if an Internet connection is not available [4]. When it comes to consumer choice, end-users are always taken into account, but the Internet also provides consumers with opportunities at intermediate market levels. From an economic point of view, it can be assumed that the internet can lead to shifting demand functions and changing the elasticity of these functions. Of course, this assumption must be proven and measured across sectors. But it is quite easy to conclude that the Internet has real opportunities through which it can influence consumer behaviour. Perhaps one of the more remarkable features the internet creates is the existence of dual markets (the Internet-based (virtual) market and the traditional market), that is, two parallel markets for trade in the same goods or services that exist simultaneously in the same space and at the same time [10].

In order to be able to apply clear competition rules, it is necessary to define the relevant markets. Here comes the following interesting question: to what extent can the Internet market be considered as a relevant market in itself or as a separate market segment from the traditional one. The position of the European Commission, reflected in a number of recent decisions, allows to make a very important clarification, which is in fact a precise answer to the above question, namely: the internet leads to the creation of two segments, physically and online, belonging to the same market. Even when it can be clearly established that the two segments belong to the same market, what is seen in many cases is that the use of the Internet allows direct contact between the manufacturer and the consumer, making it unnecessary the intermediaries.

3. Elements of the e-commerce market

E-commerce infrastructure is network communication via computer processing on the Internet. In this network, users can receive and process information that is stored in remote devices and locations. In addition, they can communicate with other users on their personal computers. Information technologies used in e-commerce help to reduce consumer costs associated with operations such as product demand, suppliers, and comparison of competitive offers. This helps to effectively combine consumer preferences and vendor offer [11]. E-commerce makes business operations more effective as it maximizes the users utility and thus reduces market failures.

E-commerce information technologies provide timely and comprehensive information to the consumer in order to reduce uncertainty in the choice of products and suppliers. In addition, they also provide information about the substitute, as well as the ability to customize the product according to the specific needs of the user and therefore lower cost and greater utility. Effective, free and full flow of information in e-commerce provides consumers and suppliers with greater value for the product. This helps the market mechanism become more effective as it reduces opportunistic behaviour in making deals [3].

4. Competitive Market Mechanism and E-Market

In many ways, e-commerce facilitates the realization of classical assumptions about a perfectly competitive market. Competition in the e-commerce market has the following characteristics:

- In e-commerce, the size of the companies is not significant, which does not create a competitive advantage.
- Easy access to a profitable industry and efficient communication channels on the Internet allow new small entrants to compete effectively with larger companies for market share, branding and image building.

- Geographic and linguistic barriers have been removed from business as well as business-to-consumer transactions.
- The cost of supplying the digitized product is significantly reduced.
- Online orders facilitate the route to remote production sites.
- The need for a physical location is removed. In this way, goods do not require physical delivery from the store to the customer's home. This reduces the cost of storing and packaging traditional distribution channels.
- E-commerce offers consumers the convenience of shopping at home. Consumers choose from many substituent products.
- E-commerce provides lower cost for searching information that is needed to compare different products and sellers.
- Through the development of complex search engines, users can easily compare the prices of many products and in most cases have the opportunity to calculate the price of their orders.

Apart from the above-mentioned features of the e-market, it is necessary to mention that there are different online methods of buying and selling. For example, online auctions are a popular online selling method. Under this method, a minimum price can be set for users to demand and product value to offer an increase in the price to reach the fair price. With the increasing use of the Internet, the final transaction price is lower than without an online transaction [12].

E-commerce creates new distribution channels through direct contact, rich information and two-way communication with users. The Internet provides an opportunity for active consumer communication instead of one-way dialogue between vendor and customers. In this message, the information no longer exists as filtered by vendors [2]. Product promotion will be through targeted, interactive marketing and advertising, unlike the traditional display in the store.

Customer service plays an important role in competition in e-commerce. Customer service includes personalization, personal differentiation, apart from traditional after-sales services. Improving customer service is of paramount importance to businesses. In this way, customers can find related information about goods and services from the internet and point out their need for online support [13]. Therefore, in order to be successful, the strategy of the companies must be a mass personalization. This personalization provides a competitive advantage as well as an increase in overall demand for goods and services.

With the features mentioned above in the report, e-commerce can build a cost-effective marketplace and create conditions that are typical of classical, perfect competition. In perfectly competitive market the product is produced when the willingness of the consumer to pay is equal to the marginal cost of its production and neither individual sellers nor buyers can influence market demand or supply. Competitive behaviour in an e-commerce environment forces the company to change, from monopoly competition to oligopoly. Ultimately, this creates the conditions for an efficient market by combining supply and demand at a level that maximizes both consumer and company profits.

5. Conclusion

The Internet is not just a modern marketing channel or other advertising medium or a means to speed up business operations. The creation of e-commerce also creates a basis for a new industrial order. E-commerce is not only a technology to effectively facilitate business but also an effective way to conduct a business that has a potential impact on the value chain of the company. However, if e-commerce is not properly implemented and aligned with the

company's overall business strategy, it will probably fail. New business models are needed to integrate the essence and specificities of e-commerce with a common business goal. Only then can it be said that e-commerce will benefit both consumers and manufacturers at once and will maximize company revenue and consumer benefits.

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Comparative Analysis of Electric Sphygmomanometers of Different Design

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Abstract: The wide nomenclature of semi-automatic electric devices for Blood Pressure (BP) measurement is supplied by large, middle and small producers of electric apparatus. They all are based on application of the Korotkoff's method of measurement the BP. The choice of some electric sphygmomanometer often is intuitive so the comparative characteristics of similar sphygmomanometers would clarify the information about their quality of measurement. The electric sphygmomanometer for upper arm is the best recommended choice but its estimation in parallel to the same electric sphygmomanometers for the wrist represents some research interest. The research aims every one studied electric sphygmomanometer would be assessed by statistic parameters of the random values about systolic BP, diastolic BP, and pulse rate per minute. The preparation of the analysis consists of definition the statistic estimations, explanation of their content and recognition the compatibilities for different sphygmomanometers by characterization and comparison. The parameters of estimation are mean values, prices, coefficients of workability, discrete distributions, criterions on consent and comparative analysis would be a complex of considerations and ratiocinations.

Key words: Analysis, Electric sphygmomanometer, Computer, Statistics.

1. Introduction

The market of electric sphygmomanometers contains a number of their different designs, especially for upper arm – recommended by International Documents and for wrist – a cheap alternative. The previous individual studies [1] manifestoes high quality of the upper arm electric sphygmomanometers, those bear stable results about blood pressure (BP).

In parallel, some electric sphygmomanometers for wrist are suggested on the market characterized by low prices. However, other wrist electric sphygmomanometers have a price comparable to the price of electric sphygmomanometer for upper arm. This variety can be explained by practice of exploration.

The International Protocol [2] describes the electric sphygmomanometers for wrist in a way of low importance, as follows: "There is little literature regarding the accuracy of devices for wrist measurement, and most studies have shown these devices to be inaccurate" – with citation of the paper "Blood Pressure Measuring Devices: Validated Instruments", BMJ 2001; 322: 531 – 536 and authors O'Brien E., Waeber B., Parati G., Staessen G., Myers M.G., on behalf of the European Society of Hypertension Working Group on Blood Pressure Monitoring.

It continues: "Measurement of blood pressure at the wrist using oscilometric devices generally overestimate blood pressure compared with conventional sphygmomanometry on the upper arm, and the differences can be substantial [36 – 38]. It must, however, be emphasized that although a device designed for measuring the blood pressure at the wrist may

be accurate when tested the International Protocol it may be inaccurate for self measurement of blood pressure if the instructions to have wrist at heart level are not strictly followed."

Hence, individual examination of the electric sphygmomanometers for upper arm and for wrist could provide a representative estimation of the contemporary devices of different design.

Unlike the sphygmomanometers of the upper arm, the wrist devices had shown normal measurement processes, often finished by absence of results or with a message of error. They can be assessed by coefficient of workability, computed as relation of successful measurements to whole number of measurement the BP.

The condition about "wrist at heart level" can be completed, when the forearm of the seated body lays on the table ahead – a normal body position of BP-measurement, shown in [1].

The examination uses two designs of devices: for upper arm and for wrist.

The aim of the paper consists of quantitative statistic estimation of the systolic and diastolic BP and heart pulse rate per minute, discrete distributions in accordance to deviations of systolic and diastolic BP. The coefficients of workability, device prices, and criterions on consent are included in the complex of the comparative analysis of sphygmomanometers of different design.

2. Technology of Exploration

With use of a normal seated position of the body at BP-measurement hundreds measurements would be executed with each one electric sphygmomanometer. The results of measurements are developed by known statistic methods and mean values and discrete distributions would be completed. The common shape of the discrete distribution prompts the expectable shape of the base discrete distribution, built with concern of binomial distribution. The coefficients of workability play important role at the comparison. In the practice one only device is available and it can disappoint, when finishes measurement with error message. In parallel, the prices with corresponding quantitative parameters clarify important comparative results of the exploration.

The discrete distributions – analytic graphic characteristics about quality of results at definition the BP random value can be assessed by criterion on consent.

The "normal distribution" is an often met law of distribution of the random value in the practice. In parallel there are other distributions of similar shape. For example, in [4] the normal distribution random value with probability $p_x(\alpha)$, rated mathematic expectation μ_x, and mean squared deviation σ_x is presented by formula:

$$p_x(\alpha) = [1/(\sigma_x * \mathrm{sqrt}(2*\pi))] * [\exp(-(\alpha - \mu_x)^2/(2*\sigma_x^2))] \quad (1)$$

At a centered rated normal distribution ($\mu_x = 0$, $\sigma_x = 1$) the graphics has the form of a symmetric bell at range $\{-\infty - +\infty\}$ and surface equal to 1.

In parallel the Relay distribution with boundary **a** is described by similar formula:

$$p_x(\alpha) = \alpha/a * \exp(-\alpha^2/(2*a)),\ \alpha \geq 0 \quad (2)$$

and the distribution also has form of bell at doubled aggregate array. Thus, hypothetically the statistic distributions can have small differences in the mathematic reason and important differences in the reason of the form. Simultaneously, the known mathematic assessment with, for example, criterion on consent, would be applied.

From one side, the discrete distributions of BP random values are supposed similar to the continual normal distribution. On the other side, they need of some sample of a base

discrete distribution that connects the continual normal to discrete normal distribution. Thus several rules of estimation with wide reason can be formulated:

- If the discrete distribution has the form, which covers the base discrete distribution bell, then it is accepted to be discretely close to the normal distribution;
- If the discrete distribution has the form near to the base one, then it is accepted to be similar to the normal distribution;
- If the discrete distribution has the form of straight line parallel to the horizontal abscess axis, then it is accepted to be equally distributed;
- If the discrete distribution has inverted form of a concave curve, then it is accepted to be nontraditional distribution;
- If the discrete distribution represents line of random variety, then it is accepted to be wave distribution.

Sometimes, discrete distributions can be a combination of some sub distributions of simple form.

The base discrete distribution can reflect variety of considerations. The first one is conducted by the numerical property of size the random aggregate array: every one number can be symmetrically separated on sums of sub numbers. Such is the binomial distribution. On the other side, the sample of standard normal distribution at random small peace wise discretion, for example, its table integral [5], also reflect the discrete property of statistic distributions. The vertical layers of statistic distributions represent several ranges of distribution the probability of random value, the BP one in the current exploration.

At definition of a prior chosen number six limited and two unlimited vertical layers of a normalized or base distribution of the random value for each one of them a theoretical discrete boundary can be formulated. This separation is facilitated by the symmetrical bell shape of the base distribution.

Hence, for example, for the two central vertical (probability) layers the expected number of right issues must be (2/3)*(N/2), and for the each one of the middle probability layers it must be (1/3)*(N/2). The end probability layers usually contain the remainder of division. At the mathematic monographs those sums are developed for binomial distribution, and the sum of the defined here base distribution is accepted as “elementary symmetric function”, page 34 of [6].

Other base discrete distributions are also possible at other considerations (admissions and limitations), and the discrete bell shape of distribution can vary.

In parallel to the analytic and graphic interpretation of distribution of a random value, presented here by the author, a method of hypothesis also exists. The zero hypothesis H_0 ”the normal distribution is applicable to the empirical frequencies of a random value” is presented in [6] in the context of criterion on consent χ^2. It is analytic method applicable in the multi dimension statistics for assessment the normal or other similar distributions to distribution of a random value. It consists of computation the so called theoretical frequencies of the random value and comparison of them to the corresponding empirical frequencies. At minimal differences the random value is accepted to be normally distributed, but at high differences – randomly distributed. It requires computation of empirical relative frequencies of the random value, which define the probabilities at each one probability layer. Actually, with empirical frequencies a real array for graphical discrete distribution is available, but scientists recommend its analytic assessment. The consent can be measured by statistics as follows:

$$y = n^* \sum_k (h_k - p_k)^2 / p_k \qquad (3)$$

with probabilities of empirical – h_k and hypothetical – p_k frequencies.

3. Exploration with Electric Sphygmomanometers

Two electric devices for measurement of BP at upper arm and two – at wrist are included into scheme of explorations. Around 250 measurements of BP with each one sphygmomanometer are completed. They are made on the left arm – 125 and on the right arm – 125. Results are remembered in four aggregate arrays for the corresponding devices during different consecutive time periods. The seated body position is shown in [1] for both upper arm measurement the BP and wrist measurement the BP.

3.1. Evaluation the Sphygmomanometers by Workability

The workability characterizes the whole reliability about devices at a common exploration here. Table 1 shows results for coefficients of workability ordered by prices of the devices. Graphics on fig. 1 manifestoes the falling workability with falling of the prices. The reasons about faults of measurements the BP consist of low signal at specific position of the cuff.

Table 1. Workability of electric sphygmomanometers

n = 250	Upper arm sphygmomanometers		Wrist sphygmomanometers	
Price	1.22 p	p	0.7 p	0.25 p
Coefficient of workability	0.996	0.988	0.853	0.756

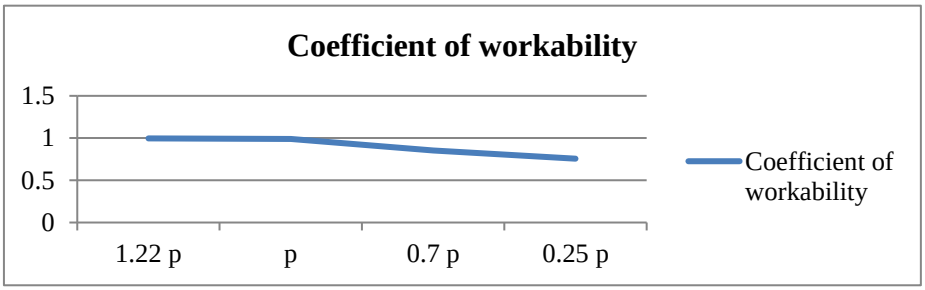


Fig. 1. Graphics of coefficients of workability as function of the price

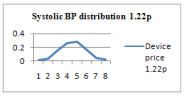
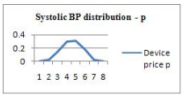
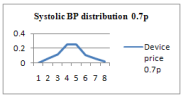
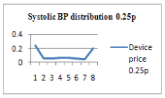
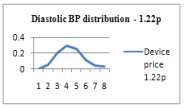
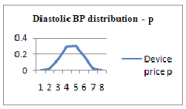
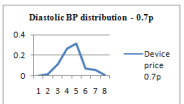
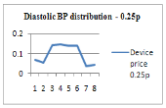
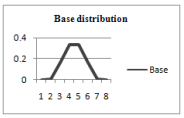
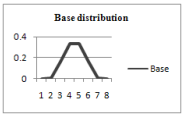
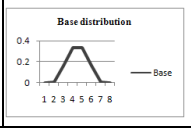
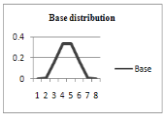
The upper arm generates power signals especially at the expensive devices and their coefficients of workability are of high values. On the other side, wrist artery lays in a joint and its signal is lesser conductive to the sensor. Similar exploration with the elbow joint is completed and presented in [1] and it also contains wavering results about BP, but at high coefficient of workability. The high price wrist sphygmomanometer provides comparatively stable results at measurement the BP. Finally, the cheap electric sphygmomanometer of 0.25p is of lowest reliability, but at permissible level – 0.756.

3.2. Evaluation the Sphygmomanometers by Mean Values and Discrete Distributions

The main parameters of random values about BP are presented in table 2. They contain the common values of the random values of BP and graphics of corresponding discrete distributions – pointers about quality of measurement with electric sphygmomanometers. The

mean values of systolic and diastolic BP of the first three sphygmomanometers are in normal limits. The same values about fourth sphygmomanometer of price 0.25p show over estimation for systolic BP and underestimation for diastolic BP. The heart pulse rate per minute is within norm of all devices.

Table 2. Mean values and discrete distributions of systolic and diastolic BP.

	Upper arm sphygmomanometers		Wrist sphygmomanometers	
Parameter	1.22 p	p	0.7 p	0.25 p
Measurements	250	247	215	189
Systolic BP	116	107	118	148
Diastolic BP	72	69	65	61
Pulse rate per minute	59	61	51	54
Discrete distribution by systolic BP	4, 9, 39, 67, 71, 42, 13, 6	1, 7, 35, 74, 76, 45, 7, 2	1, 14, 29, 62, 61, 27, 16, 5	61, 12, 12, 15, 16, 12, 10, 51
Discrete distribution by diastolic BP	1, 14, 51, 73, 63, 28, 12, 9	1, 7, 35, 74, 76, 45, 7, 2	1, 4, 28, 67, 79, 18, 15, 3	17, 13, 35, 36, 34, 34, 9, 11
Base distribution	0, 1, 41, 83, 83, 41, 1, 0	0, 1, 41, 83, 83, 41, 1, 0	0, 1, 41, 83, 83, 41, 1, 0	0, 1, 41, 83, 83, 41, 1, 0
Systolic BP Distribution				
Diastolic BP distribution				
Base distribution				

The real graphics of discrete distributions about systolic BP and diastolic BP provide visible picture for assessment the quality of measurement in comparison to the graphics of the sample normal distribution. Having in mind the base distribution as a discrete analogue of the sample normal distribution, it is used as a base for analysis.

The discrete distributions for systolic and diastolic BP of first three sphygmomanometers are similar to the base discrete distribution. This circumstance affirms their good quality of measurement. The discrete distribution of last and cheapest sphygmomanometer with 0.25p is concave for systolic BP and equally drawn for diastolic BP – pointers about absence of quality of measurement of this device – rejected from further exploration.

A quantitative assessment can be computed from comparison of empirical frequencies of base and measured distributions, but their mathematic foundation consists of the logical ratiocinations in p. 2, and hence it can be a task for future exploration.

Another quantitative assessment is presented in [7]. The discrete distribution there has good quality, when it is close to delta function, which has hypothetic criterion on accuracy.

With resume, the following issues can be formulated:

- The discrete distributions for three sphygmomanometers of price "1.22p", "p", and "0.7p" are close to the base one and random values about them are close to normal distribution, but important marginal events point to available measurements of BP of large dispersion at every one sphygmomanometer.
- A flexible quantitative criterion of base discrete distribution – some discrete analogue of normal distribution at comparison to some other discrete distributions could provide better conditions for assessment the random values for BP.

3.3. Estimation of Electric Sphygmomanometers with Criterion on Consent

The known method of criterion on consent [5] assigns to some distribution of empirical frequencies the so called theoretical frequencies. Small differences of them support inference about normal distribution. In the current exploration the empirical frequencies of discrete distribution are investigated. They are compared to the theoretical frequencies. The results of comparison the corresponding criterions on consent are typed on table 3. The rated mathematical expectation and mean squared deviation are computed with account the boundaries of vertical layers of dispersion.

The systolic BP and diastolic BP are assumed independent random values. The critical criterion on consent is taken from the handbook [6]. When observed criterion exceeds the critical criterion the distribution is not equal to the normal distribution. When observed criterion is lesser than the critical one, then it is accepted observed normal distribution. Usually, it has place at small differences between empirical and theoretical frequencies. The method of estimation the H_0 hypothesis by criterion on consent showed the following results:

- The systolic BP of sphygmomanometer "1.22p" and systolic BP of sphygmomanometer "0.7p" have observed normal distributions;
- The systolic BP of sphygmomanometer "p" has not observed normal distribution;
- The diastolic BP of sphygmomanometer "1.22p" and diastolic BP of sphygmomanometer "0.7p" have not observed normal distributions;
- The diastolic BP of sphygmomanometer "p" has observed normal distribution.

The comparison by shape of base distribution with the discrete distributions of random values showed similarity to normal distribution for all their six aggregate arrays. Rigid quantitative comparison with criterion on consent rejects half of those six results. Hence, the method of criterion on consent bears ambiguity information about quality of measurement the BP, but partially confirms good results of this exploration.

Table 3. Estimation of electric sphygmomanometers with criterion on consent.

Parameters	Upper arm sphygmomanometers		Wrist sphygmomanometer
	1.22 p	p	0.7 p
Completed measurements	250	247	215
Mathematic expectation of systolic BP	0.48	0.528	0.351
Mean Squared deviation of systolic BP	6.905	5.811	6.926
Mathematic expectation of diastolic BP	0.267	0.374	0.595
Mean Squared deviation of diastolic BP	7.149	5.712	5.906
Empirical frequencies of systolic BP	4,9,39,67, 71,42,13,6	2,4,23,88, 93,28,3,6	1,14,29,62, 61,27,16,5
Theoretical frequencies of systolic BP	3,13,38,65, 68,43,17,4	2,11,42,78, 60,42,11,1	2,12,33,56, 58,36,15,3
Empirical frequencies of diastolic BP	1,14,51,73, 63,28,12,9	1,7,35,74, 76,45,7,2	1,4,28,67, 79,18,15,3
Theoretical frequencies of diastolic BP	1,16,43,88, 42,39,15,7	8,35,74, 79,41,10	1,7,29,62, 67,37,10,2
Computed criterion on consent of systolic BP	3,749	70	5,766
Critical criterion on consent of systolic BP	10	10	10
Inference about consent of systolic BP	Yes	No	Yes
Computed criterion on consent of diastolic BP	19.069	0.604	16,629
Critical criterion on consent of diastolic BP	10	10	10
Inference about consent of diastolic BP	No	Yes	No

4. Conclusion

The price of electric sphygmomanometers represents utile information and cheaper sphygmomanometer does not provide qualitative assessment of BP: it overestimates the systolic BP and underestimates the diastolic BP.

All sphygmomanometers – for upper arm and for wrist properly measure the heart pulse rate per minute and have high value coefficients of workability between 0.756 and 1.

The sphygmomanometer for wrist of higher price – "0.7p", comparable to less expensive sphygmomanometer for upper arm – "p", provides good accuracy of measurement the systolic BP and diastolic BP. The same results manifestoes the sphygmomanometer "1.22p", which has best workability. Positive inferences are substantiated by corresponding six discrete distributions about systolic BP and diastolic BP with shapes similar to the base distribution – discrete analogue of normal distribution. These are important pointers to their good quality of measurement the BP.

The analysis through criterion on consent about H_0 hypothesis: "the normal distribution is applicable to the empirical frequencies of a random value" gives wavering information about quantitative empirical frequencies at the comparison to the theoretical frequencies. It bears some contradictions relatively to the upper graphic analytic approach of assessment, which emphasize the forms of discrete distributions.

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About the Role of Software Project Management Methodologies to Increase Project Success Rate

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Abstract: There exist various project management methodologies for the effective and timely development of software project. In spite of the several project methods, most of the software project fails due to poor management and inability to achieve the success criteria throughout the project. In addition to that, the application and selection of the appropriate project methodology is done depending upon the complexity, size and duration allocated for the software development project. This undertaken project aims at evaluating the impact of the project management methodology in improving the success rate of software projects. In this paper, Oracle Enterprise has been considered as the case study for determining and evaluating the raw data. In this particular study, the analyst has focused on evaluating the detailed and underlying information from both the primary and secondary data sources. Based on the analysis it has been identified that the cost, time and quality determines the project success in software projects. In addition to that application of project management methodology including PRINCE2 and scrum helps in increasing the success rate of the software project.

Keywords: Software Project Management, Project Management Methodologies, Project Management Success Factors, Oracle Enterprise.

1. Introduction

Software development is a significant discipline of development that is characterized with critical module that separates the development process from other development or manufacturing discipline. Kerzner [1] has defined a software as an intangible and conceptual products that can evolve or change over time.

In spite of the requirement and characteristic of the software development can be included during the development process, the cost associated with the project increases in a drastic range that often causes the project failure. Schwalbe [2] claimed that over the past five decades, various method and methodologies are being utilized for the software or system development projects for controlling the risks and uncertainties associated with them. Kerzner [1] showed that initially the software project development were focused only on the technical, automation and core business needs that has evolved towards the user, market and functional requirement of the proposed software.

2. Definition of Project Management Methodologies

Fleming and Koppelman [3] stated that project management (PM) methodology is set of suitable repeatable procedure that help to introduce efficiency as well as flexibility into improvement over quality to manage the organizational projects. Too and Weaver [4] argued that PM methodologies are used to improve alignment of the projects towards enterprise strategy. It increases the competitive advantage of the organization and produces better

organizational results earlier as well as cheaper. Sheffield, and Lemétayer in [5] demonstrated that the methodology helps to predict the requirements of staff on priority basis. It assures for using the organizational funds and resources. In order to make the flow of project faster with less wasted time and effort, then various types of project management methodologies are used as follows:

Agile methodology. Todorović et al. in [6] demonstrated that agile project management is focused on adaptation to change the situations. This method tries to present of continuous product delivery to the consumers. Within the agile methodology there is prioritization process, and constant change and daily basis communication approach is one of the section of culture.

Waterfall methodology. This methodology is mainly used in development and construction industry. These methods are simple to comprehend and easy to use. Each of the phases of this model should complete fully when next phase is ready to begin. Rosemann, and vom Brocke in [7] stated that it is used into small project where there are uncertainty into project requirements. At the end of each phase, a review is to be taken to determine if the project is going on right path and whether the project will continue or not. After completion of development phase, software testing is proceeding. Hu et al. [8] demonstrated that waterfall model is easier to manage due to model's rigidity.

Scrum methodology: This methodology is used to manage the projects and product development. The methods are focused on product development strategy where the development team should work for reaching the project and organizational goal. Teller and Kock in [9] mentioned that this methodology enables to create self-organizing teams by encouraging the co-location and verbal communication among the team members into project work.

PRINCE2 methodology. Osseiran et al. in [10] demonstrated that this methodology is a product based and it divides the project work into various distinguished stages to manage it easily. With help of the project team members, it remains focused and delivered the outcome at end of the time. The benefit of this methodology is that it improves the communication among the team members and external stakeholders. It provides more control over the project. Dwivedi et al. [11] argued on the flexibility of this methodology which allows making changes on run time. This methodology is time as well as cost effective as it saves time of new workers those are already familiar with PRINCE2 methodology.

3. Concept of IT Project Management Methodologies

C. Beringer, D. Jonas and A. Kock [12] stated that IT project management provides with a framework to plan, do and deliver the projects of any size and type. PM framework focuses on understanding of desired changes with selected methodological approach. The change within the project is core aspect that should require managing. PM methodologies are serving way to realize the changes based on time, cost as well as quality. IT project management methodologies are working based on five phases: project planning, execution, performance and control and project closure. In the initiation phase, a decision is taken to identify if the project work is completed on time. Then, a project plan outlines the work that is performed by the project manager. During this phase, the project team prioritizes the project work, calculate the budget and determine the required resources. All the project tasks are executed among the team member. The project manager controls the project status and progress as per actual project plan. The manager controls the schedule by tracking the project. Finally, after the tasks are completed and the client approved the result, evaluation is done for highlighting the project success.

4. Project Management for Controlling Main Success Factors

The Project management methodologies that have been researched in current paper are shown in fig. 1.

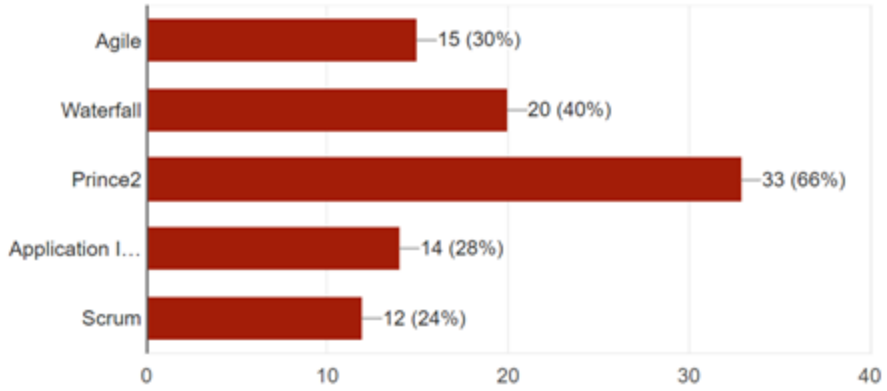

Fig. 1. Project Management Methodology Used

Each project methodologies focus on different element and criteria for the project success. Furthermore, the appropriate selection and application project methodology allows the project to obtain the success criteria. From the analysis it has been identified that PINCE2 methodology is mostly applied for the software development project. Furthermore the waterfall, agile and scrum methods are widely used in the various projects. Lastly, Application Implementation Methodology is least used for the successful development of the software project at Oracle.

The graphical representation on fig. 2 has been used for evaluating the impact of the project methodology in controlling the budget. In every software development project, budget has been considered as a significant factor for determining the project success. Apart from the labor cost, the budget in the software project is consumed in the hardware, software and networking components used during development. Therefore, the management and allocation of financial resources is essential for the project success.

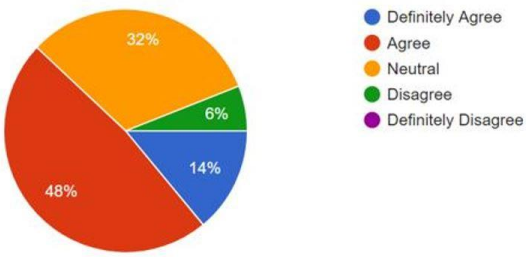

Fig. 2. Project Management Methodology for controlling Budget

Majority of respondents (fig. 2) 62% agree that selection and application of proper and appropriate Project Management plays a big role in accomplishing projects within the budget. This helps us to assess the effect of appropriate methodologies on one of the most important project success factors. From the analysis it has been identified that majority of the respondents

believed that the application of the project methodologies helps in controlling the project budget.

The pie chart on fig. 3 shows that 50% of the respondents have agreed that project methodology helps in completing the project within schedule. While the percentage is followed with 24% selecting definitely agree. Only 6% of the respondents have disagreed while 18% have remained neutral.

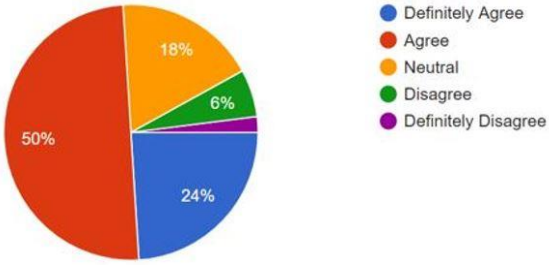

Fig. 3 Project Methodology for Managing Schedule

Completing the project on the schedule is considered (fig. 3) as one of the significant factor and constrains that needs to be fulfilled for the success of the software projects. The controlling and monitoring the progress of the software development ensures in ensuring the on time delivery of the project thus the successful completion. Maximum number of respondents has agreed that the application of proper project methodology has allowed in controlling and proper monitoring of the project schedule.

Fig. 4 shows that the maximum number of 54% of the respondents have selected agree option. Furthermore, 30% of the respondents have definitely agrees that application of project methodology helps in achieving the developed scope for the software development.

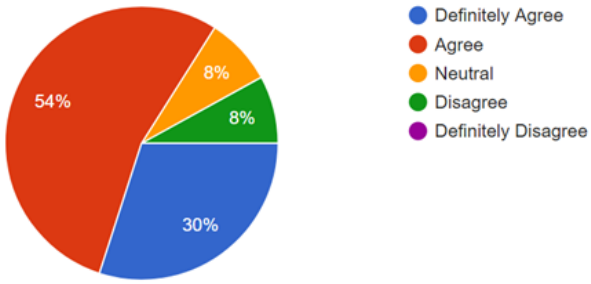

Fig. 4 Project Methodology for Managing Scope

The software development scope identifies the criteria that are required to be implemented in the proposed system. Based on the information obtained from the data collection (fig. 4) it has been evaluated that maximum number of respondents has observed that application appropriate method of project methodology helps in improving and achieving the scope identified for the development of the software.

Figure 5 represents the importance of project management methodology for meeting the quality standards of the undertaken software project.

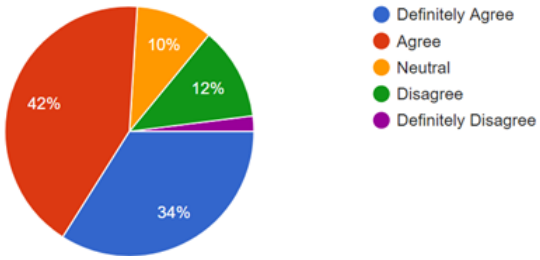

Fig. 5 Project Methodology for Managing Project Quality

From the developed graphical representation (fig. 5) it has been illustrated that 44% of the respondents have selected agree option where 24% of the respondents have selected definitely agree option. Only 2% of the respondents have definitely disagreed with the question while the remaining 10% have disagreed.

The quality of the software is based on various factors apart from the technical issues. The quality of the project provided during the software development project. The delivery of the project in appropriate deadline, the completion of the software implementation within the budget is considered as the quality of the project. Based on the data analysis, it has been observed that the application of project methodology enables the project manager to determine and ensure the project quality throughout the software development.

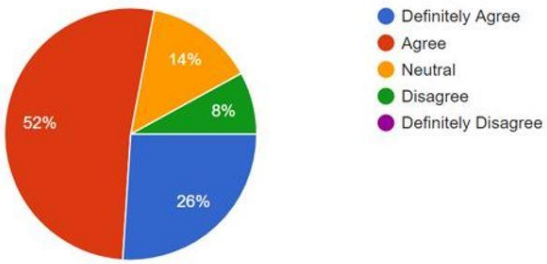

Fig. 6 Project Management Methodology for controlling Risks and Team

Risks and team management play a crucial role in software development project. Based on literature review these two factors are considered as "success factors" in software industry. Fig. 6 shows that over 70% of Oracle employees confirm the influence of appropriate methodology on project risk and team management as well as prove their significance.

5. Analysis of Criteria and Factors achieved through application of project management methodology

"Following a particular methodology throughout the development of the software project allows the project team to strategically follow and use a structured approach for ensuring delivery of the project" (M3).

The application of the appropriate methods and standards as mentioned in the project methodologies assist in the process of decision making while highlighting the underlying issues and risks associated with the software implementation and development. "Most

importantly the project management methodologies help in ensuring the budget and schedule of the software development project" (M2).

In addition to that, the project methodologies ensure the performance of the project team as well as the proposed software while effectively identifying the activities of over-budget or under-schedule.

Often the success of the software development is based on several factors that are used as a constraint while developing the project. "In most of the project, the functional requirements, budget provided and the time are treated as the major factors determining the software project success" (M2).

The application of the project methodologies for efficiently managing the software development project enables the project team for planning, conceptualizing, implementing and delivering the software system while ensuring the proper distribution of schedule, budget and resources. "It is a fact that the project management methodologies significantly assists in achieving the particular factors that are essential for the project success" (M1).

6. Conclusion

The application of suitable project management methodology helps to achieve budget, scope, quality standards and schedule of undertaken software project. Proper use of project management procedures and tools help the system developer to implement a new information system. The methodologies consist of phases to guide the developer in selection of techniques that is proper at each project phases. It helps to plan, control and manage the information system projects in Oracle. The application of the project management methodologies helps to meet expected benefits of undertaking the software project. It also controls project team and mitigates the risks in the project. The success rate of the project work is measured by delivering the work within budget and produced higher quality of deliverables. Therefore, in order to determine the success rate of the project, it is required to determine the criteria for success of the work. At the end of the project management phase, it is analyzed if the project is successes or not. The success of the project is dependent on measurement of budget, quality as well as schedule. In order to have knowledge about the objectives and targets to evaluate the progress, the project manager should have understanding and skills for application of project management methodologies.

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Profitability of Total Assets – a Factor for Dynamics of Enterprise's Equity Profitability

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Abstract: The matters of profitability of total assets and equity of the enterprise are topical at all stages of its development. Only the common methodologies for analysis and assessment of profitability, including of total asset profitability are applied in the economic practice in Bulgaria, i.e. it is studied as a separate object of analysis. In general, quite less attention is paid to the effect of profitability on the dynamics of other key indicators describing the business efficiency. The interrelations between profitability and other important indicators allow to identify the objectively existing causalities among key business indicators for efficiency of the overall business of the enterprise. This study is aimed at interrelating the profitability of total assets and the enterprise's equity return. This may be achieved through the model for equity profitability analysis in relation to the financial leverage effect. With such model, profitability of total assets in this particular case, is analyzed and assessed in its capacity of a factor affecting the dynamics of profitability of equity. This study highlights the objectively existing causality between enterprise's total asset profitability and equity return. The subject matter of the study highlights the effect of changes in total asset profitability on the dynamics of enterprise's equity return. The resultative information is to some extent useful for the business in terms of making proper and justified decisions about the borrowing amount, the capital structure and its optimization, the internal growth rate, the effect of the financial leverage, the equity return in relation to its price, and other important aspects of enterprise's business.

Keywords: Profitability, Efficiency, Analysis, Capital structure, Decisions, Cloud technologies

1. Introduction

The use of the opportunities for business analysis of enterprise's business provided by the advanced information technologies is a real competitive advantage for the enterprise. This is due to a number of objective circumstances.

Firstly, the use of cloud technologies for business analysis allows the management to focus on the principal activity of the enterprise. The information obtained from the real time business analysis enables the financial management to make decisions at a faster pace in order to achieve and maintain the market and financial stability of the enterprise in operating and strategic aspect.

Secondly, the use of cloud technologies for business analysis allows to decrease enterprise's expenses in different directions. For example, the use of such technologies significantly decreases the expenses for establishment of communication links, for installation and configuration of operating systems and other similar actions.

Furthermore, enterprise's expenses decrease because there is no need to maintain sufficient number of trained staff having the required qualification in the field of information technologies anymore, including the expenses for the continuous training of such staff.

Last but not least, the use of cloud technologies for business analysis decreases the enterprise's expenses for electricity, different software licenses, etc.

2. Application of cloud technologies in business analysis

Cloud technologies for analysis of enterprise's business may be actually applied in business in two directions, and namely for external and internal analysis.

At first place, cloud technologies may be used for external analysis in accordance with the details provided in the enterprise's financial statements.

Firstly, these technologies may be successfully used for analysis of the information contained in the profit and loss account. The analysis covers the following aspects: analysis of expenses, analysis of revenue, analysis of financial performance, analysis of revenue and expense efficiency, analysis of expense-based and revenue-based return.

Secondly, cloud technologies may be used for analysis of the enterprise's financial position in accordance with the balance sheet details. Capital structure, property structure, liquidity and solvency, as well as the return on enterprise's assets, capital and equity may be analyzed.

Thirdly, cloud technologies can be successfully used for analysis of the size, composition, structure, dynamics and efficiency of cash flows in accordance with the information in the enterprise's statement of cash flows.

To our opinion, it is possible to use cloud technologies for external analysis due to the following reasons:

1) Business analysis is made on the basis of the information disclosed in the enterprise's financial statements.

2) Financial statements are public, i.e. the information contained therein is subject to publication and is accessible.

3) The information in the financial statements is intended both for external and internal users.

4) Different methodologies for analysis of the information in the financial statements may be unified and applied in terms of enterprises with different scope of business.

As far as the use of cloud technologies for internal analysis is concerned, we should take into account the fact that such type of analysis is based on wide information, whereas the information required for such analysis is internal and is not accessible for external users. This causes some difficulties related to the confidentiality of this information. We should further note that in accordance with its features and the specificity of its business, each enterprise may develop specific methodologies for analysis.

For example, for analysis of expenses by calculation items and by types of activities, for cost of products or services, for profit from sale of products, goods or services, for evaluation and optimization of the range structure of sales, for return on sales, etc. Therefore, the methodologies for internal analysis are diverse and may not be unified. To certain extent, this fact makes the use of cloud technologies for internal analysis of the enterprise's business more difficult. Which, of course, does not mean that they cannot be at all used.

3. Analysis of return on equity in relation to the return on total assets and the effect of financial leverage – opportunities for use of cloud technologies for analysis

The analysis of return on equity is made on the bases of the information from the enterprise's balance sheet and profit and loss account. In its nature, this is an external analysis. To our opinion, cloud technologies may be successfully used for analysis of return on equity in relation to the effect of financial leverage.

The effect of financial leverage (E) is calculated in accordance with the following formula. [1]

$$E = K^d \times (ROTA - I\%) \quad (1)$$

where: K^d is enterprise's leverage ratio;
ROTA – return on total assets;
I% - internal interest rate.

Enterprise's leverage ratio is calculated as a ratio of the average amount of borrowings to the average amount of equity and characterizes the general structure of the enterprise's capital.

The return on total assets is calculated as a ratio of the amount of profit and loan (short- and long-term) interest expenses to the average amount of enterprise's total assets.

The internal interest rate is calculated as a ratio of the loan (short- and long-term) interest expenses to the average amount of borrowings. It characterizes the price of borrowings used for the company's business.

Return on equity (ROE) in relation to the return on total assets and the effect of financial leverage may be calculated in accordance with the following formula:

$$ROE = ROTA + E = ROTA + K^d \times (ROTA - I\%). \quad (2)$$

The method of calculation of the values of the factors used in the model for analysis of return on equity shows that the required information is disclosed in the enterprise's financial statements, i.e. this is public information.

These two models – for the effect of financial leverage and for return on equity in relation to return on total assets and the effect of financial leverage, given the opportunity to unify the analysis methodology, which may be used by enterprises operating in different sectors of the economy. This is an objective prerequisite to develop a part (component) of the cloud technology intended for external analysis, which can be successfully used in real time business.

The above formulas show that the dynamics of return on equity is subject to the influence of the following factors:

1) Changes in return on total assets.

2) Changes in the enterprise's leverage ratio.

3) Changes in enterprise's internal interest rate.

If ROTA > I%, then the effect of the financial leverage would be positive and the return on equity would be greater than the return on total assets of the enterprise. This means that the return on equity is greater than the return required by the beneficial owners. Therefore, the investment is beneficial.

If ROTA < I%, then the effect of the financial leverage would be negative and the return on equity would be less than the return on the total assets. This means that if beneficial owners invest their funds, they would not ensure the return they require. Therefore, the investment is not beneficial for them.

4. Application of the analysis model

We will illustrate the methodology for analysis of return on equity in relation to the return on total assets and the effect of financial leverage with data about the business of Mir OOD. Input data required for analysis of return on equity are summarized in table 1. The values of additional indicators are calculated in the same table.

Based on the details in the above table, we can make the following conclusions:

1) The effect of financial leverage is positive and its values are stable. This effect shows 0,1162 points increase for the current year in comparison with the previous year. This means that the return on equity is bigger than the rate of return required by the investors. This is an issue all external users of information are interested in with view of their investment choice and in general with view of their intention to have business relations with the enterprise. This is an issue important for the internal users too, as on the basis of obtained information, the management analyzes, assesses and manages the capital structure, the resource type efficiency and the return on equity of the enterprise.

Table 1 (BGN'000)

Indicators	Previous year	Current year	Change
I. Input data			
1. Average amount of asset, including funded:	105000	107500	2500
a) with equity	59500	61000	1500
b) with borrowings	45500	46500	1000
2. Book profit	9200	9600	400
3. Interest expenses	1035	1050	15
II. Indicators calculated in addition			
4. Leverage ratio, BGN	0,7647	0,7623	-0,0024
5. Return on total assets, %	9,7476	9,9070	0,1594
6. Internal interest rate, %	2,2747	2,2581	-0,0167
7. Effect of financial leverage, % (indicator 4 x (indicator 5 – indicator 6))	5,7146	5,8307	0,1162
8. Return on equity, %			
a) model 1 ((indicator 2 : indicator 1) x 100)	15,4622	15,7377	0,2755
b) model 2 (indicator 5 + indicator 7)	15,4622	15,7377	0,2755

2) Return on equity has increased with 0,2755 points during the current year in comparison to the previous year.

3) Return on equity calculated as a percentage ratio of the book profit to the average amount of equity (model 1) and as a sum of return on total assets and the effect of financial leverage (model 2) has equal values.

On the basis of the above we can conclude that the efficiency of use of total assets, i.e. the return calculated on the basis of enterprise's total assets, is a very important factor affecting the return on equity.

On the basis of the data in table 1 we can identify the effect of direct factors on the dynamics of return on equity of the enterprise for the current year in comparison to the previous year. This information is presented in table 2.

Table 2. Effect of direct factors

Factors affecting the change of return on equity	Effect, points	
	positive	negative
1. Changes in leverage ratio		-0,0180
2. Changes in internal interest rate	0,0127	
3. Changes in return on total assets	0,2808	
Positive and negative effect	0,2935	-0,0180
Total effect of factors	0,2755	

Based on the details in the above table, we can make the following conclusions:

1) Under the effect of changes in the leverage ratio of the enterprise (decrease by 0,0024 points) return on equity has decreased by 0,0180 points. We can see that the borrowings used for the enterprise's business have decreased with BGN 1000 thousand, and equity has increased by BGN 1500 thousand. (table 1). In principle, the use of borrowings (within reasonable scope) in the enterprise's business is a return-related factor for the increase of return on equity.

2) Under the effect of changes in the internal interest rate (decrease by 0,0167 points) return on equity has increased by 0,0127 points. Therefore, the decrease of the price of borrowings has positive effect on the changes that have occurred in the return on equity.

3) As a result of the effect of changes in the return on total assets (increase by 0,1594 points) return on equity has increased by 0,2808 points.

5. Extended model for analysis of return on equity

This model is a typical symbiosis between two analysis models. The first of them is the DuPont's model for calculation of return on total assets. We use the following formula:

$$\mathrm{ROTA} = \left[\left(\frac{1}{\frac{\overline{\mathrm{FA}}}{\mathrm{I}} + \frac{\overline{\mathrm{CA}}}{\mathrm{I}}}\right) \mathrm{x} \left(\frac{\mathrm{NP+Int}}{\mathrm{I}} \mathrm{x}\, 100\right)\right] \quad (3)$$

The second model is the extended model of the effect of the financial leverage, which may be represented with the following formula:

$$E = K^d \text{ x } \left\{ \left[\left(\frac{1}{\frac{\overline{FA}}{I} + \frac{\overline{CA}}{I}} \right) \text{ x } \left(\frac{NP+Int}{I} \text{ x } 100 \right) \right] - I\% \right\} \quad (4)$$

Therefore, the return on equity may be calculated with the following formula:

$$ROE = ROTA + E = \quad (5)$$

$$= \left[\left(\frac{1}{\frac{\overline{FA}}{I} + \frac{\overline{CA}}{I}} \right) x \left(\frac{NP+Int}{I} x 100 \right) \right] + K^d \text{ x } \left\{ \left[\left(\frac{1}{\frac{\overline{FA}}{I} + \frac{\overline{CA}}{I}} \right) x \left(\frac{NP+Int}{I} x 100 \right) \right] - I\% \right\}$$

This formula shows that the following factors influence the dynamics of return on equity:

1) Changes in the absorption ratio of fixed assets ($\frac{\overline{FA}}{I}$). It shows the efficiency of use of enterprise's fixed assets, since it expresses the average amount of fixed assets used for the generation of one-lev revenue.

2) Changes in load ratio of short-term assets ($\frac{\overline{CA}}{I}$). It expresses the average amount of short-term assets used for the generation of one-lev revenue. Therefore, this is an indicator characterizing the return on short-term assets, i.e. the efficiency of their use.

3) Changes in return calculated on revenue basis ($\frac{NP+Int}{I} \text{ x } 100$). Here Int means the loan interest expenses. This indicator characterizes the revenue-based return, provided the enterprise does not use borrowings for its business.

4) Changes in the leverage ratio.

5) Changes in internal interest rate.

6. Conclusion

The models for analysis of return on equity described above are a typical example for external business analysis. Cloud technologies may be successfully used for the analysis of key business indicators whose values are analyzed, assessed and managed on the basis of the information from the enterprise's financial statements. The main advantage of the use of cloud technologies for business analysis is that they offer a complex solution of a number of issues relevant to expenses, revenue, financial performance, financial position, cash flows and business efficiency. At the same time, the complete use of cloud technologies for external business analysis mitigates the risk of occurrence of technical problems related to the administration of the respective software and hardware in the enterprise. Furthermore, in the existing dynamic environment, enterprise's managers are too mobile. Cloud technologies give the managers the opportunity to make the respective checks at any time and at any place. Based on the resultative analytical information, the managers and the financial management of the enterprise are able to make timely and justified managerial decisions to achieve market and financial stability in operating and strategic aspect.

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The Problem of Measurement in the Revised Conceptual Framework of IFRS

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Abstract: The revised conceptual framework of IFRS (IASB, 2015) points out as the two fundamental qualitative features the relevance and fair presentation of information. This new approach to the ranking of qualitative characteristics differs from the existing understanding set out in the Conceptual framework (IAS, 1989). This raises a number of issues related to the measurement and valuation approaches of accounting items. The paper discusses the relationship between the qualitative characteristics of accounting information, the mixed accounting valuation model and the approaches to improving the usefulness (relevance) of the information in the financial statements. It is motivated by the understanding that the ideal model for financial performance of an enterprise is the one that is a bridge between internal management information used by management and the valuation and analysis process performed by investors and financial analysts.

Keywords: IFRS, measurement, revised conceptual framework, measurement uncertainty, nonfinancial information.

1. Introduction

The main issues discussed in the report are as follows:

1. Is there a link between the changes in definitions of the elements of the financial statements (asset, liability, capital, income, expense) in the Revised conceptual framework (IASB, 2015) and the approaches to measuring them?

2. Should the measurement and valuation in the financial statements be linked and how, with:

(a) the purpose of the financial statements, incl. the presentation of risks, non-financial information, and with future cash flows

(b) the qualitative characteristics of the information

(c) the business model of the enterprise

The issue of revising the conceptual framework of IAS/IFRS, which should, by its very nature, be expected to revise the conceptual basis of financial accounting itself, raises a wide range of discourses and expressions of opinion from accounting specialists. The revised draft conceptual framework, published in 2015 by the IASB and the subsequent discussions and comments, convince us that **no significant, revolutionary change has been made to the conceptual basis of financial accounting.** What has been done by the Board can be briefly summarized as follows: the revised conceptual framework (IASB, 2015) covers systemically and thematically defining the evolution that financial accounting has evolved over the last 30 years. This is the prevailing practice in market-developed countries in the area of public financial reporting, based on principles, requirements and definitions, addressed to a wide range of users of information (leading amongst which are investors and other capital providers). It is important to note that through this project, the IAS Board convincingly **sets**

the boundaries in which it has the understanding that financial accounting should be developed.

2. Discussion

The evolutionary approach to revising the conceptual framework of IAS/IFRS was anticipated, given to the traditional accounting conservatism, as well as chronologically tracking the whole process launched in 2004. Then the IASB (International Accounting Standard Board) and the FASB (Financial Accounting Standard Board) decided a joint project for revising the Concept Framework to IAS. Two chapters of this project were published in 2010: on the purpose of general financial statements and qualitative characteristics of reliable financial information. Also, some of the concept of the reporting entity, the discussions about the definitions of the elements of the financial statements and the valuation concepts were published. But in 2010 the two boards discontinued the joint work on this project. In 2012, the IAS Board resumed its work independently and in 2013 and 2015 it published discussion papers and a draft of a new Conceptual Framework. Starting again, the IAS Board decided to take advantage of the existing Conceptual Framework by updating, enhancing and supplementing it, and abandoning the original idea of producing an entirely new one (to be implemented through 8 separate phases).

In the project (IASB, 2015) several things are impressed with the definition of the purpose, the qualitative characteristics of the information in the financial statements, the elements and their relationship with the measurement:

1. Not only investors, but the more comprehensive term "capital providers" are listed as primary users of the information in the financial statements. These include both owners - investors and other - lenders (bondholders, lending banks, suppliers, staff). How did this affect the definition of measurement? In the project it can not be detected the expected logical link between prudence such as qualitative characteristics of information, valuations and assessments in financial statements and information needs of lenders as a type of information user. **The measurement is regulated mainly in accordance with the needs of the capital investors - investors.**

2. The extent to which financial accounting information is useful depends on its qualitative characteristics. As two fundamental ones in the Project, **relevance** and **fair presentation**, are indicated. And as complementary it considers: comparability and consistency; verifiability and reliability; timeliness and comprehensibility. This new approach to ranking qualitative characteristics differs from the existing understanding set out in the US Accounting Rules and the Conceptual framework (IAS,1989), namely: reliability and relevance are the two key qualitative characteristics, on the interaction of which depends the relevance of accounting information for investors, creditors and other users. The different information needs predetermine the importance, the advantage they give, to one or the other characteristic. For composers of financial statements, as well as for auditors and lenders, the leading is reliability, because it increases the data verification, especially in the field of estimates used in the report. This in turn is also linked to the legal responsibility of composers and auditors and to the possible consequences of legal actions brought against them. Conversely, for investors, the leading quality feature of information is the relevance, which is why the fair value is more relevant when evaluating the accounting items for their purposes. Through it, they could make better judgments and predictions about the future build-ups and risks in their business. However, the determination of fair value is associated with greater subjectivity, judgment and assessment by management, and it is more difficult to verify

(proving, verifying). All this leads to a lack of consensus on what qualitative characteristics to be the main guiding principle in preparing and presenting the information in the financial statements. So far, the leading accounting bodies (the American Financial Accounting Standards Board, the IAS Board) have accepted the compromise approach - reliability and relevance are equally important; they are basic. But in the 2015 Conceptual Framework version, a sort of retreat is being made, and it is only for the benefit of the users of capital investors, in the face of investors, by giving priority to the relevance to reliability as a qualitative characteristic. Assuming that the essence of "reliability" relates to concepts such as accuracy of accounting information; the possibility of verifying it; lack of error or ambiguity as well as a true representation of the economic reality in an enterprise, to some extent the use of the term "honest performance" as a fundamental requirement replaces the exclusion of "reliability" as the fundamental one and its transfer to the group of complementary qualitative characteristics of the financial accounting information. Certain studies clearly indicate that "true" and "honest" performance are not the same thing, which is why they are not accidentally used as an expression and should not be identified. Veracity is a quality that exists if the data in the financial statements correspond to the existing facts, and honesty is related to the requirement that the information in the reports is not misleading. Presenting information fairly and honestly means not giving false, misleading estimates of the real, "internal" value of the company, which in turn is a condition for the functioning of efficient capital markets. Ultimately, relevance and honest performance as qualitative features are called upon to help investors and other suppliers of capital to effectively predict and make reasonable economic decisions. Furthermore, "true and honest performance" is a dynamic concept; it is also a matter of ethics, morality.

As a qualitative feature of useful financial information, the Revised Concept Framework (IASB, 2015) states:

- Neutrality - in its clarification, the Board considers its relation to the "prudence" principle. According to it, "prudence is exercising prudence in decision-making and judgments in uncertainty and ambiguity" (IASB, 2015), and it can help achieve neutrality in applying accounting policy. Prudence helps fair presentation of information in financial statements. Thus, in par. 2.18 of the Conceptual Framework project, the board re-introduces the term “prudence” by calling it **cautious prudence**, as opposed to the abolition of this principle in the part of the project published in 2010. According to par. 1.7 the choice of a neutral accounting policy does not require recognition of the entity's overall value in the financial statements; no valuation of all assets and liabilities at current prices is required; does not restrict the performance of impairment tests to assets reported at cost; requires reporting of assets and liabilities only if they meet the defined recognition criteria.

- The board does not put a special place on the principle of "the priority of economic content before the legal form" (substance over form), but defining what leads to honest presentation of the information also makes a connection with this principle.

- Faithful representation instead of reliability: According to the 2010 conceptual framework, there was a difference between reliability and relevance. More relevant information could be less reliable, and vice versa. In the 2015 project, the Board decided not to use the term "reliability" because of its association mainly with an acceptable level of uncertainty of assessment rather than the reliability of the information. According to the Board, the extensive discussion of the measurement and valuation uncertainty, as well as the two qualitative features of the useful financial information – relevance and fair presentation, are sufficient and do not require the use of the term "reliability".

Regarding the understanding and complexity of the information in the financial statements, there is no change in the Board's view. The same is according to materiality.

However, the Board is committed to clarifying them in the context of its initiative on disclosure principles in the financial statements.

3. It is noted that **the changes made by the IASB mainly in the definition of an asset** ("An asset is a present economic resource controlled by the entity as a result of past events. An economic resource **is a right that has the potential to produce economic benefits"**(Revised Conceptual Framework, IASB, 2015, paragraphs 4.5-4.23 and BC4.23-BC4.44) have a direct link with the approaches to their measurement. Therefore, when assessing assets, the focus should be on measuring the value of the rights held, rather than to the measurement of the future economic benefit that is difficult to determine for part of the assets.The emphasis on rights would lead to a more objective differentiation of assets from costs and hence a more objective measurement of the performance of the enterprise and its financial condition.

4. As a major limitation of the information included in the financial statements, the project points to the fact that this information is largely **based on managerial judgments**, not on accurate assessments, and that professional judgment is applied when preparing it. All this leads to uncertainty in the measurement and evaluation of accounting items that users should be aware of. Therefore, it is useful to add and turn to other sources of information, including general macroeconomic developments data, anticipated legislative changes, the development of the respective sector, big data analysis etc. An important source is also the management commentary report, the activity report and the disclosure of significant judgments and assumptions that management has taken into forming accounting policies. The limitations are related to the application of the principle of "materiality" in the presentation and disclosure of information in the reports, as well as the comparison of "costs" - "benefits" in the preparation of the accounting information.

5. A whole **chapter (sixth) in the project is dedicated to measurement issues in the financial statements.** Here, besides defining the historical cost and current value and the specific types of values, the Board clarifies what are the differences between the information they provide. Thus, IASB confirms the understanding: **different assessments and values for different purposes.** The factors to be considered when choosing the relevant measurement base and applying the relevant type of assessment are also defined. They should be based on the qualitative characteristics of the information and, above all, on the requirement of relevance and fair presentation. Appendix A of the Project outlines valuation techniques based on cash flows that are applicable to certain accounting entities. This underlines the understanding that the usefulness of information is improved if the valuation of certain accounting items is linked to future cash flows and the associated risks. The understanding is that improving the usefulness of information requires the application of more than one assessment base.

Obviously, the ideal model for financial performance of an entity's business is to be a bridge between internal management information used by management and the valuation and analysis process performed by investors and financial analysts. The many criticisms of financial reporting and current financial reports show that this bridge is currently weak. Therefore, today's financial accounting weaknesses, which are mostly linked to its limited forecasting capabilities, are in fact the leading features of management accounting as a tool for planning, analysis and control. Therefore, the modern development of the economy, especially in the financial markets, necessitates an increasingly saturation of the financial statements with information traditionally generated for internal managerial needs. As a result, a number of specialists began to call financial reporting "business reporting." Because the former role of

financial accounting to reflect, present and evaluate an entity's business, changes in the direction of predicting the business with its inherent risks and sources of value creation. In addition to this, since 2009 the integrated reporting discussion has started in a more organized form.

The complexity and fluctuations of the global economy in recent years have prompted the IASB not to give up its intention to improve and update the IAS/IFRS Conceptual Framework. The aim is to develop a more complete, clear and modern system of concepts and principles for the preparation of general purpose financial statements. In the Project, it is intended that the financial statements also show the results of the management's activities on the resources entrusted to it. It should be noted that the publication of the above project was preceded by a number of professional debates and discussions. After 2012 there are particularly active discussions on the difference between some components of liabilities and equity; the presentation of profit (and loss) and other comprehensive income; valuation of accounting items, and issues related to the prudence, reliability, and stewardship by the management. The public consultation led the IASB to expand the Conceptual Framework by including the issues of presentation and disclosure in the financial statements. A leading view in developing the revised Conceptual Framework is to be a practical tool for creating financial accounting standards.

Issues related to capital maintenance and current cost are presented in the draft of the new Conceptual Framework, but there is no change compared to the existing 2010 option. According to the Board, they could be subject to further research. The situation is similar to clarifying the difference between some equity and borrowed financial instruments.

6. In the Revised Conceptual Framework, the Board states that the information from the financial statements could be more useful to the users if it is able to revise and further develop IFRS to enable businesses to present their business activities. In this regard, **the Board does not use the term "business model"** and notes that this would affect the valuation, presentation and disclosure of the different activities of the reporting entity, including the classification of separate items in the financial result or other comprehensive income. In order not to affect the valuations of the accounting items, to avoid management subjectivism, and because of the lack of a common understanding of the concept of business model, the Board **uses the notion of "business activities".** However, it does not address the question of how different business activities could affect the recognition of assets and liabilities or the classification of components in the income statement and other comprehensive income.

The term "business model" appears for the first time in IAS/IFRS in 2009 – in IFRS 9 Financial Instruments, although as an idea it has been set in its reporting framework much earlier, but is missing in the Conceptual Framework of the IAS (1989). The lack of a clear definition of this term and its relationship to financial reporting creates criticisms and difficulties in the application of IAS/IFRS. The business model is associated with the value-creation process, with how the financial result is tied to cash-flow generation. This means that the reporting model set out in IAS/IFRS and the accounting policy must show how the entity carries out its business. The business model of an entity **influences the valuation of accounting items** as well as the approaches to their reporting, presentation and disclosure in the financial statements. Any significant change in the business model should also result in changes in the entity's accounting policy. However, this would lead to problems concerning consistency in the application of accounting policies and comparability of information between the different reporting periods. It should be assumed that the change in accounting policy due to a substantial change in the business model, is a permissible voluntary change and to apply the relevant rules regulated in IAS 8 Changes in Accounting Policies, Estimates and Errors. According to some specialists, including the IAS Board, following the business model in the

reporting process would cause the same transaction or activity to be taken into account differently across businesses depending on the specific way of doing business. This, in turn, raises the issue of the important qualitative characteristic of public reporting information: **comparability.** A striking example of the leading role of the concept of following and reporting in the financial statements of an enterprise's business model, is also IFRS 8 Operating Segments.

The emergence of the concept of integrated reports is another very significant proof that information users mostly need to gain an insight into how an entity generates value **following its business model.** The availability of alternative accounting approaches in some IAS/IFRS on reporting and measurement, is also a result of business model conception. The draft Conceptual Framework (2015) also provides a focus on performance issues (including classification, aggregation, netting) and the disclosure of information in the financial statements. The understanding of the Board is that the subject of disclosure is only information related to the entity's existing assets, liabilities, expenses and income, and future events are subject to disclosure insofar as it relates to the recognized and presented in the financial statements items. Other information relating to future cash flows and events should be presented and disclosed in other parts and forms of the enterprise's statements but is not part of the financial statements. **This understanding shows that there is a difference between integrated and financial reports. The latter are part of the core of integrated reporting, each of which is based on its own conceptual framework. To date (2018), the question of how these two conceptual frameworks should be united is unclear.**

Regarding **the content of the financial statements**, the important issues and positions of the IAS Board are as follows:

- Financial accounting has its own principles based on practice and common sense, which can only be applied in its entirety to the reporting objects defined in its scope. Attempts to violate or disregard commonly accepted accounting principles and to include in the scope of financial accounting invaluable reliable objects do not result in better financial statements. The prudent approach to overcoming the natural, objective financial reporting constraints is to partner in a harmonious manner with other types of corporate reporting that use financial information on its basis but mainly provide a non-financial one. Therefore, the only way to meet the diverse needs of users today and in the future is to create timely **integrated reports** - a logically bounded set of financial and non-financial information. There is still no consensus on whether these statements should be institutionalized; how is this supposed to happen; how and should they be subject to an assurance engagement by independent auditors;

- The above explains the withdrawal of the IAS Board from the idea of classifying the company's assets, liabilities, income, expenses when they are presented in the Statement of Financial Position and in the Statement of Comprehensive Income according to the business model of the enterprise, which greatly influences the structure of the financial statements.

With regard to **the structure of the financial statements**, the Board continues its work on establishing better rules on the presentation of information in the main four statements (ie better structured information); logically more consistent disclosure and tying of information in the explanatory notes with the peculiarities in the enterprise (business model, capital management and maintenance, risks). For the purpose of better communication with users of information, IASB has made it an urgent task to resolve the issue of the complexity of financial statements and to clarify the applicability of the principle of materiality in the explanatory notes. The better structure of financial statements would improve their understanding and in-depth analysis, as well as cross-company comparisons. It is important to note that the view of the IAS Board is that integrated reports improve the structure of corporate reports (rather than

give a new content!). This means that the integrated statements do not change the content of the financial statements, but the way this content is linked to the rest - mainly - non-financial corporation information. This also explains the cooperation between the two bodies working in the commented areas - the IAS Board and the International Integrated Reporting Council.

As regards the form and manner of providing the information in the financial statements, the understanding of the IAS Board is that different users have different requirements. Some need all the components of the financial report, and others - only separate parts. But what is common to everyone is that the technical format for presentation of financial statements must allow users to use and process (according to their wishes and needs) the data in them. And it also enables companies to get feedback to which part of the report the users are most interested in. That is why the IAS Board updates each year its Guide to Understanding the IFRS® Taxonomy Update.

3. Conclusion

The Revised Concept Framework (IASB, 2015) focuses on financial statements as the most important part of public corporate reporting. It does not deal with other forms of reporting as management commentary (activity report, management analysis). The latter would take a long time, and would delay the moment of completing and adopting the Conceptual Framework. Regarding the other forms of reporting and their aggregation with the financial information in the reports, the work was undertaken by the IIRC, which at the same time when the IASB was working on revising the Conceptual Framework, Conceptual Framework for Integrated Reporting (2013) was published. The concept of integrated statements does not replace the financial statements prepared under IAS /IFRS but supplements them with another user reliable information that is at this stage **outside the scope of financial accounting**. Integrated reporting is a new approach to corporate accountability that illustrates the relationship between organizational strategy, governance and the financial dimension of the activity on the one hand, and the social, environmental and economic context in which the enterprise operates, on the other. It is a response to the criticisms made to public corporate reports. Whether the modern corporate accounting model is adequate or outdated, there is enough discussion in professional and academic literature (FEE, 2015; Papa, 2016). It is a fact that financial reporting does not provide all the information needed for external users (as already mentioned in the report above). This is especially true for intangible assets and, above all, the human intellectual potential, talents, qualities, and the risks and prospects of the company. A way to compensate for this is to provide non-financial information of a different kind and content, including in the notes to the financial statements, such as: some of the information relating to financial risk management; commitments made and agreements entered into, critical judgments in applying the company's accounting policy and key estimates and assumptions with a high uncertainty. **However, this does not radically change the accounting approach to measurement and valuation in the financial statements.**

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Foreign Investment Promotion in Ukraine: Main Speeding-up Force of the Social and Economic Development

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Abstract. Foreign investment promotion is an integral part of the development of the national economy of Ukraine contributing to its entry into the global business environment and increasing investment attractiveness. To a large extent, the effectiveness of foreign investment depends on the right choice of priority areas for the implementation of investment projects. However, before showing priorities for foreign investment, it is necessary to determine the main problems and disadvantages of this process. The article analyzes foreign investment promotion into the Ukrainian economy on the basis of statistical data in recent years. A number of key issues preventing the effective foreign investment promotion and their dependence on various factors are shown. The most important factors for solving problems are considered, positive aspects of foreign investment for Ukraine and the world economy are defined and measures to stimulate the development of investment activity in Ukraine are proposed.

Keywords: Investments, Investment expenditure, Investment activity, Quasi-innovations.

1. Problem statement

Over the past three years, pro-Russian lobbyists have deliberately imposed a global public opinion, with the active participation of Russian leaders. It is that the Ukrainian economy was left no chance to develop after Euro Maidan and military confrontation with Russia. In fact, this should not be the case for the last three years but for 26 years of the existence of an independent state of Ukraine starting with the creation and functioning of Commonwealth of Independent States (CIS).

The analysis shows that CIS is a means of expansion of the Russian imperialism, bribing the local bourgeoisie of independent market countries by the Russian bourgeoisie and a means of transforming such market states first into satellites – a semi-colony, then into the colony of the Russian ruling elite and by the definition of the United Nations it is transformed into the grouping – "organized crime" of the ruling elite.

However, after the ratification of the EU-Ukraine Association Agreement on July 11, 2017, the reality is quite the opposite: after the association with the EU, Ukrainians certainly did not start living, as in developed European countries, however, the economy is slowly recovering and even in a number of sectors a dynamic growth continues.

Today, domestic enterprises are in a crisis due to the influence of such factors: lack of own financial resources, use of outdated technologies and equipment, as well as ineffective

use of the production potential. In order to develop the economy (primarily small and medium-sized businesses), the objectively necessary task is to increase opportunities for creating a favorable investment climate. This, in turn, will increase foreign investment promotion, introduction of new technologies and use of advanced foreign experience.

Actual scientific researches and issue analysis

The problem of foreign investment promotion to the domestic economy was attracted by such scholars as L. Sysoeva, N. Blyzniuk, O. Chemerys, T. Mayorova, A. Butenko, O. Pavlova, I. Maksymov, I. Sazonets, A. Fedorova, V. Khudaverdieva, O. Varyanychenko, V. Gridasov, M. Zhuk, S. Kryvchenko, I. Pavlenko and others. The writings of these scholars show the essence of investments, factors of creating favorable conditions for foreign investment promotion, different opinions on issues of investment attraction and directions of improvement of investment attractiveness. However, given the volatility of the business environment, importance of attracting investment into the economy and taking into account that the investment climate in Ukraine is not the best, the issue of attracting foreign capital in Ukraine is in the purview of scientists and needs further in-depth research.

The main purpose of the study is to identify a number of key issues that prevent the effective foreign investment promotion and development of measures to stimulate the development of investment activity in Ukraine.

2. Presentation of basic material of the research

The study results indicate that foreign investments can be direct and portfolio, when buying shares of the Ukrainian companies, and loans (under the column «other foreign investments»). At present, «other foreign investments» are the most significant. Then there are portfolio investments and the least amount is of direct investments (about 1.9 billion dollars a year). In general, in terms of foreign investment per capita, Ukraine is 5-10 times less than the post-socialist countries of Europe.

As a part of all investments in Ukraine, foreign investments account for less than 10% and do not play the role that they could have influencing our social and economic development. Such a lag in terms of foreign investment is primarily due to the rating of Ukraine which has not reached the lower bound of the investment rating yet. Restoring economic growth in Ukraine is one of the most important tasks of today's executive power. Political stabilization continues; important laws on labor, land and judicial system are implemented; there is further development of tax legislation, the adoption of the new Customs Code and so on. All this contributes to raising the rating of Ukraine.

Increasing the rating means the risk reduction when investing funds. Attracting investments depends not only on the risk degree but also the price of these investments and, above all, the interest rate on the loan. If our government operates purposefully, meeting the requirements of rating agencies, following the experience of China, Taiwan, South Korea which influences the rating increasing, the amount of foreign investments and, above all, direct ones, will grow several times and may amount to over 30% of all investments in the national economy.

The study results of the dynamics of foreign direct investment (FDI) in Ukraine over the last five years indicate negative changes in the investment activity of the country. According to the research results during the first 3 years, the annual growth of foreign direct investment in Ukraine was 9.6% in 2012 and 6.3% in 2013 which showed the largest cash inflow of investments in the amount of 57056.4 million dollars. This gave us hope for a positive prospect of cooperation with foreign investors. However, starting from 2014, the

situation with regard to investing foreigners in the Ukrainian economy has deteriorated. The volume of direct investment attraction decreased in 2014 by 19.8% and in 2015 by 7.1% compared to the previous period and amounted to only USD 42509.2 million in 2015, that is, the investment level decreased by 5% (in 2011-2015) by 13.2% [1].

It is proved that in many cases the significance of foreign investment is significantly increasing as they have a catalyst role and contribute to mobilization and domestic investment. FDI implementation is often associated with the formation of a new technology aimed at the production of a new product and thus the Ukrainian companies are involved in scientific and technological achievements of developed countries. Foreign investment implementation is largely carried out by the Ukrainian engineers and workers with a small number of specialists from abroad. Our specialists study and are involved in Western scientific, technical and business culture which in the future will positively influence the country's social and economic development.

Of course, the conditions fixed in the contract for long-term investments should not be deteriorated during the project implementation. Unfortunately, this rule did not work for us and the investor had uncertainty. He concluded the contract and later new conditions for attracting foreign labor and a tax on unfinished construction were introduced; customs duties on certain goods were increased; taxes on land and then on real estate were introduced and so on. As a result, a project that was considered highly profitable and then it turned out to be marginally profitable or even simply unprofitable.

To a greater extent, foreigners were shocked by the widespread practice of charging bribes in order to obtain certain permits for registration of activities, obtaining licenses, certificates, minimizing the number of inspections, etc. In Ukraine, unlike other countries, too many licensing functions are assigned to officials who often abuse their powers. Foreign businessmen absolutely do not tolerate the administrative oppression for an entrepreneur that has become typical in Ukraine and is carried out, first of all, by tax, customs and law enforcement agencies.

This unnecessary administration promotes imperfection or simply lack of a sufficient legislative framework. Unlike other countries in Ukraine, there are relatively few laws of direct action and, therefore, business life is regulated mainly not by laws but by departmental normative acts. The number of such acts is measured by thousands and it is difficult to follow them. They contradict each other, thus, there is a wide field for abuses in the application of these acts by certain state bodies and officials.

Of course, in a number of cases, one or another decision can be appealed in the court. However, the Ukrainian court remained dependent on the authorities and traditionally predominantly respects its interests, not private business. The ongoing judicial reform improves it but it should probably take a long time for the court to become truly non-corrupt and independent.

The insufficient legal literacy of our parliamentarians, many legal services, the apparatus of government and agencies preparing the law, leads to the fact that legislative acts adopted by the legislative power have not always been thoroughly worked out. They have a lot of ambiguities which are skillfully used by power structures and aggressive entrepreneurs who are trying to assign someone else's property. In particular, there are many gaps in the Law of «Ukraine On Bankruptcy». The problem is that the current regulation of bankruptcy procedures allows the debtor to evade fulfillment of their obligations to creditors and bankruptcy procedures remain opaque and too long.

The problem of corporate governance studies in Ukraine is now one of the most urgent areas of the modern economic research. Corporations in Ukraine do not cope with the role of a key link in our economy. A corporation is the most important institution of the modern

economy and it is an integral part of the government system. Therefore, a significant progress in the area of corporate law and corporate practice is important for Ukraine: transition of corporations to international accounting standards; introduction of transparency in activities; systematic reporting to shareholders; adoption of corporate codes and compliance with them.

It should be noted that the effectiveness of investments, both domestic and foreign ones, depends on their quality, what progressive technology is used and the investment resource volume. The technological progress is largely determined by the innovative direction of investment when it is used not for capacity building by old existing technologies but for the development of new and improved technologies.

The first phases associated with the appearance of new technologies are the most difficult in an innovative perspective. Their financing is the most risky and therefore there should be a high role of the state and venture risky funds. We do not have a system for investing innovations and venture funds are not absolutely developed. All this must be created. We have not developed an infrastructure for the formation of innovative firms, as well as technological incubators and technological parks. In fact, there is no state support and no innovation privileges.

In our opinion, it would be advisable to develop proposals for the creation of special innovation zones, scientific and technological towns with certain privileges. The concept of the development of such zones should be methodologically developed by.

The innovative growth itself is not a guarantee of genuine modernization of the national economy which involves not just some approximation to the leaders but also entry into their ranks. Hausman and Rodrick distinguish a special version of innovation. It is a quasi-innovation when the search is aimed at identifying opportunities for production of already known and widespread in the world markets product with lower costs in a given country [2]. The organization of such production often requires a lot of efforts to adapt the foreign technology to local features. If the quasi-identifier fails, he will have all losses. When he is successful, he can hardly rely on the patent protection and is forced to share his invention with other manufacturers who come to the new industry. As a result, the company-pioneer gets only a fraction of the effect of «opening» for the national economy of new industries which weakens incentives for quasi-innovation. If you use quasi-innovation, the growth will be limited to yesterday's technologies [3].

The government's task is not to introduce knowingly unprofitable quasi-innovation projects. It is necessary to monitor the ability of the national innovation system to create effectively not just new branches for the country but also to engage in a competition for the creation and development of fundamentally new production and sales markets.

However, the process of globalization of the world economy leads to the fact that different countries are drawn into competition on the basis of quasi-innovations. Consequently, the labor division in the world innovation space occurs spontaneously only partially. Generally it has a regulatory nature. Leading countries of the world technological development are conductors of this division of labor and seek to retain such role. For most countries with the transition economy, successful quasi-innovations are the positive result since the increase in the overall technological level of production, reduction of dependence on raw material exports and some development of the field of research and development work (RDW). According to M. Porter, techniques and technologies that are procured tend to be lagging behind the world's best specimens for a generation. International competition leaders do not usually sell the latest generation techniques [4]. The pursuing country, having access to the second-hand technology, can contribute to leakage or termination of its own breakthrough R&D which will lead the country to the technological inertia of its further development. This inertia becomes a barrier to the creation of truly new technologies which a consumer of quasi-innovations is trying to

introduce since a large part of the investment potential of the country is invested in quasi technologies.

The ability of the national industry to compete successfully in the field of quasi-innovations through the improvement of foreign techniques and technologies is a significant factor in mitigating negative effects of the technological duplication and the growth of competitiveness.

Deeper integration of Ukraine within the EU provides new opportunities for foreign investment promotion. The identification of mechanisms for the intensification of mutual direct foreign investment is of particular importance. According to many scientists, including Iety E.L., Stein E. and Daide K. [5], Salike N. [6], Naruli R.I. and Belak K. [7] and others, the influence of integration processes on directions and volumes of flows of foreign direct investment is distributed unevenly between countries-members of the integration association. It affects differences both in economic growth and improving the competitiveness of the country in the long run.

3. Conclusions

In our opinion, the absence of really big investment companies in Ukraine (for example, with hundreds of millions of dollars in capital) hinders the development of investment infrastructure. Therefore, their development is the main task of forming the common investment infrastructure in Ukraine.

The globalization of the world economy means strengthening the influence on our country from other countries which are not interested in Ukraine's withdrawal from the raw material orientation of the economy and strengthening its position in high-tech industries. High concentration of resources and high coordination of participants of the technological breakthrough will be needed to overcome the entry barriers in the latest industries. Neither the latter is guaranteed by market mechanisms, since there are defects («failures») in the operation of these mechanisms. Cooperation of the state, industrialists, business and scientific and technical centers, which jointly work out priorities of the economic development and improve its institutional conditions, help to overcome such defects. The innovation sphere is one of the most important spheres of cooperation between them. This partnership can become especially fruitful in the strategy of advanced commercialization of scientific inventions. Such strategy is quite realistic for Ukraine, given the fact that our country still possesses significant R&D. The ability of the national industry not only to apply but also to modernize fully foreign techniques and technologies is essential and sometimes it is a crucial requirement for the successful competition in the field of quasi-innovations.

However, if the economic policy is focused on borrowing foreign achievements as at the present time, this does not guarantee real modernization of the country. The nature of innovative targets is largely determined by existing economic institutions. To change these targets, significant changes are needed in the institutional sphere of the Ukrainian economy, namely: detailing institutional conditions that ensure the strengthening of the national innovation system; intensification of fundamental and applied research in our country at the expense of not only public but also private resources; effective interaction of the state and business in the field of practical implementation of these developments. And, of course, it is the actual direction of further strategy of developing conceptual foundations for the modernization of the Ukrainian economy.

Only adherence to such areas of the innovation activity will change the situation and the country will cease to be eternally catching up and be among the leaders of the world economy. If more ambitious goals of returning the country to the number of the leading world countries are considered, it is necessary to reconsider fundamentally the role of the state in

overcoming the economic backwardness behind the leaders of the countries. As follows from the foregoing, the realization of such goals can ensure the future of Ukraine and neutralize threats to its development.

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Packing Spheres into a Larger Sphere with the Jump Algorithm

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Abstract. The paper considers a mathematical model of the optimization problem of packing spheres into a larger sphere. Sphere radii are supposed to be variable. A new algorithm to derive starting points belonging to the feasible region of the problem is offered. According to the jump algorithm solving the problem is reduced to solving a sequence of mathematical programming problems yielding objective improvements. A solution strategy consisting of four stages is proposed. The first stage involves formation of starting points and computation of local minima. The second stage fulfills continuous transition from one local minimum to another. The third stage realizes reduction of the solution space dimension. The fourth stage rearranges sphere pairs to refine the objective. We provide a number of numerical results.

Keywords. Packing, Sphere, Optimisation, Jump algorithm.

1. Introduction

Medical applications of the unequal sphere packing problem in radiosurgery are studied in [1-3]. The gamma-rays are focused on a common center, creating a spherical volume of high radiation dose. A key geometric problem in gamma knife treatment planning is to fit balls into a 3*D* irregular-shaped tumor. In this situation, overlapping balls may cause overdose, and a low packing density may result in underdose and a non-uniform dose distribution.

In biological sciences, the study of chromosome arrangements and their functional implications is an area of great current interest [4]. The territory occupied by each chromosome can be modeled as an ellipsoid, different chromosomes giving rise to ellipsoids of different size. The enclosing ellipsoid represents a cell nucleus, the size and shape of which differs across cell types. Overlap between chromosome territories has biological significance: it allows for interaction and co-regulation of different genes.

The purpose of this report is to review the most common concepts of corporate sustainability in order to outline basic qualitative aspects of the most popular views. The ultimate goal is to find promising directions for building quantitative models of corporate sustainability at a later stage.

The most significant consideration is that these quantitative models had to be built on the basis of information available to the organization. This is information that is collected on a daily basis in corporate databases as a result of current activities. Sutou and Day [3] propose a global optimization approach to unequal sphere packing problems. The optimization problem is formulated as a nonconvex optimization problem with quadratic constraints and a linear objective function. Paper [5] offers a mathematical optimization method for packing unequal spheres into a cuboid based on the decremental neighborhood method and a local optimization method. An algorithm to pack unequal spheres in a larger sphere using tabu search, the quasi-

human basin-hopping strategy and the Broyden–Fletcher–Goldfarb–Shanno method is developed in [6]. A set of examples are calculated.

In this paper, we adopt the jump algorithm (JA) developed for unequal circle packing [7] to pack unequal sphere in a sphere of minimal radius. JA allows to transit from one local minimum point to another one so that the larger sphere radius decreases.

All given spheres

$$S_i = \{v_i \in \mathbf{R}^3 : (x - x_i)^2 + (y - y_i)^2 + (z - z_i)^2 - \hat{r}_i^2 \le 0\}$$

where $v_i = (x_i, y_i, z_i)$ are center coordinates of S_i, $i \in I = \{1, 2, ..., n\}$, have to be packed into a sphere

$$S = \{(x, y, z) \in \mathbf{R}^3 : x^2 + y^2 + z^2 - R^2 \le 0\}.$$

We suppose that the radius R ($R \geq \hat{r}_i$, $i \in I$) of S is variable.

A sphere S_i translated by a vector v_i and a sphere S with variable size R are denoted by $S_i(v_i)$ and $S(R)$ respectively. A vector $v = (v_1, v_2, ..., v_n) \in \mathbf{R}^{3n}$ defines an arrangement of S_i, $i \in I$, in the Euclidean 3-D space $\mathbf{R}^3$.

Without loss of generality, we suppose that

$$\hat{r}_1 \le \hat{r}_2 \le ... \le \hat{r}_n, \quad \hat{r}_1 < \hat{r}_n. \tag{1}$$

Problem. Find a vector v ensuring a packing of spheres $S_i(v_i)$, $i \in I$, without their mutual overlappings within the sphere S of the minimal radius R^*.

2. Mathematical Model

A mathematical model of the problem can be stated as

$$R^* = \min R, \text{ s.t. } Y = (\mu, v) \in W \subset \mathbf{R}^{3n+1} \tag{2}$$

where

$$\begin{aligned} W = \{Y \in \mathbf{R}^{3n+1} : \Phi_{ij}(v_i, v_j) \ge 0,\ 0 < i < j \in I, \\ \Phi_i(v_i, R) \ge 0,\ i \in I\}. \end{aligned} \tag{3}$$

Here $\Phi_{ij}(v_i, v_j) = (x_i - x_j)^2 + (y_i - y_j)^2 + (z_i - z_j)^2 - (\hat{r}_i + \hat{r}_j)^2 \ge 0$ ensures non-overlapping spheres S_i and S_j, $\Phi_i(v_i, R) \ge 0$ provides a placement of $S_i(v_i)$ within $S(R)$ and $\Phi_i(v_i, R) = -x_i^2 - y_i^2 - z_i^2 + (R - \hat{r}_i)^2$.

The mathematical model (2)–(3) possesses the same characteristics as that of the mathematical models considered in [8], i.e. local minima are reached at extreme points of W the matrix of the inequality system in (3) is strongly sparse, the problem stated is NP-hard.

Thus, in general, a global minimum of the problem can be reached but only in a theoretical manner.

Consequently, for successfully solving problem (2)–(3) it needs to be able to construct starting points belonging to the feasible region W, to compute local minima and to derive an effective non-exhaustive search for local minima.

3. Searching for Local Minima

Primarily, we suppose that radii r_i of spheres S_i, $i \in I$, are variables and form a vector $r = (r_1, r_2, ..., r_n) \in \mathbf{R}^n$. In the case, the inequalities in system (3) take the form

$$\Phi_{ij}(v_i, v_j, r_i, r_j) \geq 0,\ 0 < i < j \in I,\ \Phi_i(v_i, r_i, R) \geq 0,\ i \in I.$$

Thus, $X = (v, r) \in \mathbf{R}^{4n}$ is the vector of all variables.

Let $R = R^0 > 0$. We form a point $X^0 = (v^0, 0)$ so that $v_i^0 \in P(R^0)$, $i \in I$, i.e. points $v_i^0 \in \mathbf{R}^3$, $i \in I$, are randomly thrown in the sphere $P(R^0)$.

In order to construct a point $(v, R^0) \in W$ on the ground of the point (v^0, R^0) we solve the problem

$$\Psi(\hat{r}) = \max \sum_{i=1}^{n} r_i \text{, s.t. } X = (v, r) \in D \subset \mathbf{R}^{4n}, \tag{4}$$

where

$$\begin{aligned} D = \{X \in \mathbf{R}^{4n} : & \Phi_{ij}(v_i, v_j, r_i, r_j) \geq 0,\ 0 < i < j \in I, \\ & \Phi_i(v_i, r_i, R^0) \geq 0, \phi_i(r_i) = \hat{r}_i - r_i \geq 0, \\ & r_i \geq 0,\ i \in I\}. \end{aligned} \tag{5}$$

It follows from the construction of X^0 that $X^0 \in D$. So taking starting point X^0 we tackle problem (4)–(5) and obtain a local maximal point $\hat{X} = (\hat{v}, \hat{r})$.

Note that in addition to the characteristics of problem (2)–(3), problem (4)–(5) possesses the properties:

(i) Inequalities $\phi_i(r_i) \geq 0$, $i \in I$, in (5) imply that if

$$\Psi(\hat{r}) = \sum_{i=1}^{n} \hat{r}_i = \sum_{i=1}^{n} \hat{r}_i = b,$$

then $\hat{r} = \hat{r}$ and spheres S_i, $i \in I$, are packed into $S(R^0)$. This means the point $\hat{X}$ is a global maximal point of problem (4)–(5).

(ii) If $\Psi(\hat{r}) < b$, and $\hat{X}$ is a global maximal point of problem (4)–(5), then spheres S_i, $i \in I$, can not be packed into $P(R^0)$.

Depending on R^0 two cases can be found:

i. $\Psi(\hat{r}) = b$ and ii. $\Psi(\hat{r}) < b$.

It follows from item (i) that $(\hat{v}, R^0) \in W$ if $\Psi(\hat{r}) = b$. The point $(\hat{v}, R^0)$ is not in the general case a local minimal point of problem (2)–(3). So, taking starting point $(\hat{v}, R^0)$ we calculate a local minimal point $(\breve{v}, \breve{R})$ of problem (2)–(3) regarding the interaction of the placed spheres.

Let $\Psi(\hat{r}) < b$. Then we either choose $X^0 = (v^0, 0)$ in a random way again and solve sequentially problems (4)–(5) and (2)–(3) or try to execute a transition from $\hat{X}$ to $\hat{\hat{X}}$ so that $\Psi(\hat{\hat{r}}) > \Psi(\hat{r})$.

4. Solution strategy

To compute a local minimum of problem (2)–(3) we derive a step by step procedure that includes tackling problems (2)–(3) and (4)–(5). Primarily, we choose $R = R^0$ guaranteeing an arrangement of spheres S_i of radii $\hat{r}_i$, $i \in I$, into the sphere $S(R^0)$. Then we take a point $X^0 = (v^0, 0)$ in a random way so that $v_i^0 \in S(R^0)$, $i \in I$, and, using starting point X^0, solve problem (4)–(5). As a result, a local maximal point $\hat{X} = (\hat{v}, \hat{r})$ is found. Because of the choice $R = R^0$ we always have $\Psi(\hat{r}) = b$, i.e. $\hat{r} = \hat{r} = (\hat{r}_1, \hat{r}_2, ..., \hat{r}_n)$. This means that $(\hat{v}, R^0) \in W$. So, taking a starting point $(\hat{v}, \mu^0)$, we solve problem (2)–(3) and calculate a local minimal point $(\breve{v}^0, \breve{R}^0)$.

The jump algorithm (JA) permits to execute a continuous transition from a local maximal point of problem (4)–(5) to another one ensuring an increase of $\Psi(r)$.

Let $\hat{X} = (\hat{v}, \hat{r})$ be a local maximal point of the problem (4)–(5) and $\Psi(\hat{r}) = \sum_{i=1}^{n} \hat{r}_i < b$ i.e. at least one of the inequalities $\hat{r}_i - \hat{r}_i \geq 0$, $i \in I$, is not active. We formulate the auxiliary problem

$$\max V(r) = \sum_{i=1}^{n} r_i^3, \text{ s.t. } X \in M \subset \mathbf{R}^{4n}, \tag{6}$$

$$M = \{X \in \mathbf{R}^{4n}: \Phi_{ij}(v_i, v_j, r_i, r_j) \geq 0,\ 0 < i < j \in I,\ \Phi_i(v_i, r_i, R^0) \geq 0,\ \psi_{1i}(r_i) = r_{\max} - r_i \geq 0,\ \psi_{2i}(r_i) = -r_{\min} + r_i \geq 0,\ i \in I\}, \tag{7}$$

where $r_{\max} = \max\{\hat{r}_i,\ i \in I\}$ and $r_{\min} = \min\{\hat{r}_i,\ i \in I\}$.

Now, let $(\breve{v}^0, \breve{R}^0)$ be a local minimal point of problem (2)–(3). We compute

$$r_i^\lambda = \hat{r}_i - (\frac{1}{2})^{\lambda+2} \hat{r}_i = \hat{r}_i (1 - (\frac{1}{2})^{\lambda+2}),\ i \in I,\ \lambda = 0,1,....$$

and assume that sphere radii are equal to r_i^λ, $i \in I$. Then problem (2)–(3) takes the form

$$\breve{R} = \min R \text{ s.t. } Y = (v, R) \in W^\lambda \subset \mathbf{R}^{3n+1}, \tag{8}$$

where

$$W^\lambda = \{Y \in \mathbf{R}^{3n+1}: \Phi_{ij}^\lambda(v_i, v_j) \geq 0, 0 < i < j \in I,\ \Phi_i^\lambda(v_i, R) \geq 0,\ i \in I\},$$

$$\Phi_{ij}^\lambda(v_i, v_j) = \left\| v_i - v_j \right\|^2 - (r_i^\lambda + r_j^\lambda)^2,$$

$$\Phi_i^\lambda(v_i, \mu) = -x_i^2 - y_i^2 - z_i^2 + (R - r_i^\lambda)^2.$$

Since $r_i^{\lambda} < \hat{r}_i,\ i \in I,$ then the point $(\breve{v}^0, \breve{R}^0) \in W^{\lambda}$ and $(\breve{v}^0, \breve{R}^0)$ is not a local minimal point of problem (8). So, taking starting point $(\breve{v}^0, \breve{R}^0)$, we solve problem (12) and define a local minimal point $(\breve{\breve{v}}^0, \breve{\breve{R}}^0)$. Since $\sum_{i=1}^{n} r_i^{\lambda} < b$, then, tackling problem (4)–(5) for starting point $X^0 = (\breve{\breve{v}}^0, r^{\lambda}) \in D$, we compute a local maximal point $\hat{X}^{\lambda} = (\hat{v}^{\lambda}, \hat{r}^{\lambda})$. Two cases are possible: $\Psi(\hat{r}^{\lambda}) = b$ and $\Psi(\hat{r}^{\lambda}) < b$.

If $\Psi(\hat{r}^{\lambda}) = b$, then $\hat{r}_i^{\lambda} = \hat{r}_i,\ i \in I,$ and hence $(\hat{v}^{\lambda}, \breve{\breve{R}}^0) \in W$. Since the solution spaces of problems (2)–(3) and (4)–(5) are different, then $(\hat{v}^{\lambda}, \breve{\breve{R}}^0)$ in general is not a local minimal point of problem (2)–(3). So, taking starting point $(\hat{v}^{\lambda}, \breve{\breve{R}}^0)$, we solve problem (2)–(3). As a result, a new local minimum point $(\breve{v}^1, \breve{R}^1)$ is computed. In this case a local minimal point $(\breve{\breve{v}}^1, \breve{\breve{R}}^1)$ of problem (8) for the starting point $(\breve{v}^1, \breve{\mu}^1)$ is computed again, and so on until $\Psi(\hat{r}^{\lambda}) < b$ becomes, i.e. we have $\sum_{i=1}^{n} \hat{r}^{\lambda} < b$, $\hat{X}^{\lambda} = (\hat{v}^{\lambda}, \hat{r}^{\lambda})$ and $(\hat{v}^{\lambda}, \breve{\mu}^{\lambda}) \notin W$ after λ iterations.

In this situation ($\Psi(\hat{r}^{\lambda}) < b$) we compute the steepest ascent vector Z^0 at the point $\hat{X}^{\lambda}$ for problem (6)–(7), define $\gamma = m$, construct a point $X^m = (v^m, r^m) \in D$ according to (8) and the ascending sequence (see (1))

$$r_{i_1}^m \le r_{i_2}^m \le .... \le r_{i_n}^m . \tag{9}$$

Since $V(r^m) > V(\hat{r})$ may occur, then, making use of sequence (9), we compute $r_{i_j}^{m0} = \min\{r_{i_j}^m, \hat{r}_j\},\quad j \in I.$ This ensures the inequality $V(r^{m0}) \le V(\hat{r})$ where $r^{m0} = (r_1^{m0}, r_2^{m0}, ..., r_n^{m0})$. Based on sequence (9), we construct two points: $\tilde{\tilde{X}}^m = (\tilde{v}^m, \tilde{\tilde{r}}^m)$ where $\tilde{v}_j^m = v_{i_j}^m,\ \tilde{\tilde{r}}_j^m = r_{i_j}^{m0},\ j \in I$, and point $\tilde{X}^m = (\tilde{v}^m, \tilde{r}^m)$ where $\tilde{v}_j^m = v_{i_j}^m,\ \tilde{r}_j^m = r_{i_j}^m,$ $j \in I$.

If $V(\hat{r}) > V(\tilde{\tilde{r}}^m) > V(\hat{r}^{\lambda})$, then the new steepest ascent vector Z^0 at the point $\tilde{X}^m$ for problem (6)–(7) is calculated. Taking $\hat{X} = \tilde{X}^m$, we build a new point $X^m = \hat{X} + (1/2)^m Z^0$ and construct new points $\tilde{\tilde{X}}^m = (\tilde{v}^m, \tilde{\tilde{r}}^m)$ and $\tilde{X}^m = (\tilde{v}^m, \tilde{r}^m)$ in accordance with sequence (13), and so on. The iterative process is continued until either $V(\tilde{\tilde{r}}^m) = V(\hat{r})$ or $V(\tilde{\tilde{r}}^m) \le V(\hat{r}^{\lambda}) < V(\hat{r})$ occurs.

If $V(\tilde{\tilde{r}}^m) = V(\hat{r})$, i.e. $\tilde{\tilde{r}}_i^m = \hat{r}_i,\ i \in I,$ then taking starting point $(\tilde{v}_i^m, \breve{R}^{\lambda})$, we tackle problem (2)–(3) and calculate a new local minimal point $(\breve{v}^0, \breve{R}^0)$. The process is repeated until $V(\tilde{\tilde{r}}^m) \le V(\hat{r}^{\lambda}) < V(\hat{r})$ becomes.

Reduction of the solution space dimension is realized by means of sequencial fixing initial values of sphere radii without fixing their center coordinates.

To the aim we take the point $\tilde{X}^m$, single out $\tilde{r}_i^m > \hat{r}_i$, $i \in I^1 \subset I,$ and calculate

$\delta^1 = 4/3 \cdot \max\{(\tilde{r}_i^m)^3 - (\hat{r}_i)^3,\ i \in I^1\}$.

Let δ^1 correspond to radius $\hat{r}_t$. Hence, δ^1 is an increment of volume of the sphere S_t when varying its radius from $\hat{r}_i$ to r_t^m . This means that if $r_t = \hat{r}_t$, then there is a volume reserve around the sphere S_t . In order to use the reserve we fix radius $r_t = \hat{r}_t$ and derive a point $\tilde{X}^{m1} = (\tilde{v}^m, \tilde{r}_1^m, \tilde{r}_2^m, ..., \tilde{r}_{t-1}^m, \tilde{r}_{t+1}^m, ..., \tilde{r}_n^m) \in \mathbf{R}^{4n-1}$, i.e. r_t is no longer a variable and, hence, the dimension of the solution spaces D and M decreases by 1. Then, taking starting point $\tilde{X}^{m1}$ we realize JA in the space $\mathbf{R}^{4n-1}$. If

$$V(\tilde{r}^{m1}) = V(\hat{r}) = \sum_{i=1}^{n} (\hat{r}_i)^3,$$

then we take starting point $(\tilde{v}_i^{m1}, \breve{R}^{\lambda})$, tackle problem (2)–(3) and calculate a new local minimal point $(\breve{v}^0, \breve{R}^0)$. If $V(\tilde{r}^{m1}) < V(\hat{r})$, we continue to reduce the solution space dimension. If $V(\tilde{r}^{m1}) < V(\hat{r})$ and all spheres $S_i,\ i \in I^1 \subset I,$ are exhausted, we increase λ by 1 and realize JA again. The process is continued until $(1/2)^{\lambda+2} \hat{r}_i < \varepsilon,\ i \in I$.

After that we take the local minimal point $(\breve{v}^0, \breve{R}^0)$ of problem (2)–(3) and rearrange sphere pairs whose radii are slightly distinguished. This allow to improve the objective value of problem (2)–(3). An algorithm executing such rearrangements is described in [9].

In order to obtain a good approximation to a global minimum of problem (2)–(3) we repeat the step-by-step procedure consisting of the construction of a starting point and the search for a local minimum of problem (2)–(3) with JA ν times. As a result local minimum points $(v^{*t}, R^{*t}),\ t \in T = \{1, 2, ..., \nu \le 10\}$ are computed.

Then we single out a local minimal point (v^{*0}, R^{*0}) corresponding to $R^{*0} = \min\{R^{*t}, t \in T\}$. The point (v^{*0}, R^{*0}) is taken as an approximation to a global minimum of problem (2)–(3).

5. Numerical Examples

In order to verify effectiveness of JA, we solve the benchmark instances for packing spheres into a sphere considered in [6].

We compare results of packing spheres $r_i = i$, $i = 1, 2, ..., n$, into a larger sphere calculated by the algorithm [6] and JA. In Table 1, the first and the second column give example names and numbers of spheres to be packed. The third and the forth column summarize the best values of radii obtained in [6] (R_H) and with JA (R^{*0}). The percentage of improvement of JA against the best known results is shown in the last column. The calculation time by means of JA varied from 10 seconds to 12 hours depending on the number of spheres.

Illustration for ZHXF33 is shown in Fig. 1.

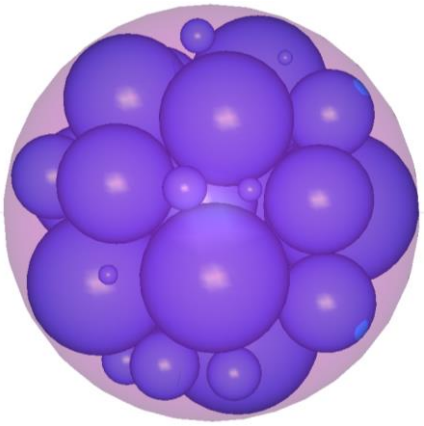

Fig. 1. Example ZHXF33

Table 1. Results of packing spheres of radii $r_i = i$ into a sphere

Example	n	R_H	R^{*0}	improve
ZHXF16	16	33.6582	**33.6572**	0
ZHXF17	17	36.2030	**36.2021**	0
ZHXF18	18	**38.8463**	38.8467	-0
ZHXF19	19	**41.5452**	41.5462	-0
ZHXF20	20	44.2737	**44.2557**	0.04
ZHXF21	21	47.0342	**47.0332**	0
ZHXF22	22	49.9068	**49.8666**	0.08
ZHXF23	23	52.8368	**52.7425**	0.18
ZHXF24	24	55.7546	**55.5782**	0.32
ZHXF25	25	58.4684	**58.4665**	0
ZHXF26	26	61.4745	**61.3883**	0.14
ZHXF27	27	64.4854	**64.4141**	0.11
ZHXF28	28	67.4837	**67.4173**	0.1
ZHXF29	29	70.5257	**70.3911**	0.19
ZHXF30	30	73.4813	**73.3704**	0.15
ZHXF31	31	76.5336	**76.5057**	0.04
ZHXF32	32	79.8018	**79.6075**	0.24
ZHXF33	33	83.1967	**82.8314**	0.44
ZHXF34	34	86.2430	**85.9206**	0.37
ZHXF35	35	89.3454	**89.1536**	0.21
ZHXF40	40	-	**105.6146**	-
ZHXF50	50	-	**140.7613**	-
ZHXF60	60	-	**178.1920**	-
ZHXF70	70	-	**217.0801**	-
ZHXF80	80	-	**258.4230**	-
ZHXF90	90	-	**300.9910**	-
ZHXF100	100	-	**345.5416**	-

The Interior Point Optimizer (IPOPT) exploiting information on Jacobians and Hessians [10], and the concept of ε -active inequalities [8,11] are used when tackling problems (2)–(3), (4)–(5) and (6)–(7).

6. Conclusion

Algorithm JA is effective to solve the sphere packing problems and improves known results for benchmark. The algorithm is especially effective if neighbor initial radii of spheres (half-axes of ellipsoids) in the sequence (1) are slightly distinguished.

A decrease of the problem dimension by means of sequential fixing sphere radius values sometimes permits to improve the objective values of problem (2)–(3).

The algorithm can be adopted to solve the problem of packing spheres and homothetic ellipsoids in containers of more compex geometric shapes.

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Implementation of the Academic Integrity in Higher Educational Institutions of Ukraine

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Abstract. The existence of the legislative basis in the country and moral readiness of the academic community to implement the principles of the students' academic integrity in the process of education in Ukraine's higher educational institutions have been determined. With the aim of establishing the level of academic dishonesty, a sociological survey which takes into account the gender aspect among the second-year students and graduates and highlights the problematic issues of this institute implementation in Ukraine was carried out. To ensure the quality of education and the implementation of the relevant ethical principles in society, a system of measures to improve academic integrity in Ukrainian educational institutions has been proposed.

Keywords. Academic honesty, Academic dishonesty, Sociological survey of students, Quality of education, Ukraine's higher educational institutions.

1. Introduction

The current level of the society and academic environment development requires the establishment of the academic integrity institute as a set of ethical principles which obliges to respect the authorship of scientific works and adhere to the certain rules of their use. It has arisen in response to the knowledge development of humanity, the complication of educational space and is associated with the emergence of the intellectual property rights. The consolidation of the intellectual property rights became relevant with the distribution of book printing and acquired special significance during the information computer revolution of the 20th century. The rapid and easy access to scientific information has led to a significant complication of the intellectual property rights protection and the necessity to develop a social attitude and academic vision of the right use of intellectual work of the other authors in research and teaching. In view of this, the academic integrity institute has appeared, so the topic is relevant and requires further theoretical and practical development.

2. Academic integrity in higher educational institutions: An overview

The issues of the academic integrity principles establishment are dealt with by many domestic and foreign scholars. The state of academic integrity and systematic manifestations of the academic dishonesty were studied by Ray M. Jones [1]. The Alison Kirk's research [2] substantiates the need to unite the efforts of an academic community in improving the quality of education through solving the problem of the scientists, teachers and students' dishonest behaviour. Also, a set of values shaping the personal teachers and students' integrity is considered.

The acute need for the academic integrity introduction in higher education is substantiated in the Romakin's V.V. [3] scientific works. Melnichenko A. A. [4] has paid much

attention to the definition of the basic concepts and principles of academic integrity in order to improve the quality of education. Buiak B. [5] has researched the legal aspects of academic integrity and the fight against plagiarism. Kalynovskyi Yu.Yu. [6] considered academic integrity as a factor of the youth's legal education. Finikov T. [7] researched the basic notions, factors and principles of improving the quality of higher education on the basis of the academic integrity introduction. Laura Teodora David [8] researched the level of academic dishonesty among the students Transylvania University of Brasov) in Romania.

However, the issue of academic integrity in the national system of education has not been covered sufficiently taking into account the changes occurring in the people's minds.

The paper objective is to determine the readiness of the Ukrainian academic environment for changes in relation to the issue of the academic integrity enrooting as a system of people's values and their behaviour patterns.

3. Conducting sociological research among the students to determine their readiness for the implementation of the academic integrity principles

In the Ukrainian academic environment, the issues of academic integrity are not sufficiently regulated, although the necessary legislative framework has already been created. The Law of Ukraine "On Higher Education" establishes the consequences of the plagiarism revealing in the dissertation thesis (article 6), the need to provide an effective system for the academic plagiarism preventing and revealing in the scientific works of the higher education staff and higher education graduates (article 16) in order to insure quality of education, the principles of autonomy of higher educational institutions. Article 42 of the new law "On Education" is devoted to the issues of adherence to academic integrity by the pedagogical and academic staff, as well as by the students.

The process of the honest academic environment creating is complicated by the fact that in Ukrainian higher educational institutions, there is a certain teachers' tolerance to the students' plagiarism while they perform their educational tasks. Thus, 62% of the teachers interviewed tend to accept the educational tasks with the evident plagiarism, taking into account different circumstances of their preparation.

In order to reveal the students' attitude to the academic dishonesty manifestation and their readiness for changes, a social survey that included 87 respondents of the second- and fourth-year was carried out. The average age of the respondents was 20.4 years (with a minimum of 19 years and a maximum of 22). The used sampling of the respondents was balanced by gender (40 boys and 47 girls). The participants filled in six questionnaires, keeping anonymity. All respondents' questionnaires were accepted. The gender aspect was taken into account.

The values of the positive and negative responses were calculated according to the varied samplings. Let the number of samplings (groups) be equal to L, L = 2 (the responses of boys and girls were handled separately). The percentage of the positive responses (for the students of the younger courses) will be calculated by the formula:

$$x_i^p = \left(\frac{\sum_{i=1}^{n} xi * 100}{ni} + \frac{\sum_{j=1}^{n} xj * 100}{nj}\right)/2$$

where:

n_i – is a number of students (females) of the corresponding i^{th} group;

n_j – is a number of students (males) of the corresponding j^{th} group.

The results of the study showed that the issue of academic integrity has not yet been actualized among the academic youth, that is, there is a weak public position. Thus, 56% of the second-year students and 43% of the fifth-year students have never thought about the need to adhere to academic honesty.

There are many students who believe that there are circumstances when a coursework or diploma thesis can be purchased and presented for defence in the student's own name, which is presented in Table 1.

Table 1. The answer to the question "Are there any circumstances when a coursework or diploma thesis can be purchased and presented for defence in the student's own name?"

Response	**Yes**	**No**	**Have not thought of this**
	according to the year of study		
2-nd year students	38 %	31 %	31 %
Graduates	71 %	14 %	14 %
	according to the gender		
Females	54,5 %	22,8 %	22,8 %
Males	46,2 %	46,1 %	7,7%

As can be seen from Table 1, the elder the students, the higher the level of tolerance to such kind of the serious academic dishonesty manifestation is, which demonstrates the peculiarities of the national educational system and the socio-economic development of the country as a whole. Most undergraduate students are already forced to work despite the need to balance the work-study time which is detrimental to the students' progress.

The answers to the question "Have you ever provided a purchased coursework or diploma thesis for defence?" are presented in Table 2.

Table 2. The answer to the question "Have you ever done it yourself?"

Response	**Yes**	**No, it is unacceptable to me**	**No, but if the need arises, I can do this**
	according to the year of study		
2-nd year students	19 %	38 %	44 %
Graduates	22 %	33 %	44 %
	according to the gender		
Females	20,5 %	34,4 %	44,1 %
Males	20 %	50 %	30%

As can be seen from Table 2, this kind of the academic dishonesty manifestation took place in the educational process of 19% of the second-year students and 22% of the fifth-year students. However, the fact that 44% of the respondents admit the possibility of such behaviour, gives an evidence of the still unstable state of the students' consciousness regarding personal integrity in studying. A study of this issue among the Romanian students showed that 30% of students sometimes bought course works, the tasks for self-study (ready-made papers) [8].

It is interesting to observe that the percentage of the dishonest behaviour among the girls and boys is the same and equals 20%. However, the number of girls for whom such behaviour is unacceptable is less than 12% compared to the number of boys who have solid principles in this regard.

Taking into account the mentality of the Ukrainians, such academic dishonesty as copying down is difficult enough to deal with, since mutual supportiveness and assistance, even at the expense of oneself, are commonplace. The answer to the question "Have you ever copied down from a fellow student during the tests or exams?" is presented in Table 3.

Table 3. The answer to the question "Have you ever copied down from a fellow student during the tests or exams?"

Response	**Yes**	**No**
	according to the year of study	
2-nd year students	75 %	25 %
Graduates	86 %	14 %
	according to the gender	
Females	80,4 %	19,5 %
Males	84,6 %	15,4 %

As can be seen from Table 3, the gender aspect has little influence on this manifestation of academic dishonesty. However, there is a tendency for this indicator to increase during the senior courses, because 75% of the second-year students and 86% of the fifth-year students were copying down during the students' knowledge assessment. This practice is adopted from the secondary schools and is a confirmation of the friendly relations among the students. Therefore, it is important that such kind of the academic dishonest manifestation be eradicated by the social effort.

The survey among the students reflects the well-known problems of the unsatisfactory state of academic ethics in higher educational institutions of Ukraine and the state of a society, including a corruption component that destroys the moral basis of the life of the Ukrainian population. However, the academic community is almost ready for change, as 59% of the students believe that it is necessary to change the worldview and carefully use the intellectual work of others, while 31% believe that this is not possible for our mentality.

However, it should be noted that the problems connected with academic ethics exist not only in developing countries but in developed countries as well. Thus, the study of the International Centre for Academic Integrity (USA), which lasted from 2002 to 2015, showed that 43% of the graduate students and 60% undergraduates were cheating during the tests and exams [9].

4. Conclusion

The advance of academic integrity in Ukrainian higher educational institutions is possible by combination of the efforts of the state, society, academic community and each participant of the educational environment in particular.

To achieve academic honesty, it is necessary:

- to create a public opinion that it is necessary to adhere to the principles of academic integrity as a system of values which are established while studying at the secondary and higher educational institutions;

- to teach the students to be guided by the principles of honesty, honest work in the process of learning or research;
- to give information literacy classes at schools and universities;
- to enroot the idea that plagiarism, copying, unauthorized use of the other people's works is unfair and unacceptable in the educational environment;
- to raise a teacher and a lecturer's status, forming on this basis a conscientious attitude towards work and responsibility towards its results;
- to adopt the codes of academic integrity in scientific and educational institutions.

In such a way, the academic integrity introduction in the world is unequal to the peculiarities of the historical development of the society and the national systems of education of different countries. However, the formation of the united European academic space provides an incentive to accelerate the process of establishing and ensuring the quality of education on the basis of the implementation of a number of principles, including the guarantee of the honest behaviour of the education community participants. This will contribute to the changes not only in the sphere of the higher education system, but also the transformation of public values the carriers of which will be the graduates and students of the higher educational institutions.

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About the Role of Cloud Computing Data Processing and Blockchain Technology for Accountants and Auditors

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Abstract. In new era of technological revolution, it's become harder to organize and process data especially financial data, this paper describe the opportunities for auditors and accountants in the field of digital economy and help to understand the perspectives of their work in new technological environment such as could system and blockchain technologies.

Keywords. Cloud computing data processing, Blockchain, Audit, Digital economy

1. Introduction

With the transition from an economy based on human force, to an economy based on information, automation of processes and technologies become unstoppable, the data becomes the main value by itself.

As all known fact that the main tasks for any audit or consulting company is to attract new customers and earn a good reputation for themselves, but in our days enterprises and small business began to use more often cloud solutions to organize and storage of their data, as a result the prosses of automation of data processing can reduce the number of jobs in the financial sector, but how far as it is certain?

At the same time, last year's study by the International Association of Management Accounting Specialists (CIMA) revealed that companies are still very reluctant to resort to cloud computing, since, according to the majority (66%), data security has the highest priority. Only 25% of the companies out of a hundred implemented cloud technologies in their business systems, 19% apply them for financial reporting purposes, and 34% use it for Managerial Accounting [1].

The main prerogative of such companies is the ability to keep track of **client's business documents** at any time for better understanding of their financial situation, and it is good that day by day more enterprises are starting to organize their bookkeeping in cloud systems such as Xero, Pandle or 1C Cloud. In such approach all processes are automated, which greatly simplifies the case, in particular, with regard to the calculation of monthly wages of a staff.

The goal of this paper is to provide a possible vision on how can be realized an audit and account business in the next 10 years, and to show a perspective of developing of their workflow processing in the new technological areas such like could computing data process and blockchain technologies.

The paper is organized as follows, section 2 reviews the key concepts of cloud computing data processing and blockchain technology. Section 3 presents a business model of accountants and auditor's activities in the perspective of CCDP and block technology, Finally, Section 4 concludes this paper with the consequences of possible predictions of further development of business in these areas.

2. Definition of cloud computing data processing and blockchain technology

The main prerogative of every intelligent technology is an aptitude to organize and process data. Every year the data volumes are being processed and store by cloud systems but it is practically unreal for a human to process such massive data storage manually if it is necessary to make some analytical decisions so this dilemma result in two questions:

a) How can be organize the storage of data more effectively?

b) How this data can be processed more effectively?

As a solution can be used two technologies which, where actively evolving a few last years is a **blockchain technology** and **cloud computing data processing**.

The organization of data storage in a decentralized way can be developed in a several ways, as one of them is to storage data directly in Bitcoin blocks [2], this is the most ingenious way, in any case it solves the problem of decentralized storage, because the copy of every block of chains with data can be stored by anyone and cannot be changed.

Data can be encrypted, by using any cryptographic algorithm, so that anyone that supports storage can store a copy of encrypted data, but only a person with a private key would have access to it. But the chains of blocks (ex. Bitcoin) were not designed to handle large volumes of data. Their purpose is quite simple to storage transaction logs, even with such a small load, the bitcoin chain of blocks has reached over the last couple of years, the size of 38 GB [2]. Uploading data into a chain of blocks, force Bitcoin miners to store our data for free, depriving them of the incentive to maintain the network, because their costs start to exceed revenues. This solution looks already threatening, but the evolution of communication channels with light speed makes possible that tomorrow can be discovered a new era of data dissemination, in which data sets in a few petabytes will become commonplace. Storage data in the chain of blocks is not the best way to organize a reliable decentralized storage of data in the short term but it can be used as a start point for developing a new digital environment for data storing.

As a second one could be used a method to storage of data in a **distributed hash table (DHT)**. These tables distribute data copies and indexing functions that provide data retrieval and ensure reliability. The first truly effective implementation of DHT was the BitTorrent protocol. It is still used by more than 300 million users. Despite the decentralized storage of data (BitTorrent, Mainline DHT), it still depends on the performance of centralized trackers that are monitoring the network. As a second part in developing and scalability of decentralized data storage, can be used the new data transfer protocol know as **Interplanetary File System (IPFS)** [3].

Now when, there is a general idea of how data can be stored in a decentralized form it is time to comprehend how this data can be processed in a new way without a need to download and store it on a static machine for processing. If it can be assumed that all data of enterprises is being store in cloud or block chains then it is logical to process this data ibidem.

The best solution for such task is a **cloud computing data processing** (CCDP) and here should be highlighted the difference between cloud computing data processing and **SaaS** (software as a service) which practically represents a software which can be rented and can be accessed remotely to execute practical need of a client. The CCDP can be represented as an algorithm that process **Big Data** in the publication of the journal of Science 2008, “Big Data” is defined as “Represents the progress of the human cognitive processes, usually includes data sets with sizes beyond the ability of current technology, method and theory to capture, manage, and process the data within a tolerable elapsed time” [4]. As well the definition of big data as also given by the Gartner: “Big Data are high-volume, high-velocity, and/or high-variety

information assets that require new forms of processing to enable enhanced decision making, insight discovery and process optimization" [5]. It's too much in volume to describe a new paradigm of a new global network based on blockchain technology but for better understanding could be presented **Blockchain-Based Decentralized Cloud Computing** known as iExec [6].

3. A business model of accountants and auditor's activities in the perspective of CCDP and block technology

Analyzing the state of the economy at current date, can be confidently confirmed that all operations of an economic and social nature are carried out exclusively in a virtual environment. Namely, searching for new partners for business, searching for goods in internet, their purchase, the taxes payments, dating in social networks, work activities. All important for the existence of humanity, economic relations are being produced in a virtual environment, for business this mean, most likely the next, that the former corporate structures will not work efficiently in the new digital economic environment, or even disappear. Considering this fact, can confidently assume that in the near future almost all current economic structures will be transferred in the virtual environment, and in our case, these will be enterprises that will be transformed into a new form of a digital enterprise.

The main features of a digital enterprise are as follows:

1.The enterprise exists exclusively in a virtual environment - this means that the enterprise is no longer legally bound to any country and is an independent structure in principle. "The term of virtual environment will be considered later".

2.Employees participating in the work of the enterprise and in its business processes can be located absolutely on any spot in the world.

3.Organization of work of employees and all relationships both in the enterprise itself and with other enterprises that are included in a virtual environment are carried out exclusively virtually with the exception of logistics.

Below is a schematic drawing that demonstrates exemplary relationships in a virtual environment. But first, for better understanding, must be explained the concept of virtual environment.

Virtual Environment - is a collection of network environment, network protocols and communication channels that establish interconnections of any unit that can access the virtual environment and here must be mentioned a fact what this environment can exist like under level of some sort of network like internet or blockchain based network or it can be developed like independent network that can be accessed throw internet or other communications channels.

As it shown in next figure, it's an example where users in our case accountants or auditors wish to make an analytical report based on data of several enterprises in classical case the data must be collected in particular from every enterprise but it is simple enough to admit that here can be applied a new concept where an account or audit make a request to a specific algorithm that's work in a virtual environment with a number of criteria that must be selected. The algorithm accesses the data that is based in cloud and analyze it when the requested criteria is found the algorithm send a result to user. To show the exclusivity of this method it is necessary to comprehend the idea that blockchain theology can be used more that just as data store it can be used like a tool to analyze data. The idea is to create a globe data storage based on blockchain theology which can include data of state structures. As a result of such adaptation of blockchain technology the relationship between economic agents will be in total

different it means that decentralization and the absence of a hierarchical management structure will provide to a new aptitude for accountant business.

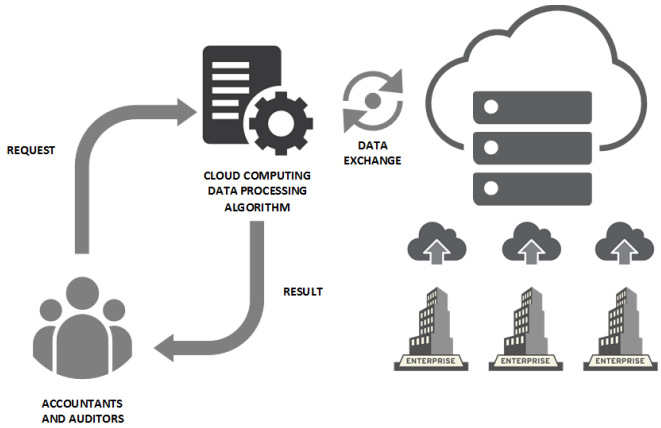

Fig. 1. Business model of CCDP and block technology

In context of new economy, namely digital economy the role of CCDP and block technologies are vital and it appear to be what the role of the state as the main regulator in commercial transactions will be reduced, approaching to zero, although it will never reach it, since the exchange of goods, services and their payment occur outside the virtual environment. In the case of economic relations in the digital economy, any agent is able to build strong contact with any other agent and begin to conduct economic activities with him without any border restrictions.

4. Conclusion

As a conclusion of this paper can be answered the question "How strong will be affected accountants and auditor?", as its clear from presented earlier information the time for changes has come, the fact that a new structure like digital economy is self-organize mechanism which adapts very quickly against aggressive external environment. This was made possible due to fast data transfer via the network channels that resulted in a quick response to a given request by any unit in the network. It will be very hard to manage such a fast-growing system but at least it can be directed in a right vector. Because in near future the meaning of accountant service will be critical changed. That means what accountant standards and methodologies must have a goal to develop mechanisms that can adapt to the virtual environment and make it safer to use instead to develop particular tools for every individual unit in the system like it is made in our days. It is necessary to develop a complex cloud storage based on block chain technology to unify all data flows in the global network what's why establishment of an international regime regulating developing of digital economy is important for the future of the international security environment and the security of all states that operate within.

Threats that will appear in virtual environment will affect every nation on earth therefore it's so important to presume and prevent their dissemination. The threats and challenges associated with the cyber domain will not dissipate on their instead they will continue to evolve. The process will certainly be complicated and time consuming. There will be disagreement between states regarding the specific nature of the problem, levels of state authority and responsibility, and the implications for state sovereignty.

The problem of establishing viable means of verification of compliance will be challenging. Multiple levels of coordination will need to be established, including interagency coordination within states, coordination between allies and partners, and global coordination and cooperation. Despite the difficulties associated with the formation of a global digital regime, makes to believe that such a regime will ultimately be achieved.

International cooperation will not be formed overnight, progress may be slow and incremental, but eventually the pieces will come together and the international community will unite in support of a mutually beneficial digital economy agreement.

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Optimization of the 3D-printing Process in SLS Technologies of Additive Production

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Abstract. The paper studies constructive tools of optimizing the 3D printing process in SLS additive production technology. We develop NLP model and solution algorithm that allow us simultaneously printing a large number of products to maximize the volume of the working chamber of a 3D printer, taking into account technological requirements. Our approach allows to minimize the time and cost of creating products by significantly reducing the number of printing cycles.

Keywords: 3D printing, SLS technology, Packing, Phi-function technique, Nonlinear optimization.

1. Introduction

The important problem of modern enterprises is to optimize the material and financial resources, increase the efficiency of production and in general change the outlook of industrial production.

Today's 3D prototyping technologies [1] can accelerate the processes of engineering, developing and manufacturing of design details. Modern design employs the three-dimensional prototyping that allows creating prototype models or a working model of the system rapidly to demonstrate to the customer or verify the possibility of implementing a completely new idea. At the moment considerable progress has been made in the technology of the layered formation of three-dimensional objects using their computer models. These technologies are called additive and known under various terms: STL - Stereolithography, SLS - Selective Laser Sintering, FDM - Fused Deposition Modeling, and others.

In this paper, we develop methods of optimizing the 3D printing process in SLS additive production technology. This technology uses a high-power laser for sintering small particles of plastic, ceramics, glass flour or metal into a three-dimensional structure.

The main feature of this technology is the use of powders, consisting of metal particles covered with a polymer. After the sintering process, the particle is placed in a high-temperature oven, where the plastic burns out, and it is replaced with the light-melting bronze. The advantages of technology include the lack of need for support materials. The particle is immersed in a powder, which serves the support function [2].

Within the last 10 years, 3D printing technologies have been developing rapidly: new ones emerge, existing ones improve, new applications of existing technologies arise. The aim of the research is to develop modern information technologies that will improve the process of 3D printing with the use of modern additive technologies.

We propose the development of methods for accelerating printing cycles at the expense of simultaneous printing of several models at once, ensuring the dense filling of the whole

volume of the working camera of a 3D printer using SLS technology. To this end, optimization problems of packing of 3D objects are solved on the basis of constructive tools of mathematical and computer modeling, mathematical models, optimization methods and state-of-the-art local and global NLP-solvers.

The process of 3D-printing combines two main stages: the creation of virtual models and the production of prototypes. This study is designed to develop technologies for improving the named stages of prototype development process.

At the first stage, it is necessary to create virtual models of 3D objects (computer models of prototypes).

One of the tasks of the second stage is to reduce the time and cost of manufacturing prototypes of products. Every SLS printer startup takes time and energy to heat up and maintain the temperature. Paper [3] discuses a problem of savings that can be achieved by optimizing the placement of 3D objects.

Our mathematical models and solution algorithms proposed in the research allow to optimize the process of 3D printing with respect to the following objectives:

- maximize the number of products printing at once;
- minimize the height of the occupied part of 3D printer's working chamber.

As a result we can minimize the time and cost of creating prototypes (products) at the expense of a significant reduction of 3D printer runs and of the number of printing cycles (printing layers).

The analysis of publications devoted to the optimal object packing has shown that in most cases heuristic and meta-heuristic algorithms are used to solve the problems, that leads to the loss of optimal solutions.

We formulate here the packing problem of arbitrary shaped 3D objects (that allow continuous rotations) taking into account technological constraints (e.g. given the minimum allowable distances) in the form of NLP model and propose efficient algorithms to search for local optimal solutions.

2. Problem Formulation

The problem of minimizing the number of layers can be formulated as a problem of packing objects in a container of minimum height.

Let be given objects P_i, $i \in I = \{1, 2, ..., n\}$, and a straight rectangular parallelepiped $C = \{X \in R^3 : w_2 \le x_1 \le w_1, l_2 \le x_2 \le l_1, \eta_2 \le x_3 \le \eta_1\}$, where η_1, η_2 are variables. Then the vector $\eta = (\eta_1, \eta_2)$ determines the height of C. Objects P_i can take arbitrary shapes [4]. The placement of objects P_i is determined by the translation vector $v_i = (x_i, y_i, z_i)$ and the vector of rotation angles $\theta_i = (\phi_i, \psi_i, \omega_i)$, $i \in I$. Thus, $u = (u_1, u_2, ..., u_n) \in R^m$, defines the vector of variable objects, where $m = 6n$, $u_i = (v_i, \theta_i) = (x_i, y_i, z_i, \phi_i, \psi_i, \omega_i)$. We denote object P_i with a vector v_i and angles θ_i by $P_i(u_i)$, and parallelepiped C with variable dimensions η by $C(\eta)$.

Problem. Define a vector $u \in R^m$ that provides the packing of $P_i(u_i)$, $i \in I$, taking into account the minimum allowable distances in container $C(\eta)$ so that its height $H(\eta) = (\eta_2 - \eta_1)$ reaches the minimum value.

3. Mathematical model and solving method

Based on the method of phi-functions [4-7], the mathematical model of a problem can be written in the form of the following nonlinear programming problem:

$$\min_{(u,\eta)\in\Lambda} H(\eta), \tag{1}$$

where

$$\Lambda = \{(u,\eta) \in R^{m+2} : \Phi_{ij}(u_i,u_j) \geq 0, 0 < i < j \in I, \Phi_i(u_i,\eta) \geq 0, i \in I, \eta_2 - \eta_1 \geq 0\} \tag{2}$$

In (2) $\Phi_{ij}(u_i,u_j)$ is either an adjusted quasi-phi-function, or an adjusted phi-function (responsible for non-overlapping of objects P_i and P_j), $\Phi_i(u_i,\eta)$ is a phi-function for P_i and $cl(R^3 \setminus C^*)$ (responsible for placement of P_i within the container C).

It is well known that the problems of packing 3D objects are NP-hard and therefore to find their approximate solution, a fairly wide range of heuristic methods is used (e.g., genetic algorithms, simulation annealing).

To search for a good approximation to the global minimum of problem (1) - (2), we propose the approach that consists of the following stages: the construction of starting points, the search for points of local minima, and the direct search of the local minima found on the previous stage.

To get the starting points, we cover the objects P_i with the spheres S_i of minimum radii ρ_i^{∇}, $i \in I$. Assume, that $\eta = \eta^0$, is fixed and provides placement of polyhedra in the container C. The radii ρ_i of spheres S_i, $i \in I$, are variables and form a vector $\rho = (\rho_1,\rho_2,...,\rho_n) \in R^n$. Let's formulate the following problem:

$$\max_{(v,\rho)\in\Omega} \sum_{i=1}^{n} \rho_i, \tag{3}$$

where

$$\Omega = \{(v,\rho) \in R^{4n}, \Phi_{ij}^{SS}(v_i,v_j,\rho_i,\rho_j) \geq 0, i < j \in I, \Phi_i^S(v_i,\rho_i) \geq 0, i \in I, \rho_i - \rho_i^{\nabla} \geq 0, i \in I\}, \tag{4}$$

$v = (v_1,v_2,...,v_n)$,

$$\Phi_{ij}^{SS}(v_i,v_j,\rho_i,\rho_j) = (x_i - x_j)^2 + (y_i - y_j)^2 + (z_i - z_j)^2 - (\rho_i + \rho_j)^2,$$

$$\Phi_i^S(v_i,\rho) = \min\{x_i - \rho_i - w_2^0, y_i - \rho_i - l_2^0, z_i - \rho_i - \eta_2^0, w_1^0 - x_i - \rho_i, l_1^0 - y_i - \rho_i, \eta_1^0 - z_i + \rho_i\}.$$

We set the starting point (v^0,ρ^0), where $v_i^0 \in C(\eta^0)$, $\rho^0 = 0$ and for this point, we calculate the point of the global maximum (v^*,ρ^*) of problem (3)-(4).

Then we take polyhedral $P_i(v_i^*)$ instead of spheres $S_i(v_i^*)$, randomly set the angles $\theta_i^s = (\phi_i^s,\psi_i^s,\omega_i^s)$, $i \in I$, fix them and solve the problem

$$\min_{(v,\eta)\in W \subset R^{3n+2}} H(\eta), \tag{5}$$

where

$$W = \{(v,\eta) \in R^{3n+2} : \Phi_{ij}(v_i,v_j) \geq 0, i < j \in I, \Phi_i(v_i,\eta) \geq 0, i \in I, \eta_2 - \eta_1 \geq 0 \tag{6}$$

It is obvious, that $W = \bigcup_{q=0}^{\zeta} W_q$, where Γ_q is determined by a linear system of inequalities. This means that the search for the points of local minima is reduced to the solution of the sequence of linear programming problems.

Let a point (v^*, η^*) be the point of a local minimum of the problem (5) - (6). After that we build the starting point $(u^s, \eta^s) = (v^*, \theta^s, \eta^*)$. For this starting point we find the point (u^{0*}, η^{0*}) of the local minimum of problem (1) - (2).

Then we realize the direct search of the local minima of problem (1) - (2) (see [4]).

We note that to search for local extrema of problems, a special optimization procedure (see [7]) is employed that allows us significantly reduce computational costs due to a significant reduction of the number of inequalities.

4. Conclusions

The 3D printing process using SLS technology is quite lengthy (printing can take many hours or even days) and requires high financial costs associated with printer startup, camera heating and temperature stabilization.

It should be noted that the time required for sintering the powder is much less than the time it takes to prepare each layer of powder. The paper proposes to reduce time and financial expenses by ensuring simultaneous printing of the maximum number of products with optimal packing of objects, taking into account technological constraints. Minimizing the height of the area in which the objects will be placed will minimize the number of 3D printing layers.

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Design Thinking as a Breakthrough Technology to Create Human-Centered Digital Services

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Abstract. Many Western and Russian universities and colleges began to include the course Design Thinking. The article presents an approach of generating creative ideas and exploring human needs. Emphasizes importance of understanding companies' orientation on economy experiences demands. It presents three modifications of design thinking tools: a Stakeholder Map, PEDPL MAP, Model of "Innovation Reachability". Model of "Innovation Reachability" is our modification of John Whitmore's model "SMART-PURE-CLEAR". The application of this methods allows to consider the problem from different perspectives, and useful for designing digital projects.

Keywords: Design thinking, Decision making, IT education, Creative ability, Economy experiences

1. Introduction

Key trends of digital transformation are: increasing importance of creating customer experience; transformation of the operating model which enables flexible rebuild for changing market conditions and new breakthrough technologies (informed decision-making, fast execution); introduction of digital thinking into corporate culture of organization (creating cross-teams and new working principles for effective tasks execution); creation of multi-channel ecosystem with personal clients' values by analyzing their needs and preferences (analysis of digital trails: big data and data mining).

What is design thinking? In 2004 David Kelley, founder of IDEO and Hasso Plattner, co-founder of SAP, have created this approach. They have created philosophy of innovative solutions, that combines various tools and development methods of person creative skills, analysis of customer's behavior, generation of ideas and visualization. Design Thinking consists of visualization and searching for patterns, empathy and system approach for problems solving. We had many questions in the beginning. Then we loaded our brain, we thinking, keep thinking … and WAW! The insight! We received ideas which we can sell. Design thinking is common sense.

Design thinking' Philosophy consist of some principles. There are Teamwork, Gamification and Interdisciplinarity, Empathy, human-centered creativity and lateral thinking, iteration, reflection, emotional and thought processes, divergently thinking and convergence, a number of processes – system analysis, how we can, nor what you can (the process, not the result), coup situations and problems, uncertainty and risks, think with hands, constraints (space, time), the economies of scale, binding of randomness.

Development of design thinking tools are actively engaged in Hasso-Plattner Institute (HPI school of design thinking, Potsdam) and d. school at Stanford. This approach is presented in the book of Tom Kelley and David Kelley (2013), Jeanne Liedtka and Tim Ogilvie (2011), Alexander Osterwalder, Yves Pigneur (2012), , Philip Kotler and Fernando Trias de Bes

(2003). Design Thinking includes many good tools of Lateral thinking by Edward de Bono (1970) and ideas by Michael Michalko (1998).

The theme of Design Thinking is very popular worldwide, not only in Moscow, of course. In Russia, design thinking is actively developing last 5 years. Design researchers create long-term value for the economy and education. We know about design projects in the state corporation "Rosatom", telecommunication company "TELE2", Sap Labs (Russia), Mos.ru, Sberbank, Raiffeisenbank, PromsvyazBank and other. The results have been applied on Moscow Government Internet-services, in the Moscow subway. There are 5 famous business school in Moscow which design session are organized for companies and people: Wonderfull Laboratory, IKRA, Lumiknows, Corporate University of Sberbank, INEX Partners. Creative methodologies are used in educational programs in ITMO (Saint Petersburg) and in our Financial University under the Russian Federation Government.

In design thinking approach Russian researchers include achievements of Russian scientists in field of decision-making and cognitive technologies. For example, now it includes TSIT - Theory of solving inventive tasks (by Genrikh Altshuller). This approach to generation of ideas was founded in 1946, and first article published in 1956. In 1950-1999 years actively developed the approach of Georgy Shchedrovitsky (Moscow methodological circle) to coordinate people and their thinking by developing creative solutions with a use of game mechanics.

The Design Thinking approach includes various heuristic techniques of solving non-trivial problems in the face of uncertainty; the development of creative skills and innovative thinking (out-of-the-box thinking) person; and also game mechanics that allows you to organize communication between different perceptions of the problems involved in the development of innovation. The popularity of the approach is primarily due to its ability to work with tacit knowledge that is important in terms of trend of development of a modern business-oriented person.

The apparent advantage of the method of Design Thinking is changing the approach to the study of the problem. It is based on a search of the answer to the question "how to do something" not "what to do". And the most important is, if a process running into an unexpected result, generates a new one. Generated ideas explored in the intersection of the three spaces of innovation are: the idea, that should be feasible in the foreseeable future from the point of view of technology, and wishes of the user, which are profitable for the business.

2. Empathy is main base of the economy experiences

Design thinking is an approach to design innovative solutions-oriented person. The center of Design Thinking' philosophy is empathy. Main objective are people and their needs. Technologies are always secondary.

The basis of Design Thinking is empathy, understanding of user experience, one's feelings and sensations; which aims to further develop innovative content of the product, that will aim on the consumer's emotions.

Now we are moving "from a knowledge economy that was dominated by technology into an experience economy controlled by consumers and the corporations" who understands them and empathizes with them (from article Bruce Nussbaum "The Empathy Economy", 2005 [1]). Last December German Gref, Head of Sberbank, has participated in project on studies of customer experience. He was in a special suit, simulating disability. He wanted to understand: Are people with disabilities feel comfortable in his office? It is the Method Of "Moccasin".

How to implement "design thinking" in company process with strategy of digital transformation? The answer to this question depends on company's purpose. This may be the

solution of research changes tasks, client requests or problem areas in client service, search directions transforming legacy approaches while doing business, training decision making tools in unusual situations.

It is important for company to apply design thinking tools to obtain effective results in meetings, negotiations, strategic sessions, brainstorming. They are necessary in the project creation strategies, business models, processes. Design thinking skills helps people to be more flexible in applying their knowledge, develop thinking, helps finding unconventional solutions in the face of uncertainty, to create breakthrough ideas.

In training of digital world future leaders' ecosystem, applicant of other's areas are also important. Vocational guidance work with students should be carried out, for creating result-oriented people. Two years on Department of "Business Informatics" we are actively using various forms of scientific work, communication events and designing. From 2015, we introduce the methodology of design thinking in various courses: "Business modeling", "Internet entrepreneurship", "Marketing", "business Models in digital markets", "decision making Methods", etc. This helped to maintain interest in science, to lose business situation at the expense of game mechanics, team discussions, marketing research and testing of solution models.

There are six main stages of Design thinking: Empathy, Focus or Point-of-View, Generation of ideas, Choice of ideas, Prototyping, Testing (Figure 1). The key steps are built on the ability to quickly generate many ideas to get away from banality, and the rules on how to choose the best solution to create it, even at the level of the prototype.

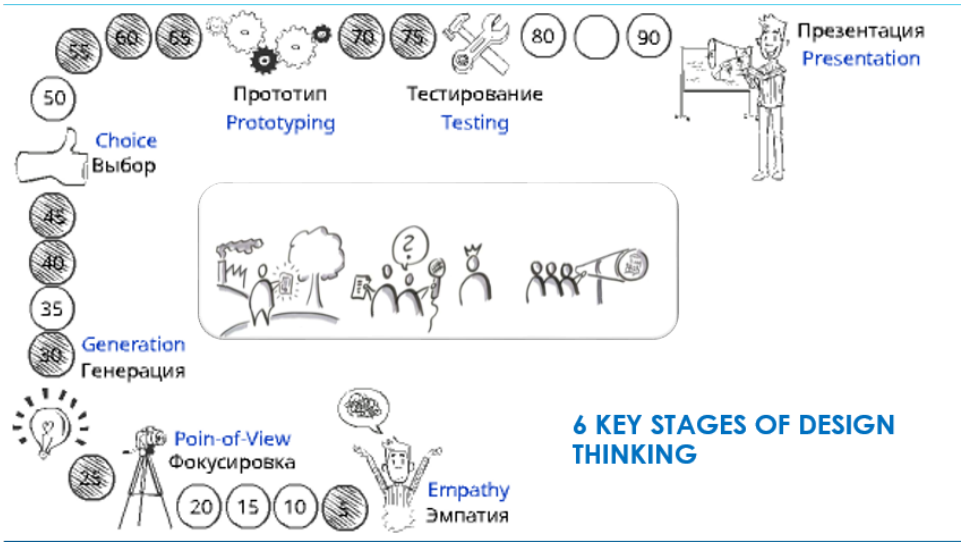

Fig. 1. 6 key stages of Design thinking

There are many interest tools of Design thinking. We use these tools in our work [2]. In our researches we use Map Of Empathy, Pinocchio Method, Ladder of questions: 5 Whys & How to do it? When conducting an interview, the technique of "Five whys & How to do it?» is used. The technique of "Five why?" can help in the formulation of questions. The secret of technique is to have the question "Why?" raised several times, even if the answers seem obvious. This will allow one to trigger the Respondent's sincerity and reveal tacit knowledge of key research questions; to make the interview effective.

Customer Journey Map (CJM) helps to take the place of the client and describe his experience and to visualize results of the client research. This technique is one of the most popular tools of analysis convenience, mobile app interface, pages of the Internet site. In the study of the experience of the relationship between company and customer, first identify the main groups of buyers (buyer personal), and then determine the questions that can help to analyze each stage of the interaction. The difficulty level can be different and depends on the degree of development of interactions.

To highlight of the many challenges one key there is a method "Point-of-View – formula ("How can we ...?“ & «It turns out that he needs» & Persona-model)". The wording of the question: "How can we help?" applied design: a User – Need – Idea. For example, "How can we help [the user] to solve [the problem] as follows: [the idea]". The question serves as a good incentive for finding ideas, start brainstorming. The question is a good stimulus for finding ideas, launching a brainstorm. The real need is well described and allows you to study the phrase "It turns out he needs to" from different angles.

Generating of crazy ideas is very interest tool. Crazy ideas can start the idea generation process. Stupid ideas make the process fun and non-boring and therefore will remove the frame pattern of thinking. The most absurd ideas can be further adapted to the constraints imposed by technology or conditions for the achievement of profitability of the innovative project.

To generate unconventional solutions to problems, and to approach familiar from differently the SCAMPER technique can be used. SCAMPER is an acronym of the words: Substitute, Replace, Combine, Adapt, Modify, Put to other uses or Use otherwise, Eliminate, Reverse or Turn.

Method of personal ideas (SIL and KJ) consists in consecutive execution of the following actions:

1. Each participant writes their ideas, what competencies they believes are in demand in the future. In this step, ideas are not discussed with other team members. One can immediately prioritize their decisions – from the best ideas to the worst.
2. Ideas are read out loud one at a time. It can be done in the following order: first is the best idea of the beginning player, then second one’s worst idea, then the second good idea of the first player and the second worst idea of the second player, and so on.
3. Similar ideas are combined into separate groups (clusters of themes).
4. General ideas during the discussion are ranked from best to worst.

On stage of Choice we use Affinity Maps, Matrix of choice (Costs/ Effects Matrix), The method of "Content grouping", Associative maps, Mind map, Fishbone Diagram.

On stage of Prototyping, Testing and for presentation of results: Storytelling, Bodystorming. Business origami is created from a paper prototype. Our student like “Storybord” and Lego Serious Play (LSP) and method “The Wizard of OZ” is for testing with user. It’s funny. When prototyping ideas, one can use the technique of "The Wizard of OZ." The method was developed by John F. Jeff Kelly from the research center Thomas J. Watson of IBM in 1980. It is aimed at the study of the human factor, and allows to estimate the reaction of people to the product, in order to understand how users perceive development, and how they will be able to use it.

In practical tasks we include such steps as selecting problem situation, study domain and user experience of interacting with a product or process, recording of results, analysis and discussion of ideas in the case study templates, presentation. We created 15 templates for researches and we changed some tools for our tasks. For example, Testing of hypotheses about the problem in Customer Discovery techniques and in-depth interviews We use Stakeholder Map. The map can be constructed in the form of a matrix with two axes, which sometimes is called the "2x2 Matrix". We Fix on the map the position of all who come in contact with the

product or service in order to take into account the interests of each party in the design. We added risk and cooperation research In Stakeholder Map (Figure 2). In our opinion, the level of possible cooperation, as well as the degree of possible threat from those who may lose as the result of the successful completion of the project should be presented on the map.

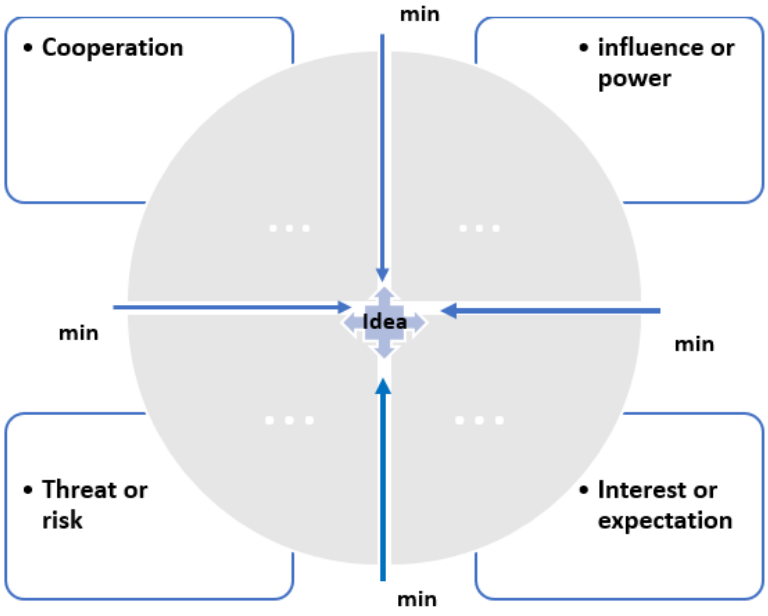

Fig. 2. Stakeholder Map

Analysis of user experience with process and products we create PEDPL MAP, acronym of English words: Pre-Experience, Experience, Post- and Lost user Experience with process and products (Figure 3). The Lost segment can be drawn all the possibilities for the development of (value gap): new processes out-of-plane current business, an alternative to the use of a known product, expansion of functions, some direction to reach an initial goal, the reincarnation of the user experience in another plane, taking into account unrealized characteristics and interests of consumers (cultural characteristics, preferences, habits, traditions etc. that were not taken into account, and therefore is lost in the product, but a dedicated user experience patterns allowed to identify).

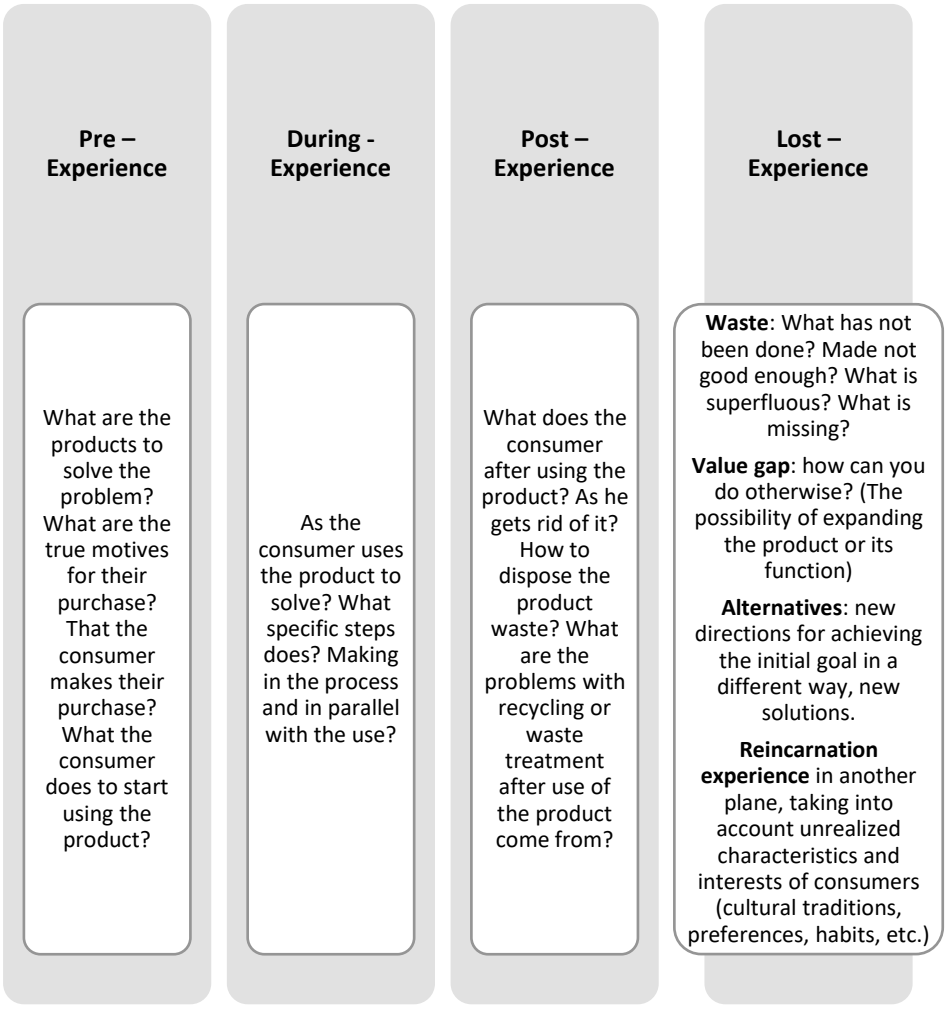

Fig. 3. PEDPL MAP

Model of "Innovation Reachability" is our modification of John Whitmore's model "SMART-PURE-CLEAR" (Figure 4). We have identified a goal "the value of innovative solutions for potential customers" and also emphasized the gauges (KPI) Smart branch (planned costs, revenues, etc.), on completion of the project ideas in the branch of PURE (Understood) and its consistency with the implementation point of view (technology, resources, distribution channels, etc.), and in the branch Clear (challenging) - relevance, competitiveness and security from potential threats and risks (trends, competitors, security).

Now we finished book "Internet entrepreneurship: practice application of design thinking in the creation of project (bachelor and master)" about practice application of design thinking and it would be published in this year. The authors are Laureates of the Prize of the rector of the Financial University "For the contribution to innovative development of the system of management of Financial University", have diplomas of the Fund of development of Internet initiatives and Certificate of participation "Design Thinking Fundementals and Technics" by SAP EMEA-2017 (Academic).

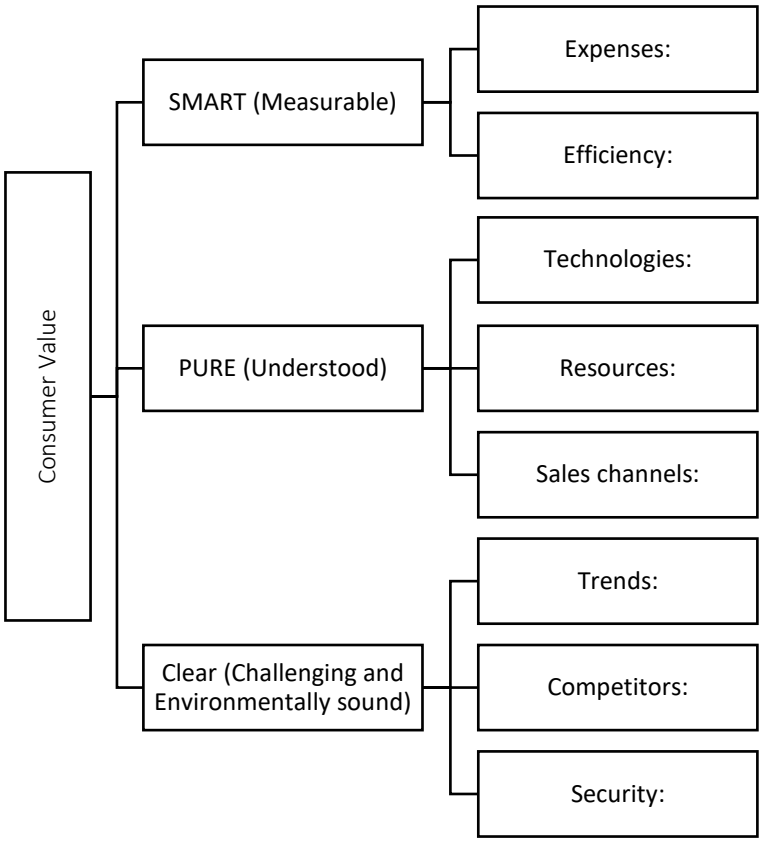

Fig. 4. Model of "Innovation Reachability"

3. Conclusion

We emphasize that the main purpose of teaching University can see is preparation of young and enterprising personnel able to expand the digital space of useful new services and innovative products, as well as developing students' qualities that will enable them in their future profession to solve complex non-standard situations in conditions of uncertainty. Our approbation of new forms of learning has produced good results in final qualifying works. Master's thesis included the results of the design studies and the proposed digital strategy development for companies such as Post of Russia, Sberbank. Creative thinking skills, teamwork and personal development will certainly have an impact on strategy formation of the professional growth of our graduates.

The trend of customer orientation and reactive, sometimes unexpected changes in their needs, tastes, and preferences forces business to change, find new moments, which in the terminology of Gartner means a constant search for short-term opportunities that are used dynamically: "business time can come from nowhere, and yet they are becoming more" [3]. More recently, human resources were perceived as main participant business processes in enterprises, as an integral part of company capital organization. However, automation and implementation of industrial 4.0 technology replace human programs, robots, bots, drones, etc. But this does not mean that a new era of human functions in processes will be minimized.

Goals focused on the new business tasks implementation in the conditions of constant changes will demand human skills to work in a team to effectively use their competencies, focused and successful, thinking outside the box and finding original solutions to actively use the accumulated individual and collective intellectual capital that will make use of various techniques of design thinking an integral part of human activity in the company.

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Social and Economic Mechanism of Regulation of Labor Motivation System under the Conditions of Modern Innovation Dynamics

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Abstract. Modern economy of Ukraine, undergoing profound changes under the influence of innovative factors, globalization processes and increasing competition, require the search for new methods, tools, organizational measures and other elements of external motivation that can provide innovative changes in the economy, its growth, achievement on this basis and high quality of life of the population. When forming the social and economic mechanism of labor motivation under the conditions of innovative development of the economy it is necessary to take into account labor complexity, manifestation of creativity, based on non-standard approaches to finding effective incentives, attraction of highly skilled personnel, development of the staff competitiveness and flexible response to market demands. The article presents the structure of the social and economic mechanism of labor motivation under the conditions of modern innovation dynamics which is based on the use of certain methods and tools, taking into account current features of the influence of external and internal environment. Directions of improvement of the social and economic mechanism of labor motivation under the conditions of formation of an innovative model of economy are substantiated. The conducted study of the state of the motivational system at enterprises and the state of social and labor relations in the region made it possible to improve the existing social and economic mechanism of labor motivation in the context of its influence on the formation of the labor motivation system. It is formed on the basis of the use of general laws of the evolutionary development of labor relations, application of certain methods and tools, influence of the external and internal environment on its formation which increases the competitiveness of an enterprise satisfying needs and interests of workers, quality of life and competitiveness of the country's economy.

Keywords: Labor motivation system, Labor motivation, Organizational and economic mechanism of labor motivation, Innovative model of economy.

1. Problem statement

Modern economy of Ukraine, undergoing profound changes under the influence of innovative factors, globalization processes and increasing competition, require the search for new methods, tools, organizational measures and other elements of external motivation that can provide innovative changes in the economy, its growth, achievement on this basis and high quality of life of the population.

Based on the foregoing, there is an objective need to improve the existing social and economic mechanism of labor motivation which meets the requirements of the innovative model of the economic development and takes into account changes in the labor nature, increase in the degree of its intellectualization and the level of education of a modern worker,

increasing the activity of workers as subjects of innovation activity, creating new ways to generate innovative knowledge and tools for their dissemination and use.

Actual scientific researches and issue analysis

Theoretical and applied aspects of the formation of the organizational and economic mechanism for regulating the system of labor motivation are the subject of research by many economists. The study of this problem is devoted to scientific works of well-known foreign researchers such as: A. Maslow, R. Coase, A. Anchian, P. Heine, M. Weber, K. Menger, J. Schumpeter and others.

The need for specific approaches to the formation of the structure of the social and economic mechanism of labor motivation is justified in the publications of domestic authors, in particular: D. Bogynia, G. Golovchenko, V. Grinova, M. Doronina, V. Shpalinsky, A. Goshko, E. Gluhachov, G. Nazarova, T. Khomulenko, S. Klimov, A. Kolot, A. Kutsenko, S. Lysenko, L. Lutai, M. Salun, O. Yastremska and others.

The analysis of scientific publications and business practice indicate the need for further scientific substantiation of directions of improvement of the social and economic mechanism of labor motivation under the conditions of formation of an innovative model of the economy.

The main purpose of the research is to form the structure of the social and economic mechanism of labor motivation and to develop recommendations on directions of its improvement under the conditions of the formation of an innovative model of the economy.

2. Presentation of basic material of the research

The formation of an effective social and economic mechanism for motivating labor at enterprises is an urgent requirement of the present. At present, such a mechanism is not effective at most enterprises. The proof of this is their loss-making, significant turnover of personnel and other negative processes. The root cause of it is the low level of satisfaction with labor and the low level of satisfaction of basic needs of employees.

In our opinion, the social and economic mechanism of labor motivation is a concept which means a system of levers, incentives, organizational measures and other elements of external economic and administrative inducement of workers. It is aimed at the implementation of managerial functions related to management through motivation. It is intended to harmonize the existing incentives that are used for the purpose of the most effective impact on an employee and at different levels (teams, enterprises, state, etc.) has its own peculiarities in elements, structure, orientation, etc. [4].

It should be noted that the formation of the labor motivation mechanism is aimed at: maintaining the employment of staff; fair distribution of income and the effect of the growth of the bonus part of wages; creation of conditions for professional and career growth of an employee; ensuring favorable working conditions and maintaining the health of employees; creating an atmosphere of mutual trust and feedback; incentive to revitalize the creative content; ensuring favorable conditions for the use of the latest technologies and creation of new products and services based on their use.

When forming the social and economic mechanism of labor motivation under the conditions of innovative development of the economy it is necessary to take into account labor complexity, manifestation of creativity, based on non-standard approaches to finding effective incentives, attraction of highly skilled personnel, development of the staff competitiveness and flexible response to market demands [3].

Short-term goals and value orientations begin to prevail among motives. People seek to get the benefits now and immediately. Personal and group selfishness becomes a priority.

Motives of public recognition of labor and participation in the management process which were traditionally relied on by Soviet researchers occupy the last place among the incentive factors of labor activity, regardless of forms of ownership of enterprises.

Lack of opportunities for decent and adequate self-realization, psychological disorder and reduction of labor motivation, even for professionals with a high level of intelligence and experience of survival under the conditions of transformation processes in society, require powerful efforts to overcome deformations in the intellectual development of the entire society and formation of a new effective mechanism of labor motivation with an active position of each individual in choosing a place of work according to his own desires and abilities and not for the compelled need [2].

It is worth noting that Ukraine has all opportunities for the social and economic mechanism of labor motivation to work effectively. Unlike many countries, including Eastern Europe, Ukraine has strategically important production technologies in aerospace, transport and nuclear technologies. However, ambitious projects for the development of the national economy must be based on the effective use of the mechanism of labor motivation that is maintained at the institutional level.

The conducted study of the state of the motivational system at enterprises and the state of social and labor relations in the region made it possible to improve the existing social and economic mechanism of labor motivation in the context of its influence on the formation of the labor motivation system. It is formed on the basis of the use of general laws of the evolutionary development of labor relations, application of certain methods and tools, influence of the external and internal environment on its formation which increases the competitiveness of an enterprise satisfying needs and interests of workers, quality of life and competitiveness of the country's economy [1].

The action of this mechanism is aimed at solving issues: economic – the restoration of the incentive function of wages, financial rewards for productive innovation activities; social – relations of social partnership, means of non-material stimulation; organizational and administrative – conditions for innovation, reorientation of the labor market to stimulate demand for highly skilled labor to meet needs of innovation-oriented industries; intellectual – education and professional development, intellectual property, information and communication technologies; innovative – introduction of various innovations both in the process of output of products (services) and in the field of labor organization; information – constant tracking of the labor motivation and its level of effectiveness in the innovation activity of employees.

This mechanism is to combine the existing set of incentives that are to influence effectively on an employee and at different levels (teams, enterprises, state, etc.) has its own features in elements, structure, orientation, etc. [4].

In order to ensure the effectiveness and efficiency of the proposed social and economic mechanism of labor motivation, it is necessary to create favorable conditions for the development of personnel which enable to stimulate the increase of intangible values and intellectual potential.

Importance and necessity of the formation of the social and economic mechanism of the labor motivation should be considered, first of all, from the point of view of probable factors influencing the behavior of a team and management of the enterprise. The mechanism should be aimed at achieving success under the conditions of competition in the short and long term. The functioning of this mechanism is provided by motives for competition and cooperation in the creation of new products and technologies, business strategies, motives of the entrepreneurial risk, motives of entrepreneurial reactions to change the external

environment, motives of the internal entrepreneurship which provide flexibility in managing and perceptions of innovations.

An effective mechanism of the labor motivation should ensure the successful transition of a number of factors, principles, incentives, motives, value orientations, expectations and behavioral reactions from the linear discrete state into a closed and constantly repeating process.

It should be noted that the improvement of the social and economic mechanism of the labor motivation enables to determine directions in the development of the labor motivation system and thus create preconditions for increasing the efficiency and profitability of enterprises. It also allows the company to enter an economically new level of development and opens prospects of realizing its capabilities at the world level.

The shown labor motivation system under the conditions of innovative changes in the economy should be flexible and serve as one of tools for improving the planning of the economic activity of enterprises. The flexibility of the labor motivation system is ensured by incentives of employees to achieve the final quantitative and qualitative results, among which individual indicators of the activity of a worker, the structural unit and the enterprise as a whole are determined [3].

3. Conclusions

The proposed approach to the feasibility of introducing the social and economic mechanism of labor motivation and development of the labor motivation system is based on the understanding of multidimensionality and multi criteria of this system at all levels of the economic analysis, the need for using multiple techniques and criteria for the corresponding assessment. Despite the fact that identified effects are of high quality and reflect only some aspects of the effectiveness of the labor motivation system, use of proposed methodological and methodical approaches to its evaluation may already be useful today as it will contribute to: guided regulation of labor potential development processes; increasing the efficiency of the mechanism of labor motivation and search for social and economic levers of ensuring economic growth under the conditions of increased competition; implementation of tasks of the innovation development and building a competitive economy.

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The Ways How Social Media Correlates with Corporate Culture

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Abstract. In this paper the growing phenomenon of social media and its impact on organizations' corporate culture were observed. Due to the fact that social media there is lack of understanding in terms of how social media benefits the organization the main definitions were described. Considering the growing importance of social media as a strategic tool among organizations, this research aims to investigate the impact of social media usage on corporate culture.

Keywords. Social media, Social networking, Privacy, Confidential information, Employee behavior, Corporate culture.

1. Introduction

New social media have become increasingly popular components of our everyday lives in today's globalizing society. They provide a context where people across the world can communicate, exchange messages, share knowledge, and interact with each other regardless of the distance that separates them. While cultures around the world value their individual traditions, beliefs, and norms that make them unique, social media links people around the world regardless of differences and geographical boundaries.

According to Chen and Zhang [1], the compression of time and space, due to the convergence of new media and globalization, has shrunk the world into a much smaller interactive field. People across the globe can interact with each other within seconds of sending and receiving messages.

Regardless of the existing hot debate on advantages and disadvantages of social media, investments in these technologies are growing high [2]. As many organizations are investing in these technologies, it is important to identify the factors that influence the successful usage of these technologies [3, 4, 5].

The primary issue with any strategic tool or technology is the degree that its usage benefits the user. Technologies in some cases have uncertain, little, or no impact on organizational performance [6].

Considering the new trend of social media, some researchers say corporate adoption of social media, while new, is already showing enormous benefits. Many process improvements may be found through efficient social networking programs and organizational connectivity [2].

But the impact of social media usage on organizational performance has not been empirically investigated.

Therefore with the aim to fill up the above gaps, the current study investigates the factors that influence the organizational usage of social media and its subsequent impact on organizations.

2. Definition of Social Media and Corporate Culture

Social media is basically about the technologies that have increased the social interaction of individuals online. The websites related to social media are most significant in recent time. These sites use blogs, videos, pictures, message boards, to help people communicate more often. The trend of this technology started with basic texting and later on many graphics were added in it. Websites, including YouTube, MySpace, Facebook, Orkut, and Flicker give opportunities to people for expressing their ideas with ease [7].

Social media has several benefits including easy exchange of information created and generated by users [8]. Social media uses include:

- social networking (e.g., Facebook);
- blogging (e.g., blogger.com);
- microblogging (e.g., Twitter);
- video sharing (e.g., YouTube);
- presentation sharing (e.g. Slideshare);
- picture sharing (e.g. Flickr).

Social media is now increasingly used in workplace other than for hedonistic purposes [9, 10]. In social media, people have the opportunity to express their opinions to the public and participate in conversations and dialogue through a common virtual medium.

Social media networks are enabling businesses to become more socially engaged, exploiting new business model innovation based on firms' ability to monetise and extract value from crowd-generated data and content. Social media has enabled organizations to establish a stronger relationship with the community of reference, in order to exploit the network effect and harness collective intelligence [11]. Corporate culture is a term that is frequently used in workplace discussions. In the publication In Search of Excellence, Peters and Waterman discussed the significance of culture in achieving Corporate goals effectively. Corporate culture can be generally described as set of norms, beliefs, principles and ways of behaving that give a distinctive character to organizations collectively [12].

According to Schein [13] culture is a pattern of shared basic assumptions – invented, discovered, or developed by a given group as it learns to cope with its problems of external adaptation and internal integration – that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think and feel in relation to those problems.

Corporate culture has three main functions:

- it is a deeply embedded form of social control;
- it is also the "social glue" that bonds people together and makes them feel part of the corporate experience;
- corporate culture helps employees make sense of the workplace [14].

Corporate cultures keep on forming and changing over the period of time as organizations reflects the industry characteristics such as competitive environment and customer requirements along with values and behaviors of employees and leaders [13]. Corporate culture determines the ways in which an organization operates and how the Corporate members frame events inside as well as outside the organization.

Social media could affect, or be affected by, the organizational climate, the subjective norm on knowledge sharing, and attitudes toward knowledge sharing. Their key variables include sense of self worth, anticipated reciprocal relationships, and organizational climate. Their elements of organizational climate included fairness, innovativeness and affiliation [15].

3. The Influence of Social Media on Organizational Socialization

While socialization benefits are clear, the means of achieving effective socialization are complex with many tools and techniques available. Historically, socialization programs have relied upon formal onsite orientation sessions, offsite training sessions, buddy systems, mentoring programs, and business trips with co-workers [16]. Recently, social media technologies have provided a new tool for organizational socialization. In particular, organizations are using internal social media systems to help new employees learn about their jobs, their colleagues, and the organization [17]. Social media provides a familiar tool that organizations can integrate into new hire socialization practices.

In spite of internal social media's potential, it remains unclear which organizational benefits can be achieved from employees' social media usage [18]. To date, internal social media's impact on employee socialization has received very little attention [19]. Our work will explore the value of internal social media use by new hires. Specifically, we conduct a theoretically guided investigation of whether the use of internal social media systems by new hires increases the effectiveness of their socialization into an organization. This paper is organized as follows. We first provide the theoretical foundation. We then present the method, a case description and the analysis. The paper concludes by discussing the implications and conclusion.

Many organizations implement socialization programs such as buddy systems and training programs to reduce turnover and increase employee commitment. Organizational socialization is the process through which individuals learn their organization's social norms [20]. Many factors play a role in successful organizational socialization programs. Four key socialization adjustment indicators are: role clarity, self-efficacy, knowledge of organizational culture and social acceptance [21], [22]. Role clarity provides an indication of how well adjusted a new hire feels about his/her new job. It is the new hire's understanding of his/her job responsibilities and organizational role. Uncertainty is often experienced when there is a disconnect between the job description and the specific expectations that new hires must complete as part of their role. As new hires understand their roles, they experience higher role clarity. Self-efficacy refers to learning the tasks of a new job and gaining confidence in a particular role [23]. It is the degree to which new hires feel capable of completing their assigned job tasks successfully.

Social acceptance refers to feeling liked and accepted by peers [23]. It includes having a support system that will help new hires succeed. New hires need to feel that they fit in within their new workplace. When a new hire feels socially accepted by his or her peers, he/she develop an attachment to the organization. Knowledge of organizational culture refers to an employee's understanding of his/her role in the organization and understanding the organization's goals and objectives [24]. It includes the new hires' understanding of organizational norms, values, and working environment.

Some studies [21], [22] provide insights into new hire socialization effectiveness and adaptation through traditional socialization practices such as buddy programs and/or on-site orientations. However, the impact of technology use on socialization has not been explored. As organizations strive to provide the right resources to their new hires, internal social media applications may play a crucial role in the socialization process. Because social media facilitate relationship building, open communication, and information sharing [25], [26], [27] these technologies have the potential to facilitate socialization of new hires.

Social media are used by business firms and governmental organizations as a communication tools. These entities actively make use of social media for advertising and marketing, communicating with customers, building relationship with customers, branding etc. [28]. In order to investigate the usage of social media in organizations we consider the

informed and effective use of social media which is an important indication of technology success, which in turn have an impact on organizations [29]. Social media impact refers to the actual benefits organizations receive from using social media. Previous studies have proved the positive impact of internet usage on organizations in various areas such as enhance CRM practices [30], provide interactional and transactional benefits [31], improve export marketing performance [32], provide strategic benefits such as Cost reduction, revenue generation and managerial effectiveness [33], improves innovation [34], Reduce marketing cost, improve customer relationships, improve company image and competitive position etc. [35]. Similarly through social media it is possible to perform integrated marketing activities with much less effort and cost than before. Social media can have a dramatic impact on organizations in areas such as enhancing brand's reputation, improve value, relationship and brand equity, digital advertising and promotion, handle customer service issues, mine innovation ideas and building customer relations [36].

4. Conclusion

Nowadays the Internet has provided a new paradigm for corporate culture and empowered millions of people to network socially beyond the continents. Social media includes various methods such as social networking, user-sponsored blogs, web-sites, company-sponsored websites, collaborative websites, podcasts, etc. From the business perspective for any business, effective networking is an essential component to success. Modern social media tools are bringing rapid change to corporate culture and public relations. These technologies have shifted the emphasis of internet services from being consumption-based towards becoming interactive and collaborative, creating new opportunities for interaction between organizations and publics.

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Planning Future Financial Performance of Small and Medium Enterprises trough Econometric Modeling

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Abstract. This paper is dedicated to the topic of financial performance of the small and medium-sized enterprises (SMEs) sector in the Republic of Moldova. Improving financial performance of SMEs is a goal established at the state level, as stipulated in the Strategy of development of small and medium enterprises sector for 2012-2020, and in the development strategy of the country - 2020. In this research, we carried out an econometric model, which allows us to see how the source of finance will influence future financial performance of small and medium business, and to establish the optimal combination of these sources for the SMEs.

Keywords. Small and medium sized-enterprises, source of finance, econometric modeling, financial performance.

1. Introduction

Improving financial performance of SMEs is a goal established at the state level, as stipulated in the provisions of the Strategy of development of small and medium enterprises sector for 2012-2020. However, in current economic conditions, a small and medium-sized business cannot tend towards high financial performance without continuous access to diverse funding sources. Namely, the financial structure of the enterprise is the factor that directly affects its financial performance, and an extremely important concern in the financial structure is to establish the optimal proportion of own and borrowed sources. In an attempt to explain how companies finance their assets and the factors influencing these funding decisions, in financial theory and practice have been proposed a number of theories and models of capital structure.

2. Theories and models of capital structure.

Among the most popular, we remind: naive theory, classical or traditional theory, Modigliani – Miller theory, theory of compromise, agency theory, signal theory and theory of hierarchical funding. All these theories and models attempt to explain the percentage of debt and equity in the balance sheet of entities. Many of them managed to prove that an enterprise may change its rate of economic growth by changing the ratio between equity and debt, but they could not determine with certainty: which is the optimum ratio between funding sources generally valid for each company? So far there has not been developed a universal theory of optimal capital structure because of the multitude and complexity of factors that explain how finance businesses. In acknowledgment come Myers S.C.'s words ,,there is no universal theory of capital structure choice and no reason to expect the development of such a theory".

3. Selecting the variables for the econometric simulation.

Based on this reality, related with the subject study theme, we chose to elaborate a forecast through the econometric modeling, which will allow us to see how the source of funding will influence future financial performance of small and medium business, and to establish the optimal proportion of these sources for the SMEs in the bakery sector of Moldova?

The outlook (simulation) conducted within the research sought to validate the assumptions of those theories of capital structure that best explains the behavior of SMEs financing in Moldova. The simulation started with the selection undertaken of the most representative coefficients of the financial structure, which will result in increased financial performance of SMEs. The difficulty of right selection of the coefficients was marked primarily by the fact that the financial structure indicators can be measured by many variables and there is a risk of choosing the indicator that is not the best for the purpose. Secondly, it is extremely difficult to identify those variables that influence the financial performance of the entities, but that are not dependent on other financial indicators of interest. In the present research, as representative variables (variables impulse) of financial structure the following indicators were selected: coefficient of autonomy, the rate of long-term debt to permanent capital and the rate of short-term debt in total financing sources.

The reason of choosing the first coefficient - of the autonomy was based on respect for ranking potential ways of financing supported in the theory of finance hierarchy (pecking order theory) first formulated by economist Donaldson (1961) and further developed by Myers (1984) according to which the entity, first it cares to develop its business at the expense of its own sources. Economical, the reason for including the given coefficient is to follow how the growth of its sources from the total funding sources will affect the future performance of SMEs.

In this context we must remind ourselves that *the coefficient of self-financing* is viewed from an angle, as share of own capital for the total amount of funding sources of asset and from another angle - as a share of assets formed from the own sources in the total amount of assets company.

Another way to finance the business is on account of raised funds. However, the difficulty of right selection of a coefficient of indebtedness consisted in the fact that in its "pure" form the coefficient of attracting borrowed resources could not be used simultaneous with the coefficient of autonomy, because the result of appreciation would have been inversely and simulation veracity had been compromised. So, we resorted to dividing the raised funds depending on the term of attraction. Attracted long-term sources are presented in the most commonly form used in the practice of countries with developed economy - the rate of long-term debt compared to permanent capital. Respectively the borrowed sources in the short term we presented in terms of a short-term debt in total financing sources. Within SMEs from the Republic of Moldova the third way of financing sources cited in the hierarchy theory - the additional issue of shares is less popular and not representative for a large sample of SMEs surveyed.

4. Selecting indicators that characterize the financial performance of SMEs.

However, in our research of the many indicators that can characterize the financial performance of SMEs, we focused only on some, who are the most representative of the industry for the production of small or medium size as: *sales revenue; the result from operating activity; economic profitability and financial return.*

In order to validate the initial econometric model were taken data from financial reports of 270 entities currently existing in the bakery sector of Republic of Moldova for 2012-2016. From this group of enterprises that have introduced comprehensive financial report for National Bureau of Statistics were selected only those SMEs that met *the following three criteria*:

- number of employees and sales revenue achieved size category of micro, small and medium enterprises;
- at least 80% of the indicators presented in the financial statements had positive values;
- SMEs had a continuously activity in the analyzed period.

Following the selection, the number of entities taken into modeling narrowed to 120 SMEs. Based on data from these SMEs was developed econometric simulation in form of regression models VAR (Autoregrresion vector).

5. VAR modeling stages

Choosing VAR methodology is justified by the very nature of the investigation. Microeconomic phenomena are manifesting as complex dynamic systems with time and causal influences on each other. Consequently, only type analysis system (simultaneous equations) are able to grasp the interconnections among microeconomic variables.

Analysis of autoregressive vector (VAR) prevails in econometric studies in the early 70s as its main promoter being Christopher Sims, later Nobel laureate for his econometric researches. The main aim of the VAR analysis is to evaluate the effects of various shocks on the system variables, in our research - *the effect of financing resources on future financial performance of enterprise.* The study was conducted by the author with the support of the software EViews 7.0 and included a forecast prediction for 5 years (2017-2021).

Mathematically, a VAR process of p order can be described by the equation:

$$y_t = c + \sum_{m=1}^{p} A_m y_{t-m} + \varepsilon_t \qquad (1)$$

where:

Yt - a vector of endogenous variables of K x 1 size;

A - matrix of regression parameters, needed to the estimation the size K x K ;

C - parameter vector of free regression of K x 1 size;

m – present the used lag ;

ε_t - ally variable.

In the VAR modeling were used the following abbreviations variables included in the model:

1. C_AUTON - the coefficient of autonomy;
2. R_IND_TR – the ration of long-term debt;
3. R_D_TS – the ration of short-term debt in total financing sources ;
4. VV – sales revenues ;
5. R_OPER - the result of operating activity;
6. R_EC - economic profitability;
7. R_FIN - financial return.

The main stages of VAR modeling are:

- diligence on seasonality;
- selecting the number of lags of the VAR;

- stability testing (stationarity) VAR;
- Granger-causality test (GC);
- following impulse response function (FRS).

First stage provides diagnostic analysis to seasonality, it is mandatory for all time series. Within, its aims if quarterly indicators entities in a particular sector were or not influenced by the seasonal component.

Choosing the number of lags of the VAR was based on the synthesis results of several methods, namely: sequential testing lags significance; criterion to minimize final prediction error, Akaike, Schwartz and Hannan-Quinn. Given the number of observations in the sample were considered models with four lags;

Advancing to the third stage of VAR modeling *was used stationarity testing application*. A VAR is stable (stationary) if the effects of shocks on the variables of the system are reduced to exhaustion after a period of time. Economists prefer to work with stable VARs, arguing that in reality explosive economic phenomena are extremely rare.

According to VAR methodology a time series is considered stationary if it complies the relations:

- average time series is constant, the observations fluctuate around the mean: E (y_t) = E (y_{t+m}) = μ;
- variance series is constant and finite: var (y_t) < ∞;
- the covariance between two different periods of the process is constant and independent of time, depending only on the length k of interval separating the two submissions: cov (yt, yt+k) = E [(yt - μ) (yt+k - μ)] = γk; cu γk= γ-k, any k$\in$Z (Z is the set of integers).

By other words, the series is considered stationary only when under the impact of important factors the series will change, other factors have little influence on series. Checking the stationarity can be accomplished using several tests: Levin, Lin and CHU (2002), Breiting (2000), Im, Persian and Shin (2003), Fisher-type tests using ADF and PP tests ((Maddala and Wu (1999) and Choi (2001)), Hadri (2000). We must emphasize that these methods can produce results contrary from the application of the estimation procedure. To avoid this contradiction in econometric practice, usually, resort to the tests Im Pesaranan and Shin, ADF - Fisher Chi-square, PP - Fisher Chi-square - in the case of those series that presents the evolution of phenomenon for a long time and the stationarity variable is analyzed after Levin, Lin and Chu when ordering information for a short period of time.

In the case of this research, taking into account that we have information for a modest segment of time, it is important to "go through" stationarity test Levin, Lin and Chu t *. The investigated hypothesis being:

$$H_0 : \ \delta = 0 \text{ (Unit Root)}$$

$$H_1 : \ \delta \neq 0$$

Decision directions that we took into account to prove the stationarity of the series were:

- if Prob. ** > 0.05 or 5 % == > do not reject the null hypothesis, unit root exists, the series is not stationary;
- if Prob. ** < 0.05 or 5 % == > reject the null hypothesis, unit root do not exists, so the series is stationary.

Tests mentioned in the research gave us optimal solutions, prooving that *all time series under study are stationary*. Stationarity has been proved at a significance level of less than 5 % and, in case the lag time is not specified (lag 0). The fact that the data sets is stationary

allows us to retrieve into account directly without any further adjustments and advance to the next stage of VAR modeling. Stationarity series was performed for each variable separately.

In VAR modeling next step is checking Granger causality. The need for Parwies Granger test results from the fact that using vector autoregression method has some limitations and its results do not always allow the economic interpretation of the link between indicators examined. The preceding steps are resorting additional and Granger causality testing in order to better argue the influence of a performance indicator on another, and momentum indicators on the performance indicators of the research, and vice versa. Granger causality tests indicate that variables are useful for other variable weather.

In the Granger causality test carried out, aimed at identifying the extent to which the level of a single indicator is due to its previous level, showing all along the causal variable pair to it. All Granger causality obtained were systematized.

The final stage of modeling VAR we move toward identifying *impulse functions* generated by elements of the financial structure, the performance indicators of SMEs in the bakery sector.

In the obtained model, we can identify how will behave the indicators characterizing the financial performance of SMEs in shock effects of increasing the coefficient of autonomy. The first case will refer to the reaction studied *characterizing the financial performance indicators* as a result of momentum (growth) *factor of self-financing*, Figure 1.

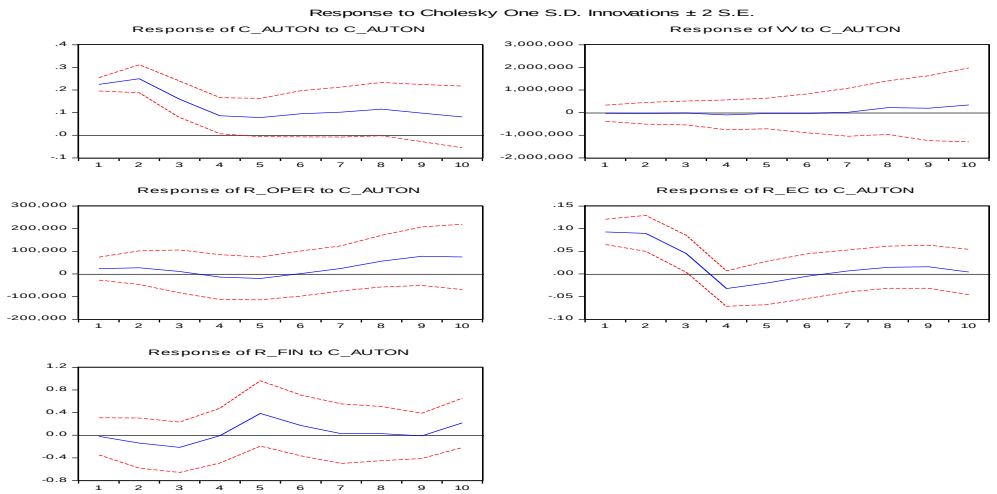

Fig.1. The response of financial performance to the impulse of self-financing coefficient, VAR I. Source: created by the author with the support of the software EViews 7.0.

Following the simulation undertaken under the VAR I we note that the evolution of revenues from sales generated by SMEs in the bakery sector has a neutral reaction to the momentum of the coefficient of autonomy. What can be easily justified by the fact that the size of this indicator does not depend directly on the source of funding chosen. However, the reason for including the revenues from sales indicator in the set of simultaneous equations was to pursue its dynamic behavior in relation to the result from operating activity. Examining the evolution of this result, due to the momentum of the coefficient of self-financing we notice the registration of positive values over three years, after which the result from operating activities is negative. Getting operational losses, after the first three years of the forecast can be subscribed on account of high operating costs. Another performance indicator investigated in

simultaneous forecast is economic profitability, which in the first two years of the forecast shows a neutral trend, due to the momentum of the coefficient of self-financing. Then, the next two years passes from positive to negative levels, managing to recover in time. We should mention that this indicator does not depend directly on chosen source of funding, but rather is a result of the quality of internal management of the entity. Simultaneously, this indicator of the VAR was made from comparative approach reasons to the financial return, the former being a strong factor influencing the efficiency of use of own sources. Namely financial return is the indicator that mostly depends on the source of funding chosen and therefore showed the prompt response to the impulse of the coefficient of self-financing, reaching positive limits from the negative ones in a period of three years, one denoting that invested entity's own sources were used efficiently, and result achieved largely due to streamlined management of assets.

Another modeling purpose was undertaken to measure the reaction of performance indicators due to the momentum of the coefficient of long-term debt to permanent capital, shown in Figure 2.

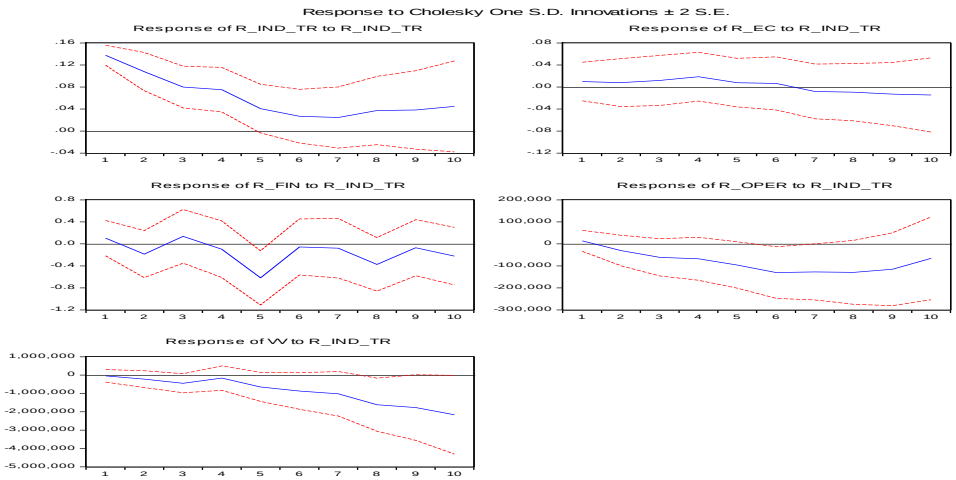

Fig. 2. The response of financial performance to impulse coefficient of long-term debt compared to permanent capital, VAR II. Source: created by the author with the support of the software EViews 7.0.

The burden of long-term debt along with operational costs is too heavy for small and medium businesses which is reflected in the size of the negative result from operating activities for the forecast period, due to the momentum taken. In parallel, examining the expected level of economic profitability we notice something paradoxical at first glance: economic profitability is positive in terms of recording losses from operational activity.

However this has an economic explanation based on the argument that momentum coefficient includes in its structure both repayable debt (credits, loans), and the special purpose financing and receipts, attracted by SMEs on account of grants. Subsequently, this form of grant becomes established as part of financial income from non-operating activities. Thus, the loss resulting from operating activities, offset by the size becomes non-operational profit from activities, which led to a level of profitability resulting positive forecast period.

Another performance indicator level, caution in the forecast, the financial profitability shows a prompt reaction and impulse oscillation while the long-term debt ratio towards permanent capital. Last indicator examined in VAR simulation is shown in Figure 3.

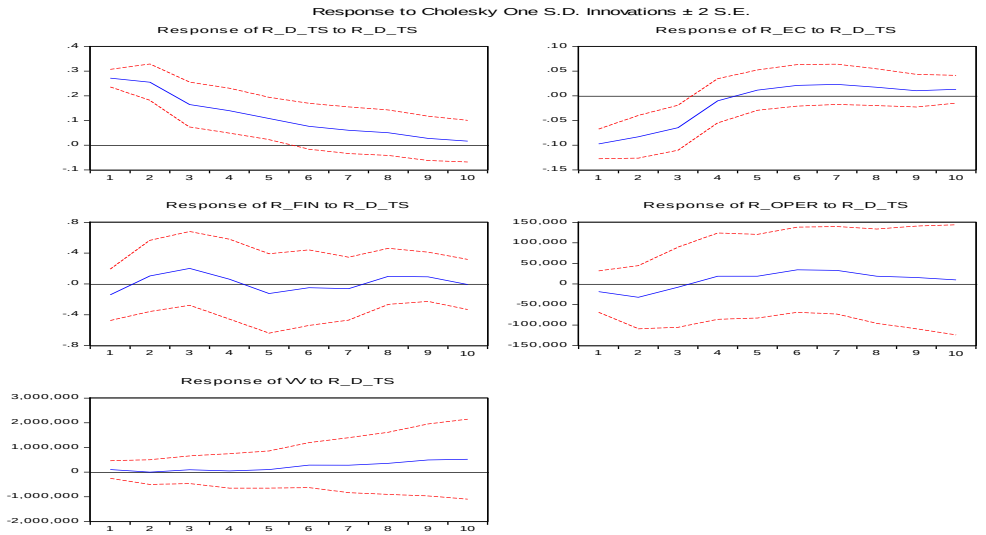

Fig.3. The response of financial performance to impulse coefficient of short-term debt ratio, VAR III. Source: created by the author with the support of the software EViews 7.0.

The momentum on the upside short-term debt in total financing sources is proving to be a debt burden easier for SMEs, not so much etches company performance in the future because they have a shorter repayment period. In these conditions result from operating activity is negative only for attracting funding period, then managed to come back positive.

6. The impact of obtained results

Among the differences between the financial results obtained of these VARs, there is one that will represent a major concern for the economic sector, the result from operating activities. The result will behave better than the result of self-financing, but will have a positive trend of recovery in the case of attracting short-term loan.

This suggests that in the planned period 2017-2021, reliance on own sources of funding, and the recourse to short-term liabilities will ensure bakery business operators the highest operational result.

Other interesting observations in assessing future financial performance of SMEs in the bakery sector can be highlighted by examining the economic profitability, which will achieve the best financial performance due to the momentum of the coefficient of long-term debt compared to permanent capital. Explained situation in the investigation by the component of long-term debt - attracted special purpose funding, which eventually rose to be a part of the result of their financial activity. The positive effect of the level of profitability achieved in the forecast comes in contrast with the consensus that is passed like a red thread throughout the research, which stresses the necessity of financial support to these enterprises by the state or other institutions and bodies. The most used form and most important financial aid is the state subsidies or grants attracted through financing programs, which are still quite modest for the needs of the SMEs sector in Moldova.

The most powerful of all performance variables examined, due to the momentum of all three factors, is affected the financial return that shows a favorable situation both to increase funding at the expense of short-term debts and for self-financing. Negative level for a short period of time this indicator impulse coefficient of autonomy at first seems irrational, but while

his comeback shows that the negative impact of the recently has caused the burden of taxation and taxation of these entities. What serves as a valuable addition to argue the proposal stated during the investigation that providing fiscal incentives for sustainable development of the sector is necessary.

The momentum of the debt ratio in the long term this indicator tends oscillation, often reaching negative values, the enterprise does not have assets formed at the expense of own sources. Pooled conclusion of those three VARs shows that:

- own sources and short-term ones are recommended as the first means of funding that might appeal undertakings in this sector;
- long-term burden is the source that should be caution with great prudence by these entities.

Another target object of modeling undertaken by us aims to establish and therefore recommend an optimal structure of funding sources under study examined entities. We examined five financing options shown in Table 1. The optimal variant was selected by the criteria for obtaining the best performance variables included in the model, detailed in the VAR IV.

Table 1. Financing options

Financing - 1	Financing-2	Financing -3	Financing- 4	Financing -5
1	2	3	4	5
1. OE - 50%	1. OE – 60%	1. OE – 50%	1. OE – 50%	1. OE – 55%
2. LTL – 25%	2. LTL – 15%	2. LTL – 15%	2. LTL – 35%	2. LTL – 15%
3. STL – 25%	3. STL – 25%	3. STL – 35%	3. STL – 15%	3. STL – 30%

Source: *created by the author.*

After reviewing all financing alternatives presented in Table 1 we find that the highest performance are obtained by examined SMEs in conditions of financing option number five (owner's equity - 55 % , long-term debt -15 % and short-term debt - 30 %).

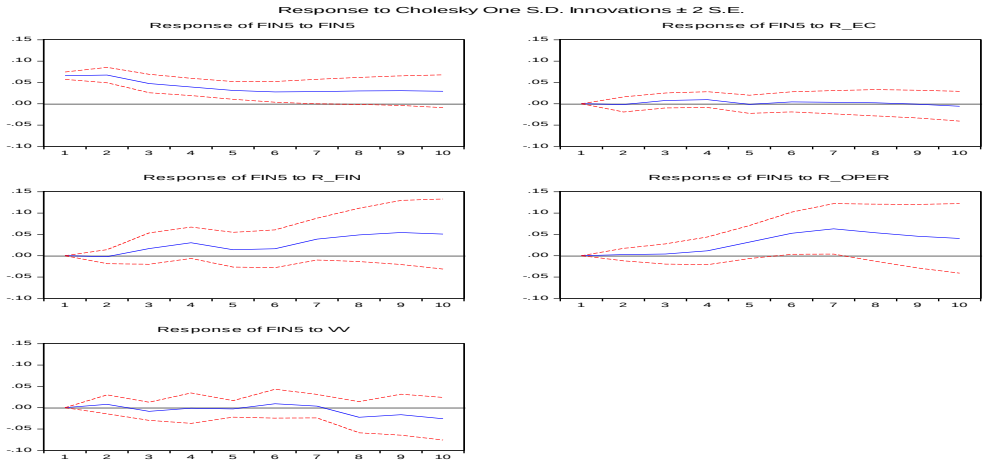

Fig.4. The response of financial performance when applying financial structure under number 5, VAR IV. Source: created by the author with the support of the software EViews 7.0.

7. Conclusions

Under the financing option number five all examined indicators will achieve favorable growth trend. The proportion of owner's equity 55%, followed in the ranking by short-term debt in the amount of 30% confirms simulation obtained in the first three VARs.

We should mention that the proposed methodology for determining future financial performance of SMEs, can be used in development strategies at both the enterprise and sector level. However, the proposed methodology can be used by any company in the small and medium business sector regardless of the type of activity conducted in drawing up its financial strategy. Econometric modeling proposed was "narrowed" to only one branch to validate and demonstrate the applicability of the proposed model.

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Ways of Increasing the Competitiveness of the National Economy

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Abstract. Processes of economic clustering aimed at increasing the competitiveness of economic actors at the macro, meso and macro levels became the important and relevant trend of the modern world economic development. Clustering content is to accelerate the economic development and increase the competitiveness of individual economic entities (enterprises, regions, countries, separate territories and cities) by using advantages of the social division of labor and consolidating their scientific and production interaction as a result of the formation of so-called cluster associations. Thus, in the process of globalization and internationalization, problems of ensuring competitiveness come to the fore, since only competitiveness guarantees the survival of a commodity producer both on the domestic market and on the external market. Competitiveness of the product is a manifestation of the competitiveness of an enterprise and the competitiveness of the latter reflects the competitiveness of the country as a whole, that is, the competitiveness of the national economy. The article deals with the issue of the competitiveness of the national economy and possible ways of its increasing on the basis of clusterization. It is noted that one of the main functions of the state in the process of formation of integrated structures is to prevent the emergence of monopoly phenomena. In the international market, the practice of cluster creation is well developed. And as experience has shown, this has greatly increased the competitiveness of individual countries.

Keywords: Economy, State, Competition, Globalization, Commodity producer, Cluster, Manufacturer, Firm, Innovation, Model.

1. Introduction

Problem statement

Ensuring the competitiveness of the national economy is the main concern of every state that cares about the economic growth and achieving the necessary level of the national security [4, p.27]. In addition, under the conditions of the process of globalization and internationalization, problems of ensuring competitiveness come to the fore, since only competitiveness guarantees the survival of a commodity producer both on the domestic market and on the external market. Competitiveness of the product is a manifestation of the competitiveness of an enterprise and the competitiveness of the latter reflects the competitiveness of the country as a whole, that is, the competitiveness of the national economy [4, p. 28].

Actual scientific researches and issue analysis

The issues of competition and competitiveness have attracted the attention of scientists. The founders of the competitiveness theory are A. Smith and D. Ricardo. Subsequently, their ideas were developed in the works of F. Edgeworth, A. Marshall, A. Cournot, E. Chamberlin, J. Robinson, J. Schumpeter and J. Galbraith. An enormous contribution to the development of

the theory of competitive advantages was made by M. Porter. The following scientists contributed significantly to the development of various aspects of the competitiveness of the national economy: L. Abalkin, O. Amosha, O. Bilorus, A. Galchinsky, V. Heyets, V. Deming, Y. Zhalilo, M. Kirtsner, K. Kettels, P. Krugman, J. Stiglitz and R. Fatkhutdinov.

Analysis of scientific publications and business practice indicate the need for further scientific substantiation of directions of ensuring the competitiveness of the national economy under the modern economic conditions.

The purpose of the article is to consider peculiarities of the formation of the competitiveness of national economies and the use of foreign experience of the competitiveness which are actualized in the context of constructing an innovative model of the socio-economic development.

2. Presentation of basic material of the research

Processes of economic clustering aimed at increasing the competitiveness of economic actors at the macro, meso and macro levels became the important and relevant trend of the modern world economic development. Clustering content is to accelerate the economic development and increase the competitiveness of individual economic entities (enterprises, regions, countries, separate territories and cities) by using advantages of the social division of labor and consolidating their scientific and production interaction as a result of the formation of so-called cluster associations. Clusters which are the embodiment of a complex system of interconnections between economic entities can enhance the beneficial effect of the entrepreneurial activity and serve as an effective tool for organizing the economy, controlling economic activity, increasing the competitiveness of individual economic entities, regions, countries and macro integration groups as a whole [7, p. 44].

It should be noted that in the international market, the practice of cluster creation is quite developed. And as experience has shown, this has greatly increased the competitiveness of individual countries. As an example of a successful cluster we can consider the association of the Italian manufacturers and designers of shoes, referred to M. Porter [8, p. 18].

In Western Europe, clustering projects providing enhanced interaction between firms of different profiles and, subsequently, of different industries, are among elements of the applied research oriented towards promoting innovation.

There are three most widely known cluster definitions.

1. Regionally limited forms of the economic activity within related sectors (technological affinity, for example, a biotech cluster) are usually tied to those or other institutions of the knowledge industry (research institutes, universities, etc.).

2. Vertical production chains: very narrowly defined sectors in which adjacent stages of the production process form the core of the cluster (for example, the chain "supplier – manufacturer – implementer – client"). In this category, there are networks formed around the main firms (focus clusters).

3. Industries that are defined at a high level of aggregation (for example, a chemical cluster), or aggregation of sectors at higher level of aggregation (for example, agricultural and industrial cluster). Usually they are called metaclusters which differ sharply ranging from simply local ones (for example, horticulture in the Netherlands) to truly global ones (aerospace cluster) [12, p. 76].

The overall level of efficiency for both business entities and the state from the application of the cluster model of business organization is achieved by combining competition with co-operation, uninterrupted mutual exchange of knowledge between business entities and their focus on the systemic innovation development [3, p.28].

The concept of "principles of formation of innovative clusters" is considered to be the system of objectively inherent clustering processes of the starting ground, indisputable requirements put forward by the members of cluster relations in order to ensure a harmonious interconnection of social, group and individual interests. The previous experience in their creation and operation is accumulated in the principles of the development of innovation clusters [10, p.208].

One of the important functions that the state must perform in regulating cluster activities is the formation of a competitive environment. In turn, this ensures maximum satisfaction of rights and needs of the end-user. It is the competitive environment that is a prerequisite for the development of market relations. It is the result of the interaction of conditions and factors that create the necessary environment for the achievement of competitive advantages by economic entities. Under the conditions of the development of the domestic economy, there is a rather high probability of transforming the cluster into a monopoly. Thus, one of the main functions of the state in the process of formation of integrated structures is to prevent the emergence of monopolistic phenomena, since competition is an indispensable feature of a developed, civilized economy [2, p.42].

The institutional environment is decisive in the model of state regulation of the economic growth and is determined by a set of factors: legal, economic, foreign economic, socio-cultural and political. As a result of many studies, scientists confirmed that: "The institutional environment has a significant impact on the efficiency and growth rates of the economy. Politically open societies that adhere to the rules of law, protect private property and market sharing of resources, grow three times faster and 2.5 times more efficiently than societies where freedom is limited" [9, p.623].

The lack of information and knowledge on the formation of cluster structures is another factor behind the weak development of such integrated associations on the territory of Ukraine. To bring to leaders of enterprises and authorities the idea that clusterization is one of the most effective mechanisms for improving the financial and industrial condition of enterprises and regions is difficult enough under the current conditions of development of the national economy because, first of all, the management of enterprises under the current economic situation in the country, seeks to preserve existing potential and profits. That is why it is important to conduct information work on clustering issues. Central and regional authorities are called upon to facilitate the collection and compilation of specific information on clusters, take special measures in the field of education (harmonization of university programs with real needs of cluster structures), simplify provisions affecting cluster activities, financially independent researchers and product certification, convene forums of enterprises and organizations on issues of cluster development of the region, organize local departments to promote the development of clusters [5, p.516].

The particular attention in ensuring the development of clusters should be devoted to the formation and continuous support of a favorable investment climate, since the efficient functioning of economic systems based on small and medium-sized businesses is the basis for ensuring economic rise at the macro level, in particular, through the formation of such benefits as lowering unemployment, ensuring a stable high level of employment and increasing the tax base [11, p.36].

The geographical location of the branch cluster is determined by the principle of maximum synergy: within the branch cluster, the concentration of media carriers, personnel resources, industrial enterprises, innovative infrastructure and related industry organizations is proportionally balanced. Groups of domestic competitors are often surrounded by suppliers and located in areas with the most significant and demanding consumers. Concentration of competitors, buyers and suppliers contributes to the growth of efficiency and specialization of

production. Thus, the influence of determinants of the country's competitive advantages is amplified by the influence of geographical proximity. Universities located close to a group of competitors often interact with it. Competitors support and fund the activities of local universities, suppliers located in the neighborhood, have the benefits of interchange and cooperation in research and development. Demanding clients-neighbors offer affordable information transmission opportunities by taking part in processes of the formation of the demand level and exchange of technologies increasing requirements to the level of service and product quality [1, p. 79].

During the formation and functioning of a cluster, the necessary and sufficient cooperation between formerly separate enterprises is carried out. It is to promote production at the expense of material and intellectual means which leads to the growth of productive potential of branches. Relations within the cluster contribute to the quality improvement of the human factor, due to the reduction: isolation of internal problems, inertia, inflexibility and cartel conspiracy between market participants. Namely, these negative manifestations reduce and sometimes almost completely block the positive effect of competition on the development of the market and emergence of new firms [6, p. 30-33].

3. Conclusions

An important aspect of integration into the world economy is the achievement of an appropriate level of competitiveness of Ukraine. That is, the process of ensuring competitiveness requires, first of all, the intensification of the economic activity. The transition to a new paradigm of the economic growth under the conditions of globalization requires modernization of its economy, activation of innovation activity, creation of a favorable investment climate and continuous improvement of market mechanisms of the economic activity from each country. Only in such way Ukraine will be able to join the world community on a worthy basis and provide the necessary level of the economic and environmental security.

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The Effective Internet Usage in Public Relations

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Abstract. The paper reviews current trends in research on PR in the Internet. It shows the main techniques that can be used while promoting any organization. The web-site has been characterized as a basic tool of communication in the Internet. Moreover, the target groups of online Public Relations have also been presented.

Keywords. Public relations, Internet marketing, Target group, PR methods, Mass media, Social communication.

1. Introduction

For the public relations practitioner, the internet is one of the greatest innovations of all time. Its continually increasing popularity opens up myriad opportunities for improving our ability to practice our profession. The internet facilitates nearly every imaginable form of communication, but this article will focus on three major areas of the practice: professional development for the practitioner, the ability to do research, and the all-important ability to actually disseminate our messages.

The purpose of the present study is to identify the trends in the application of the various Internet tools in the public relations practice. The ultimate goal is to review the main PR methods in the Internet and to show practical abilities to PR-managers.

2. The Internet and public relations: An overview

Public relations are often regarded as a secondary promotion tool as compared with advertisement or direct sale. However, this does not detracts from the fact that public relations have considerable influence on the final result of a company`s activity and play an increasingly important role in marketing, also in online marketing [1].

The aim of public relations activities is creating and maintaining the desired image of an enterprise or an organisation. This goal can be effectively achieved also on the Internet. This is particularly true for the following forms of PR:

- shaping of the company`s image;
- cooperation with mass media (media relations);
- communicating with investors (investor relations);
- internal public relations, or communicating with the company`s employees through the network [2].

The use of the Internet in PR activities is relatively new. The promotion of Amazon.com carried out by Eric Ward, a PR specialist, can be regarded as the beginning of public relations activities on the Internet, where telephone calls and fax transmitted to journalists were replaced with communication by electronic mail, thus achieving a wider range of influence and a greater response by the media.

In fact, PR in Internet performs a broader role than PR created and built in the real world. In a virtual reality, image creators are not at journalists' mercy.

A message goes directly to receivers, not being halted, shortened, or - what often happens - distorted by press agents [1]. Moreover, the Internet is an interactive medium providing a possibility of virtually unlimited publications at a low cost. All those features cause PR specialists to increasingly high appreciate the advantages of the Internet and increasingly often practically utilize its capabilities in their everyday work.

3. The impact of the Internet on the practice of public relations

Much has been written about the communication revolution brought about by the Internet and the implications for the public relations practitioner.

According to Castells [3], since the consumers of the Internet are also the producers, it leads to unprecedented decentralization of information and power. Castells [3] refers to the Internet as the computer mediated communication (CMC) network that enables interactivity and states. Castells' [3] view is corroborated by Holtz [4] and Lattimore [5], who argue that the organisations now operate in an information economy as opposed to an industrial one, and this causes a change in the traditional public relations practices that were rooted in a top-down approach.

Breakenridge [6] further explains that the instant availability of real-time information with social media tools such as Really Simple Syndication (RSS) news feeds, blogs and social networks can be used by public relations practitioners for research, media monitoring and issues management.

It has been noted that while the public relations practitioners are increasingly monitoring social media like the blogosphere, their relationship with citizen journalists like bloggers remains tenuous due to their desire to maintain control over information and its dissemination [8]. This issue is further addressed by Kent [7] who adds that the challenge for a practitioner is that controlled messages have the risk of being treated like propaganda in the blogosphere.

It is widely acknowledged that the communication revolution has empowered the 'publics'. This implies that while the Internet offers several opportunities to the public relations practitioners, it also creates challenges for them as they now operate in a non-traditional and more transparent environment that requires them to relinquish control [6, 8, 9, 10]. It has been identified that the most important impact of the Internet on the practice is its phenomenal capability to make any kind of information available almost instantly [11].

The greatest challenge in online public relations is to create an effective action programmed. This will be practically impossible, if a mistake has been made when defining the strategy of the organisation`s presence in the Internet. The difficulty arises from the necessity of combining numerous competencies and interdisciplinary knowledge. In addition to the knowledge of the industry, the company`s needs in many planes of its functioning, Internet-marketing and, obviously, public relations, provide a good understanding of the Internet as a medium and broad technical knowledge.

4. The most important tools for conducting PR in Internet

There are a lot of facts indicating that the significance of PR as a promotion instrument is relatively growing. Three features are decisive to the popularity of PR.

A company becomes, as it were, an objective third party instead of a simple organization that maximizes its profits.

Secondly, through public relations, firms reach segments that are hardly accessible by using other means, such as governmental circles, or academic people.

Thirdly, PR are covered by legal regulations to a lesser extent.

In many countries, expenditures to public relations are growing twice as rapidly as for sale advertising and promotion. This undoubtedly results from the fact the strength of mass publicity is weakening due to rising costs, an increasing advertising confusion, and a decreasing number of receivers. The marketers of many companies increasingly often orient themselves to PR activities [12, 13].

Online public relations can be conducted using the following basic tools:

- the web-site;
- electronic mail;
- mails and discussion groups;
- Internet conferences (chat rooms);
- electronic newsletters;
- services sponsoring.

The skilful and properly integrated use of the above-mentioned PR tools provides a guarantee of success for every specialist in this field. However, it should be emphasized that first and foremost tool for conducting online public relations activity is the web-site. It is in most cases the web-site that corporates PR activities on the Internet should be started from.

The best method of using Internet sites in online public relations activities is to create a special section directed to the media, so called press rooms or press releases. The aim of this section is to collect in one place of all information that could be useful for both journalists and any other people interested in the company's activity. When creating a press room, it should be borne in mind that it can be very helpful in building the company's image in the media, but it may also undermine that image; therefore, the proper construction of the press room is of paramount importance.

It should be added that, from the Internet public relations point of view, any other materials related to the company's activity, such as photo reports of interesting events, video films and sound records of important conferences to be used by radio or TV stations, are also worthy to be inserted on the Internet [1]. Any actions undertaken within PR by organisations must have their specific addressee. In the case of public relations, three main target groups can be distinguished (Table 1).

Table 1. Main target groups of online Public Relations

First group	Traditional media	Information agencies and press.
Second group	Internet media	These are horizontal portals (designed for all Internet users), portals (topical services intended for small groups of audience), discussion mails and etc.
Third group	Internet users	People who are interested in the products of company which we promote.

It can therefore be suggested that public relations practitioners need to strengthen their knowledge of the Internet in terms of environmental scanning, media monitoring, research and evaluation, which according to Broom [8] are typically assumed to fall under the manager role, and avoid being too involved with technician functions such as uploading content on websites, web design an d search engine optimization and leave these for the IT teams to handle in order to manage encroachment. However, there is no evidence in the existing literature that could support the above deduction.

5. Conclusion

However, it could be argued that while public relations practitioners can use the Internet to communicate directly with their publics, they need to conform to ethical practice to avoid bringing disrepute to the organisation they are representing. Hence, more research is required in this area to establish theories that can be applied in a global context.

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Applying the National Process Metadata Structure to the Bulgarian Labour Force Survey Data Production Process

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Abstract: The standardization is an inevitable process in the world of globalization. The Eurostat efforts for the 'unification' of the statistical production processes of the EU members' national statistical organisations lead to the development and the implementation of a standardization 'tools' such as SDMX, GSBPM, ESMS, NPMS, etc. The paper discusses the application of the National Process Metadata Structure (NPMS) to the data production process in the largest national representative statistical survey in Bulgaria – the Labour Force Survey.

Keywords. ESS, ESMS, NPMS, LFS, business process, metadata, structure.

1. Introduction

In a world of diversity and variety in the products and services, it is an ultimate challenge to provide unification in the production process. However, the modern society always looks for products of the highest possible quality [6]. The only 'cure' for this quality 'madness' is the 'struggle' for standardization of the business processes at all possible levels.

The official statistics of the European Union is nothing more than a 'manufacturing' process which product is the data at different levels of aggregation (see fig.1).

Fig.1. European statistical system (ESS) data 'production' process

At the lowest level of the 'production' business process are the NSIs of the EU members that gather the 'raw material' and use it for the first level of data aggregation – country level. Then the processed data are sent to Eurostat in order to supply 'material' for the final level of production process that provides data and indicators at EU level. Now the 'product' is ready to be delivered to all stakeholders such as the government, corporations, private companies, research institutes, etc. [5]

The ESS vision for the quality assurance of this data production business process is the 'path' of horizontal and vertical integration within the ESS. The horizontal integration means an 'amalgamation' between broader statistical domains and the vertical integration concerns the consolidation between Eurostat and National Statistical Institutes. [1]

Eurostat, in order to ensure integration of the business process at all stages of data production, provides a framework in which the 'local' data manufactures should fit in.

This framework is also known as Euro SDMX and Metadata Structure (ESMS).

The 'Statistical Data and Metadata eXchange' is an international initiative aimed at developing and employing more efficient processes for the exchange and sharing of statistical data and metadata among international organisations and member countries [5]. Metadata are data that serves to provide context or additional information about other data [5]. ESMS aims to provide standard documentation of the data production process with sufficient details (see fig.2) [10].

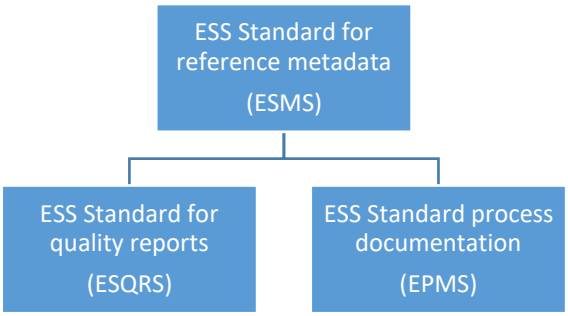

Fig.2. ESMS structure

The ESMS could be considered as the first level of standardization and the ESQRS and EPMS provide more details on certain ESMS concepts.

The standardization of all stages of the official statistics production process is based also on so called the Generic Statistical Business Process Model (GSBPM) [2]. The latter is a solid base for the building of the standard framework and harmonized terminology for the modern statistical production processes and the sharing of survey methodologies. GSBPM defines the data production process in 8 phases that consist of 44 sub-process as follows [3] (See fig. 3).

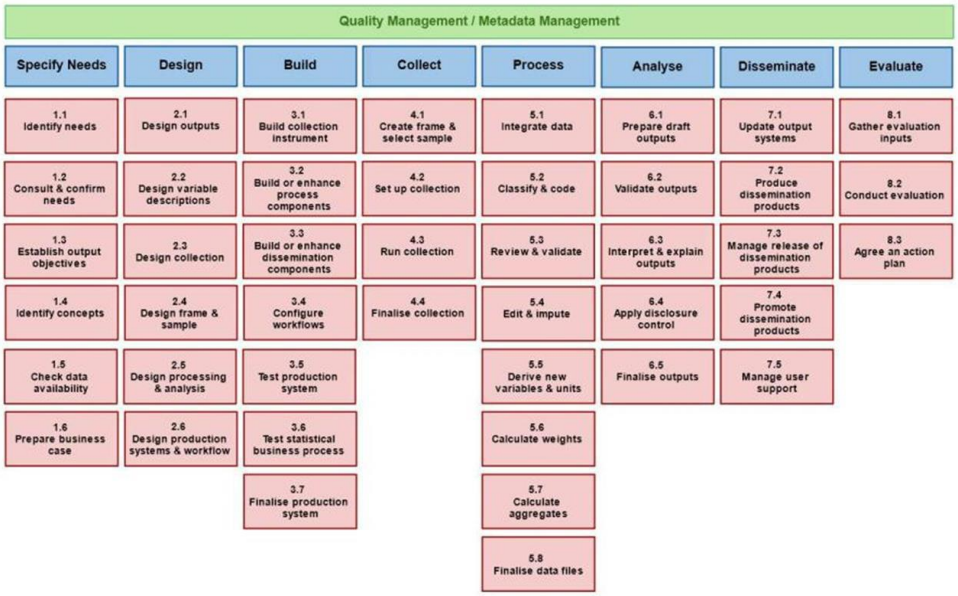

Fig.3. GSBPM ver. 5.0 contents

In order to provide a deeper insight into the 'real' production process procedures, Eurostat decided to atomize the structure of the phases 4 to 7 of the GSBPM and therefore the EPMS was 'invented'. Here it should be noted that EPMS is not fully applicable to the business processes of the local NSIs because initially it was made to serve the Eurostat business process description purposes [4]. Because of this, EPMS is further formalized into a local (country) version called National Process Metadata Structure (NPMS). Basically, the latter includes all sub-processes of the GSBPM which concern the EPMS (4-7) but applied locally to a certain data production process for a given country [7].

2. Applying the NPMS to the Bulgarian Labour Force Survey

In order to demonstrate the idea of NPMS, the latter is applied to the largest representative survey conducted by the National statistical institute of Bulgaria – Labour Force Survey (LFS). The latter is a sample survey that collects information from the households living at the territory of Republic of Bulgaria. The main purpose of the survey is to provide data on the labour status of the population aged 15 years and over and on the main characteristics of employed, unemployed and persons out of labour force. The LFS results are published in Bulgarian statistical publications and newsletters. In addition, the results are periodically submitted to the research organisations, informational agencies and international organisations [9].

The application of the NPMS concerns the detailed description of every aspect (concept) and procedure of the Labour force survey conduction process, and follows these stages:

1. *Description of the organisation* (name, address, department) and *experts* (name, position, e-mail, telephone and fax) responsible for the organisation and conduction of the Labour Force Survey.
2. *Specification of statistical process* from a general point of view. In details the following is described:
   - purpose and the objectives of the LFS (incl. scope, users, periodicity, etc.);
   - main stages of a 'typical' quarterly survey: **preparation** (standardized survey questionnaires revision and update, ad hoc modules development, forms and instructions printing, interviewing schedule preparation and sending, technical specification for the data entry software update, etc.), **survey realisation** (respondents interviewing, questionnaire coding and checking, data entry, logical control, sending the databases to the central office, etc.) and **data generalization** (data aggregation and merging, additional logical checks, data adjustment - imputation, weighting and calibrating, data grouping, tabulation, parameters estimation, etc.);
   - main concepts and definition used (incl. the legal acts and other agreements that concern the survey) – labour force, employed and unemployed persons, working time, economic activities, economic sectors, occupation, duration of unemployment, persons not in labour force, education attainment, etc.;
   - main statistical indicators used – activity rate, employment rate, unemployment rate, jobless households, early leavers from education and training, young people neither in employment nor in education and training and many more;
   - units of measurement (number of persons in thousands and rates in percent);
   - detailed description of the classifications used (ISCED, NUTS, etc.);
   - survey coverage (a sample of the non-institutional households);
   - reference period (one calendar week);

- periodicity;
- comparability over time;
- survey completeness.

3. *Survey design* and *statistical instruments* (incl. description of questionnaires used)
4. *Data collection process description* – comprehensive specification of the process of:
   - primary **data collection** (organisational plan, training of the interviewers, **sampling design** (population, sampling frame, survey units, etc.), **sampling procedure**, usage of **administrative data**, combining **data sources**, etc.);
   - **conversion** of the primary data, coding and file transmission;
   - primary data **validation** (incl. software used)*;*
   - **consolidation** of the primary data.
5. *Statistical processing and data analysis* – a complete characterization of the additional procedures applied to the LFS database:
   - Data **integration**;
   - Data **coding** of the open-ended questions;
   - Data **validation** in two stages (during the data entry and centralized validation)
   - Data **editing** and computation of **additional variables**;
   - Data **imputation** for the missing values;
   - Data **aggregation** – includes: the description of the procedures of generalization of the survey sample data and tabulation of statistical distributions, stochastic reliability of the date, non-sampling errors estimation, weights calculation, preparation of the draft outputs, etc.
   - **Validation of the outputs,** not only from the comparability over time point of view, but also cross-domain coherence with data from other sources of information about the labour market and the population (coherence of LFS data to other sources of information);
6. *Confidentiality of the individual data* (national and EU legislation).
7. *Release policy* and *release calendar* (incl. the NSI site dissemination policy, user access, data exchange, data sharing, etc.).
8. *Dissemination format* (incl. publication, online databases, micro-data access, etc.).
9. *IT application used* (incl. IT applications for: data reception/collection, data processing, data validation, data confidentiality, metadata).
10. *Quality evaluation* (incl. quality evaluation of the LFS results from the point of view of: designs and methods of the survey, relevance and completeness, accuracy, timeliness and punctuality, accessibility and clarity, comparability and coherence).

The National process metadata structure documentation is compiled by the experts of the NSIs and some external experts (such as researchers, university professors, etc.) in two versions: in local language (Bulgarian) and in English. Then the NPMSs from each NSI are sent to Eurostat where they are validated and stored online for future integration and harmonization purposes.

3. Conclusion

A multilevel production process without the coordination and the unification is a 'lost cause', especially when high quality standards are pursued. Building standards for products and services (such as ISO, ESMS, NPMS, etc.) is the main base on which the goal for 'perfection' can be successfully achieved. Eurostat, as a coordinator and a facilitator of the official statistical information production process in European Union, promotes the harmonization and standardization of the statistical methods across the EU member states and provides a solid basis for the adequate consolidation of the individual country's data production processes. As an example it was shown that the methodology of one of the largest and most complex sample surveys in Europe – Labour Force Survey, could be and should be also 'rearranged' according to the EPMS by the means of National Process Metadata Structure in order to certify its quality.

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Tourism Mobile Applications – Development Benefits and Key Features

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Abstract: The rapid deployment of mobile computing technologies has enormous potential to provide access to various services at any time and from anywhere. The mobile phone provides wider functionality than a simple call. It accesses applications and services via an Internet connection or by building stand-alone applications. Mobile devices contribute to the development of tourism by allowing the user to access Internet content or specific tourist information from an installed mobile application. Existing tourism applications use the latest technology to improve quality, with the goal of meeting the specific user requirements. In this paper we examine potential of mobile devices for tourism, the benefits they bring. Some practices for developing tourism mobile applications are described.

Keywords: Mobile applications, tourism

1. Introduction

The importance of information technology in tourism, especially mobile devices and their technologies, has increased significantly over the last few years and this trend will certainly continue. Technological innovation in the sector shows high dynamism and flexibility, similar to the current trends in the world tourism market.

Mobile devices have the potential to have significant impacts on the tourism industry [5]. The widespread deployment and continued enhancement of mobile performance and capabilities has led to the development of specific applications that make travelers feel free to travel according to access to specific information and services. It is key to properly approach the development of mobile mobile applications, costs, opportunities to operate on a wider range of devices, and account for the specific needs of users.

2. The potential of mobile devices

In tourism mobile devices are used mainly for information, reservation and payment [9]. Relevant applications are developed for them by the providers of tourism services. The constant contact with the tourist turns in a leading advantage of the mobile device. As a result, bids to it are customized, targeted, and directly served with apps.

The number of mobile users has increased significantly last 10 and above years [2] as the average annual growth rate for the period 2005-2013 is close to 37%. In recent years, mobile reservations have been growing at an ever faster rate [1]. According to a PhoCusWright report for the period 2012-2014 [8], this indicator has tripled in the US and has reached nearly $ 26 billion, where three out of ten users have booked through a mobile phone and more than half used it to inform and Exploration of destinations and products.

Booking through mobile devices is also important for last minute orders which are used in all phases of the tourist service purchase process (from a destination survey and online

booking to a post-travel review) for easy access and usefulness in searching for information [4]. Smartphone barcode reading is successfully used in many countries to describe menu dishes, receive promotional offers, and landmark descriptions. However, the primary way of booking is via a laptop or a desktop computer, with 25% of people using it saying they have booked a holiday component through a mobile device too.

3. The use of mobile applications

The fact that travel agencies direct their efforts and invest money in mobile apps, shows that they surely see benefits in it. Moreover, travelers prefer it over websites because they see many advantages. Here are multiple benefits of travel mobile app [3]:

1. Travel Ticket Booking Travel apps assist in planning people's trip.

2. Payment Gateway Integration – payment gateways are integrated in the app to accept payments made for flight tickets and hotel reservations.

3. Holiday Packages Browsing through innumerable travel agencies to search for the best holiday package is painstaking task. The tourism mobile application refines and presents the best available holiday packages for the said destination. Users can get details on the package and view the itinerary to get an idea on sightseeing spots covered.

4. Travel Guide - users who like to explore the place on own without buying a specific tour package and restricting their discovery of place, then travel application accompanies and guides the traveler about the place. It gives precise information about various famous and even lesser known, unexplored regions of the place the traveler is about to visit. App can be a travel guide and even a map to reach the traveler to the desired place without anyone misguiding him during his travel.

From business point of view, mobile applications bring many benefits. We can summarize the following [7]:

- encouraging customers to use your services while on the road;
- generating new leads;
- online exposure;
- giving people what they need.

The following can be added:

- branding is strengthened and validated through the use of mobile applications;
- encouraging customers to use your services while on the road;
- the large number of installations in the app provide a wide range of loyal customers;
- mobile app construction is a serious investment that is paid in the long run with a positive growth in sales volume;
- the mobile app is an excellent tool for promoting new products and services;
- mobile applications can be a convenient tool for collecting customer data and contextually bidding respectively;
- mobile applications are the new channels for active communication with customers.

The advantages of mobile information applications for tourism service customers can be summed up in the following:

- the user can select an appropriate application according to the specifications, rating, or reviews of users already using the service;
- they are easy to install digital solution - mobile applications are built to the requirements of the respective operating system of the mobile device;
- they are extremely accessible - one click of the relevant mobile device screen icon activates the application;
- the user has access to the necessary information at any time of the day;

- if this option is preset, the mobile application can be accessed and fully functional even in non-Internet mode;
- mobile applications can have an additional feature allowing to set interest filters and set the data stream to individual user preferences;
- mobile applications automatically update their content when accessing the Internet.

4. Key features in mobile applications development

The development of mobile applications must be consistent with a variety of factors in order to be able to respond the specific information needs of users. In this direction, we recommend the following main features to pay attention when developing trip mobile app:

- Geolocation.
- Itinerary generator.
- Translator.
- Weather forecasting service.
- Currency converter.
- World Clock Time Converter.
- Local emergency services and insurance.
- Taxi. Cab service is an important feature of travel guide app;
- Trip reviews, recommendations and diaries.
- Social media integration.

5. Conclusion

Mobile applications are used on many mobile platforms and their users is increasing every day. Therefore, the continued development of mobile applications is key to the tourism industry.

A key point in the design and development of these applications is the inclusion of a host of functionalities and capabilities that are useful to the user in order to obtain the necessary information and organize the desired trip with several screen touches.

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Information Aspects of Administrative Services

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Abstract: The paper deals with the main issues of information technologies in the provision of administrative services. Emphasis is placed on the role of information technology in the modernization of processes in administrations. This can be considered as the basis for the introduction of electronic administrative services and implementation of the principles of e-government. The main challenges facing the introduction of state-of-the-art technological solutions in the administration are outlined. At last, conclusions are drawn.

Keywords: Administrative services, Electronic administrative services, public administration.

1. Main issues of administrative service

Administrative service is a complex area because it is related to customer service. In recent years, we have witnessed major changes in public expectations about the role of administration in the development of the economic system. These expectations are measured by applying different policies and actions to improve the service of businesses and individuals. A key role in these processes lies with the provided administrative services and their modernization. The pursuit of full modernization of administrative activities goes naturally through analysis and optimization of the working processes.

Administrative service and its principles are defined by the Administration Act as "any administrative service activity performed by the structures of the administration and by organizations providing public services" [1]. The main role in the provision of administrative services is the work processes. Our understanding of them is related to a succession of activities that lead to a result.

From the point of view of this study, administrative services are a multi-component system. The main elements of this system are (fig. 1):

- Investigation and analysis of administrative activity;
- Description, analysis and modeling of the work processes in the administration;
- Reengineering of business processes;
- The role of human resources in the implementation of work processes;
- Characteristics of the provided administrative services;
- Modernization of administrative services;
- Information provision of administrative services.

The description, analysis, modeling and subsequent improvement or reengineering of the processes according to the methodology for improvement of the work processes for provision of administrative services to the Council of Ministers [4] is a rethinking and redesigning of the processes to achieve significant improvements in key performance indicators of the organization, costs, quality, service. Here is the place to emphasize the key role of employees in improving administrative service delivery and improving the efficiency

of workflows. In her study, Krasteva points out that "the capabilities of human and information resources are important for improving public service delivery through modeling of processes" [3]. The same author describes the details of the functional capabilities and the application of an information system for human resource management.

To achieve maximum user satisfaction, it is necessary to develop new or upgrade existing administrative services.

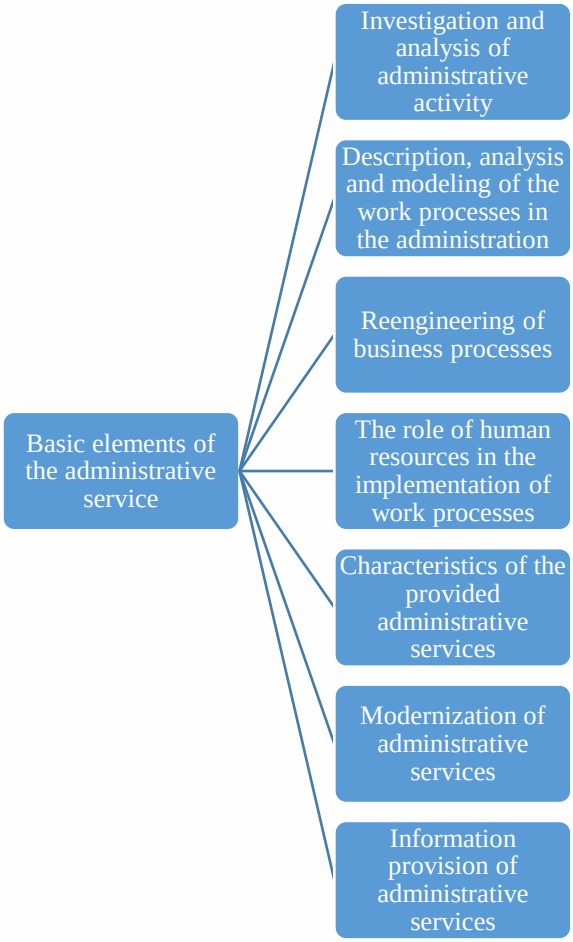

Fig. 1 Basic elements of the administrative service

2. Information aspects of the provision of administrative services

Providing administrative services is a complex and responsible task. The focus in its realization is the satisfaction of every particular user. In this sense, the role and place of information provision is key. It is not just software that supports the specific activity, but a comprehensive approach to information provision to solve the problems of the user. Fig. 2 presents the concept of the described approach.

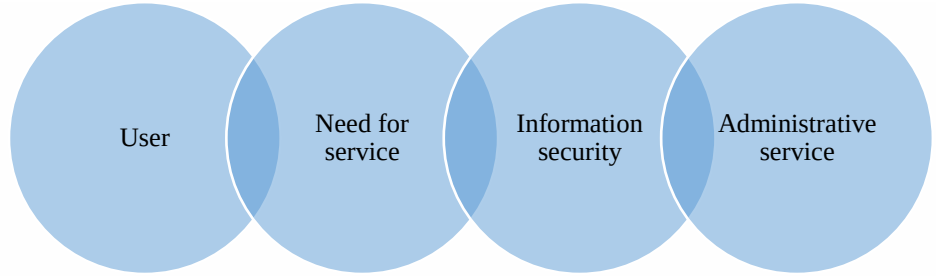

Fig. 2 User at the center of administrative service

In today's digital society, with large volumes of data, finding quality information is a difficult task. Providing the right software to solve every problem and task is related to conducting preliminary studies and comprehensive comparative analyzes. In his study, Kirilov offers the application of different approaches to the comparison of software products to solve a specific information problem [2]. In the context of this study, it is suggested to analyze the selection of software for the performance of administrative activity:

- Opportunities to provide quality and timely information;
- The time for performing the administrative service;
- The information sources on which the administrative service is based;
- The degree of optimization of the working processes in the administration;
- The degree of modernization of the administrative service
- Reduce the risk of errors;
- Cost reduction, etc.

To make the process of using information provision more effective in providing administrative services, the necessary initial data and their transformation are the ultimate result. Different methodologies can be used for this transformation to get quality end-to-end information. It should also be noted that in most cases the information sources in the provision of administrative services are several (fig. 3).

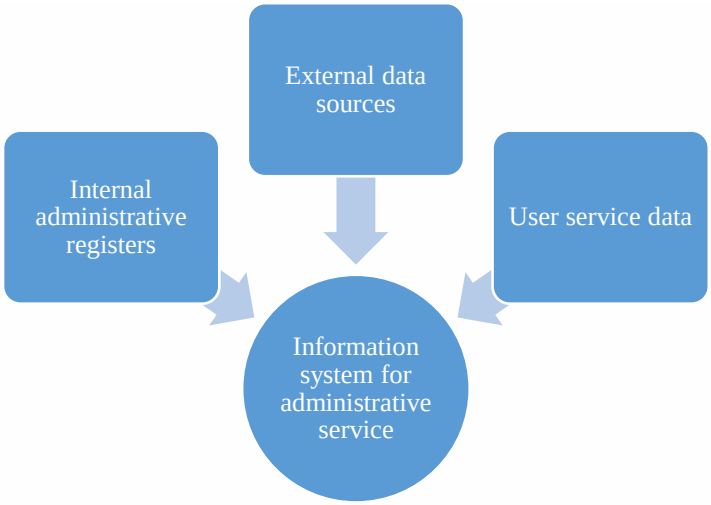

Fig. 3 Using multiple information sources

The implementation of the described approach is possible only after analyzing the characteristics of the different software applications that are used in the working processes. The integration of these applications is a rather difficult task, and many authors describe approaches to make it happen. Milev, in his research, describes in detail the different approaches for developing integrated information systems [5]. The integrity of software applications in the administration will allow the creation and use of a common conceptual model for information provision of administrative services.

3. Conclusion

Administrative services occupy a key place in the activity of each administrative structure. For these reasons, the issue of the main factors on which the quality of service depends. Information security is one of these factors. Current practice is constantly looking for ways and means to improve service delivery processes by improving their modernization.

At last, the following conclusions can be drawn:

- Improving the efficiency of administrative services can be done based on achieving integration of the software applications that the organization operates with;
- The integration of existing software solutions can be accomplished after the reengineering approaches to the core business processes are implemented;
- Methodological approaches to measuring the effectiveness of the provided administrative services should be constantly sought.

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System Architecture of Software for Media Monitoring

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Abstract. The paper examines some features of modern software architectures. The paper discusses issues related to the functionality of software for media monitoring. On this basis, an appropriate system architecture for media monitoring software is proposed. The conclusion outlines some trends in development of media monitoring systems in the context of the critical role of modern software architectures.

Keywords. Software architecture, information system, media monitoring

1. Introduction

Modern software solutions are based on some of the successful software architectures. Nowadays, the predominant part of the information systems on the market are web-based systems. In this sense, the paper will focus on these architectures. In theory, web-based architectures are known as multi-tier architectures. The most popular software architecture for web platforms development is the three-tier application architecture, which contains the following three layers:

- Client browser, where visualization of the user interface takes place;
- Web server, which handles customer requests;
- Database server, which stores and manages all the information on the information system.

Although the three-tier web application model is the most common architecture for such solutions, there are also other multilayer architectures, which are used in more specific software systems. They usually add additional (one or many) architectural layers to the processing of some specific business logic. In this sense, the purpose of the paper is to present the traditional architecture of web-based software solutions and to propose a system architecture, which would be appropriate for implementation of media monitoring platforms.

2. Traditional systems architectures

Traditional software architectures could be classified into the following types:

- Single-tier architecture – desktop-based architecture, that integrates in a single layer the presentation logic, business logic and data of the software solution;
- Client-server architectures – they could be divided into two types, namely a two-tier architecture with a thick client (one layer for the presentation logic and business logic of the software solution and a second layer for the data of the system) and a two-tier architecture with a thin client (one layer for the presentation logic of the software solution and a separate layer for the business logic and data of the system);
- Three-tier architecture – the most popular architecture for development of web-based information systems;

- Multi-tier architectures – typically they have one layer for the presentation logic of the software solution, a second layer for the data of the system and more than one layers for managing business logic.

Fig. 1 presents a traditional multitier architecture with the following tiers:

- Presentation tier, which in general represents the user interface (UI) of the software solution;
- Business logic tier, which contains all the functionalities of the software solution;
- Storage tier, which manages all the stored data of the software solution, most probably with the presence of a database management system (DBMS).

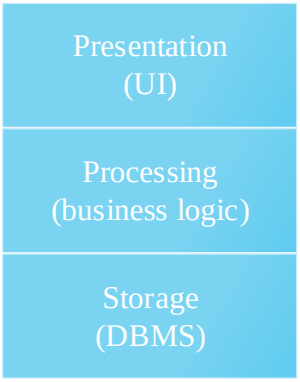

Fig. 1 Three-tier architecture of web-based software solutions

3. Systems architectures in field of media monitoring

Overall, most media monitoring solutions are using specialized systems for collecting of information by different sources. According to this paper, most important online sources of information for media monitoring platforms, could be summarized in the following categories:

- Websites;
- Blogs;
- Message boards;
- Social media posts.

Many of the websites of public sector are also a part of daily monitoring of interested organizations. Issues, related to web-based platforms for public services have been investigated by different authors [2, 3]. Platforms for media monitoring provide daily information, based on extracted publications from the mentioned sources. This daily information is stored within a search index, that provides opportunities for different types of queries and reports. Fig. 2 presents a flowchart of processes within a media monitoring system.

According to Brand Watch [1], the fifteen most used (free of charge under certain conditions) software systems for media monitoring are Hootsuite, TweetReach, Klout, Buzzsumo, Twazzup, Boardreader, HowSociable, Likealyzer, TweetDeck, Mention, Twitonomy, Followerwonk, SumAll, Simply Measured and Google Alerts. According to the same source, Hootsuite is one of the best free social media listening tool available and covers multiple social networks and it is well known for its social media management functions. In the same time, TweetReach is described as also a great monitoring tool, because it measures the actual impact and implications of social media discussions.

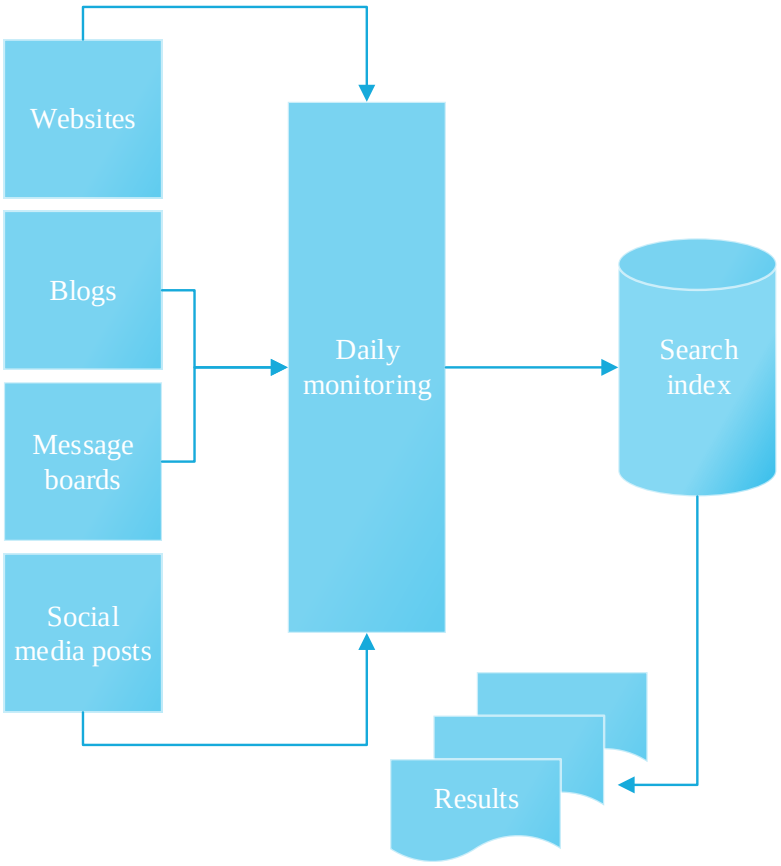

Fig. 2 Flowchart of media monitoring process

On the other side, Klout is probably one of the most controversial social media monitoring tools, because it measures influence through engagement on Twitter. Buzzsumo is described as a great tool for content research, but it also has an excellent way to analyze and monitor Facebook pages. When it comes to Twazzup, it is described as a great for social media monitoring, because it doesn't just include the social networks, but also message boards. In this sense, Boardreader allows searching for specific terms on a range of different forums, too. HowSociable is described as a handy tool for measuring social media presence and Likealyzer as a tool, that allows analyzing of Facebook pages. TweetDeck also covers the basic needs of social media monitoring, with the accent placed on Twitter posts. On the other side, Mention monitors millions of sources in many languages on social networks, news sites, forums, blogs or any web page. In this sense, Twitonomy provides functionalities for showing details of Twitter lists, followers and followings and most popular Tweets. Also focusing specifically on Twitter, Followerwonk is described as the right tool to find, analyze and optimize online presence for social growth. Targeted at small-medium businesses, SumAll is a cross-platform social media monitoring tool, that will help with understanding the correlation between different social channels. Simply Measured is described as an appropriate tool for providing of individual reports for Facebook and Instagram. At last, Google Alerts is described as a tool for monitoring the web for interesting new content, mentions of different brands or individuals.

All the researched solutions have their own software architecture, which is mostly based on the traditional three-tier web architecture. The paper presents system architecture of software for media monitoring, which contains four layers. In this sense, it could be related to multi-tier architectures with the following tiers (fig. 3):

- Presentation tier, which either represents the user interface of the media monitoring solution in the form of different reports (including dashboards), or provides software as a service (SaaS) capabilities for sending wanted reports to other systems;
- Storage tier, which manages all the stored data of the media monitoring solution;
- Business logic tier, which contains all the functionalities of the media monitoring solution, including the algorithms for creation of dictionary of keywords of publications for future search operations;
- Web crawling tier, which provides functionalities of extracting the wanted information from web publications.

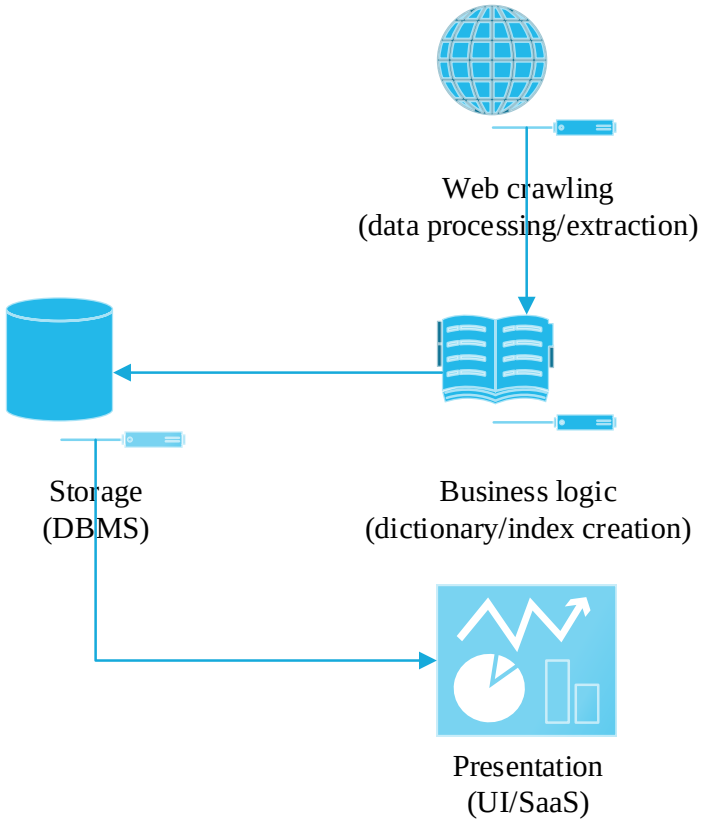

Fig. 3 Four-tier architecture of software for media monitoring

The advantages of the presented system architecture over the traditional systems architectures could be summarized as:

- Although in theory it is also possible to visualize media monitoring results through a desktop-based software solution, the current trends suggest, that the user interface of the platform will be web-based and accessible from anywhere;
- The ability to use the information system as a SaaS, due to modern trends, that allow specific software systems to provide information to other systems in the form of services;
- Creation of a dictionary with keywords, that increases the possibilities for searching and grouping of searches by different criteria;
- Separating the web crawling part into a separate architectural layer, that can be physically elsewhere and work independently of the business logic, that creates the dictionary and the ability to search within the publications.

4. Conclusion

In conclusion, it can be said, that the architectures of platforms for media monitoring have differences in comparison to traditional systems architectures, basically in their business logic, due to the presence of an additional independent tier for web crawling and data processing.

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Cyber Security – Seven Basic Principles for Self Control in Work Environment

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Abstract. This article is continuation of series of such for management of cyber security. The problem that is observed is management of behavior of the personal in his work environment. This article indicates connections between human attitude, standards and policy for self control in work environment. The main threats and defence mechanisms are indicated. Practical examples are given to show the fluent problems in different organizations. Thus this article represents a review of top basics priorities concerning the problems with the personal.

Keywords. Security management, Cyber security, Security education

1. Introduction

The **problem** that is addressed in this article is the lack of *self control* in work environment when it comes to *information/cyber security*. The employee's behavior often reflects in successful attacks from malicious agents. The author provides several cases and statistics addressed to the problem. They are based on popular statistics that are published and the author observation on his students, trainees and observation on random organizations.

In reality the number of principles can be more or less than seven. They can be combined or disassembled according to the situation in different work environment. The idea of this article came from the discussion with the employee in leading IT company in Bulgaria. He states that corporate policy forbids them to use livechat communication or social media but they have access to the Internet sites that offer jobs. So in this company there is a problem to use communication related to a personal life but is no problem to search for new job.

This problem of the article is an object for social studies. No mathematical formula or technical achievement can solve it. On the other side there can't be made a model or methodology that can provide a solution. It's all about self-control.

2. First principle – Never give your user name and password to anyone else

There is a strange practice everybody in one office or work environment to know everybody's access tools as ***username, password PIN*** and etc.

According to a report of SANS (State Agency for National Security) in Bulgaria, the customs information system is compromised. The customs system had been accessed by customs officers, information technologies (IT) support specialists, and others. Employees deleted data without leaving traces. Deleted transactions are related to excise goods, and over 300,000 entries being deleted. The amount of excise duty is several hundred million EUR [1,2]. This action was possible because over 300 employees have the same access tools – *user name and password*. Also there was an option to access the database from a distance through

internet, not just from the customs work environment. This problem was solved just for four years(2012-2017) [3] and according to the control organizations there are now individual access tools for every employee. Also there is no more the option to access to the system by distance [4, 5]. *The problem can be multiplied because of the synergy effect of the number of people who knows the administrative accounts and the option for remote access.* ***There is a positive thing in this case. The group knowledge of this information or the hive-mind prevents the loosing of important information like account settings, so the system can work without harm.***

On theoretical part of the things ***Access & control*** are the first defence mechanisms (DM) in computer security. General concepts and definitions ***Access & control*** concerns the subject of entity that can perform actions in the system e.g. user or system and the object of the entity representing resources to which access may need to be controlled e.g. information or computer resource. The access means the ability of a subject to technically do something with an object (the asset). Access Control means to ensure that access to assets is authorized and restricted based on business and security requirements [6]. The goals for Access & control DM are clear and proper differentiation on authorization of subjects to objects. The after control can be provided from the data of the log file. In the shown above case that can't be done, because everybody used the same account.

The Access Control has several enforcement functions [7] -Identification - the assignment of a real identity to a computer readable identity – an entity – e.g. user ID. A validation and inventory of such identity and assignment is assumed. Authentication - the provision of assurance that a claimed characteristic of an entity e.g. a user is correct [6]. Authorization - the permission what a subject can do with the objects e.g. on a computer system. Permission need to be granted. Accountability - the post-event correlation of activities from subjects on objects by using system or external components for keeping records e.g. audit trails or logs.

3. Second & Third principles – Never use public (business) resources for personnel purposes. Never use personnel resources for public (business) purposes

This topic is connected to the ***syberpsycology***. The term that is used often is "cyberloafing". Cyberloafing — engaging in non-work online activities while "on the clock" — is a modern form of counter-productive workplace behaviour. Rather than stealing company goods, the modern work environment with its various digital devices easily allows many employees to essentially steal company time [8]. ***The new technologies – Internet, social media, e-mail and chat communication and etc. allows a person to be 24/7 at work and 24/7 to be connected to his personal life.***

Using the IT work environment for personal purposes is not a new problem. In the beginning it was used primary for word processing, in the 90-ties it was the speed Internet, and now it's the social media. Usage of IT at work can harm the company and the user in several ways - 1. Compliance Violation 2. Breach of Data Protection Law 3. Full Liability with No Chance for Exclusion 4. Theft of Corporate Data 5. Loss of Corporate Data 6. Productivity Loss 7. Inefficient Workflows 8. Interruptions of Operations 9. Technical Damages 10. License Violation [9].

We can use for example cryptomalware for the Facebook. The cryptocurrency mining bot spreading through Facebook Messenger and targeting Google Chrome desktop users to take advantage of the recent surge in cryptocurrency prices. Dubbed Digmine, the Monero-cryptocurrency mining bot disguises as a non-embedded video file, under the name

video_xxxx.zip (as shown in the screenshot), but is actually contains an AutoIt executable script [10]. In work environments, because of the overconfidence of the DM, the users often forget about computer security basics. The target usually receives a video file (packed in zip archive) sent by someone (or your friends) on your Facebook messenger and clicks on it.

Once clicked, the malware infects victim's computer and downloads its components and related configuration files from a remote command-and-control (C&C) server.

Digimine primarily installs a cryptocurrency miner, i.e. miner.exe—a modified version of an open-source Monero miner known as XMRig—which silently mines the Monero cryptocurrency in the background for hackers using the CPU power of the infected computers. Besides the cryptocurrency miner, Digimine bot also installs an autostart mechanism and launch Chrome with a malicious extension that allows attackers to access the victims' Facebook profile and spread the same malware file to their friends' list via Messenger.

Since Chrome extensions can only be installed via official Chrome Web Store, "the attackers bypassed this by launching Chrome (loaded with the malicious extension) via command line." [10].

The usage of the private IT informant for work can be compared to using a personal vehicle for work. In first place the individual have to have an appropriate driver's licence, and know about the vehicle's safety features and how to use them. On second appropriately registered, roadworthy, in good working order, and has comprehensive insurance cover [11].

According to this the person who use the personal IT environment for work/business issues has to have proper cyber/information security training, proper hardware, proper DM's computer – Access & control, cryptography and est., and network DM's firewalls, VPN's and est.

From my personal experience for example in a private company a trainee used regularly she's personal accounts in several social media, even that she was instructed in advance about cyber security policy. One day the owner of the company decide to publish an official social media post. When an advertisement was post, he found that it was posted on trainees account, because she` forgot to log out.

4. Forth principle – "Don't talk to strangers"

This principle is connected to a case in Bulgaria. A lot of people that are victims of this fraud are selected by their work environment and their professional obligations. In 2012, thanks to a fake profile, a cheater began to communicate with various social interest groups. He is extremely active on political issues, quickly recruiting friends, although no one knows him personally. Based on the credibility he built, he devised a criminal scheme by selling fake airline tickets. A few dozen people have been deceived. The scheme was discovered in 2017 [12, 13].

In cyber environment everybody can presents as anybody else. The most vulnerable groups are this with high self-esteem, without or with little cover. These groups are often targeted by psy-ops but this is the topic for other article.

5. Fifth principle – Not everything is trash

In the past several years there are many cases of spear-phishing attacks on the bank clients. The interesting thing in these cases is from where the attackers have the personal information about clients. In many of these situations this information can be found in the trash of those banks. It's a common practice to throw critical information in the regular trash. The employee's often neglecting organization policy on this meter.

6. Sixth principle – Don't open e-mails or mass problem with the spear-phishing

According to IBM's X-Force researchers, not only is the number of spam emails rapidly increasing — it's currently estimated that more than half of all emails are spam — the number of spam emails containing malicious attachments is on a dramatic rise, as well. For many companies, that increase is reinforcing the realization that spam isn't just a mere nuisance, it's one of the primary delivery mechanisms for attacks, and therefore a direct threat to their organization [14].

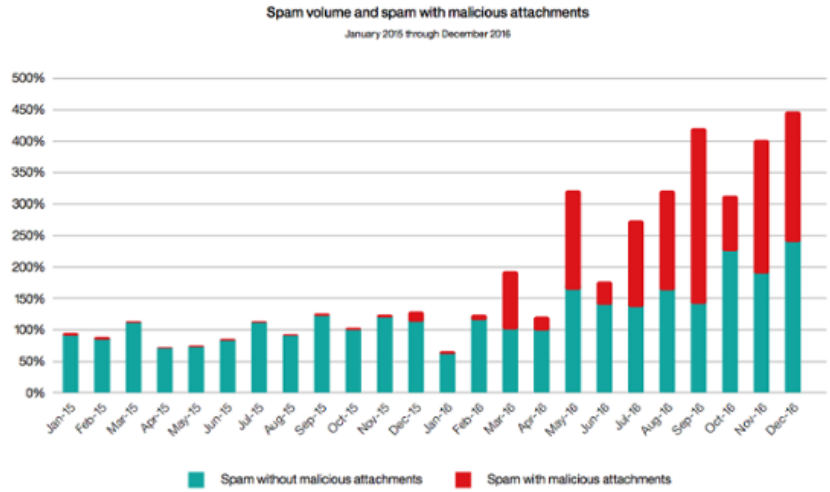

Fig.1. Malicious attacks [15]

The data found that display name spoofs are the clear phishing weapon of choice for cybercriminals. Attackers are increasingly relying on highly targeted, non-payload attacks that exploit trust and leverage pressure tactics to trick users into taking action that will put their organizations at risk. Of the more than 537,000 phishing threats GreatHorn detected in its research, 91 percent (490,557) contained characteristics of display name spoofs. Display name spoofs impersonate a person familiar to a business user in order to fool the recipient into thinking that the message came from a trusted source. It's an extremely effective tactic against a workforce deluged with incoming communications all day, every day. Direct spoofs were the second most popular attack type (8 percent), and domain lookalikes made up less than 1 percent of phishing attacks [16]. In Q1 for 2017 alone, Kaspersky Labs products "blocked 51 million attempts to open a phishing page." That same report found that 1 in 8 attacks targeted a financial services organization. Similarly, mobile ransomware attacks, frequently delivered via SMS text phishing (aka smishing), are up 250% since January [17]. We saw a significant improvement in click rates on Cloud-based templates, which indicate that organizations are doing a good job at making users aware of these types of attacks. But organizations should consider including more Commercial-style phishing tests in their assessment mix in the future, given that these messages tend to fool users most often [18].

These tendencies will increase true time as the usage of work environment for personal purposes. As in the second principle was explained the employees are 24/7 at work and in their personal life.

7. Seventh principle – Don't eat, drink near the work station or else…And overall conclusions

This topic is about keeping the hardware and information in good shape. The social studies starts with the Maslow pyramid [19]. In 21st century there can be made interpretation on this pyramid. As there is explained about 24/7 personal/work life there are different needs as it's shown on fig. 2.

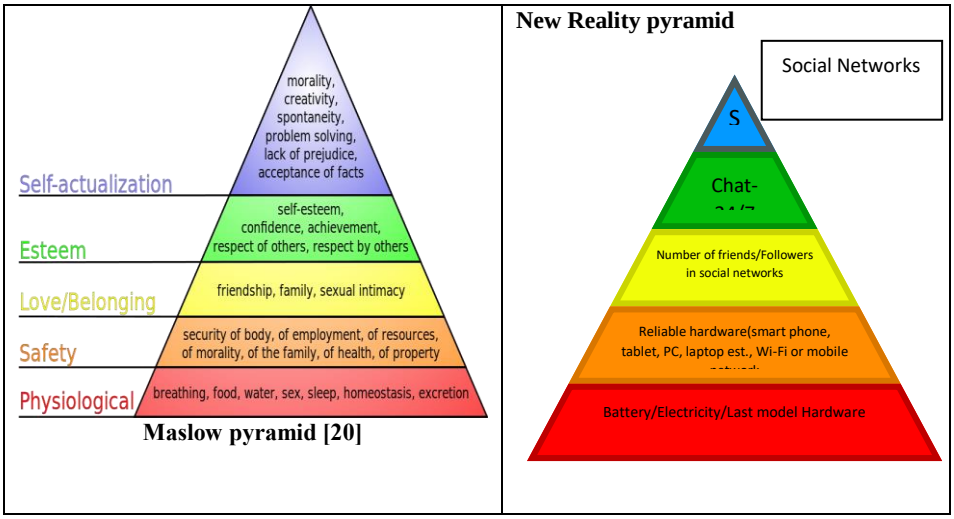

Fig.2. Maslow pyramid of needs vs new reality pyramid

The author of the article made an observation on his student, trainees and in some work environments. 100% of the people are 24/7 in chat. The most used platforms are FBChat, Viber and Skype. The communication is realized by short massages or with pictures. The only people that are not in chat are those which have no battery or their communication device experience some problems. In the past there were several situations to receive an e-mail in the time of lecture, by a student that is in the class. In 2017-2018 it's a common practice to receive a Live chat massage from student in the class during the lecture. In work environment Livechat is useful to communicate with customers. This is shown in study made in 2018 named "21 Live Chat Statistics for 2018 (Backed by Unique Research)". Parts of the results that can explain addiction to the chat are shown on Fig. 3.

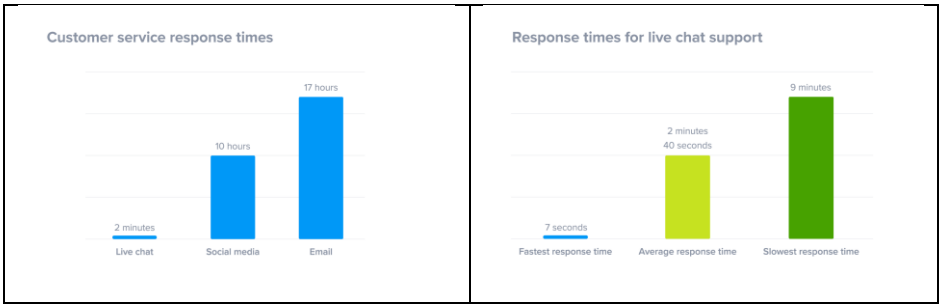

Fig.3. Livechat observation on reaction [21]

The other support for these tendencies is the statistics shown in Fig.4.

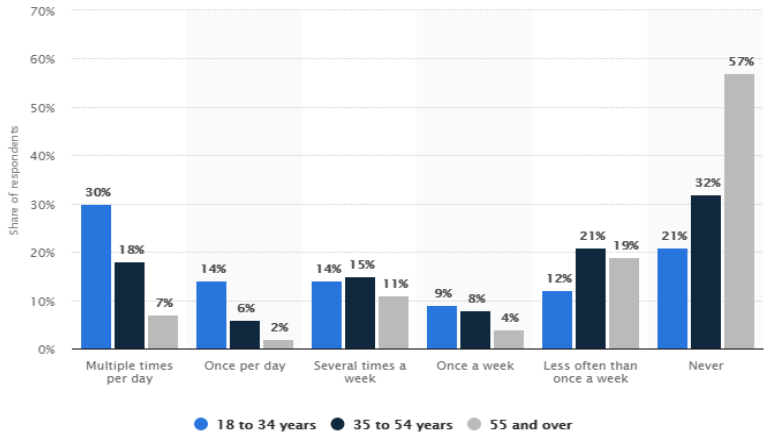

Fig.4. Livechat usage by age in US [22]

Based on the observations and statistics ***we can make the assumption - the loose of ability for Livechat, caused by technical problems like lack of battery, communication device or network connection, will lead to serious psychological trauma.*** This state of mind can be healed only by serious treatment with social media usage. This brings us to the second observation - the percent of nonstop usage of social media.

Depending on the age and gender between 10-30% of the students is connected 100% of the time to social networks. Most of the others connect themselves on different time spots 15 minutes, 30 minutes, and 50 minutes. The connection includes video and audio. There are no cases for a student not to connect in such network for more than one hour. In 2017-2018 there are tendencies to follow random bloggers in different media.

To support these observations there can be applied some statistics from the US. In previous Pew Research Center surveys of social media use, there are substantial differences in social media use by age. Some 88% of 18- to 29-year-olds indicate that they use any form of social media. That share falls to 78% among those ages 30 to 49, to 64% among those ages 50 to 64 and to 37% among Americans 65 and older.[23] This data can be observed in the trends graph by the same researchers in Fig. 5 and Fig.6.

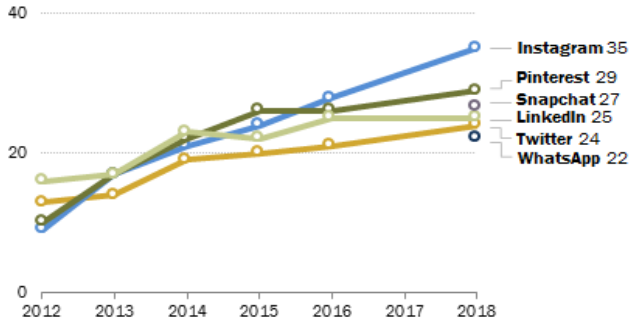

Fig.5. Usage of social media in US [23]

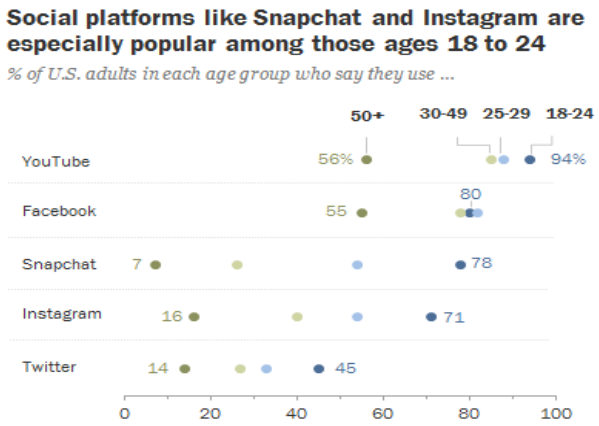

Fig.5. Popularity of social media in US [23]

The other statistic shows that the number of internet users worldwide in 2018 is 4.021 billion, up 7 percent year-on-year. The number of social media users worldwide in 2018 is 3.196 billion, up 13 percent year-on-year. The number of mobile phone users in 2018 is 5.135 billion, up 4 percent year-on-year.[24]

Based on this there can be made another assumption. ***The physical condition of the hardware, software and network reflects on the physical, mental and psychological condition of the employee.*** In other words there are several threads to the IT recourses in the work environment:

a) Self-reappearing the company/organization hardware, software and network. ***There are standards, requirements, training, experience and policies about these topics. Thrust the professionals.***

b) Food and drinks on the work station. In the over 25 years of experience of the author, there are several cases in that direction. ***The "computers" don't eat human food, it can harm them.***

c) Violence on the IT infrastructure. Everybody knows that the "computers" feels the desperation and they slow when somebody is in a hurry. ***Beating them will not help. Stay come. Close the unnecessary application for personal usage in work environment. The husband of your friend will be the same idiot in fifteen minutes.***

d) Lack of recourses on the personal devise. ***Don't use the work resources for personal usage. Think about them as a backup. When your devise is out you can use this backup for livechat and stay connected to social media.***

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Forcing Execution Plans for Specific Queries Using Query Store in SQL Server 2016

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Abstract. Monitoring and troubleshooting query performance are traditional and well-known tasks. Therefore, there are many various concepts and software products developed in this direction. In Microsoft SQL Server 2016 there is a new feature - Query Store which gives valuable performance insights by providing several new ways of troubleshooting queries, studying their plans and checking their performance metrics. Whether forcing execution plans using Query Store could be a sustainable solution? The current paper presents a practical example using "force plan" via Query Store.

Keywords. Query performance, performance monitoring, performance analysis.

1. Introduction

With the growth of managed and stored data, a need for monitoring and management systems arises. The companies are increasingly interested in performance monitoring of the systems which manage their business.

Data begins to be stored also in database, based on so-called Entity-attribute-value (EAV) models except in typical relational database models. EAV is a model that describes the data entities, where the number of attributes that can be used to describe them is potentially huge [1].

As the increasing of data volumes, the query performance decreases, and some of the main database problems remain monitoring and troubleshooting the query performance [2].

The main goals of this paper are to present some capabilities of Query Store and to describe a practical example using "force plan" in SQL Server 2016 for the query performance analysis.

2. Query Store definition

Query Store is a new feature in Microsoft SQL Server 2016 and provides valuable insights on query plan choice and performance. It simplifies performance troubleshooting by providing a quick and easy way to find performance differences caused by query plan changes. Query Store automatically captures a history of queries, plans, and runtime statistics, and retains these for review [3].

Microsoft describes some uses for the Query Store as follows:

- Quickly find and fix a plan performance regression by forcing the previous query plan. Fix queries that have recently regressed in performance due to execution plan changes.
- Determine the number of times a query was executed in a given time window, assisting a DBA in troubleshooting performance resource problems.
- Identify top n queries (by execution time, memory consumption, etc.) in the past x hours.
- Audit the history of query plans for a given query.

- Analyze the resource (CPU, I/O, and Memory) usage patterns for a particular database.
- Identify top n queries that are waiting on resources.
- Understand wait nature for a particular query or plan [3].

Capturing every Execution Plan that has been generated for a specific query, the Query Store gives the opportunity for direct use of one of the stored execution plans for a query. This is referred to as plan forcing. Data changes all the time, so the Query Optimizer might generate a different plan for the same query. Sometimes the new plan is less efficient than some of the previous plans [4, 5].

It sounds that the plan forcing could resolve a query performance regression caused by a plan change but let see the developed example in the current paper. Whether forcing execution plans using Query Store could be a sustainable solution on a case-by-case basis?

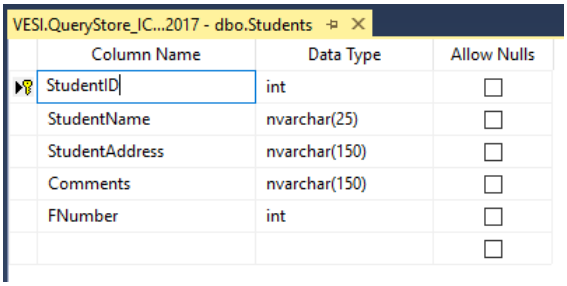
3. Example of forcing execution plans for specific queries using Query Store

In the current example there is a database with enabled Query Store, data table with 'Students' data, Non-clustered index, based on this table, and a stored procedure. The stored procedure will be executed with different parameters.

One of the built-in reports "Top Resource Consuming Queries" will be examined and the different execution plans, generated by Query Optimizator, will be compared. After that forcing execution plan will be performed and then the result from the executed stored procedure will be compared again. Conclusions will be made based on the results.

- **Table**

The test table, named Students, contains 100 000 rows of students data. The primary key in Students table is StudentID column. There are some exampled columns: StudentName, StudentAdddress, Comments and FNumber. The data type of the StudentName, StudentAdddress and Comments fields is nvarchar. The data type of the StudentID and the FNumber field is integer.



- **Non-clustered index**

Quite often, searching students in an information system is performed by the faculty number or by year of admission. For example in the University of National and World Economy, the faculty number is a combination of the year of adoption and the code of specialty. This is the reason to create a non-clustered FNumber index in the current example.

```
-- Create a Non-Clustered Index based on FNumber field.
CREATE UNIQUE NONCLUSTERED INDEX idx_fNumber ON Students(FNumber)
GO
```

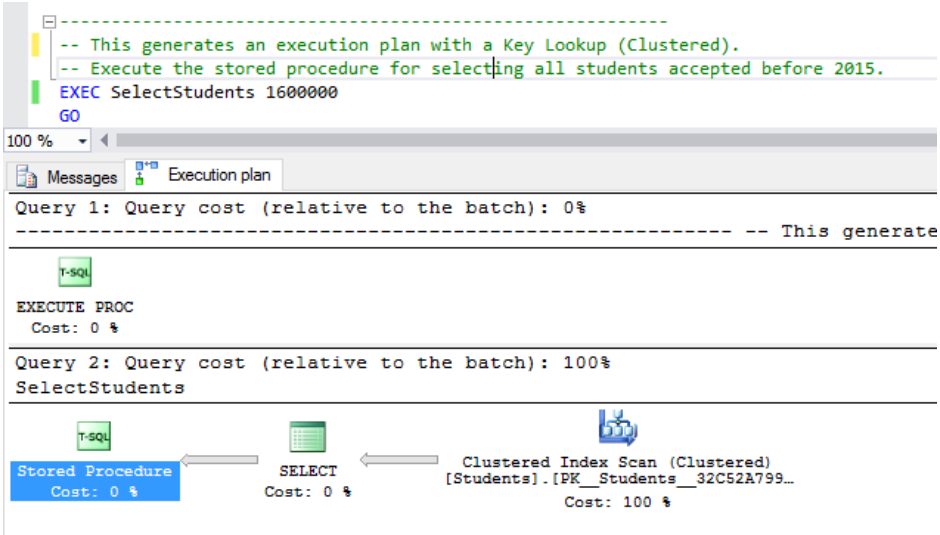
- **Store Procedure**

One simple stored procedure has been created. The stored procedure selects students who have been admitted before a relevant year. The year is a parameter for the procedure.

```
-- Create a test stored procedure to select the data
CREATE PROCEDURE SelectStudents
(
    @FNumber INT
)
AS
BEGIN
    SELECT * FROM Students
    WHERE FNumber < @FNumber
END
GO
```

- **Executing stored procedure with different parameters**

The procedure will be executed with different parameters for the current example. Firstly, the stored procedure is executed with parameter value of 1600000. This execution generates the following execution plan:

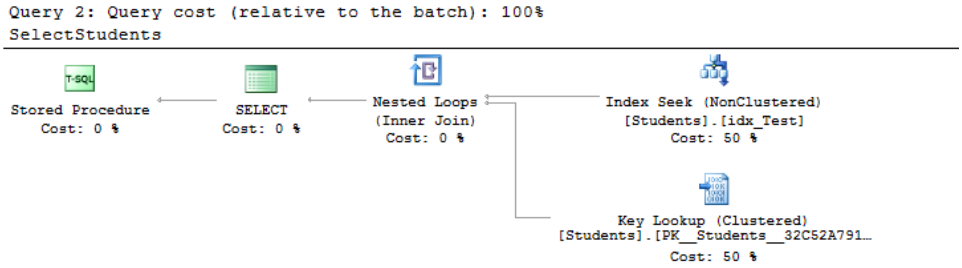


The Query Optimizer has chosen to use a Clustered Index Scan operator that produces 1587 logical reads, total duration time 493.17. In this case, SQL Server doesn't use the Non-Clustered Index. Secondly, the stored procedure is executed with 1 and after that with 160000 as parameter values.

```
-- Execute the stored procedure.
EXEC SelectStudents 1
GO

-- Execute the stored procedure again
-- Non-Clustered Index Scan instead of the Key Lookup (Clustered).
EXEC SelectStudents 1600000
GO
```

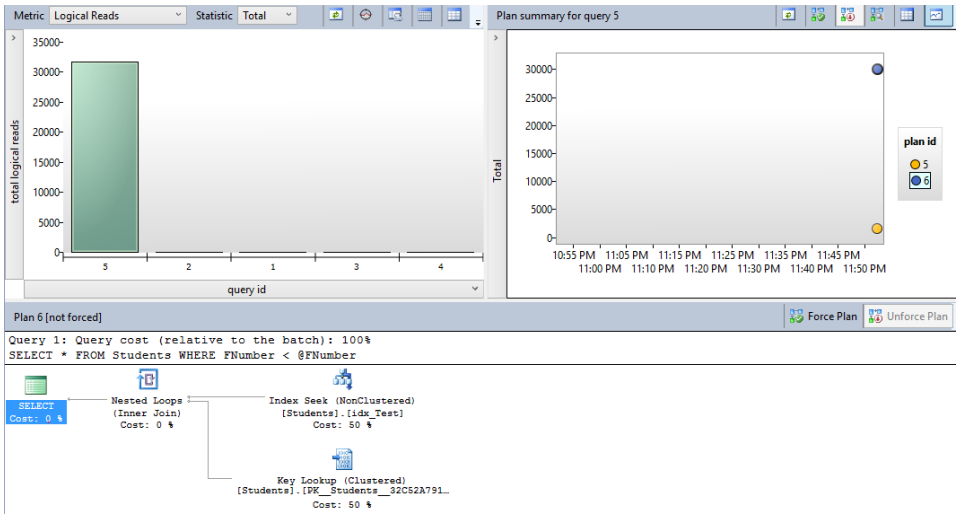
Let's take a look at the actual execution plan again. This generated the following execution plan and the logical reads are 30017:



- **Monitoring the queries using Query Store**

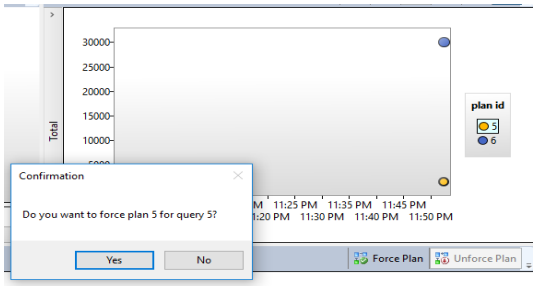
The "Top Resource Consuming Queries" report shows the most expensive queries, based on a chosen metric. Let switch to Logical Reads.

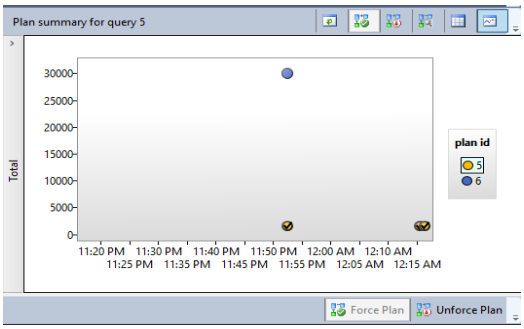
As we can see, the Query Store has captured 2 different execution plans: one with the ID 5, and another one with the ID 6. When you click on the plan ID, SQL Server also shows you the estimated execution plan on the lower part of the report.



The report shows that plan, which uses Clustered Index has less Logical Reads than the other plan. It seems that forcing execution plan with id=5 is a good decision for the query performance for the corresponding query.

- **Forcing execution plans for specific queries**





The query performance troubleshooting is a complex task and forcing execution plan could be a solution in particular cases.

Depending on the input parameter values and the number of the rows we get a different initial execution plan that gets reused – over and over again. So, we can say that forcing a specific execution plan just solves the performance problem temporarily.

4. Conclusion

The volumes of stored data are constantly changing, the data processing requirements in the database are also changing. From the current example, it can be concluded that the existing feature "forcing execution plan" is a very useful part of the Query Store feature in SQL Server 2016 and it could help to easily understand plan regressions, but we have to be very careful with its usage, because the solution of a query performance issue can lead to another in time.

It has become clear in this report, that using the new features in SQL Server 2016 should be considered very carefully. The query performance optimization is very complexed task and it is necessary to have a clear strategy for using Query Store because forcing execution plans could solve the problem of efficiency but the solution with query performance issue could be temporarily. The root cause must be found and fixed if it is possible.

Acknowledgment

The author express their gratitude to the Bulgarian National Science Fund for the partial financial support under the Grant № DFNI-I02/15 from 12.12.2014, titled "Information System for Integrated Risk Assessment from Natural Disasters".

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Building IoT Solution for Better University Using IBM Watson IoT Platform

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Abstract. The turbulent growth of the Internet of Things during the last few years logically led to the development of various platforms, supporting and improving, the implementation of IoT solutions. Platforms like Microsoft Azure IoT suite and IBM Watson IoT platform are providing resources and tools for rapid development and simulation of IoT solutions. The first section of the paper analyzes the opportunities for IoT applications in university education. Then a brief introduction of IBM Watson IoT platform is presented. Finally, an example of IoT solution is described and presented.

Keywords. IoT, Education, IoT in Education, RFID, Sensors.

1. Introduction

The Internet of things (IoT) is an extensive topic that has been booming in the recent years, indicating that this trend will continue in the near future. IoT transforms the traditional way of communication between individuals, such as organizations and customers, university professors and students. IoT makes it possible to gather, exchange and analyze all the information coming from connected devices, actuator, sensors and networks. This information can serve various purposes, such as strategic and operational decision making, marketing, security and many others.

Hardware innovations, like the Raspberry Pi, are enabling faster and cheaper development of new devices. Networking standards for low power networks, like LoRaWAN or Sigfox, create new opportunities for connecting very small devices to a network. New standards are being developed specifically for IoT use cases, like MQTT for messaging, or OMA Lightweight M2M for device management. And finally, significant improvements in data storage, data analysis, and event processing are making it possible to support the amount of data generated in large-scale IoT deployments [1, 2].

In addition to growing IoT industry, the general software industry has moved towards cloud technologies as being a key supplier of critical software components. Cloud platforms like Microsoft Azure IoT suite and IBM Watson IoT are providing the ability for managing and supporting IoT initiatives. Even more, they are giving the opportunity for simulating real-life solutions for analyzing the return of investments for example. The cloud IoT platforms are suitable for developing demos and prototypes prior to production development and implementation.

Technology is just one of many disruptive influences in education today. An IoT project can bring numerous amount of positive changes in education and more specifically in university education.

The goal of this paper is to analyze and demonstrate possible IoT solution in University of National and World Economy (UNWE).

2. IoT in university education

Before considering the possible solutions to university education, let's look at the architectural components of an IoT solution. The typical architecture of one IoT solution consists of many devices, which are using gateways for data sharing and communication with back-end server, running IoT platform and hosted on the cloud or on premise (Figure 1).

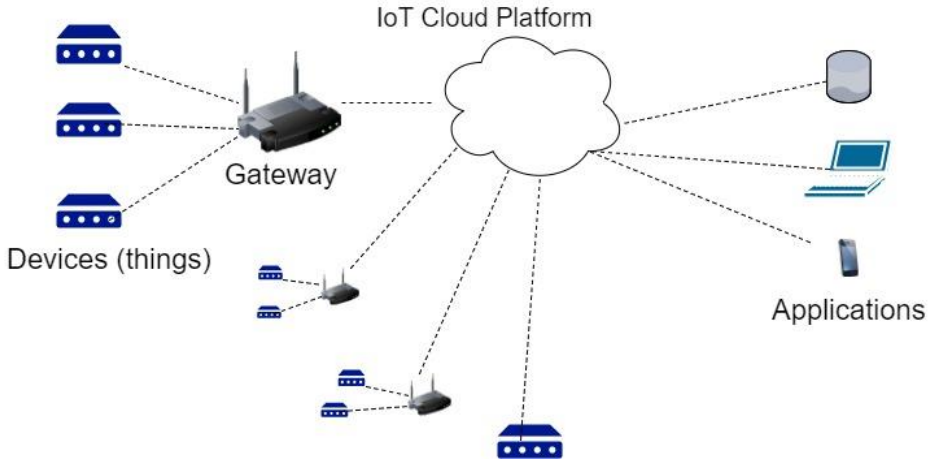

Fig. 1. IoT solution architecture components

The "Thing" in the IoT is the starting point for an IoT solution. Usually they are generating the raw data source and are communicating with physical world.

The IoT gateway is an aggregation point for a group of devices (things) and manages the communication between each other and to an external network. An IoT gateway can be a hardware device or functionality incorporated into a larger "Thing" that is connected to the network. Choosing the right communication mechanisms is a key part of building any solution with IoT. This choice will determine not only how data is collected from the IoT platform (for example, via Wi-Fi, WAN, LAN, etc.), but also how to communicate with devices that are currently involved into existing IoT solution.

The IoT Cloud Platform is a software infrastructure which enables an IoT solution. An IoT Cloud Platform typically operates on a cloud infrastructure (e.g. OpenShift, AWS, Microsoft Azure, Cloud Foundry) or inside an enterprise data center. The IoT Cloud Platform will facilitate the interoperability of an IoT solution with existing enterprise applications and other IoT solutions [2].

Based on this architecture an IoT solution demonstration is proposed for implementation in UNWE.

This solution is one of many possible applications of IoT in education and it aims to build a system for access control to university resources, such as halls, offices, computers, and so on. This application, in addition to an access management mechanism, can be used as a solution for analyzing the quality of university education. All collected from heterogenous sources like web scrapping systems [3, 4] and social networks information, can serve as a basis for analytical and BI solutions for decision making such as:

- Analyzing student attendance at the university by disciplines, professors, rooms and part of the academic year.

- Analyzing the relationship between student success and presence.
- Analyzing of professor's lectures quality and performance. We can assume that the more a lecture is attended, the better the professor is.

One advantage that would facilitate the appropriateness of such an application is the existing e-student book system, which will significantly reduce the cost of building such a solution.

Other possible IoT solutions implementation in UNWE may include:

- Equipping the university with components, related to the management and control of resource costs. For example, there are options for optimizing and ending surplus resources such as heat, electricity, water, etc. Cost control and management is a must for constructing a "smart building". The benefit of building an IoT solution for cost-optimization is visible and undeniable. Still, building up functioning solutions is an effort which requires a lot of investment, and for such an approach a thorough analysis is needed to confirm its return in the near future.
- Laboratory equipment for better educational process.
- IoT can also support professional development for teachers who may adopt new learning models, as data about their practice is collected through student feedback, teacher achievements, and video recordings.
- Building interactive learning with "smart" study rooms where students actively participate in the learning process.

3. IoT solution with IBM Watson Analytics

To demonstrate the practicality of an IoT solution, access control system, in university study rooms, is developed and presented. The cloud platform IBM Watson IoT [5] is used for implementation of the prototype.

The operational model of the solution includes the following components:

1. IBM Watson IoT cloud platform - plays the role of asynchronous unifier of all other components.
2. IoTAppInUNWE-cloudantNoSQLDB service [6] is an Apache CouchDB NoSQL database based on JSON documents. Used to store IoT sensor data coming from the RFID reader simulator.
3. Simulator of RFID reader – used to simulate a sensor or actor in the absence of a physical IoT system. The RFID reader is simulating the extraction of data from student's e-student book.
4. Node-RED Cloud [7] – used to create data flow application and streaming IoT sensor data to cloud storage. Node-RED is an open source data flow editor written in JavaScript and running on Node.js.

The process of implementing the prototype solution can be described in the following steps (Figure 2):

1. A simulator of RFID reader simulates student entry in study room 2067.
2. Simulated data is transferred to a RFID reader with a unique RFID2067.
3. RFID reader (output device RFID2067) sends the student data to an "event receiver" (IBM IoT receive event)
4. The student data is loaded to database accesscontroldb.

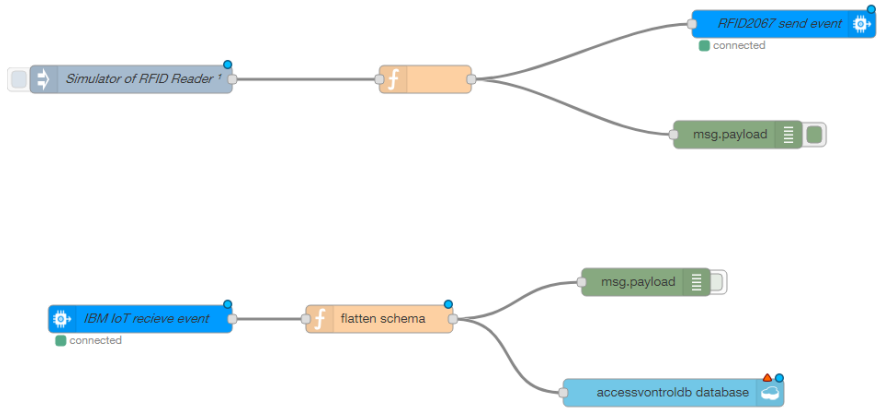

Fig. 2. IoT solution data flow

For every student entry in room 2067, the IoT solution will store a JSON document (Figure 3).

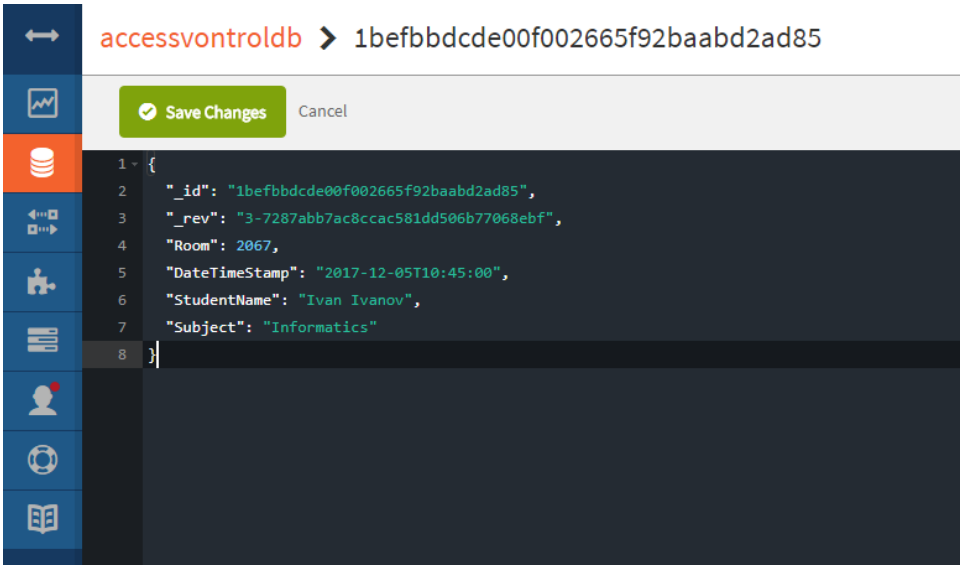

Fig. 3. JSON document structure

In addition to the possible use as a source for analytical reporting, the IoT sensor data can be processed in real-time for detecting anomalies in student presence at university. Different anomaly detection algorithms can be used [8].

4. Conclusion

Building a solution with IoT requires a significant amount of technology in the form of software, hardware and networking. Launching an initiative to implement an IoT project requires a thorough cost analysis, return on investment, and possible applications. This paper presented some options for implementation of IoT solutions at UNWE. Additionally, a prototype solution was implemented, using the IBM Watson IoT platform, and presented. The development of a prototype cloud-based technology solution demonstrates a quick and easy way to analyze the feasibility of such a project as well as its future results.

Acknowledgment

The author express their gratitude to the Bulgarian National Science Fund for the partial financial support under the Grant № DFNI-I02/15 from 12.12.2014, titled "Information System for Integrated Risk Assessment from Natural Disasters".

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Using Machine Learning to Predict Web and Mobile Behavior of Users

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Abstract. The behavior of the users on web and mobile devices is important for evaluation of the efficiency of the user experience and adapting the interface and the content to the user's needs. In this paper, a machine learning algorithm is applied to labeled data of the graph of user activities on web and mobile websites of University of National and World Economy and then its efficiency is evaluated. A few approaches to adapt the user interface and content are proposed with the goal of enhancing the overall user experience and satisfaction.

Keywords. Machine Learning, User behavior.

1. Introduction

Understanding and automatically adapting to the behavior of the users on web and mobile platforms is a critical success factor for achieving a high-quality user experience and online service satisfaction. Depending on the content and the types of users, the possible number of behavior flows through the application might be quite large and therefore unpredictable from the point of view of a human, analyzing the data [8]. Thus, it seems like a task that can be approached by a machine learning algorithm for classification of the user flow without explicit human intervention. Then the learned user paths might be used to improve (manually or automatically) the user experience.

In order to apply supervised machine learning algorithms, it is necessary to prepare labeled data – for this purpose we are using data from the Prospective Students Admissions web site of the University of National and World Economy (UNWE), Bulgaria. The data includes the steps taken through the website by different (anonymous, but uniquely identified) users in a given time period. The steps consist mostly of mouse clicks and link navigations and additional data like the duration of the page visit, the browser type and the approximate geographical coordinates (retrieved from the IP address). A feasible approach would be to use a recurrent neural network to attempt to predict the next step in a series of user activities. Then the prediction can be used to optimize the user flow through the information on the website with specific goals in mind.

2. Research

The standard approaches for user experience customization and optimization consist of classification of the user [7], based on their characteristics like demographics and interests. They do not capture the dynamics of the sequential actions, performed by the users.

Recurrent neural networks allow for classification of sequential data, in the form of time based data points. They are widely used for classification and prediction of textual and speech content but can be applied for various scenarios where the data is sequential in nature [6].

The simple recurrent network is a specific version of the backpropagation neural network that makes it possible to process sequential input and output [2]. The recurrent neural network is an extension of the conventional feedforward neural network, which can handle a variable-length sequence input. The RNN handles the variable-length sequence by having a recurrent hidden state whose activation at each time is dependent on that of the previous time step [4]. It is typically a three-layer network where a copy of the hidden layer activations is saved and used (in addition to the actual input) as input to the hidden layer in the next time step. The previous hidden layer is fully connected to the hidden layer. It can be trained to read a sequence of inputs into a target output pattern, to generate a sequence of outputs from a given input pattern, or to map an input sequence to an output sequence (as in predicting the next input). Simple recurrent networks have been particularly useful in time series prediction, as well as in modeling cognitive processes, such as language understanding and production [2].

Long short-term memory (LSTM) networks [5] can capture dependencies throughout the sequence and are able to remember the information for varying periods of time. LSTM has been widely used and has obtained promising results in variants of problems of understanding latent semantics of texts [1].

GRU (Gated Recurrent Unit) is another model achieving good performance on sequential data. A gated recurrent unit aims to make each recurrent unit to adaptively capture dependencies of different time scales. Similarly to the LSTM unit, the GRU has gating units that modulate the flow of information inside the unit, but unlike LSTM it does not have separate memory cells [4].

3. Implementation

For the implementation we need several steps: to prepare the training and testing data; to apply the ML algorithm; to evaluate the results; to implement a prediction for any new input. In our case we are using the Keras Python library (https://keras.io/), which provides a higher-level abstraction of the ML model, and Google's TensorFlow (https://www.tensorflow.org/) as a backend.

The training and testing datasets are extracted from the cloud service FullStory (which logs the user activities on the website) in the following CSV format: IndvId, UserId, SessionId, PageId, EventStart, EventType, EventTargetText, EventTargetSelectorTok, PageDuration, PageActiveDuration, PageUrl, PageRefererUrl, PageIp, PageLatLong, PageAgent, PageBrowser, PageDevice, PageOperatingSystem, PageNumInfos, PageNumWarnings, PageNumErrors, UserAppKey, UserDisplayName, UserEmail, EventModDead, EventModError, EventModFrustrated.

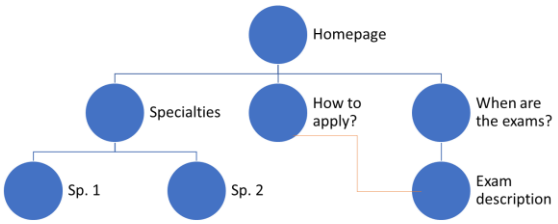

Fig. 1. A sample graph of user actions

The dataset is prepared with the pandas (https://pandas.pydata.org/) and numpy (http://www.numpy.org/) libraries as follows (Figure 2.):

```
import numpy as np
import pandas as pd
from os import path
import datetime as d
from keras import Sequential
from keras.layers import LSTM,Dense

pathname = path.dirname(path.realpath(__file__))

dataset = pd.read_csv(path.join(pathname, "result1.csv"))
dataset.sort_values(by=['UserId','SessionId','EventStart'], inplace=True)
```

Fig. 2. The training data is prepared by transforming the raw data

The navigation URL-s are then grouped by the session identifier in order to generate the necessary sequences (Figure 3.):

```
ds_for_session = dataset.groupby('SessionId')

allurls = []
outputs = []
for name, group in ds_for_session:
    n = group['PageUrl'].values
    allurls.append(n)

sequence = allurls
```

Fig. 3. The data is grouped by the unique session identifier

The model is using a LSTM layer with tanh activation function, a dropout layer to reduce the risk of overfitting and finally a dense layer with a leaky ReLU activation function.

The alternative approach uses a GRU layer instead of the LSTM one, otherwise the neural network model is the same (Figure 4. and Figure 5.).

```
max_len = 5
dataX = []
dataY = []
dictionary = dict()
counter = 0
for session in sequence:
    for i in range(len(session)):
        if i+max_len >= len(session):
            break
        sequence_in = session[i:i+max_len]
        sequence_out = session[i+max_len]
        hots = [one_hot(s, 50) for s in sequence_in]
        dataX.append(pad_sequences(hots, maxlen=20, dtype='int32', padding='post'))
        dictionary[counter] = sequence_out
        dataY.append(counter)
        counter += 1
```

Fig. 4. The sequences are encoded as integers

```
batch_size = 1
model = Sequential()
model.add(LSTM(8, input_shape=(X.shape[1], 20)))
model.add(Dense(y.shape[1], activation='softmax'))
model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy'])
model.fit(X, y, epochs=50, batch_size=batch_size, verbose=2)
# summarize performance of the model
scores = model.evaluate(X, y, verbose=0)
```

Fig. 5. Training the neural network with a LSTM layer

To predict the category of a new input vector, we are loading the saved model

```
model = keras.models.load_model('model.hdf5')
```

and then using the predict method to generate an output:

```
y = model.predict(x, batch_size=32, verbose=1)
preds = np.argmax(y, axis=1)
```

In order to expose the prediction functionality to the website, the prediction function is wrapped as a simple REST web service with the Flask framework (http://flask.pocoo.org/).

4. Results

The loss function of the described model is steadily decreasing (Figure 6) and this could lead to the conclusion that the model is a feasible approach to use machine learning for the specified type of problem.

Fig. 6. A graph of the loss function

A lot of approaches to improve the model are possible – from hyperparameter tuning to using different types and stacks of layers in the deep neural network. However, it is important to keep in mind that training on large volumes of data require a lot of computational power (the experiment described here is performed on a lower grade GPU, a dedicated modern GPU might allow for further training and better prediction accuracy).

While the results are preliminary, and the actual value of this approach can only be evaluated from the point of view of the generated business value and improved end-user experience, the presented system can serve as a tool to quickly iterate through different ideas and measure the effect on specific business goals.

Acknowledgment

The authors express their gratitude to the Bulgarian National Science Fund for the partial financial support under the Grant № DFNI-I02/ 15 from 12.12.2014, titled "Information System for Integrated Risk Assessment from Natural Disasters".

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Optimization and Analysis of Cargo Ships Movement with SPSS

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Abstract: A method for optimization and analysis of optimal cargo ships scheme development using the resources of SPSS program is presented in the report. The theoretical setting of the task for optimal linking of ports with surplus and shortage of burden on the basis of the two phase method and its application with the SPSS program is illustrated in an exemplary task for optimal scheme of development of cargo ships movement. An approach for transport tasks solution with SPSS is presented. A cluster analysis of obtained circle trips for cargo ships movement is made with SPSS.

Keywords: Optimization of cargo ships movement, SPSS, Circle trips, Two phase method.

1. Introduction

Bulgarian ports are important logistics points. The development strategy of sea and river transport and ports of the Republic of Bulgaria considers ports as a national port system. In the water transport, freight traffic is directed to a port or a shipping port. Cargo ships movement schemes may be considered separately for laden and unladen runs.

One of the main indicators of the numeracy and the production capacity of the fleet of shipping companies is the voyage of ships, which may consist of a laden or unladen mileage. Unlike passenger ships, cargo ships make a simple trip when it has only one movement. When ships make a simple but circle trip, it has two movements. For complex circle trips, i.e. when the ship serves more than two ports, there are more than two movements and the number corresponds to the number of ports serviced [1].

As a result of the linking of ports with surplus and shortage of ship's cargo burden, an optimal ship movement scheme of unladen ships can be achieved. For the efficient use of the fleet, the task of optimally linking laden and unladen ships' voyages, as a result of which a system of simple and complex circle trips can be developed with minimal movement of unladen ships [2].

This report presents a SPSS (Statistical Package of the Social Science) approach for optimizing and analyzing cargo ship traffic. SPSS is one of the main statistical packages of applied programs used in practice in statistical, sociological and marketing researches. The SPSS program is a product that can create and process data across a network of rows and columns with many calculation capabilities, by setting formulas and analyzing different data sets.

2. Theoretical setting

The common setting of the transport problem for linear optimization of optimal linking of ports with surplus and shortage of ship's cargo burden is as follows [2, 3]:

Previously known are the waterways and the flow paths in both directions of each water section, which are to be utilized by cargo ships. It is necessary to compile the most efficient fleet movement scheme where unladen ship runs are minimal.

If the ships' cargo burden is recorded $D'_k \ (k=1,2,...,m)$ *in ports with excess unladen ships ,* $D''_r \ (r=1,2,...,n)$ *– the required ship burden for loading in deficient ports,* l_{kr} *– the distance in river kilometers (or nautical miles) of ships movement from the port* k *to the port* r *,* x_{kr} *– the ship burden of unladen vessels to be diverted from the port* k *to the port* r *, the economical-mathematical model of the task can be written in the following way:*

$$\min\left\{L=\sum_{k=1}^{m}\sum_{r=1}^{n} l_{kr}x_{kr}\right\} \tag{1}$$

$$\sum_{r=1}^{n} x_{kr} = D'_k \ (k=1,2,...,m) \tag{2}$$

$$\sum_{k=1}^{m} x_{kr} = D''_r \ (r=1,2,...,n) \tag{3}$$

$$x_{kr} \geq 0 \ (k=1,2,...,m; r=1,2,...,n) \tag{4}$$

It is supposed that $\sum_{k=1}^{m} D'_k = \sum_{r=1}^{n} D''_r$ *, i.e. there is a balance between the amount of ship's cargo burden in ports with surplus unladen vessels and the amount of ship's cargo burden in deficient ports.*

Representing the distances between ports with surplus and deficiency as follows: l_{11} with l_1, i.e. $l_{11} \to l_1$, $l_{12} \to l_2$,..., $l_{1n} \to l_n$, $l_{21} \to l_{n+1}$, $l_{22} \to l_{n+2}$,..., $l_{2n} \to l_p$,..., $l_{m1} \to l_{s+1}$, $l_{m2} \to l_{s+2}$,..., $l_{mn} \to l_t$, and the requested burden of the unladen ships as x_{11} with x_1, i.e. $x_{11} \to x_1$, $x_{12} \to x_2$,..., $x_{1n} \to x_n$, $x_{21} \to x_{n+1}$, $x_{22} \to x_{n+2}$,..., $x_{2n} \to x_p$,..., $x_{m1} \to x_{s+1}$, $x_{m2} \to x_{s+2}$,..., $x_{mn} \to x_t$, the following linear optimization task is obtained:

$$\min\left\{L = l_1x_1 + l_2x_2 + ... + l_nx_n + l_{n+1}x_{n+1} + l_{n+2}x_{n+2} + ... + l_px_p + ... + l_{s+1}x_{s+1} + ... + l_tx_t\right\} \tag{5}$$

$$\begin{array}{l} x_1 + x_2 + \ldots + x_n \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad = D'_1 \\ \qquad\qquad x_{n+1} + x_{n+2} + \ldots + x_p \qquad\qquad\qquad\qquad = D'_2 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \qquad\qquad\qquad\qquad\qquad\qquad x_{s+1} + x_{s+2} + \ldots + x_t = D'_m \\ x_1 \qquad + x_{n+1} \qquad + x_{s+1} \qquad\qquad = D''_1 \\ \quad x_2 \qquad + x_{n+2} \qquad + x_{s+2} \qquad = D''_2 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \qquad x_n \qquad + x_p \qquad + x_t = D''_n \end{array} \tag{6}$$

$$x_j \geq 0, \quad j = 1, 2, \ldots, n, n+1, n+2, \ldots, p, \ldots, s+1, s+2, \ldots, t \tag{7}$$

Thus formulated problem could be solved with the **two-phase simplex method** [3]. In **phase I** the auxiliary problem is solved:

$$\min\left\{Z = x_{t+1} + x_{t+2} + \ldots + x_{t+m} + x_{t+m+1} + x_{t+m+2} + \ldots + x_{t+m+n}\right\} \tag{8}$$

$$\begin{array}{l} x_1 + x_2 + \ldots + x_n \qquad\qquad\qquad\qquad + x_{t+1} \qquad\qquad = D'_1 \\ \qquad\qquad x_{n+1} + x_{n+2} + \ldots + x_p \qquad\qquad + x_{t+2} \qquad = D'_2 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \qquad\qquad\qquad\qquad x_{s+1} + x_{s+2} + \ldots + x_t \quad + x_{t+m} \qquad = D'_m \\ x_1 \qquad + x_{n+1} \qquad + x_{s+1} \qquad\qquad + x_{t+m+1} = D''_1 \\ \quad x_2 \qquad + x_{n+2} \qquad + x_{s+2} \qquad + x_{t+m+2} = D''_2 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ \qquad x_n \qquad + x_p \qquad + x_t \qquad + x_{t+m+n} = D''_n \end{array} \tag{9}$$

$$x_j \geq 0, \quad j = 1, 2, \ldots, n, n+1, n+2, \ldots, p, \ldots, s+1, s+2, \ldots, t, t+1, t+2, \ldots, t+m+n \tag{10}$$

If $\min Z = 0$, the initial basic program of the given task matches the optimal basic program of the auxiliary problem.

If this condition is met, we proceed to **phase II**, where the given problem is solved seeking

$$\min\left\{L = l_1 x_1 + l_2 x_2 + \ldots + l_n x_n + l_{n+1} x_{n+1} + l_{n+2} x_{n+2} + \ldots + l_p x_p + \ldots + l_{s+1} x_{s+1} + \ldots + l_t x_t\right\},$$

but the limiting conditions are taken from auxiliary problem's optimal simplex-table.

3. Coming to an optimal solution with SPSS program

The theoretical settings exposed (5), (6) and (7), allows the resources of SPSS program to be used for coming to an optimal solution of a transport task, for optimal linking of ports with surplus and shortage of ship's burden, with the two-phase simplex method.

To illustrate the developed approach, with application of SPSS program, we are going to look through the following transport problem:

Five ports on the Danube river are given – Nikopol, Svishtov, Ruse, Tutrakan and Silistra (table 1). Data in table 1 are from Executive agency for exploration and maintenance of the Danube river [http://appd-bg.org /].

Table 1. National RIS index

Ports on Danube river /Pan-european transport corridor №7/	River kilometer
Nikopol	*579,5*
Svishtov	*554,8*
Ruse /iztok/	*489,8*
Tutrakan	*433,6*
Silistra	*375,6*

Source: EA „Exploration and maintenance of the Danube river"

Freight transported by dry-cargo ship between the five ports in two directions is given in table 2. We seek the most efficient scheme for fleet movement where the unladen run of ships are minimal.

Table 2. Freight transported between ports of departure and ports of destination

Ports of departure	Ports of destination	Freight type	Ship burden, thousand tons
Nikopol	Svishtov	paper	9
Nikopol	Tutrakan	paper	10
Svishtov	Nikopol	timber	8
Svishtov	Ruse	timber	9
Ruse	Svishtov	briquets	10
Ruse	Silistra	briquets	8
Tutrakan	Svishtov	gravel	7
Tutrakan	Ruse	sand	9
Tutrakan	Silistra	sand	10
Silistra	Ruse	wheat	6

Analyzing the transported freight between the ports of departure and ports of destination, a square table can be made (table 3), that shows sent and received ship's burden (in thousand tons) between the five ports. Based on table 3 data, the surplus or shortage of ship burden can be separately established for each port. For that purpose, the quantity of sent ship burden is deduced from the total quantity of received ship burden. The differences obtained are written in the main diagonal cells of table 3.

Ports with surplus burden Svishtov, Ruse and Silistra with surplus respectively $D_1' = 9$, $D_2' = 6$ and $D_3' = 12$ thousand tons, and ports with shortage of ship burden are Nikopol and Tutrakan with shortage respectively $D_1'' = 11$ и $D_2'' = 16$ thousand tons. There is a sum balance of 27 thousand tons of burden between the ports with surplus and shortage. Using the data in table 1, the distances between the ports with surplus and shortage of unladen ship burden are given in river kilometers (table 4).

Table 3. Ports with surplus and shortage of ship's carrying capacity

Ports of destination. / Ports of departure	Nikopol	Svishtov	Ruse	Tutrakan	Silistra	Total sent ship burden thousand tons
Nikopol	**–11**	9		10		19
Svishtov	8	**+9**	9			17
Ruse		10	**+6**		8	18
Tutrakan		7	9	**–16**	10	26
Silistra			6		**+12**	6
Total sent ship burden thousand tons	8	26	24	10	18	86

Table 4. Distances in river kilometers between the ports with surplus and shortage of burden

Ports with surplus of carrying capacity	Distances in river kilometers between the ports with surplus and shortage of carrying capacity	
	Ports with shortage of carrying capacity	
	Nikopol	Tutrakan
Svishtov	42,7	121,7
Ruse	107,7	56,2
Silistra	221,9	58

Representing the sought burden of unladen ships $x_{11} \to x_1$, $x_{12} \to x_2$, $x_{21} \to x_3$, $x_{22} \to x_4$, $x_{31} \to x_5$, $x_{32} \to x_6$, the following problem of linear optimization is derived:

$$\min\{L = 42,7x_1 + 121,7x_2 + 107,7x_3 + 56,2x_4 + 221,9x_5 + 58x_6\}$$

with conditions $x_1 + x_2 = 9$, $x_3 + x_4 = 6$, $x_5 + x_6 = 12$, $x_1 + x_3 + x_5 = 11$, $x_2 + x_4 + x_6 = 16$, $x_j \geq 0,\ j = 1,2,...,6$. The distances in river kilometers between ports of surplus and shortage of burden are adopted as a criterion of optimality.

Thus formulated, the transport problem could be solved with the two-phase simplex method with SPSS program. For obtaining the optimal solution the false variables x_7, x_8, x_9, x_{10} and x_{11}, are introduced and are added respectively in the first, second, third, fourth and fifth equation of the limiting conditions.

The auxiliary problem $\min\{Z = x_7 + x_8 + x_9 + x_{10} + x_{11}\}$ is solved with the simplex-method at phase I with the new limiting conditions. In order to solve the transport problem with SPSS, first we need to define the variables on the **Variable View** page. The output data for solving the problem's **phase I** are inserted in the **Data View** page of the SPSS program – the first simplex-table is filled as shown in fig.1.

The value of the function $Z_0 = \sum_{i=1}^{m+n} l_i D_i$ (where l_i are coefficients in front of the basic unknowns from the target function Z, and $D_i, i = 1,2,...,m+n$ are respectively

$D_1', D_2', ..., D_m', D_1'', D_2'', ..., D_n''$) and optimality evaluations $\Delta_j = \sum_{i=1}^{m+n} l_i a_{mj} - l_j, \quad j = 1,2,..,t+m+n$ (where l_j are coefficients in front of the basic unknowns from the target function Z, and a_{mj} are coefficients in front of the unknowns from the limiting conditions) can be calculated with SPSS program in three stages.

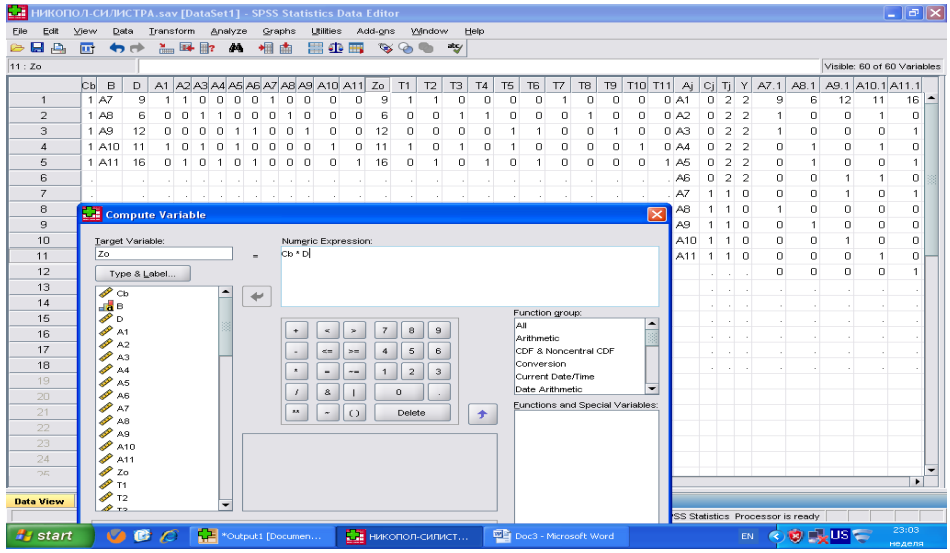

Fig.1. Output data for solving the problem's ***phase I*** *with SPSS*

At the first stage the sums of $Z_0' = l_i D_i, i = 1,2,...,m+n$ and $\Delta_j' = l_i a_{mj}, j = 1,2,..,t+m+n$ are calculated with the functions **Transform** $\Rightarrow$ **Compute Variable** respectively with variables Zo and $T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11$ by presetting the formulas $Zo = Cb * D$ (fig.1), $T1 = Cb * A1, T2 = Cb * A2, T3 = Cb * A3, T4 = Cb * A4, T5 = Cb * A5$, $T6 = Cb * A6, T7 = Cb * A7, T8 = Cb * A8, T9 = Cb * A9, T10 = Cb * A10$, $T11 = Cb * A11$. At the second stage are calculated the sums of $Z_0 = \sum_{i=1}^{m+n} l_i D_i$ and $\Delta_j'' = \sum_{i=1}^{m+n} l_i a_{mj}, j = 1,2,..,t+m+n$ with the functions **Analyze** $\Rightarrow$ **Descriptive Statistics** $\Rightarrow$ **Descriptives** $\Rightarrow$ **Options** $\Rightarrow$ **Sum** and by choosing the variables Zo, $T1$, $T2$,..., $T11$. The calculated values for $T1, T2, ..., T11$, generated on the **Output** page are inserted in the column of the Tj variable. At the third stage are calculated the optimality evaluations $\Delta_j = \sum_{i=1}^{m+n} l_i a_{mj} - l_j, \quad j = 1,2,..,t+m+n$ with the functions **Transform** $\Rightarrow$ **Compute**

Variable with variable Y by presetting the formula $Y = Tj - Cj$. At this stage of the problem solving, a check is made whether the criterion for optimality, when seeking a minimum, is met $\Delta_j \le 0 \ (j = 1,...,t+m+n)$, because an optimal plan is sought, where the minimum product value of the fleet's zero mileage is received. The criterion for optimality is not met for the first six cells in the Y column, and we proceed to finding a better basic program by defining a key column and a key row. The key column defines the vector with the smallest index in the Aj column corresponding to the biggest positive number for optimality in the Y column. For the considered problem this is the $A1$ vector, as it corresponds to the biggest positive number 2, calculated in the Y column. The key row defines the least ratio of the respective number from the free coefficients column D and the respective positive number from the key column of the variable $A1$. For the considered problem this is the number (the key number) 1 from the first row. The vector from key column $A1$ enters the new basic program on the place of basic vector $A7$ from the (first) key row.

At this stage of the problem solving, a new simplex-table is made, as the first one is only corrected without being copied. For this purpose the basic vector $A7$ should be changed, its correspondent coefficient from Cb column and the $A1$ key column should be transformed by application of Gauss – Jordan transformations in a singular vector-column with one in the main (first) row. In order the $A1$ column to be transformed into a singular vector-column, the first row of table one (the key element is 1) has to be multiplied by (-1) and to be added in the fourth row of the first table. With the SPSS program these transformations can be done with the functions **Transform** $\Rightarrow$ **Compute Variable** respectively with the variable $A10.1$ by setting the formula $A10.1 = A7.1*(-1) + A10.1$. The SPSS program generates the new values in the $A10.1$ column. The values obtained in $A10.1$ are inserted in the fourth row of the table in the cells from D to $A11$. For the second table, analogical to the first table, the Z_0 and Δ_j values are calculated and a verification is made whether the optimality criterion holds. For the considered task the basic program of the auxiliary problem is generated in the seventh table of the first phase ($\min Z = 0$) and we proceed to **phase II**.

The present problem is solved with the simplex method in the second phase as we seek:

$$\min\{L = 42,7x_1 + 121,7x_2 + 107,7x_3 + 56,2x_4 + 221,9x_5 + 58x_6\},$$

but the limiting conditions are taken from the optimal table seven of the first phase. The output data for solving the second phase of the task are inserted in the **Data View** page of the SPSS program – the first simplex-table is filled in as shown on fig.2. With SPSS program the function $Z_0 = \sum_{i=1}^{m+n} l_i D_i$ (where l_i are coefficients in front of the basic unknown from the target function L) and the optimality evaluations $\Delta_j = \sum_{i=1}^{m+n} l_i a_{mj} - l_j, \ j = 1,2,..,t+m+n$ (where l_j are coefficients in front of the basic unknown from the target function L) can also be calculated in three stages.

At stage one the sums of $Z_0' = l_i D_i, i = 1,2,...,m+n$ and $\Delta_j' = l_i a_{mj}, j = 1,2,..,t+m+n$ are calculated with the functions **Transform** $\Rightarrow$ **Compute Variable** respectively with variables $Zo.2$ and $T1.2, T2.2,..., T6.2$ by presetting the formulas $Zo.2 = Cb.2 * D.2$, $T1.2 = Cb.2 * A1.2$, $T2.2 = Cb.2 * A2.2$,…, $T6.2 = Cb.2 * A6.2$.

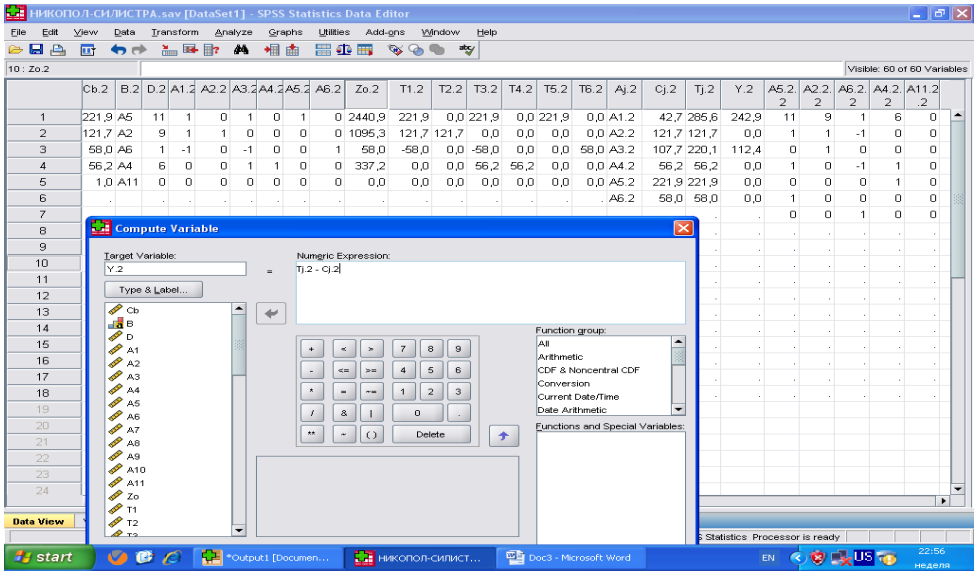

Fig.2. Output data for solving the task second phase with SPSS

At stage two, the sums $Z_0 = \sum_{i=1}^{m+n} l_i D_i$ and $\Delta_j'' = \sum_{i=1}^{m+n} l_i a_{mj}, j = 1,2,..,t+m+n$ are calculated with the functions **Analyze** $\Rightarrow$ **Descriptive Statistics** $\Rightarrow$ **Descriptives** $\Rightarrow$ **Options** $\Rightarrow$ **Sum** and by choosing the variables $Zo.2$, $T1.2$, $T2.2$,…, $T6.2$. Calculated values for $T1.2, T2.2, ..., T6.2$, generated on the **Output** page are inserted in the column of the $Tj.2$ variable. At stage three the optimality evaluations $\Delta_j = \sum_{i=1}^{m+n} l_i a_{mj} - l_j$, $j = 1,2,..,t+m+n$ are calculated with the functions **Transform** $\Rightarrow$ **Compute Variable** with $Y.2$ by presetting the formula $Y.2 = Tj.2 - Cj.2$, as shown in fig.2.

The SPSS program generates the optimal basic program of the present task in the third simplex-table of second phase. The optimal solution ensuring minimum value $L_{\min} = 1520,50$ ton-kilometers of fleet's zero mileage is $x_1 = 9$, $x_2 = 0$, $x_3 = 2$, $x_4 = 4$, $x_5 = 0$, $x_6 = 12$. Consequently the sought optimal scheme of ship unladen movement is: *Svishtov-Nikopol* 9 thousand tons, *Ruse-Nikopol* 2 thousand tons, *Ruse-Tutrakan* 4 thousand tons, *Silistra-Tutrakan* 12 thousand tons.

4. Cluster analysis

At the next stage of problem solving, the common scheme of fleet movement is defined, that includes a system of simple and complex circle trips with minimum movement of unladen ships. For this purpose, first, the simple circle trips of fully laden weight ships are determined: ***I. Nikopol-Svishtov-Nikopol*** (9 – 8 thousand tons), ***II. Svishtov-Ruse-Svishtov*** (9 – 10 thousand tons), ***III. Ruse-Silistra-Ruse*** (8 – 6 thousand tons). After that the simple circle trips are developed, including the laden and unladen ships: ***IV. Nikopol-Svishtov-Nikopol*** (1 – 9 thousand tons), ***V. Tutrakan-Ruse-Tutrakan*** (9 – 4 thousand tons), ***VI. Tutrakan-Silistra-Tutrakan*** (10 – 12 thousand tons). Last, the complex circle trips composed of ships' laden and unladen runs are determined: ***VII. Tutrakan-Ruse-Nikopol- Tutrakan*** (5 – 2 – 10 thousand tons), ***VIII. Tutrakan-Svishtov-Nikopol-Tutrakan*** (7 – 8 – 8 thousand tons), ***IX. Ruse-Silistra-Tutrakan-Ruse*** (2 – 2 – 3 thousand tons), ***X. Ruse-Svishtov-Nikopol-Tutrakan-Ruse*** (1 – 1 – 1 – 1 thousand tons).

By choosing the functions **Analyze** ⇒ **Hierarchical Cluster** ⇒ **Plots: Dendrogram** ⇒ **Method: Nearest neighbor** ⇒ **Interval: Euclidean distance**, with which a hierarchy clusterization [4] is realized with SPSS, a cluster analysis of circle trips for cargo ships movment is made. A dendogram of the clusterization is presented in fig. 3. There, the sequence of incorpotating the circle trips and clusters can be tracked.

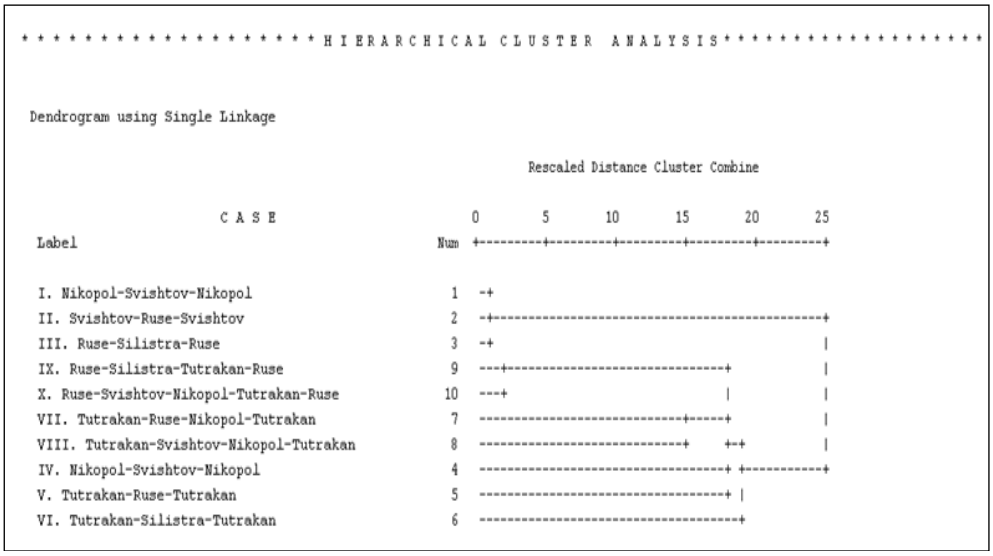

Fig.3. Dendogram of circle trips clusterization

The result of the analysis made with SPSS program aiming distribution in two and five clusters is as follows: in the first version of circle trips clusterization in two clusers (table 5) – in cluster 1 are the simple circle trips of laden weight ships, and in cluster 2 are the simple and complex cirlce trips including laden and unladen ship movements. In the second version of clusterization of cirle trips in five clusters (table 6) – in cluster 1 are again the simple circle trips of laden weight ships, in separate clusters 2, 3 and 4 are the simple cirlce trips

including laden and unladen ship movements, and in cluster 5 are the complex circle trips composed of laden and unladen ship runs.

Table 5. Clusterization of circle trips in two clusters

Cluster Membership

Case	2 Clusters
1:I. Nikopol-Svishtov-Nikopol	1
2:II. Svishtov-Ruse-Svishtov	1
3:III. Ruse-Silistra-Ruse	1
4:IV. Nikopol-Svishtov-Nikopol	2
5:V. Tutrakan-Ruse-Tutrakan	2
6:VI. Tutrakan-Silistra-Tutrakan	2
7:VII. Tutrakan-Ruse-Nikopol-Tutrakan	2
8:VIII. Tutrakan-Svishtov-Nikopol-Tutrakan	2
9:IX. Ruse-Silistra-Tutrakan-Ruse	2
10:X. Ruse-Svishtov-Nikopol-Tutrakan-Ruse	2

Table 6. Clusterization of circle trips in five clusters

Cluster Membership

Case	5 Clusters
1:I. Nikopol-Svishtov-Nikopol	1
2:II. Svishtov-Ruse-Svishtov	1
3:III. Ruse-Silistra-Ruse	1
4:IV. Nikopol-Svishtov-Nikopol	2
5:V. Tutrakan-Ruse-Tutrakan	3
6:VI. Tutrakan-Silistra-Tutrakan	4
7:VII. Tutrakan-Ruse-Nikopol-Tutrakan	5
8:VIII. Tutrakan-Svishtov-Nikopol-Tutrakan	5
9:IX. Ruse-Silistra-Tutrakan-Ruse	5
10:X. Ruse-Svishtov-Nikopol-Tutrakan-Ruse	5

5. Conclusion

There are three main results obtained in the paper.

First, that with the original method illustrated in the paper, transport problems could be solved with the SPSS program.

Second, that the presented theoretical setting for solving the problem of optimal linking of ports with surplus and shortage of carrying capacity, on the basis of the two-phase method, can be applied in developing optimal schemes for cargo ships movement

Third it is the cluster analysis made with SPSS program, of the obtained circle trips of cargo ships movement.

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Application Model for Developing and Applying of University Information System

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Abstract: The paper shows the application of modern information tools to ensure the operation and management of university IT systems. The described application solutions are based on open source technologies and tools. The integrated information system tool itself uses the good practices through which these systems are put into operation. This is a solid basis for improving information security and the effective functioning of the university network.

Keywords: Information technology, Information systems, Internet development, University information systems, Academic network, Cloud, Security.

1. Introduction

Ensuring the performance of modern information systems is a complex task requiring complex integration and synchronization of multiple information applications. When it comes to the management of university activities, this is particularly challenging, given the specifics and requirements, especially when it comes to a low budget project, and where the best use of open source solutions is needed.

This report presents an aggregated applied networking model for managing information systems in an academic network. The approach used is based on modern information systems and tools that require a high degree of automation and stability at work. The implementation of an integrated system of information tools and the use of good practices for their implementation and exploitation are shown. This is a solid basis for improving information security and the effective functioning of the university network.

In this publication results from the deployment of the core information systems and their application integration, configuration deployment and use at the Todor Kableshkov University of Transport in Sofia are presented. The specific solutions are the result of years of experience of the IT team who has been involved with them and aim to share the experience gained on the issue.

2. University Information Systems common management model

University management is a multiparametric and dynamic task requiring generalized and detailed planning, organization and implementation of the processes related to conducting a qualitative teaching process, development of scientific and applied activity, as well as fully applied activity, related to the management of the material and human resources.

The construction and management of university information systems is a complex process going through four main life phases:

- building the business logic of processes subject to automation;
- configuration, programming, testing and validation of the system;
- deployment, adaptation and use;

• maintenance and improvement of the information system.

In fig. 1 presents the structure of the university computer network in question, as well as the connection with the Internet. The main four segments of the network include: Servers Area Segment; University LAN; Students campus LAN; WiFi Free LAN.

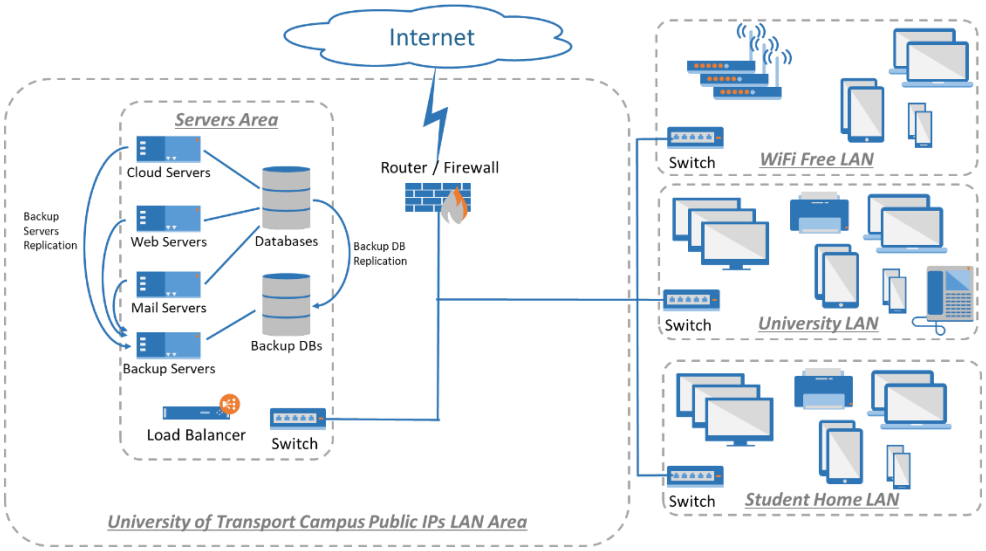

Fig. 1. Structure of the university computer network.

The construction of the university network is the result of many years of development and is dealt with in more detail in [4, 5, 6, 7, 10, 11]. Virtualization of systems and shaping of so-called cloud university is more closely addressed in [1, 3, 4], and their monitoring and job security are in [3].

The basic information systems are described in [2, 8, 9], and as a basic module of these are the specially designed project for a unified management information system [2, 8].

3. An applied model for building and managing a university information structure

The application model for the implementation and operation of the embedded information systems is based on the theoretical and applied formulations [1÷11], the main practical realization being based on the applied tools [12, 13, 14, 15], based on which the results are presented below.

According to the scheme of fig. 1 has built-in VLANs through which the university network is segmented. These VLANs are collected and managed from the basic router through which the Internet is also connected. On the same router, there is a firewall configured to filter and analyze traffic using the Intrusion Detection System (IDS) [16, 17].

In fig. 2 shows the basic interface support module for the support network and the internet connection. The firewall window shows some of the local network security rules, as well as the Network-based IDS (NDIS) connection (fig. 3).

The NIDS architecture works with redirected traffic from the Router / Firewall and includes the following elements: - Pre-processing module - a statistical analysis module; -

signature analysis module; - data base with predefined signatures; - a database of detected anomalies; -reasonable logic, so whether a package or source is intrusive or not.

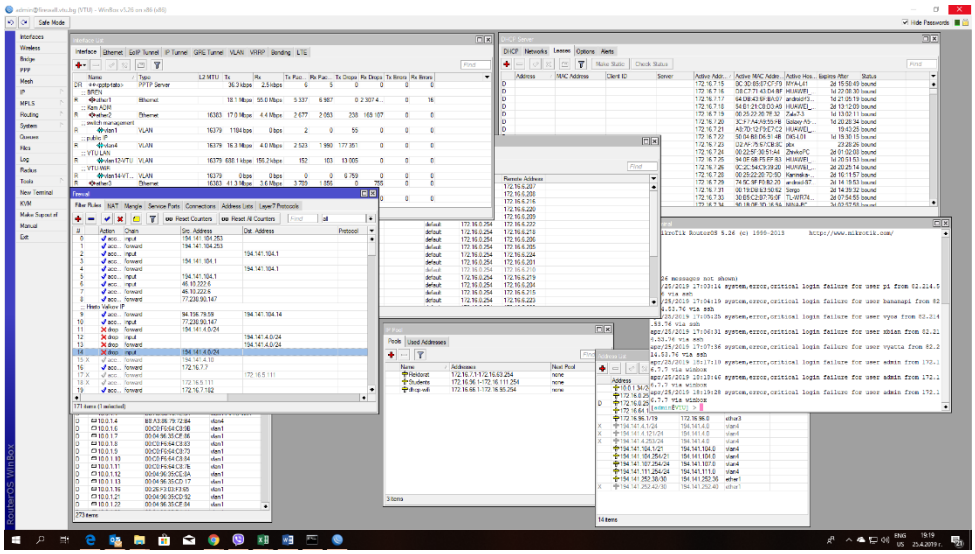

Fig. 2. Core-router Mikrotik management interface

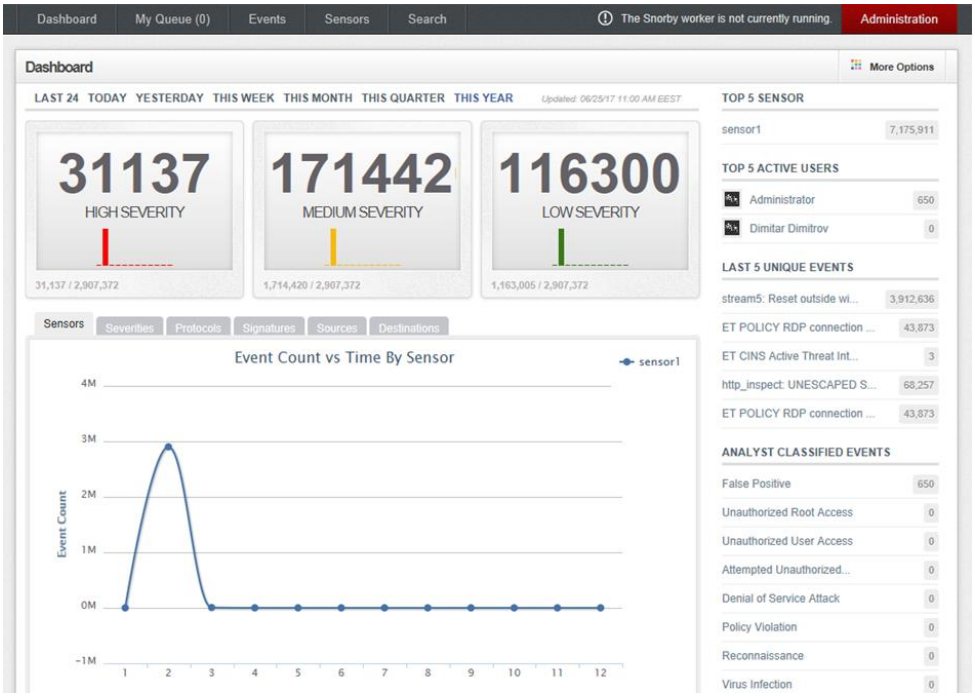

Fig. 3. General view of the main visualization screen of the NIDS embedded system

In fig. 4 is a screen view of the web-based ISPConfig system for setting up basic university information services (websites, mail, dns, etc.).

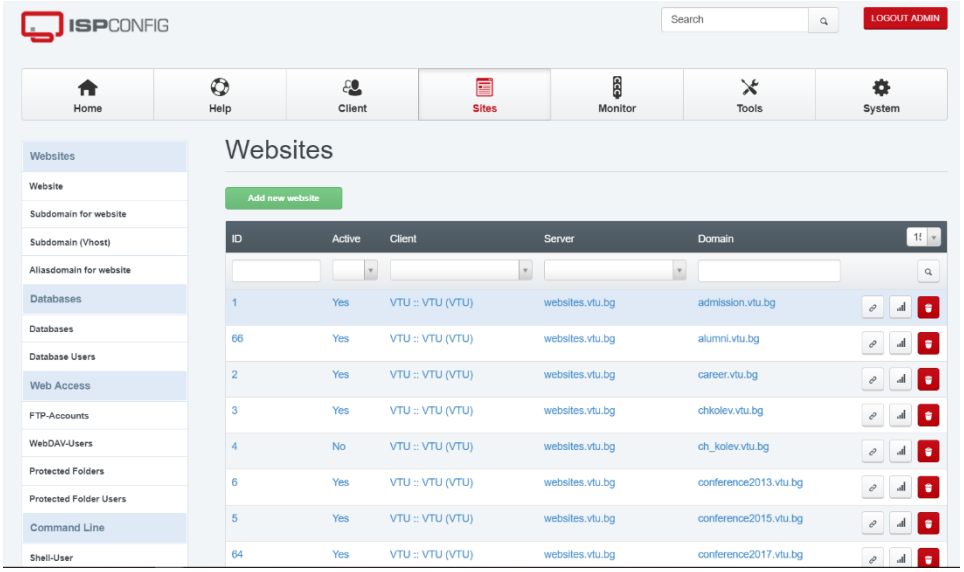

Fig. 4. Fragment of the ISPConfig hosting server configuration system

Figures 5 and 6 show the Cloud-based virtualization model via the VirtualBox and Virtual Server Parameters Settings Panel. Each server is personally configured with what resources it has (Memory, Disk Storage, CPU power, etc.).

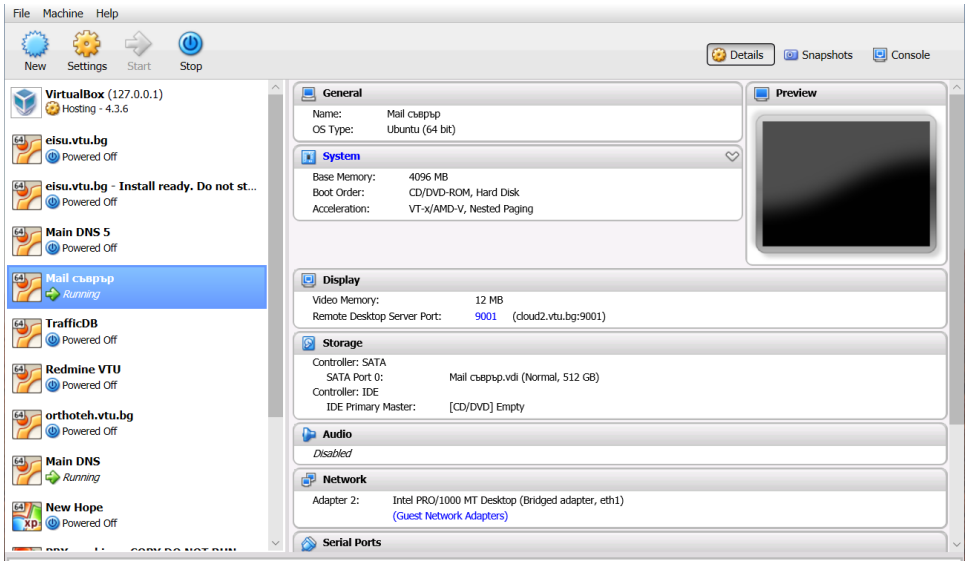

Fig. 5. Cloud-based virtualization model via VirtualBox.

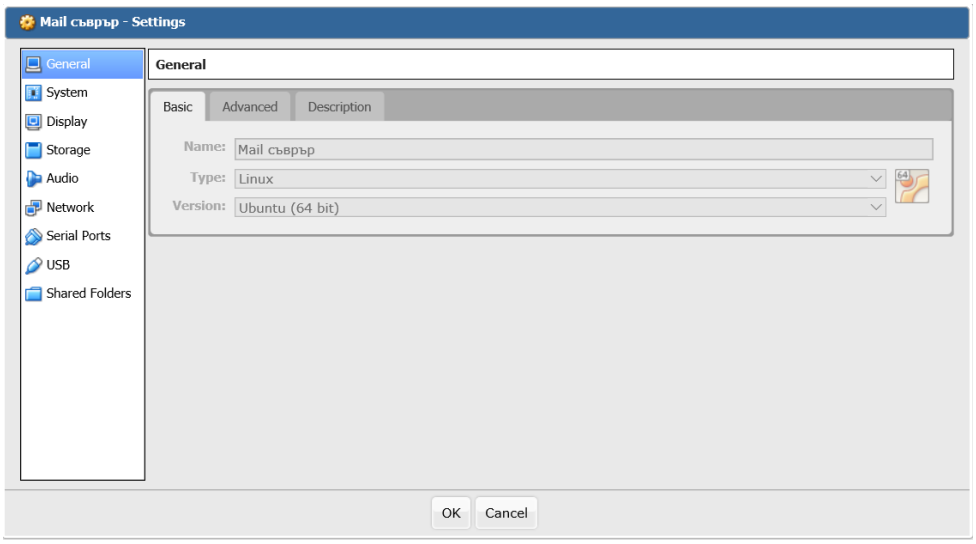

Fig. 6. Virtual Server Parameters Settings Panel

The systems presented here are the backbone of the common university information system, based on which the management and security of information flows and databases develop. The remaining modules are built on a modular basis and include several Desktop and Web solutions for university business processes and services.

4. Conclusion

This report presented a summary of an applied networking model for the management of information systems in an academic network. The issue is particularly relevant and relevant, as they can be used for unlawful actions, and the control and management of these networks is in most cases low budget. The approach used is based on good practices for the development of modern information systems and tools that require a high degree of automation and stability at work.

In practice, the implemented information tools based on Ubuntu Server, phpVirtualBox, ISPConfig, Microtik, Snort, etc., as well as their adaptation and configuration, are presented. There are also so-called good practices for their use, through which the academic network is managed. All this is a solid basis for improving information security and the effective functioning of the university network.

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Analysis and Problems in Internet of Things' Communication Environment

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Abstract: The paper reviews current trends in Internet of Things' communication environment. Key connection problems are mentioned. Marked are strengths and weaknesses of analyzed communication channels. Common IoT applications are presented and grouped based on the suitable communication environment.

Keywords: Internet of Things, Communication, Narrow Band IoT, Low-Power Network

1. Introduction

There are different types of wireless communication environment that can be used to connect IoT infrastructure. One type stands out and it will be detail discussed later – LPWAN (Low-Power Wide Area Network). LPWAN provides: battery-efficient network, large numbers of low-power devices connected in a wide area range, cost-effective support.

Other type of wireless technologies that can be used for IoT infrastructure are: Cellular networks and wi-fi, Radio frequency technologies, Mesh technologies. Main disadvantages of them are:

- **Cellular networks and wi-fi** - poor battery life and gaps in coverage.
- **Radio frequency** (RF) **technologies**, (for example Bluetooth and near-field communications (NFC)) do not provide the range many IoT applications require.
- **Mesh technologies** (for example - ZigBee), are better suited for medium-distance IoT applications such as smart homes or smart buildings. They are far less battery-efficient than LPWAN.

2. LPWAN communication environment technologies

LPWAN is a group of various low-power, wide area network technologies that use licensed or unlicensed frequencies and include proprietary or open standard options. LPWAN are created for machine-to-machine (M2M) and internet of things (IoT) networks [1] and operate at a lower cost with great power efficiency. LPWANs can accommodate packet sizes from 10 to 1,000 bytes at uplink speeds up to 200 Kbps. LPWAN's long range varies from 2 km to 1,000 km, depending on the technology. LPWANs have a star topology where, each endpoint connects directly to common central access points. Following are presented four technologies for building LPWAN infrastructure:

2.1 Sigfox

SigFox is proprietary, unlicensed widely deployed LPWANs. Running over a public network in the 868 MHz or 902 MHz bands. It uses ultra-narrowband technology and allows a single operator per country. While it can deliver messages over distances of 30-50 km in rural areas, 3-10 km in urban settings and up to 1,000 km in line-of-site applications, its packet

size is limited to 150 messages of 12 bytes per day. Downlink packets are limited to four messages of 8 bytes per day.

2.2 RPMA

RPMA (Random phase multiple access) is a proprietary LPWAN developed by Ingenu Inc. Its range is based up to 50 km line of sight and with 5-10 km nonline of sight. RPMA offers better bidirectional communication than Sigfox. However, because it runs in the 2.4 GHz spectrum, it is prone to interference from Wi-Fi, Bluetooth and physical structures. It also has higher power consumption than other LPWANs.

2.3 LoRa

LoRa is unlicensed network, specified and maintained by the LoRa Alliance. It transmits in several sub-gigahertz frequencies, making it less prone to interference. LoRa is deployed in 868MHz or 915MHz (for USA) and allows users to define packet size. Bandwidth [2] can be set from 7.8kHz up to 500kHz (common bandwidths are: 125kHz, 250kHz and 500kHz. LoRa is the physical layer and LoRaWAN is the media access control (MAC) layer protocol that manages communication between LPWAN devices and gateways.

2.4 NB-IoT and LTE-M

Narrowband-IoT (NB-IoT) and LTE-M are both 3rd Generation Partnership Project (3GPP) standards that operate on the licensed spectrum. While they have similar performance to other standards, they operate on existing cellular infrastructure, allowing service providers to quickly add cellular IoT connectivity to their service portfolios.

NB-IoT operates on existing LTE and Global System for Mobile (GSM) infrastructure. It offers uplink and downlink rates of around 200 Kbps, using only 200 kHz of available bandwidth.

3. LPWAN communication environment comparison

Eight important aspect [2] are taken into consideration in the following comparison between NB-IoT (and LTE-M), LoRa, SigFox and RPMA.

3.1 Bandwidth support

RPMA – bandwidth is limited by the used frequency (2.4 GHz) and is about 1MHz to 80 MHz. NB-IoT bandwidth is 180 KHz. LoRa commonly works with bandwidth of 125 KHz. Sigfox bandwidth - 0.1 KHz

3.2 Gateways

LoRa, SigFox and RPMA needs dedicated gateways for functioning, while NB-IoT uses the Cellular Base station of the operator.

3.3 Frequency spectrums required

The LoRa, Sigfox and RPMA technology works on an unlicensed spectrum. NB-IoT services are provided over licensed frequency bands (Sigfox, LoRa and NB-IoT use frequency bands lower than 1GHz). The costs for frequency band licensing is calculated per-MHz but telecom operators have the option of deploying NB-IoT into 4G LTE spectrums [3].

3.4 Suitability for different types of applications

SigFox and LoRaWAN are optimized for apps/devices that have non-frequent communication requirements (for example 10 to 15 times in a day), and have to deliver top-notch battery lives at very low costs. In comparison, the NB-IoT specification works best for applications that need to have minimal latency and are required to communicate more frequently.

3.5 Customer profiles

Leading telecom operators, from different parts of the world, are the main customers for IoT communication standards like LoRa, NB-IoT, RPMA and Sigfox. However, the LoRa, Sigfox and RPMA technology can be implement by non-telecom operators as well unlike NB-IoT.

3.6 Network coverage

Long-distance coverage is a common fact for all - Sigfox, RPMA, NB-IoT and LoRa. NB-IoT coverage can extend to 18-21 kilometers – higher than the average 12-15 kilometers coverage delivered by LoRa, Sigfox, RPMA. NB-IoT works best in sophisticated urban locations, and its performance is not up to the mark in suburban or rural areas where LoRa, Sigfox, RPMA provide up to 20-50 kilometers coverage. In urban area LoRa, Sigfox coverage drop significantly to less than 3 kilometers based mainly on the building density.

3.7 Battery performance

SigFox and LoRa have leading position about this criteria since NB-IoT works on a cellular, licensed spectrum, and RPMA on 2,4GHz. In NB-IoT the devices must be synced with the network at regular intervals which increase battery consumption. No such network synchronization is required in LoRa and SigFox architecture.

3.8 Data rates

NB-IoT is leader with average data rate in a narrow band setup of 200 Kbps. Next is RPMA - 35 Kbps in duplex mode then is positioned LoRa with wide range of available data rates from 0.3 kbps to 27 kbps [5], and last is Sigfox – 0.098 Kbps.

4. LoRa and SigFox

Priority in IoT architecture are communication environments with lower energy consumption and this is the reason that the focus will be set to LoRa and SigFox for more summarized comparison [6] (Table 1).

Table 1 LoRa and SigFox comparison

Specifications	SIGFOX	LORA
Frequency band	868/902 MHz (ISM)	433/868/780/915 MHz
Urban range	3-10km	2-5km
Rural range	30-50km	15-20km
Packet size	12 bytes	Defined by user
Devices per access point	1M	100k
Topology	Star	Star
Channel Bandwidth	125 KHz [7] Modulation: Chirp Spread Spectrum	0.1 KHz Ultra-narrow band
Downlink data rate	300 bps to 27 Kbps	4 messages of 8 bytes/day
Uplink data rate	300 bps to 27 Kbps	100 bps, 150 messages/day

SigFox [8] uses a proprietary technology, which usies a slow modulation rate to achieve longer range. Due to this design choice, SigFox is an excellent option for applications where the system only needs to send small, infrequent data packages.

Possible applications include parking sensors, water meters, or smart garbage cans. However, it also has some drawbacks. Sending data back to the sensors/devices (downlink capability) is severely limited and signal interference can become an issue.

LoRa [9] functionality is similar to SigFox in that it's primarily for uplink-only applications (data from sensors/devices to a gateway) with many end-points. Instead of using narrowband transmission, it spreads out information on different frequency channels and data rates using coded messages. These messages are less likely to collide and interfere with one another thereby increasing the capacity of the gateway.

LoRa is a better option if you need true bidirectionality because of the symmetric link. If it is needed command-and-control functionality LoRa the option.

Conclusions

There are many companies offering IoT communication environments on the market. In order to get the appropriate decision which is the most suitable option, three questions should be answered:

- Is the sensor's battery lifetime duration important?
- Which technology is available at the geographical location of the implementation?
- What data rate is needed in order to receive quality results of the implementation (downlink/uplink)?

Gartner [10] expects that IoT will grow fast next couple of years and most ITC vendors already start the competition in development of IoT sensors and devices. All they need proper communication environment and this will lead to expansion of the use of current technologies and development of new. One issue is left behind and this is the information security [11] of IoT communication environment. Forester Research [12] alarm on the matter with report about IoT security last year and masseurs in this area should be developed.

Despite at first glance all LPWAN technologies might look interchangeable, in every implementation there is one of them more suitable than the rest. This will give chance to all of them to evolve and new IoT communication environment technologies to be created.

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Opportunities to Reengineering Administrative Processes

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Abstract: The paper is dedicated to the pace of development of e-government in the municipalities of southwest region in Bulgaria. It analyzes the results achieved in the computerization of government services during the period from 2003 until 2016. On this basis, the paper presents the results of the study of public awareness on the electronic services in some of the leading municipalities. Finally, the author makes conclusions and recommendations.

Keywords: Electronic administrative services, Public administration, E-government.

1. Modeling administrative processes

The processes running in the administration are quite complicated. Especially this concerns those directly related to the administrative service of citizens and businesses. The idea of their modeling is rather old, with many researchers offering methodologies for performing process analysis and subsequent improvement. In the present study, we follow the following sequence of actions related to improvement of the working processes in the administration (fig. 1).

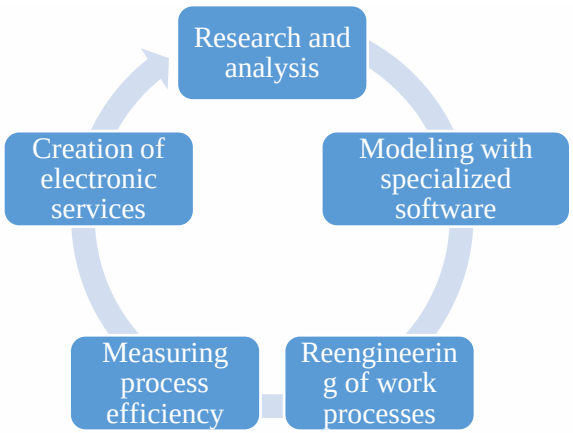

Fig. 1 Modeling administrative processes

Administrative processes are an essential part of administrative services in organizations. Because of this process modeling, which is the basis for their reengineering, is a key point for achieving efficiency in administrative service provision and e-services. Many authors, as Milev, put the leading role of e-services for taking appropriate management decisions in organizations [3].

In this part, the description and modeling of an administrative process related to the activity of the National Revenue Agency [1] will be presented. The process concerns the receipt of a non-tax document. According to the rules for the use of the electronic administrative services of the National Revenue Agency (NRA), provided with a qualified electronic signature, to ensure the possibility of using the electronic administrative services of NRA (fig. 2), it is necessary to submit:

- Application for submission of documents electronically and use of the electronic administrative services provided by the NRA with QES to an obligated person;
- Application for submission of documents by electronic means and use of the electronic administrative services provided by the NRA with QES to an authorized person.

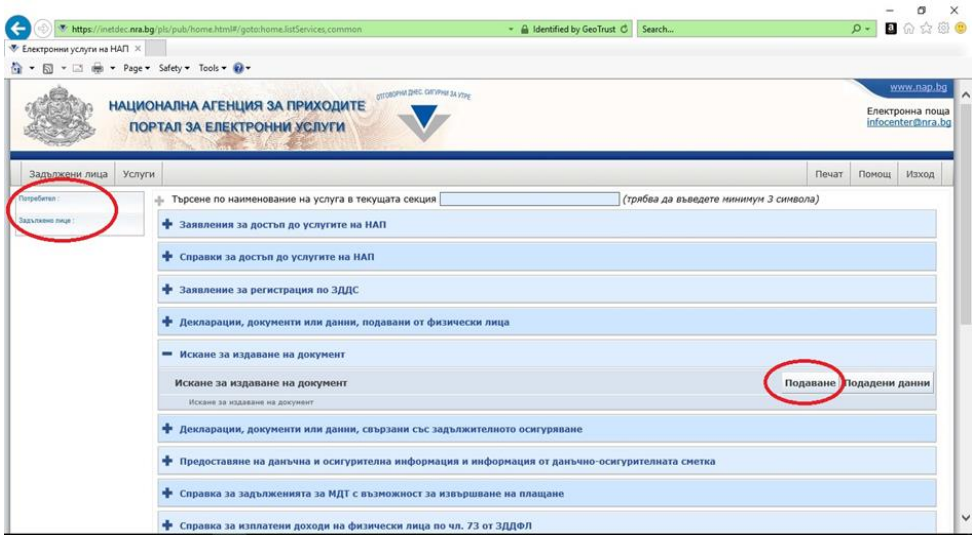

Fig 2. Use of electronic services

In fig. 3 is a diagram of the modeling process: filing a request for issuance of a document for lack of tax obligations and obtaining a resultant document.

The process is related to the user filling in the electronic administrative services of an application for use of electronic services by the NRA with QES. For this purpose, it is necessary to register, by submitting the application and filling in the necessary data in the NRA electronic services portal, and it is successfully registered. Once registered, the person must go to a NRA office to certify with his or her personal documents that the relevant registration is made by him and receives the necessary access. Based on the registration, the user has the right to submit an electronic application for a document for lack of obligations. The administration issues the document and receives it in paper form and is made personally.

2. Reengineering of administrative processes

One of the main difficulties for users as participants in this process is the personal visit of the administration to receive the document. This has the following disadvantages:

- Greatly complicates the procedure of using this document in real business;
- Leads to a waste of time;

- Does not allow effective use of the capabilities of electronic signature;
- Leads to increased risk, especially when implementing public projects [2];
- Increases the final costs of providing the service, etc.

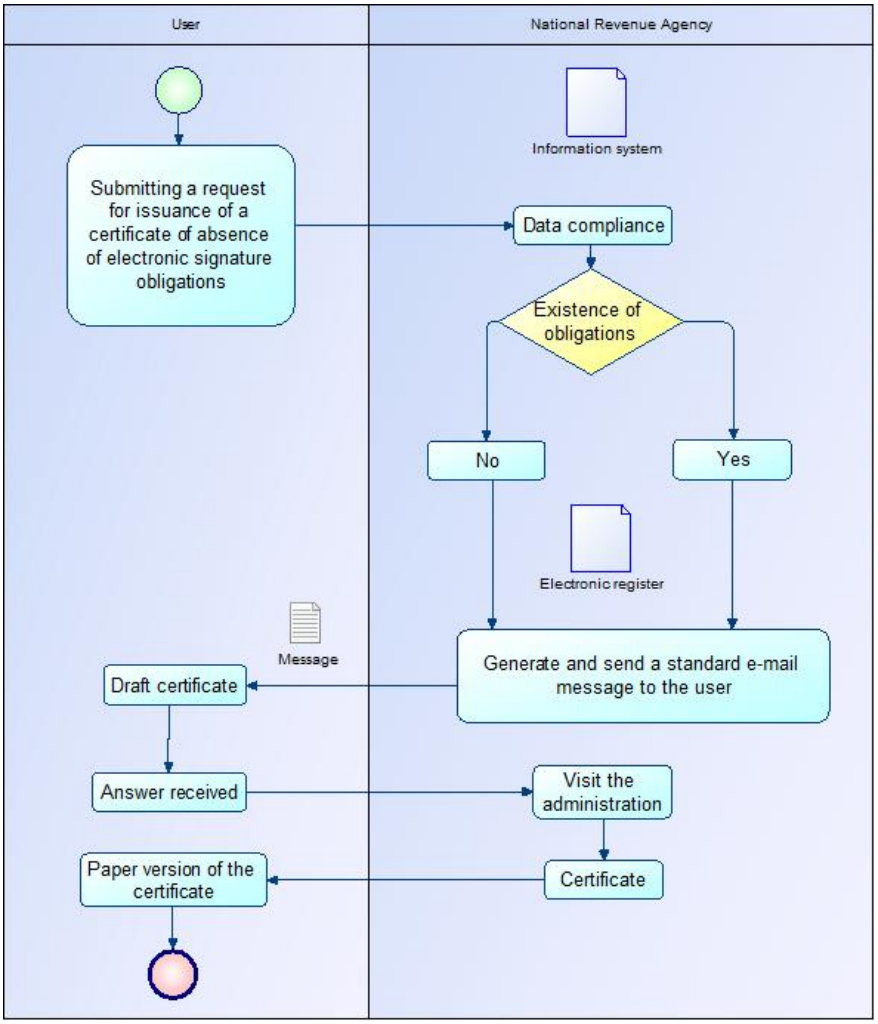

Fig 3. Submitting a request for issuance of a document for lack of tax obligations

For these reasons, the reengineering of this process naturally leads to the need to remove the actions related to the administration visit as shown in fig. 4.

These actions can be removed by administering the technology to send a ready-made electronic document. Similar opportunities are already being realized in some administrations and lead to many benefits for end users and businesses.

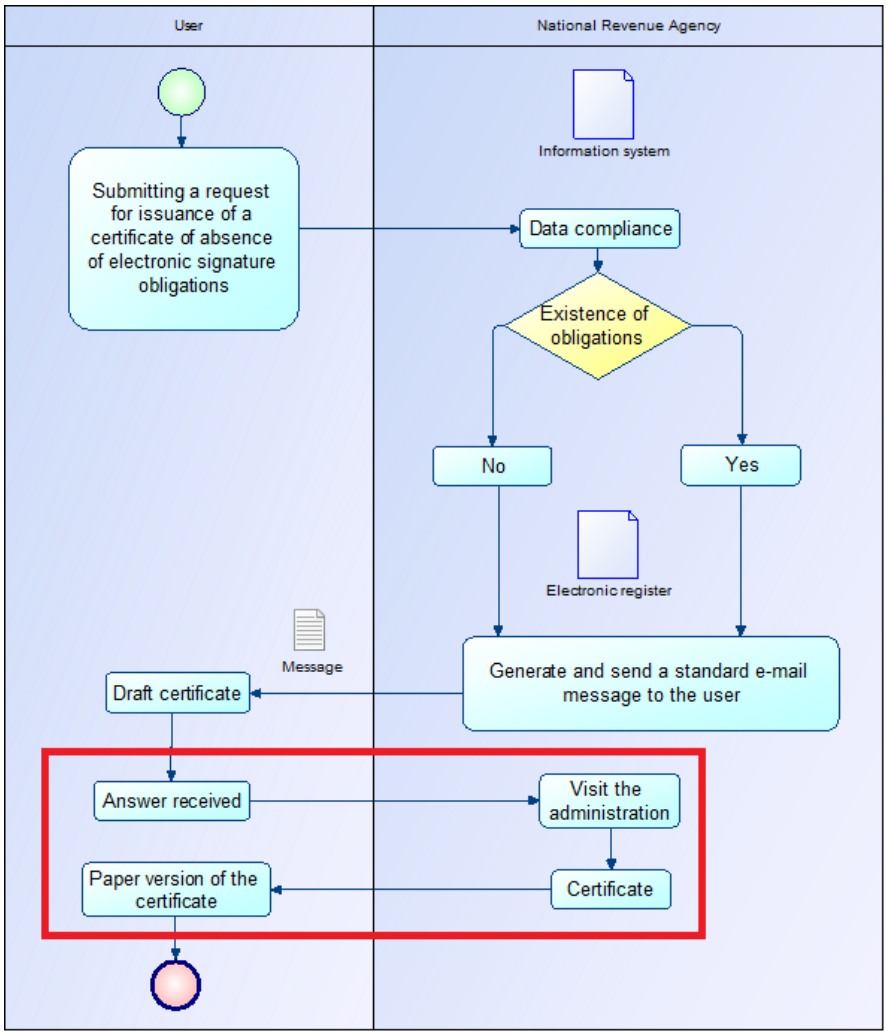

Fig 4. Need for reengineering the administrative process

3. Conclusion

When performing reengineering of administrative processes, some essential features should be considered:

- Reengineering of work processes is related to changes in some of the main features of the process;
- In most cases process optimization involves a change in the organizational structure or the functions of the individual participants. This means adding a participant or dropping one;
- It is necessary to change the sequence of the process, as well as to add or drop specific actions of the participants;

- The reengineering of administrative processes is related to a change in the existing documents or their elements. This means adding or dropping documents, especially when introducing electronic services;
- It is necessary to introduce methodologies for measuring the efficiency of administrative processes.

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Problems in the Implementation of Mobile Information Technologies in the Hotel Industry in Bulgaria

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Abstract: Tourism, as one of the sectors where reaching customers at the right time and the right place is of particular importance, is a suitable environment for the deployment and use of mobile devices and technologies. The contemporary hotel sector in Bulgaria has an obvious need for more efficient management of the functioning information systems, which has to be improved by applying up-to-date information and communication technologies. The presented paper analyses part of the results of a survey conducted on the extent of the spread of mobile information technologies in different categories of hotels in Bulgaria and the problems with their implementation.

Keywords: Hospitality Information Systems, Mobile Information Technologies, Computer Reservation Platforms.

1. Introduction

The present-day world is mobile - most people around the world consider themselves to be "living mobile life" (Elliot & Urry, 2010), whether they have chosen it voluntarily or by compulsion. In the changed modernity, dominated by online social media, mobility and communication technologies have become extremely important in the field of tourism as well.

During last decade the increased use of mobile information technologies in tourism as a whole, imposes changes in the hotel sector, in particular. Mobile information technologies are essential for the sustainable development of the tourism industry in the 21st century.

The successful implementation of mobile information technologies in the Bulgarian hotel industry depends on managers' knowledge of the key issues in the sector, the strategies for deploying mobile IT, the tools that will ensure the safety of the tourist data and the requirements for the staff working with the operating or newly created hotel information systems. Incorrect built strategy for applying mobile information technologies is a common problem that Bulgarian hotels overlook, unlike their foreign counterparts who invest many resources in this activity.

2. Research methodology and main results

In order to fill the gaps in the practical research and analyses of the problems of introduction of mobile information technologies in the Bulgarian hotel industry, was made an inquiry via an electronic questionnaire with 31 questions distributed to 388 Bulgarian hotels from different categories (hotel chains and hotels, motels, hostels and holiday stations). For the hotels' selection was purchased a database of 443 e-mail addresses of tourist sites, for which catalogues of the following branch organizations were used: Bulgarian Hotel and Restaurant Association, National Association "Hotel, Restaurant, Cafeteria", Varna Association of Restaurant & Hotel Owners.

The MailChimp system, which allows detailed analysis of the e-mail (whether it was open, how long it was opened, whether it was clicked on the e-mail addresses provided to the poll, etc.), was used to send the questionnaire online. Analysis of system logon responses by respondents shows that out of the 388 verified authenticated emails 126 were opened and read, and only 31 respondents were interested in completing the survey. Another part of the respondents filled in the questionnaire directly on the site **http://anketata.eu** and another nine questionnaires were collected as a result of personally conducted interviews. The total return of electronic and filled in on-site forms is 48, 39 of which filled in correctly (10.05% of all emails sent).

3. Study results

Based on the use of a number of general scientific logic (analysis, synthesis, comparison, measurement, induction, deduction and analogy) and general scientific empirical methods (observation, description, measurement, evaluation and comparison) we summarize the degree of application of mobile information technologies in the surveyed objects in the following more important **results**:

1) 53.80% of the respondents use mobile information technology in their activities for:
    a. internet advertising and internet marketing – 87.20%
    b. making electronic payments with customers – 66.70%
    c. customer database support – 61.50%
    d. to carry out mobile communications with customers via SMS, MMS, etc. – 15.40%
    e. for e-business with partners – 20.50%
    f. to increase the efficiency of the workflow – 28.20%

Encouraging is the fact that 41% of the respondents say that they do not use mobile technology in their business, but they intend to do so.

2) 82.10% of the tourist sites have a web site, a 10.30% advertise their services in specialized portals. However, the functionality of the created sites is:
    a. informing about hotel products - 79.50% of the respondents
    b. 51.30% say they use a small number of electronic services
    c. 25.60% of the tourist sites have dynamic information and means to implement different electronic services on their websites.
    d. Barely 10% declare that their official website has a dynamic mobile web-version
3) Only 10.30% of the respondents are not included in any reservation systems (Galileo, Amadeus or Worldspan for example), mainly using regional and international ones. 33,3% say that they are not registered in this type of systems but still plan to do so. 25,60% of the sites declare that they have registered their services in online portals, such as: Trivago, Booking etc.
4) With regard to online reservation systems, the largest number of hotels are included in Booking.com (79.50%), followed by Trivago.bg (33.30%) and Hotels.com (20%).
5) A small percentage of hotel guests make reservations via a mobile app or device.
6) 94.40% of the surveyed people would use social networks, Facebook, Twitter, or others to advertise and explore customer satisfaction.

7) The incorrect built strategy for implementing mobile information technologies is a common problem that Bulgarian hotels overlook, unlike their foreign counterparts who invest many resources in this activity. 59% of the surveyed sites do not have such strategy for their business.
8) ¾ of the hotel managers are willing to allocate funds for the deployment of a mobile information system or application in their site, as the largest share of the costs is up to BGN 5,000 (35.90%), followed by BGN 10,000 (28.20%) and over BGN 10,000 (10.30%).
9) 82.10% of the respondents believe that the economic effect of investment in mobile information technologies will be positive.

Only 20.50% of the respondents report the lack of support of mobile information technologies from the information system in the tourist site as a difficulty. The distribution of the remaining answers to the question on the problems of the currently functioning information systems in the researched hotels is presented in Figure 1:

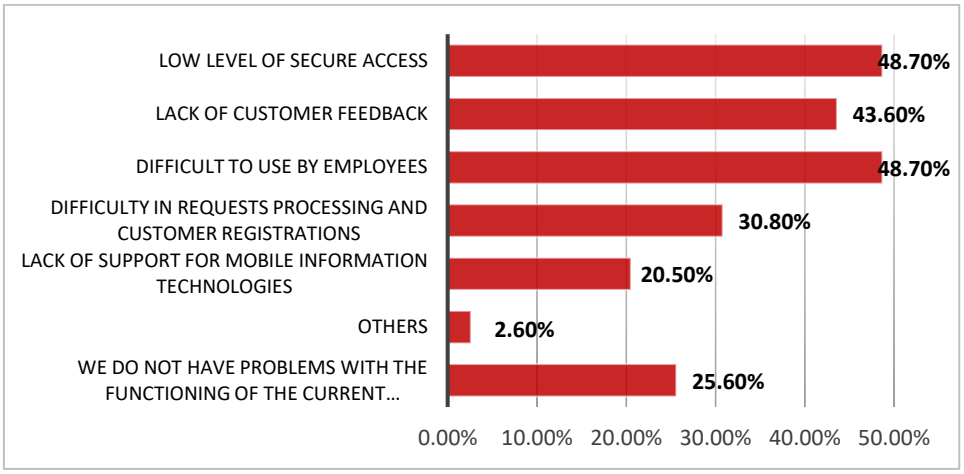

Fig 1. Information systems problems of the studied objects.

Surprisingly, 56% of the respondents do not believe that the quality of the products and services they offer needs improvement by means of new information technologies. The rest declare the following main opportunities for improving the quality of the information service and better meeting of the customer needs by implementing technologies:

- making user reservations for accommodation and transport – 30.80%
- sightseeing and entertainment services before purchasing the tourist product - 30%
- study of the availability and accessibility of different types of tourism and routes, tourism potential of countries and regions - 56%
- others - 61.50%

One of the positive aspects of the deployment of mobile information systems at the sites of the tourism industry is the unification in a single database of information about all services and clients - this corresponds to 76.90% of the respondents. Better communication between employees and customers is the benefit that is important to 74.40% of all respondents, and the easier access of employees to company resources from anywhere in the world through web application is a major advantage for 33.30% of the sites (Figure 2).

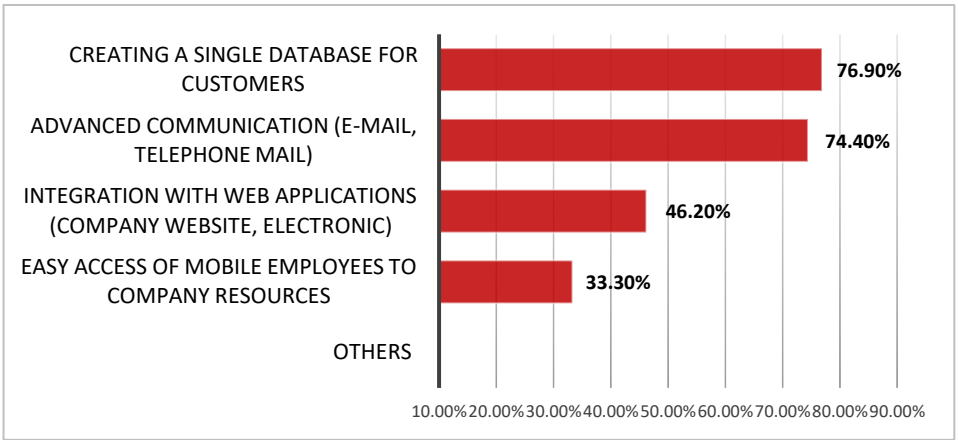

Fig 2. Benefits from the implementation of mobile information systems in the tourist industry.

Touristic sites that consider the use of mobile computing devices in their environment should assess not only the **benefits** of mobile information technology, but also the **risks** and the consequences for business under the management of these devices. Losing, stealing, or infecting sensitive data, malware that can affect not only the mobile device itself, but also the corporate network and the way the workers use the devices are just some of the risks associated with this type of technology.

The deployment of mobile devices can pose a significant risk to the overall security system of the tourism industry. Mobile devices can also be very vulnerable, since they are accessible to malicious attacks as well as non-malicious internal threats. The prime risks of using mobile devices in the tourism industry are:

- loss or theft of the device
- data infection by a malware
- phishing attacks
- attacks through disguise
- attacks in the layer of communications etc.

Despite the increased use of mobile devices in the tourism industry in recent years, consumers have not shown increased booking activity. This is due to several major **barriers** (Newtrend.bg, 2014), the main ones being:

- a necessity of using other familiar ways of booking
- security considerations
- small screen and relatively complex navigation on tourist sites through smartphones.

With respect to Bulgarian consumers, we can note the following **obstacles**:

- the purely physical need to visit the company on the spot, to specify deadlines, prices, conditions
- security issues - almost 72% of Bulgarians are afraid of becoming a victim of identity theft (Economy.bg, 2012)
- technical problems - they relate to the low banking culture of Bulgarian consumers and the fact that they do not take advantage of the use of modern mobile payment systems
- the severe economic situation of Bulgaria - this is considered more as a psychological than a real problem. The standard of living in Bulgaria is lower than in other European

countries, but if we pay attention to the lifestyle of Bulgarians, what they buy, etc., it turns out that they are not as poor as they are considered to be and maintain a standard of living, which is similar to that in other countries. It turns out that Bulgarian consumers are regarded as insolvent and as having a psychological barrier to online shopping.

Based on the study of various literary sources we can summarize the main **problems** with the implementation of mobile information technologies in the hotel sector in Bulgaria in the following four:

1) **Mobile devices safety** - it is necessary to ensure that the use of mobile devices when visiting tourist sites is protected and effective. Due to the nature of mobile devices being open to the wireless network, the security of these devices involved in the booking process is much more critical than desktop computers. A significant part of the risks associated with mobile devices comes from their most important advantage - portability.
2) **Mobile devices interface** - a small screen and an impractical keyboard are often inconvenient, especially for men, since the screens are smaller than those of an ordinary computer monitor is and only part of the content of the web pages is displayed. Mobile phones and other mobile devices cannot provide the same quality of Internet access compared to a desktop computer connected to the network.
3) **The limited traffic of wireless communications compared to cable.** In an ordinary mobile network, one or more transaction parties may be mobile-based, which means lower data exchange rates than a cable connection and inconvenience in communication between the parties.
4) **The presence of a large selection of mobile devices**, making it difficult for the user to purchase a device, as well as for retailers when selecting devices to offer to users.

As mobile devices become an important tool in the business operations of any business organisation, it is necessary to address their security issues in a timely manner by applying a number of **measures** such as:

- remote control of the device in order to be traceable;
- secure methods to authenticate the user such as PIN code, passwords, and other protection;
- encrypting mobile devices so that their information becomes unusable in the event of a theft;
- encryption and privileged control over accessible systems;
- tracking and limiting the transfer of data to pocket and portable devices from a single point;
- informing users about the latest and most secure devices;
- accountability, responsibility and transparency when using the device;
- adjusting devices from their installation up to the point when they are out of use, etc.

4. Conclusion

In conclusion, we can summarize that the used in tourism mobile technology brings together many services by offering its users easier access and saving time and resources. They are constantly evolving and improving, and this trend will continue in the future. Technical innovations have paved the way for mobile devices to penetrate the workplace. Many tourist managers choose to use mobile information technology, often without taking into account the

risk or business management implications associated with these devices. Losing, stealing, or infecting sensitive data, malware that can affect not only the mobile device itself, but also the corporate network and the way employees use the devices are just some of the risks associated with this type of technology.

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Possibilities for Carrying out SWOT Analysis in the Implementation of Information Systems

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Abstract. The paper examines the problems of application of the SWOT analysis in the implementation of information systems. On the one hand, the problems of the implementation process are well-known, but on the other hand, the peculiarities and changes in modern business require new approaches. The methodological problems are related to the necessity of linking the achieved efficiency of the concrete implementation and the costs incurred for the individual activities. At last, conclusions are drawn.

Keywords. Software implementation, Software platform, SWOT analysis

1. Methodological foundations of the deployment of information systems

Implementation of information systems is a complex and lengthy process. The main participants in it are the deployment team on the part of the developer and the organization in which the implementation takes place. In the usual practice the actions of the participants are regulated by contractual relations. They cannot go unnoticed, however, the effort of both parties to achieve as a result the most efficient information system that justifies the costs incurred.

Two main types of implementation can be identified in terms of the link at this stage with the rest of the life cycle of a system (fig. 1).

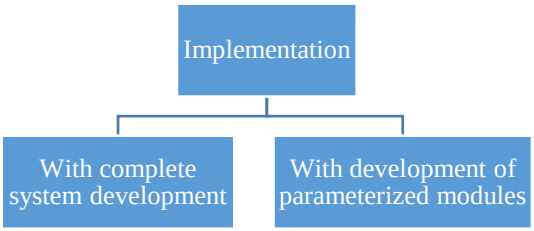

Fig. 1 Types of information systems implementation

In practice both are widespread and have the specific features. This paper will primarily look at the application of SWOT analysis to the first type of implementation process described. The main activities that can be carried out in the implementation of an information system as part of the whole development process are:

- Software distribution;
- Performing system settings
- Making specific settings
- Completion of the installation process;
- Software licensing;

- Dissemination of digital aids;
- Key user training;
- End user training;
- Final system acceptance, etc.

It is necessary to point out that these activities are tasks that are exemplary, depending on the specifics of each implementation can be added additional activities.

2. Performing a SWOT analysis of the implementation of information systems

The exemplary determination of the strengths, weaknesses, opportunities and threats of the process of implementing information systems is presented in table 1. The scores are based on the 10-point system in the range of 0 to 10 points. Their aim is to quantify the qualitative indicators of the four components of the analysis.

Table 1. SWOT analysis

Strengths			**Weaknesses**		
№	Description	Score	№	Description	Score
1	Comprehensive approach to implementation of information system	10	1	Need for a complete description and modeling of business processes	8
2	Improving the impact of business process analysis on implementation	8	2	Higher level of qualification and competence of employees	10
3	Improving the level of information management	6	3	Impossibility of program interpretation of analyzed processes	6
4	Sustainability in business process changes in the subject area	8	4	Time to develop a ready application	8
5	Less need for reprogramming of individual modules	10	5	More sophisticated program implementation	8
		8,4			8
Opportunities			**Threats**		
№	Description	Score	№	Description	Score
1	Choice of versions	10	1	Incorrect description of business processes	6
2	Easily add new modules	8	2	Gaps in description of business processes	8
3	Export of settings	6	3	Problems in program interpretation of applied settings	6
4	Features to extend functionality	6	4	Problems with the organization of the interface	8
5	Opportunity for easy integration with other systems	8	5	Module dropout and functionality issues	6
		7,6			6,8

Fig. 2 illustrates an exemplary ratio of the four components of the assay evaluated on a 10-point system.

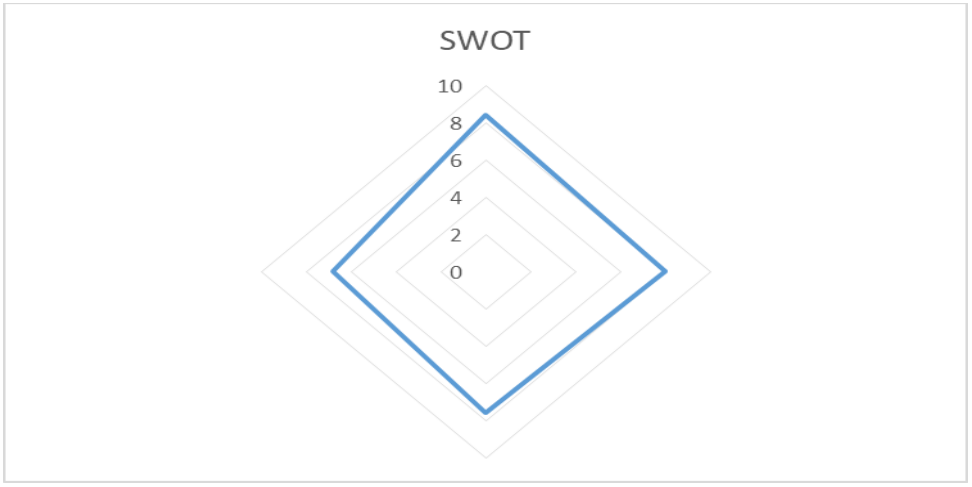

Fig. 2 Sample SWOT analysis

The main components of the SWOT analysis can be grouped in four groups - strengths, weaknesses, opportunities and threats. They can develop and expand. This is also the case with the continued expansion of the platforms offering e-services and platforms for management of research projects [1, 2]. In addition, SWOT analysis can be applied to each of the implementation activities. In this respect, it remains the issue of taking into account the mutual influence of individual activities on the final outcome of the system's effectiveness.

3. Reporting SWOT analysis results to improve deployment

The reporting of the results of the SWOT analyzes carried out on the individual activities to improve the implementation of the information systems should go through the following stages:

- Defining the components of the SWOT analysis for each activity;
- Determination of points on each of the components;
- Defining the final meaning of the components;
- Graphic presentation of results;
- Considering the mutual influence of the activities;
- Graphic presentation of changes (fig. 3);

Improvement the six steps mentioned in the process of implementing information systems is exemplary. It can be modified and supplemented according to the specifics of each particular system. However, it is necessary to constantly seek the rejection of the negative impact of the individual activities on the implementation and achievement of the maximum efficiency of the finished system.

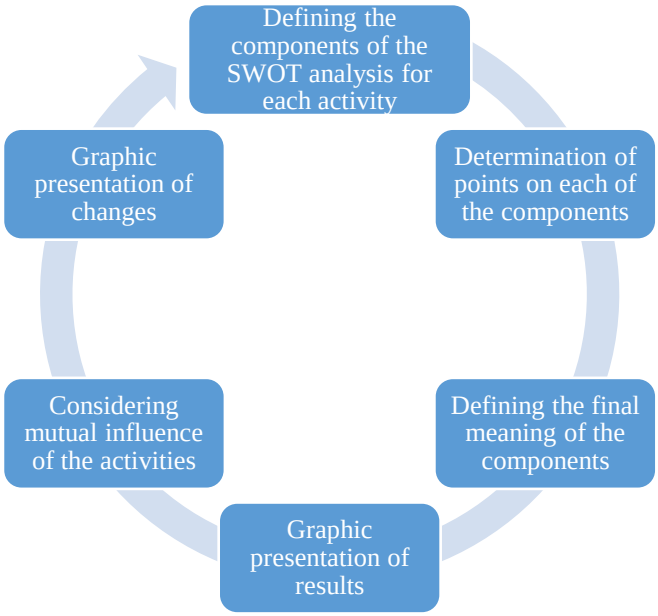

Fig. 3 Improving the implementation of information systems

4. Conclusion

Because of the research we can draw the following conclusions:

- Each process of information systems implementation can be divided into separate activities;
- SWOT analysis can be performed on both the whole implementation and each of the activities;
- In practical terms, it is important to continuously seek opportunities to improve the implementation of information systems and increase their efficiency.

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Query Performance Monitoring Using Query Store in SQL Server 2016

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Abstract. Many database experts are interested in monitoring and troubleshooting query performance. Query Store is entirely new feature in Microsoft SQL Server 2016 that helps database administrators in this direction. Query Store gives possibilities for gathering, storing and monitoring valuable performance statistics for queries execution. In SQL Server 2016 there are four reports presenting these statistics. Whether it is possible to create custom reports for database administrators that would like to get another view of the gathered data? The current paper reviews possibilities for creating custom reports using Query Store.

Keywords. Query performance, Performance monitoring, Performance analysis.

1. Introduction

With the development of new technologies in the modern world, the work of a business organization is monitored by the so-called monitoring systems. The monitoring of an information system's operation and database monitoring in particular is a task which has been defined and implemented for a long time.

Most of the modern database management systems (DBMS) integrate various implementations of these concepts in the form of software components, system elements and integrates external ones.

According to some sources [1-3], in many cases, data which resides in multiple and independently developed data sources is needed for monitoring and decision-making.

The main goals of this paper are to present in brief the Query Store reports, their data sources and capabilities for using independently developed data sources for creating custom reports using Query Store feature of SQL Server 2016.

2. Query Store built-in reports

Query Store is a new feature in Microsoft SQL Server 2016 and provides valuable insights on query plan choice and performance. It simplifies performance troubleshooting by providing a quick and easy way to find performance differences caused by query plan changes. Query Store automatically captures a history of queries, plans, and runtime statistics, and retains these for review [4]

All the information inside the Query Store can be accessed through Microsoft SQL Server Management Studio built-in reports and Dynamic Management Views (DMVs).

In the structure of the database with enabled Query Store within SQL Server Management Studio there is a section named Query Store. This section contains several reports, presenting information from the Query Store [5].

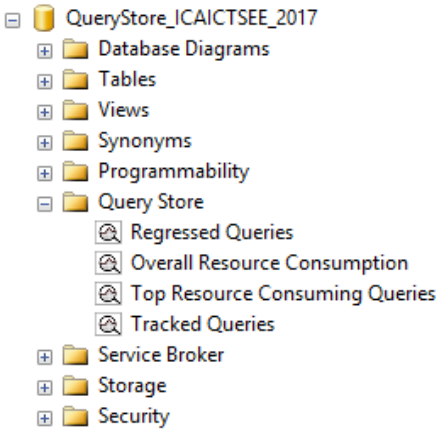

Fig. 7. Query Store Reports

As it shows, the query store has four reports. All reports can be configured according user's needs [4, 6]:

- **"Regressed Queries" report**

This report can be used to identify all queries which execution metrics have been degraded in the time period of interest (last hour, day, week, etc.). The Regressed Queries pane shows the queries and plans in the Query Store in different selected formats (grid, chart, etc.).

There are drop down boxes in this built-in report for selecting queries based on various criteria, metrics and statistics. Except in grid and chart format, each execution plan can be selected and seen in graphical view.

This built-in report is not only a view of Query Store data, this report also can be used for forcing and unforcing a query execution plan.

Also, different execution plans for the same query can be viewed and compared.

- **"Overall Resource Consumption" report**

This report shows the overall resource consumption during the configured time interval in 7 charts, if so configured: CPU time, duration, execution count, logical reads, logical writes, memory consumption and physical reads. All the query-runtime statistics of those queries that have been executed within the specific time interval are aggregated to give an overview of the query performance.

- **"Top Resource Consuming Queries" report**

As the name says, this report shows the queries that are consuming most of the resources, like most of CPU or the queries that are taking more time to finish the execution (elapsed time), or still the ones that are consuming more memory, or top logical reads, writes and even physical reads.

This report shows the most expensive queries, based on custom selection criteria that were executed during a specific time interval.

Although the workload may generate thousands of queries, typically only a handful of them use most of the system resources and therefore require attention.

- **"Tracked Queries" report**

With this report it is possible to monitor a specific query. It must be filtered using the query ID and for filtered one it shows the runtime statistics for query execution, and allows to inspect the various Execution Plans.

3. Dynamic Management Views (DMV)

Query Store works as a flight data recorder constantly collecting compile and runtime information related to the queries and plans. Query related data is persisted in the internal tables and presented to users through a set of views.

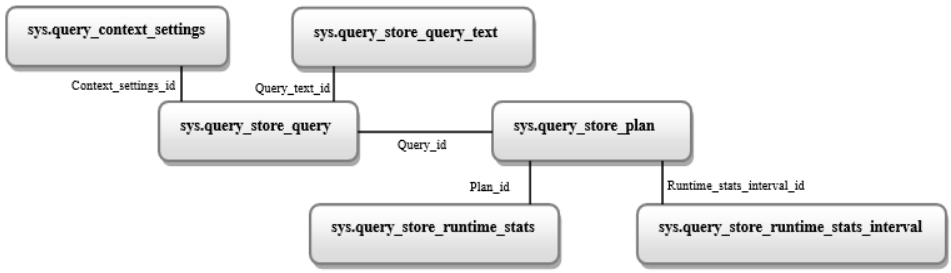

Fig. 8. Query Store DMV relations

Query store Catalog Views can be divided into 2 groups: Plan Store and Runtime Stats Store.

Plan Store is accountable for capturing all information that is related to query compilation.

Runtime Stats Store is probably the most frequently updated store. These statistics represent query execution data.

Each store has a set of DMVs that represents the idea of the store:

Plan store DMVs:

- sys.query_store_query_text – Presents unique query texts executed against the database.
- sys.query_store_plan – Presents estimated plan for the query with the compile time statistics.
- sys.query_context_settings – Presents unique combinations of plan affecting settings under which queries are executed.
- sys.query_store_query – Query entries that are tracked and forced separately in the Query Store.

Run-time stats store DMVs:

- sys.query_store_runtime_stats_interval – Query Store divides time into automatically generated time intervals and stores aggregated statistics on that interval for every executed plan.
- sys.query_store_runtime_stats – Aggregated runtime statistics for executed plans.

There is another view - sys.database_query_store_options, that does not hold any query-related information. It returns the Query Store configuration options and their settings for the specific database.

4. Custom reporting

The built-in Query Store reports that Microsoft has proposed are dynamic and flexible. They can be configured in different ways in order to be most suitable for database administrators. But sometimes the database administrators need to develop customized reports for even greater convenience.

Perhaps this is one of the reasons Microsoft has allowed accessing all the information inside the Query Store through Dynamic Management Views (DMVs). These views are opening the door for custom reporting for users who would like to get another view of the gathered data.

Custom reporting can be made in several directions. Sometimes the necessary information also can be accessed with some of the four built-in reports, but with more clicks and drilling down. That's why it is one direction to work - creating reports with a different view of data than the built-in reports using Query Store, or to develop a report that visualizes data as a combination of existing views.

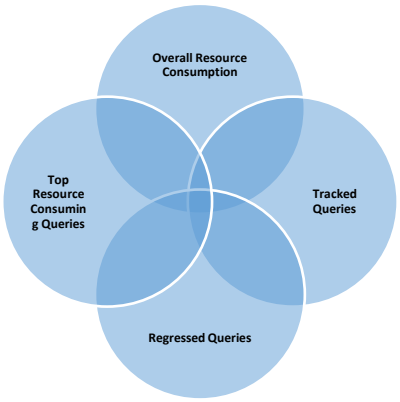

Fig. 9. Custom reporting using combination of Query Store built-in reports

Another direction for developing reports can be using Query Store DMVs combined with data from other system views and system tables, even with other databases.

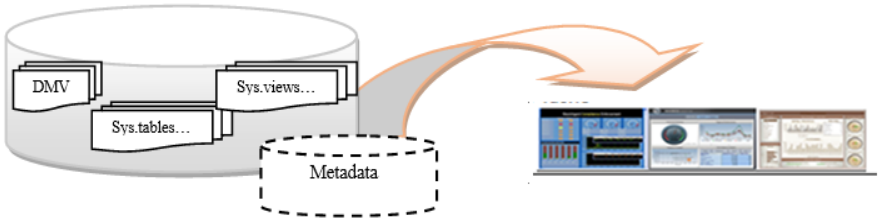

Fig. 10 Custom reporting using Query Store, system tables, views and other databases

In addition to the top consuming queries and their execution plans, it would be interesting to be able to monitor on a dashboard, the data sources of these queries, and their number of rows.

This would be possible using previous researches which consists ideas for describing some metadata of the sql queries with performance issues in a separate database. It is about characteristics as bottlenecks of a query, timeout thresholds, data sources for particular query, etc. [7] Thus, for example, information about troubleshooting the query performance and changing the various metrics over time against to the data sources for these queries could be gathered together in one report.

For example, the data for the rows number for different objects in the database can be accessed again through system tables and views, and there is sufficient data collateral from this point of view.

Also, all of this would be interesting if we apply it to all databases on the server. In a such customized report, filtering on a selected database would be advantage. In general, ensuring a powerful filtering would be a good idea for this type of dashboard.

If we would like to import a custom developed report into Sql Server Management Studio (SSMS), we have to use Reporting Services report (.rdl). Of course, given that Query Store data can be accessed through system views, many other technologies can be used to develop Query Store reports.

5. Conclusion

The problem of query monitoring and optimization has been a current topic in recently because the need for a solution is recognized in more and more business areas. It is important to have a good dashboard for database performance monitoring in order to identify potential risk areas for improvement.

The current paper reviews possibilities for creating custom reports using Query Store and in summary, guidelines of custom reports for query performance monitoring are outlined.

A literature review for Query Store built-in reports and their data sources is briefly presented.

As for future work, the author intends to develop and present a dashboard using the concept of this paper.

Acknowledgment

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Analysis and Problems Using Enterprise Mobility Management Systems

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Abstract: The paper reviews current trends in Enterprise Mobility Management platforms. Evolution of Enterprise Mobility Management (EMM) systems is mentioned. Marked are strengths and weaknesses of the solution. Different platforms are analyzed.

Keywords: Enterprise Mobility Management, Mobile Device Management, Communication, Networking, Mobility

1. Introduction

In recent years, the use of mobile devices, at work and at home, has been increasing dramatically. The workplace is becoming less and less connected to a physical office (working place). The desire of businesses to increase the productivity and mobility of their employees, requires the use of mobile devices (laptops, tablets, smart phones). Businesses have two options:

- Support the BYOD (Bring Your Own Device) policy, which allows employees to use their personal mobile devices at work;
- Supply mobile devices to the employees.

Whether BYOD or using company devices the information security should be reorganized to suits the new requirements. Turning a mobile device into a protected resource for business applications is a complex task and this will be the main topic of the paper.

2. Enterprise Mobility Management (EMM)

EMM [1] solutions allow a business to remotely configure and manage devices through Mobile Device Management (MDM) and Mobile Application Management (MAM).

MDM platform enables tracking, managing, and securing an employee or corporate-owned device. Each device and employee have a profile that is created for them and their specific tasks. An MDM solution means a business can configure network and storage access of mobile devices (Wi-Fi, Bluetooth, 3G/4G, GPS, etc.). MDM also enables the IT department can remotely lock and wipe a device if it's lost or stolen.

Mobile Application Management (MAM) [1] solution that limited the management and control of business applications. MAM helps in creating an enterprise application store and pushing or updating necessary applications on business devices remotely.

EMM platforms including both MDM and MAM provide an instrument for managing mobile devices in the following directions (Figure 1):

- Policy management;
- Application management;
- Security management;
- Device management;

• Service Management.

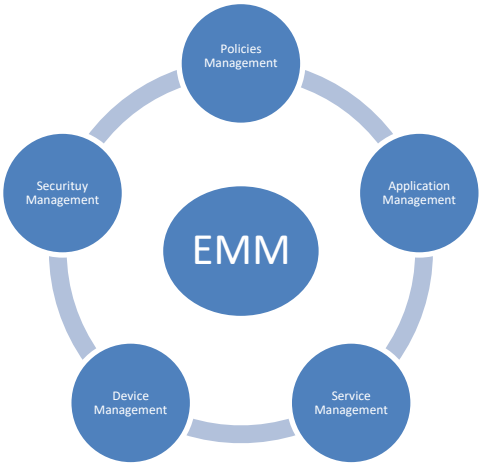

Fig. 1. EMM architecture

3. EMM platforms

Based on the Gartner [2] and Forrester [3] research in 2017, leaders in the development of such platforms are: VMware, IBM, BlackBerry and MobileIron.

a. VMware AirWatch

VMware is well-known for its server virtualization technologies but is also a major vendor in the EMM field [4]. VMware has been active in EMM since 2014, when it acquired Atlanta-based AirWatch. AirWatch was founded in 2003. AirWatch, combines enterprise mobility management with identity and digital workspace capabilities. VMware's product [5] is distinct at several levels, including its broad support for traditional and emerging endpoints, such as ChromeOS and smart glasses, and its unification of virtual applications with native, SaaS, and web applications in a single enterprise app. store, enabled with single sign-on (SSO) [3]. VMware bundles AirWatch in five different suites based on the business needs. VMware pushes its product ahead to what Gartner [6] calls UEM (Unified Endpoint Management) which allows endpoints, whether iOS or Windows 10, to be managed from a single console, making life easier for administrators.

3.2 MobileIron

MobileIron [4] was founded in 2007 and is publicly traded on the NASDAQ under the symbol MOBL since 2014. MobileIron is a solution for customers with stringent security and compliance requirements. The platform includes security and compliance certifications, such as Common Criteria MDM PP V2, EU Privacy Shield, and FedRAMP [7], which has helped it win customers in highly regulated environments. MobileIron's Access and Tunnel products provide secure connectivity to cloud and on-premises resources [3]. MobileIron has achieved wide adoption rates among enterprises as a single integration point for mobile policies "due to its broad integration capabilities with third-party infrastructure components, such as certificate authorities, security information and event management (SIEM), network access controls

(NACs), mobile threat defense tools and the AppConfig ecosystem," according to Gartner [6]. MobileIron is the only stand-alone EMM in the Leaders Quadrant [2].

3.3 BlackBerry

BlackBerry's EMM technology was gained through the acquisition of MDM vendor Good Technology in November 2015. BlackBerry integrated their EMM with BlackBerry Enterprise Server (BES) [6]. BlackBerry continues to win large enterprise customers in highly regulated industries due to its secure [3] VPN-less connectivity technology and the strong security capabilities. BlackBerry is the only one on the market to receive Common Criteria EAL4+ certification. BlackBerry lacks the advanced management and software delivery capabilities of its competitors. Blackberry pointed next step with achieve managing not only mobile devices but PCs, Macs and Internet of Things (IoT) as well.

3.4 IBM MaaS 360

IBM entered the EMM market in 2013. A core differentiator for IBM is its cognitive approach, powered by the IBM Watson system. The IBM MaaS360 with Watson capability adds machine learning and artificial intelligence insights to mobile user behavior [4]. IBM uses "better together" strategy, in which a specific IBM product leverages other parts of the vendor's portfolio [6]. In the case of EMM, IBM's MaaS360 cloud-based solution can leverage IBM's cloud access security broker (CASB) as well as Watson Analytics for cognitive insights to help IT managers understand their environments. IBM is one of the vendors to provide native mobile threat detection (MTD) in its solution [3]. Maas360's Insights Advisor leverages Watson to help administrators identify and take action against newly discovered threats, such as malware or out-of-date software. However, IBM offers the solution in the cloud only, which would exclude customers that want to deploy EMM in their own data centers.

4. EMM problems

Despite the numerous positive and useful features, some companies do not invest in mobile device management software because it is costly. But there are also some gaps that mobile device management software cannot address [8]:

- Companies may have more stringent security requirements than an EMM system can support; for example, some organizations may not want any data to leave their control, but EMM cannot always prevent data leakage via cloud services or other means.
- Some VPN implementations only secure partially the device's network communications.
- The piece of software installed on the mobile device (the EMM agent) is not sophisticated enough to fend off all attacks because device and OS manufacturers do not provide EMM vendors with all the code necessary to totally manage devices, different device and OS makers provide different levels of EMM access.
- EMM providers experience problems providing support for new operating systems as quickly as those OSes come out.
- Application management features could be weak. For example, some EMM products lack a proper test environment for company-developed applications.
- There are different MAM techniques implementing application management [9] but there are always tradeoffs, and all techniques (including app wrapping, SDKs, device-based frameworks, and the AppConfig approach) have their own strengths and weaknesses.

5. Conclusions

Despite the problems of EMM Platforms business shows that will rely on such solution and will expect the development of new features. The transition from EMM to unified endpoint management (UEM) is already in progress and vendors already started releasing platforms with single point of management of variety of devices (computers, laptops, tablets, smart phones etc.) next step will be to add in the managed device specter, the IoT devices (gateways and sensors). But the bottom line is that mobile device management software is necessity for companies that want to encourage more productivity and provide an appropriate level of security for their employees.

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Creation of a Platform for a Smart Beehive Management

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Abstract. The paper presents an approach for the creation and development of a system for tracking the parameters of a beehive. It describes the architecture of the proposed system, its hardware and software. The paper also reviews the usefulness and the advantages of the producers in the bee sector. An analysis is carried out of the future development of the system.

Keywords. Smart beehive, IoT platform development, IoT applications.

1. Introduction

There are two versions of quotes attributed to the great physicist Albert Einstein in regard to the importance of bees for the world: "If the bee disappeared off the surface of the globe then man would only have four years of life left. No more bees, no more pollination, no more plants, no more animals, no more man.", and "If the bee disappears from the surface of the earth, man would have no more than four years to live" [1].

There has been a serious concern about the declining bee populations, due to use of pesticides and economic reasons [2]. Whatever the roots and reasons for alarms are, it is certain that helping the professional and amateur beekeepers in business, by means of technological innovations, will help the preservation and even can increase the bee population.

The purpose of this paper is to present a non-expensive and easy to create platform for beehive management.

2. Reasoning and Support for Beehive Management

Keeping the bee colony healthy is the most important task of beekeepers. They have to keep track of the health of their bees, to monitor their behavior, to improve their productivity and to minimize the costs for all that. Until recently, all such activities have been carried out in a manual way, using measuring equipment to determine important factors like temperature and humidity inside the beehives. In the last couple of years, with the advance, widespread and affordable prices of sensor technologies and microcontrollers, digital hive monitoring became available. There are numerous examples of both research and commercial products [3], [4], [5], [6]. We have taken an approach of our own, not using another system as an example, but rather developing a system of our own with hardware and software basis, available to us.

The system for temperature and humidity (with an easy possible extension for other parameters) helps remote beehive monitoring, which reduces the stress for the bees during the opening and supervision of the beehive. On the basis of those parameters, the beekeepers can watch the conditions for each family, especially in winter. Then, when necessary, additional supplies can be given to those bees, which need it and at the same time, the system will prevent loss of energy of the insects during opening of the beehive. One of the most important impacts of such system is that the beekeeping changes from calendar driven (beekeepers acted on the

basis of what should be happening according to their calendar experience) to data and event driven management.

There are various proposal in various applications of how to connect sensors (in a wired or wireless manner), how to process and transmit data (at site or remotely). Our team had to take into consideration an approach that fits the environment, where the smart beehive management is to be employed.

3. Approaches for Smart Beehive Management

Several approaches for environment monitoring in hives and data processing from it have been considered.

The easiest solution is to place sensors inside a beehive with a microcontroller, and to mount a display at the outside, that can be used by people to read data on the conditions in the beehive (thus preventing the stress for bees of opening the hive). This very simple approach has the disadvantage that people have to visit each (or each group) hive by themselves on regular basis.

Another way is to incorporate a wired (e.g. Ethernet) or wireless (e.g. 802.11) network with the microcontroller, linked to a local (at site) computer, where the information on the environment in the hives is collected. In regard to further data processing, the computer can handle data and then send them (or important information) over Internet. This is a case, suitable for places with Internet connection at the site but no conditions to handle data in more complex manner (see Figure 1). If such conditions exist, data can be gathered, analyzed and archived and also sent remotely to the place, where the beekeeper resides.

A third approach is to create a sensor network, with nodes connected to the microcontrollers and sensors, sending data to another node, designated as coordinator, from where all data is sent via mobile network to a remote site (see Figure 2).

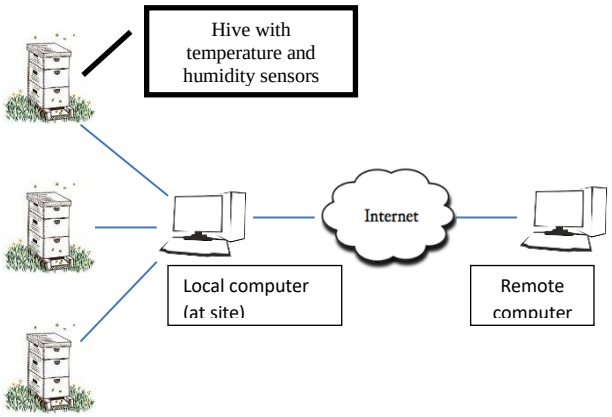

Fig. 1. Beehive management architecture with networked sensors and a local computer.

There can be variations of those approaches, some of which are given in [5]. Due to the fact, that there is a good mobile connection at the place the system is going to be built, but no Internet access exists, we opted for the third approach. It has been also considered, that other types of applications, where mobile phone coverage exist and no Internet provider at the site, the same architecture can be implemented.

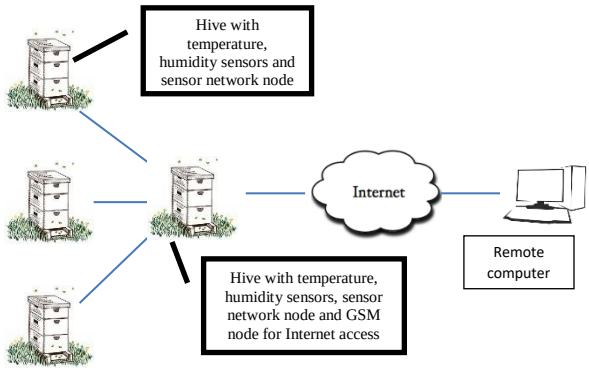

Fig. 2. Beehive management architecture with sensor network and no local computer.

4. Implementation of the Smart Beehive Model

To implement the proposed approach, the team discussed possible hardware and software options and decided to use the following components:

- Sensors – modules DHT-22 and Si 7021, capable of measuring temperature and humidity;
- Microcontrollers (main processing elements) – Arduino Pro mini;
- Sensor network – Xbee;
- GSM module - Adafruit Fona.

The choice of the microcontroller was made because of its very small size and low power requirements, both of which are convenient for remote outdoor use. The Xbee sensor network was selected due to its simple operation, free license and also low power requirement. Both boards use 3.3 V power supply, which makes the modules with very low power consumptions. Breakout modules were needed for loading the code into the controllers.

The team had no previous experience with those sensors and modules, so soldering the Arduino Pro mini with the sensors and Xbee modules, and running the code on them was an important learning experience. The setting of the Xbee network was with one coordinator and four nodes. At all places with monitoring, there are Arduino Pro mini boards and humidity and temperature sensors. The Arduino boards control the work of the sensors and sending the proper data via the Xbee network. The coordinator receives data from all other nodes, passes it to the Arduino board, which also fetches data from the humidity and temperature sensor, attached to it. Having collected data from all five beehives, the Adafruit Fona module sends them to a remote site – it is used as a gateway to Internet. To configure Xbee sensor network we use the DIGI XCTU free multi-platform application [7]. With it one can manage Xbee modules through a simple graphical interface. The software allows to:

Discover the modules – automatically discovers local and remote radio (Xbee) modules connected to the PC; *configure* any module – manages and configures multiple Radio Frequency (RF) devices, including remote devices communicating over the air; *communicate* with modules – uses command consoles to communicate with the radio modules and records console sessions and loads them at any time; *explore* the network – visualize the topology of the RF network, displaying all network nodes and connections graphically or in a table, and *access* a range tools – use embedded tools to perform operations, from recovering modules to performing range test.

In the coming months we are planning to develop a desktop application, web site, database and analytical platform to collect, store data from the beehives, and to make decisions based on that data. We are also aiming at making strategic analysis after collecting long term data. The platform can also be used by other experts and students for all other kind of experiments.

5. Conclusion

The smart beehive management system was entirely developed by the team working for the UNWE project and allowed the participants to learn a lot on IoT applications, and to develop skills of working with Arduino, various sensors and a sensor networks like Xbee. The system is also open to enhancement – for example, a module for the weight of the hive can be easily added with no other change in the architecture. Another possible measurement which can be added is for check whether the hive has fallen or not, so the beekeeper can quickly react to restore its position and minimize the loss of bees, and possible loss of the queen bee.

The options for the enhancement of the system mentioned above are not the only advantages, which it has. A very similar system can be used in logistics, where such (or similar) modules can be attached to containers or storages with goods that require certain temperature and humidity limits.

Acknowledgement

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Cleaning Data with Cloud Based Platform Toolsets

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Abstract. The paper reviews current opportunities and tools for Cloud based big data processing. Three cloud-based data processing platforms are explored namely Amazon Web Services (AWS), Google Cloud Platform (GCP) and Microsoft Azure Cloud and their approach to import and process big sets of data. Follows analysis and comparison of the approaches used**.**

Keywords. Data cleaning, Cloud services, Big data, Scientific data

1. Introduction

Despite the fact that cloud computing has been around since the turn of the millennium it is still developing and growing rapidly and in various directions. It is worth mentioning that a decade ago Oracle CEO Larry Ellison even called it “complete gibberish” and “insane”[1]. Few years later, around 2012, the business trends showed clearly that cloud computing is indeed here to stay and expand in future.

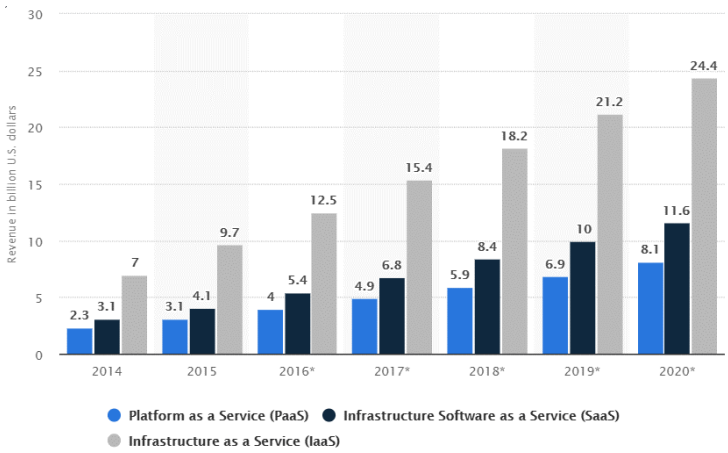

Fig. 1. Expected cloud market revenue growth.

Oracle, along with other industry giants like Google, Amazon and Microsoft embraced the initiative and started serious investments in cloud computing. As shown in Figure 1, the portfolio of the cloud market grows rapidly not only vertically but also horizontally by adding additional services like Platform as a Service (PaaS), Software as a Service (SaaS) and Infrastructure as a Service (IaaS) [2]. Currently a quick look at the companies providing cloud services reveals, without being exhausting, following main players - Amazon Web Services,

Microsoft Azure Cloud, Google Cloud Platform, Oracle Cloud Platform, IBM Cloud, The Salesforce Platform, SAP Cloud Platform, Heroku, OpenStack, etc.[3].

Microsoft Azure Cloud, Amazon Web Services (AWS) and Google Cloud Platform (GCP) have been chosen for this paper as Amazon, Google and Microsoft are among the leaders in the IT world and have solid cloud offerings. On top of that, there are free subscriptions for test drives of the platforms which makes them perfect to serve the purpose for cloud platform comparison.

2. Google Cloud Platform

Google Cloud Platform (GCP) has been released by Google in late 2011 [4]. The platform is written in Java, Python, Go and Ruby. It presents cloud computing services like computing engine with virtual machines, storage and databases, networking, big data, data transfer, security, developer tools, IoT and others. GCP runs on the infrastructure, used by Google for products like Google Search and YouTube [4]. Some of the Google products in the platform providing the most popular services are: Google Compute Engine, Google App Engine, Google Kubernetes Engine, Google Cloud Bigtable, Google BigQuery, Google Cloud Functions, Google Cloud Datastore, Google Storage, etc.

Fig. 2. Google cloud platform family.

Registering for GCP is an easy and fast process. Even more so, if you already have a Google account. GCP usage during the first year is free of charge.

Once registered into GCP, one can start exploring it right away and using the vast amount of available services. For test purposes, comma separated values (csv) file with size of 334MB, containing tabular data for 538 184 European tenders, held in 2016 [5], were prepared and imported after tuning in GCP SQL instance. After successful import, cloud platform interface was used to export data as SQL dump in a specifically designed bucket (cloud data storage). A screenshot of SQL instance, running with some real data for SQL queries along with CPU and memory footprint is given in Figure 3.

Microsoft Azure Cloud

Microsoft Azure is a cloud computing service created by Microsoft for building, testing, deploying, and managing applications and services [6] through a global network of Microsoft-managed data centers – Figure 4. It provides Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) and supports many different programming languages, tools and frameworks, including both Microsoft-specific and third-party software and systems (including Linux). Azure has been announced in 2008 and released in 2010 [7].

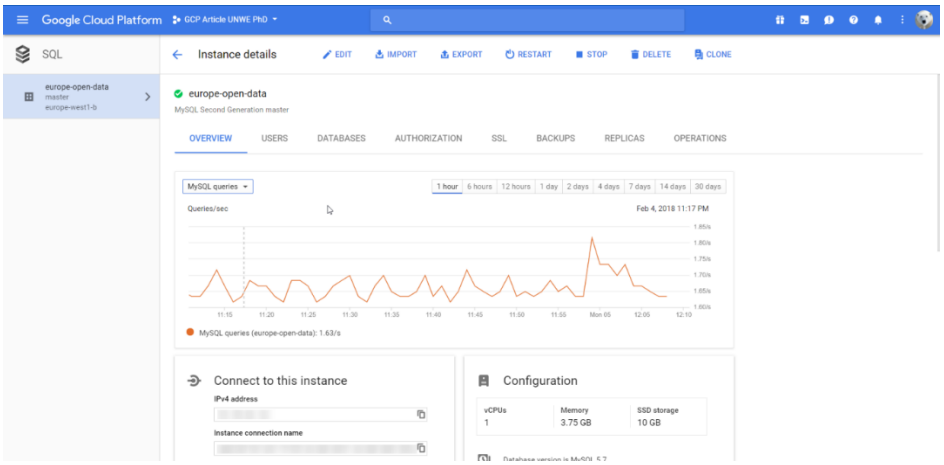

Fig. 3. CPG SQL instance real data.

Fig. 4. Microsoft Azure Cloud.

Registering for Microsoft is also an easy and quick process. Even more so, if you already have a Microsoft ID, Azure cloud also offers free usage during the first year after registration.

Once registered into Azure, one can start right away exploring and using the available cloud services. There is, however a catch. Azure cloud services, even for the free accounts, which are limited to 30 days only compared to 1 year for GCP and AWS, are linked with Azure marketplace and costs can really escalate fast, unless great amount of attention is paid to each and every action and associated fine print. For example, dashboard shown on Figure 5 is not included in Azure free trial and comes at additional cost as CLEARDB add-in bough from marketplace. Creating SQL instance and importing data into it is requires more efforts than those needed for similar results with GCP SQL instance.

Database instance is not automatically linked to Azure command line interface console and additional tools have to be used in order to connect to the created DB instance. For example, HeidiSQL (graphical SQL tool now part of MariaDB distro) was used to import SQL dump from GCP into Azure MySQL instance – Figure 6.

Fig. 5. Performance of Azure MySQL DB using CLEARDB from marketplace.

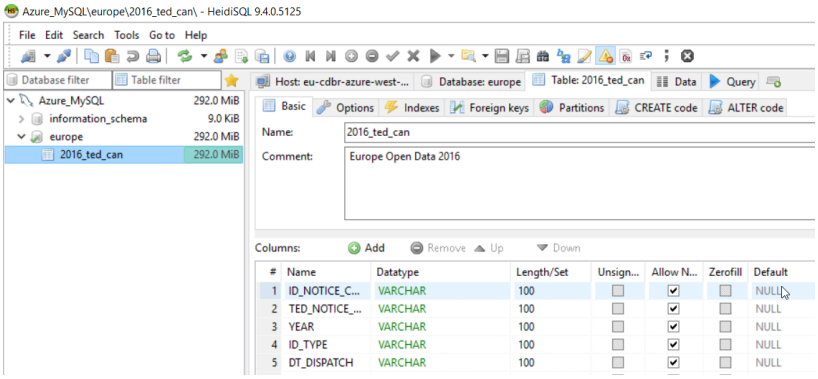

Fig. 6. Imported GCP MariaDB SQL dump into Azure MySQL instance.

3. Amazon Web Services (AWS)

Amazon Web Services (AWS) is a subsidiary of Amazon.com that provides on-demand cloud computing platforms to individuals, companies and governments, on a paid subscription basis [8]. The technology allows subscribers to have at their disposal a full-fledged virtual cluster of computers, available all the time, through Internet. AWS's version of virtual computers have most of the attributes of a real computer including hardware (CPU(s) & GPU(s) for processing, local/RAM memory, hard-disk/SSD storage); a choice of operating system; networking; and pre-loaded application software such as web servers, databases, CRM, etc. – Figure 7. Each AWS system also virtualizes its console I/O (keyboard, display,

and mouse), allowing AWS subscribers to connect to their AWS system using a modern browser. AWS was launched in 2006.

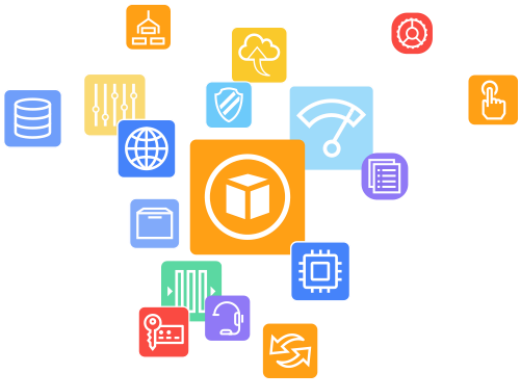

Fig. 7.Amazon Web Services (AWS).

Registering for Amazon Web Services is as quick and easy as with GCP and Azure. First-time users typically do not have an earlier Amazon account via which to streamline the process, even if the person possesses registration for Amazon shopping platform. Both accounts are distinct and do not relate to each other. AWS provides free one-year subscription like Google

Unlike the other platforms reviewed above, AWS requires dual authentication and one-time passwords (OTP). This adds one more level of security, needed to access the cloud platform and the data within, but requires additional software installed on your computer and/or smartphone.

There are different options for DB engines like NoSQL DynamoDB and Aurora DB proprietary for Amazon and offering performance at affordable prices. However, the best DB engine reviewed for the purpose of this paper and cost free was found out to be the MySQL relational database management system MariaDB. Creating an instance of MariaDB is a straightforward process in AWS, using the web interface of the platform. Connecting to it is not so easy task as it was with GCP because AWS lacks embedded console giving convenient access to the under laying OS and mysql command line interface. Additional tools needed to be installed - like the HeidiSQL tool (now part of MariaDB distro) and then point them to connect to GCP instance, export Europe DB as SQL export file and use HeidiSQL to import data into AWS MariaDB instance – Figure 8.

During and after data import via HeidiSQL tool it is interesting to monitor AWS dashboard and see how resources usage is dynamically changed – Figure 9.

Comparison and comments

Table 1 represents the findings of the main features and tools used during DB instances test drive of AWS, Azure and GCP.

It is worth mentioning that while all three cloud platforms – AWS, Azure and GCP - provide comparable database tools and utilities as DB engines available, they are not fully interchangeable as some of the features available in one platform are not always available in

the others. Also, efforts to connect to, import and export data into DB instances are different and sometimes additional software and computing power is required to accomplish those activities.

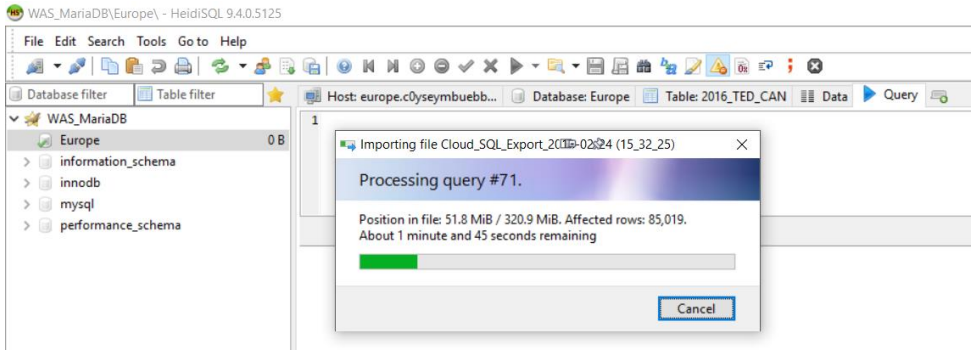

Fig. 8. Importing data into AWS MariaDB.

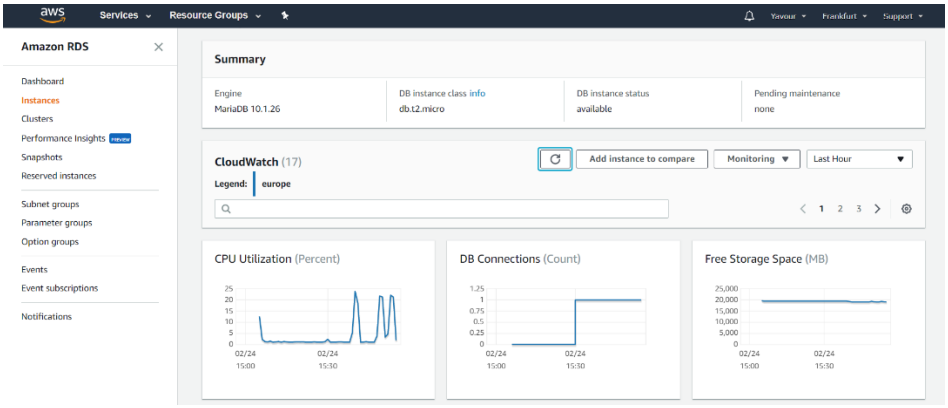

Fig. 9. AWS dashboard resources utilization - CPU, DB connections and Storage.

Table 1. Tools and features of AWS, Azure and GCP.

Cloud platform	Free trial (days)	Free DB engines used	Free DB Dasboards	Intuitive GUI	DB CLI console
AWS	365	MySQL, MariaDB	Yes	Yes	No
Azure	30	MySQL, MariaDB	No (paid)	No	No
GCP	365	MySQL, MariaDB	Yes	Yes	Yes

4. Conclusion

I have chosen the three most popular and well-established cloud platforms so that I can compare their current portfolios and specifically abilities for big data processing and thus lay a solid foundation for future cloud processing researches including IoT data transmission, processing and storage. MySQL and MariaDB DB engines were used for importing predefined set of data [8] into each cloud platform. Azure and AWS are easy to use and offer free trials, have nice interfaces and provide robust documentation. Same applies for Google Cloud Platform and based on all tests conducted and information collected and compared Google Cloud Platform seems to have edge over other two platforms because:

- it provides intuitive well designed and linked interface for data processing;
- it provides dashboards for easy monitoring and cost planning for data processing;
- there are no hidden costs for trial period;
- everything can be accomplished using only the platform itself.

Based on our experiments described above, our choice for test research fells on GCP. We shall continue experiments with those platforms and investigate further in what way they meet various customer requirements.

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Main Design Stages of Key Performance Indicators

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Abstract: An organization's ability to manage its performance is of essential importance for its future development. Monitoring the key performance indicators (KPIs) is a crucial part of the performance management. Many organizations use KPIs without preparation and analysis; this leads to disappointing effectiveness of the KPI implementation. The paper reviews the main stages of developing and implementing a KPI system. The activities on different levels of management, from the executive level down to low level managers are considered. The design process includes also mapping of KPIs to the balanced-scorecard perspectives.

Keywords: Key performance indicators, Business performance management, Balanced-scorecard.

1. Introduction

Key performance indicators (KPIs) are a powerful performance management tool. They are instruments to measure the results of an organization. The KPI system specifies what has to be measured and how has to be estimated the result of the measurement. A KPI system must state clearly the goals of the organization and indicate some activities, which could help to achieve those goals. Many organizations use KPIs without preparation and essential analysis; the link between KPIs and managers' activities is missing and this leads to disappointing effectiveness of the KPIs.

There are a lot of recommendations and requirements for KPIs implementation, but very few studies on how the KPI development has to be organized step-by-step. David Parmenter (2010, 2015) describes a detailed KPI development methodology. The prime focus of his methodology is the role of the managers. The purpose of this paper is to explore how a manager-centered methodology, as the one presented by Parmenter (2010, 2015), can be helpful for understanding the activities related to the development of a KPI system from an IT perspective.

2. The Development of a KPI System from an IT Perspective

Parmenter (2010) describes a development process that contains 12 steps and gives many concrete recommendations and checklists for each step. The methodology considers the case of big organizations, where the development of KPI system could take 20-30 weeks. In the 3rd edition of the book, Parmenter (2015) proposes a 6-stage methodology, which is focused on small and middle organizations, and the development of KPI system would take 6-8 weeks. The new model incorporates the twelve steps development process in a six-stage process.

Parmenter gives detail recommendations of what the managers have to do during the development of the KPI system; he provides even checklists for the tasks included in any of

the steps. But this methodology does not consider the technical implementation of the KPI system.

Table 1.

Six stage methodology for KPI development in small organizations (Parmenter, 2015)	Twelve-step methodology for KPI development in big organizations (Parmenter, 2010)
S1. "Getting the CEO and senior management committed to the change"	**Step 1** "*Senior Management Team Commitment".* **Step 4** "*Establishing a Just-Do-It Culture and Process".*
S2. "Up-skill in-house resources to manage the KPI project"	**Step 2** "*Establishing a Winning KPI Team*". **Step 3** "*Establishing a Just-Do-It Culture and Process".*
S3. "Leading and selling the change"	**Step 5**. "*Marketing the KPI System to All Employees"*
S4. "Finding your organization's operational critical success factors"	**Step 6**. "*Identifying Organization-wide Critical Success Factors"*
S5. "Determining measures that will work in your organization"	**Step 7**. *"Recording Performance Measures in a Database"* **Step 8**. *"Selecting Team-Level Performance Measures"* **Step 9**. *"Selecting Organizational Winning KPIs"*
S6. "Get the measures to drive performance"	**Step 10**. "*Developing the Reporting Framework at All Levels"* **Step 11**. *"Facilitating the Use of Winning KPIs"* **Step 12**. *"Refining KPIs to Maintain Their Relevance"*

The development of a modern KPI system needs a methodology where the focus of attention is the technical implementation: How is the KPI systems integrated in the corporative information system? How is the design of the KPI system realized with the tools of Business Intelligence (BI) systems as Tableau, Microsoft BI, or IBM Cognos BI? How is the KPI database organized?

The life cycle of a KPI system (that is not composed of manually prepared paper reports) could be considered to be going through the typical software development life cycle stages:

Analysis→Design→Implementation→Testing→Deployment→ Maintenance

The presented life cycle will be referred to as the "IT perspective" of KPI systems development in this paper. It gives us a framework in which we have to 'translate' the manager-centered methodology.

From the IT perspective, the Parmenter's steps 1 to 5 belong to the stage of preliminary conceptual analysis and initiation of a software development project. Step 6 belongs to the phase of analysis. Parmenter's stage S5 "Determining measures that will work in your organization" (steps 7, 8, 9) cover the development of the KPI system as a software subsystem. Respectively, the activities on steps 7, 8, 9 and 10 have to be divided into (a) design, (b) implementation, and (c) testing activities. The last two steps (11 and 12) describe activities that are part of the deployment and maintenance.

Table 2.

'Life cycle' phases of the KPI system from an *IT perspective*	6 stages and 12 steps of the KPI development process from a *manager-centered perspective (Parmenter 2010, 2015)*											
	S1	**S2**		**S1**	**S3**	**S4**	**S5**			***S6***		
	1	2	3	4	5	6	7	8	9	10	11	12
Conception and initiation of KPI system development	+	+	+	+	+							
Analysis						+						
Design							**+**	**+**	**+**	**+**		
Implementation							**+**	**+**	**+**	**+**		
Testing							+	+	+	+		
Deployment and Maintenance					+					+	+	+

The Implementation phase traditionally includes the activities of coding and integration (connecting the new modules to the existing parts of the system). When the KPIs are designed in modern interactive systems like Tableau, Microsoft BI, IBM Cognos, there is no clear stage boundary between KPIs design and implementation. The interactive development tools realize automatically the coding and integration. In the case, the design phase overlaps with the implementation phase. (See table 2, in the bold rectangle is the scope of the design phase.)

3. The Agile Approach Applied to the Development of a KPI System

Could we include in the IT perspective recommendations about the team organization and the involvement of the managers in the KPI development process (Parmenter's steps 1 to 5)? These are "preliminary activities", i.e. activities which precede the development of the KPI system. The traditional IT approach takes as starting point the "analysis of requirements".

Agile methodology is often presented as an alternative way of life cycle management that stands in opposition to the more traditional software development models. The "*Manifesto for Agile Software Development"* (Beedle, van Bennekum, Cockburn, & Cunningham, 2007) contains only a few general claims: "Individuals and interactions over processes and tools", "Working software over comprehensive documentation", "Customer collaboration over contract negotiation", "Responding to change over following a plan". However, the implementation of the agile approach is filled with innovative ideas.

The first important characteristic of the agile methodology is the replacement of the traditional "*waterfall*" development process, where the development phases follow in a strict linear sequence and each stage finishes before the next one can begin. In contrast the agile methodology follows an iterative and incremental approach, where the deliverables of each iteration are prioritized by the business owners of the project.

The second important characteristic of the agile approach is that it requires an intensive interaction between the development team and the users. Applied to the development of a KPI systems, it means that the IT experts should be part of the initial phase of the KPIs development process - starting with conceptual analysis, building the KPI development team and defining the general vision of the new KPI system.

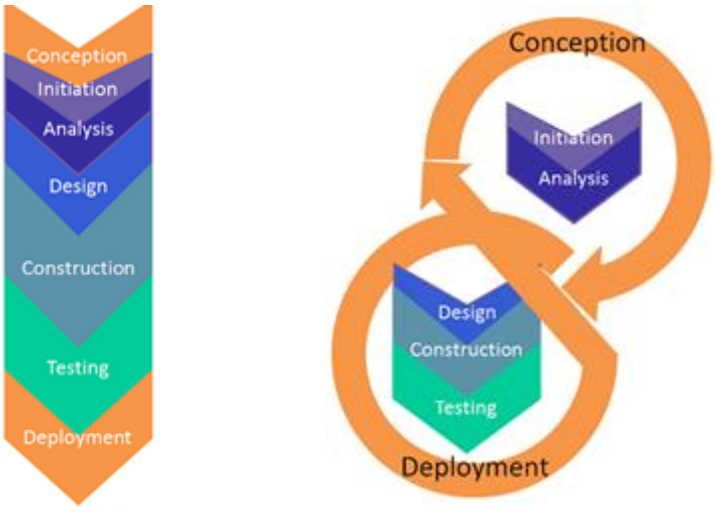

Fig 1. In the waterfall approach, the development process starts from the top, and does not move into the next stage of development until the previous one is completed. In contrast, in the agile approach, the overall development is broken into atomic components, and each component goes through the entire development cycle, repeating the process constantly. From (San Gil , 2014)

4. KPI System Design Stages

We could define four main design stages of a KPI system:

- ***Stage 1***. *Design of KPIs on top level of management*.
- ***Stage 2***. *Design of KPIs on lower levels of management*.
- ***Stage 3***. *Design of the database of the KPI system*.
- ***Stage 4***. *Design of performance dashboards and reports*.

Let's review some of the aspects of the first two stages - the design of KPI on the top level and on the lower levels of performance management, considered separated from the data acquisition and the visual presentation of the KPIs. These two stages have a central place in both perspectives – the manager-centered perspective and the IT perspective.

Stage 1. Design of KPIs for the top managers

From Critical Success Factors (CSFs) to KPIs

A precondition for the KPI design is the identification of the organization-wide critical success factors (CSFs), during the phase of analysis.

"*Critical success factors should be the source of all performance measures that really matter: the KPIs. It is the critical success factors and the performance measures within them that link daily activities to the organization's strategies."* Parmenter (2015, p. 113)

The definition of a KPI includes six components: 1) performance characteristic, which has to be measured and evaluated; 2) measurement period 3) unit of measure, 4) target value 5) estimation criteria for the actual values, 6) related actions aimed to move the measured characteristic toward the target value. The "To Do" section in the definition of KPI, is what transforms the KPI from merely collection of metrics to a performance management instrument.

Table 3. The definition of a KPI includes six components:
1) performance characteristic, which has to be measured and evaluated; 2) measurement period 3) unit of measure, 4) target value 5) evaluation criteria, 6) To Do.

Measured characteristics	Period of measure	Unit of measure	Target value	Evaluation rule (A - actual value)	**To Do:**
1	2	3	4	5	**6**
KPI 1 Sales amount	**Monthly**	Euro	50000	**Excellent (**A > 110%) **Good (**90%<A<110%) **Bad** (A < 90%)	**If Excellent**: ... **If Good**: … **If Bad**: …

Balanced Scorecard perspectives

Important requirement to the KPIs on the top level is that they have to cover all aspects of the performance of the organization. Robert Kaplan and David Norton's "The Balanced Scorecard: Translating Strategy into Action" proposes aspects of performance, which has to be evaluated by the KPIs. The balance scorecard, as it is originally defined, includes four perspectives. (1) Financial perspective (2) Customer focused perspective, (3) Internal business processes (4) Learning and growth. These four perspectives will be referred to as the classical perspectives of a balanced scorecard. However, the scorecard approach is not necessary restricted to just these perspectives. There could be other perspectives, which need to be considered as an essential part of for the performance of the organization, and which has to be included in the design in order to keep the balance between the different strategic goals of the organization. Parmenter (2015, p. 261) proposes six balanced-scorecard perspectives. He adds the following: "staff satisfaction" and "environment and community". All top level KPIs, must have essential impact on one or more of the performance perspectives included in the Balanced Scorecard (see table 4).

Table 4. Any KPI has impact on some of the aspects.
The impact quotient (Qi,j) could be between 1 and 0. KPI 1 ("monthly sales amount") has impact on the finance perspective, and does not have impact on the other performance perspectives included in the balanced scorecard.

KPIs	**Impact of the KPIs on the Balanced Scorecard perspectives**					
	classical				**additional**	
	Financial results	***Customer focus***	***Internal business processes***	***Learning and growth***	***Environment and community***	***Staff satisfaction***
	1	***2***	***3***	***4***	***5***	***6***
KPI 1	$Q_{1,1} = \mathbf{1}$	$Q_{1,2} = \mathbf{0}$	$Q_{1,3} = \mathbf{0}$	$Q_{1,4} = \mathbf{0}$	$Q_{1,5} = \mathbf{0}$	$Q_{1,6} = \mathbf{0}$
KPI 2	…	…	…	…	…	…
...						

Stage 2. Design of KPIs for the lower levels of management

The term 'lower levels' is used for all levels of management except the top-managers (the CEO and the members of the board of the organization). In many organizations it is useful to distinguish three tiers of management: Top management (*Tier 1*); the management of

business units, support units or departments (*Tier 2*); and management of teams (*Tier 3*). Respectively, the term 'lower levels' covers both Tier 2 and Tier 3.

We will distinguish three KPIs design approaches on lower levels: the top-down approach, the bottom-up approach and the combined approach.

Top-down, Bottom-Up and combined KPIs design approaches

According to the top-down approach, the design of KPIs on the lower levels is a process of "cascading" a balanced scorecard. A tutorial of the Balanced Scorecard Institute (2017) describes this process: "Cascading a balanced scorecard means to translate the corporate-wide scorecard (*Tier 1*) down to first business units, support units or departments (*Tier 2*) and then teams or individuals (*Tier 3*). The end result should be focus across all levels of the organization that is consistent."

According to the bottom-up approach, the lower-level managers could define new KPIs for a department, or a team, which are not derivative from the corporative scorecard.

The decentralized and centralized approaches are not equally effective on Tier 2 and Tier 3. On Tier 2, the managers of business units have to select KPIs which, on the one hand, summarize the results of the teams, on the other hand, roll up to high-level KPIs that ate included in the corporate-wide scorecard. The decentralized approach could be more appropriate for KPIs design on Tier 3 (team management).

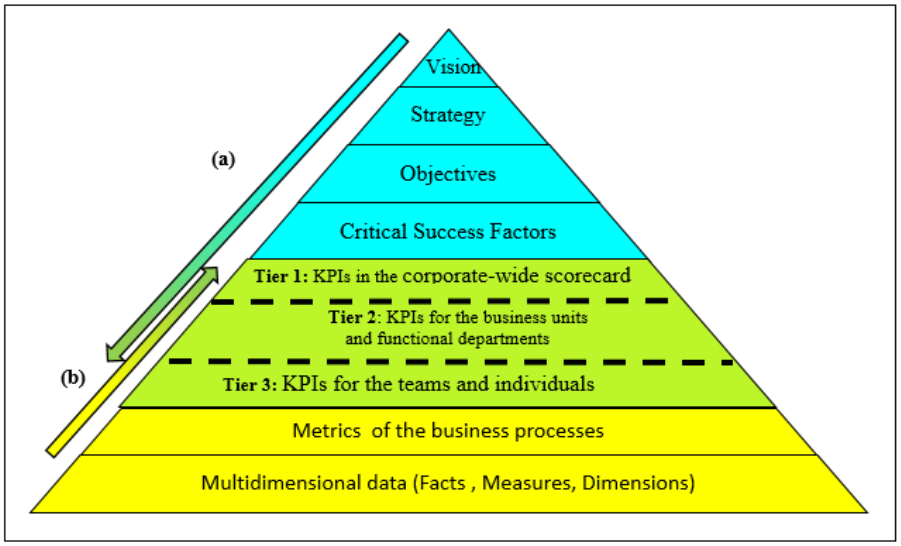

Fig. 2. The combined KPIs design approach. (a) The centralized, top-down approach is necessary for tier 1 KPIs (corporate-wide scorecard KPIs). (b) The decentralized, bottom-up approach dominates on tier 3, KPIs for the teams. Both approaches are appropriate for KPIs design on tier 2 (business units). (Lazarova, 2017) .

5. Conclusion

A manager-centered KPI system development methodology, as the Parmenter's one, and a methodology from an IT-perspective, based on the agile approach, have the same scope; both cover the full KPIs life cycle. However, the focus of attention of the first methodology is treated as a side task in the second one, and vice versa. Therefore we have to consider these methodologies as complementary.

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CASH, CARD or MOBILE payments

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Abstract. The report looks at current trends and changes in payment technologies, follows the emergence, development and prospects of various technological solutions for non-cash payments - through payment cards and mobile applications. Future developments of payment technologies and cash substitution with new payment methods are presented.

Keywords. Bank payment cards, mobile payment applications, forecasts for the future of payment technologies.

1. A brief history of money

Cash as a means of payment in trade have more than 2,000 years of history. And have always been the subject of perfection as a material form, ways of using, managing and storing. With the founding of the first banks in the 13th century in Italy, the banking system was launched as a fundamentally new way of cash management. In the 20th century, the development of the world economy and the need for more convenient payment methods stimulated banks to be the main initiator and investor of change and innovation.

Bank cards as a new and convenient payment instrument appeared in 1958 and gradually began to replace cash. The big change in bank cards began with the establishment in 1994 of enough secure smart cards - EMV technology, developed by the global payment operators Europay, Mastercard and Visa, and used by many banks - card issuers. As a continuation of this technology, projects for contactless EMV bank cards were launched in 2004.

Governments actively stimulate and support the development of non-cash payment technologies as a means of combating the gray economy, money laundering and terrorist financing.

Since 2013, there are new and very strong players on this market. The big players in mobile technologies Apple, Google and Samsung want to enter the payment services market by releasing their own Apple Pay, Android Pay and Samsung Pay apps. New technology companies have a focus on financial markets (fintech companies), various start-up companies offer and develop innovative ideas for payment technologies. It is certain that cash will gradually grow down, or even disappear in the longer term. The big question is - who will conquer the market in the coming years?

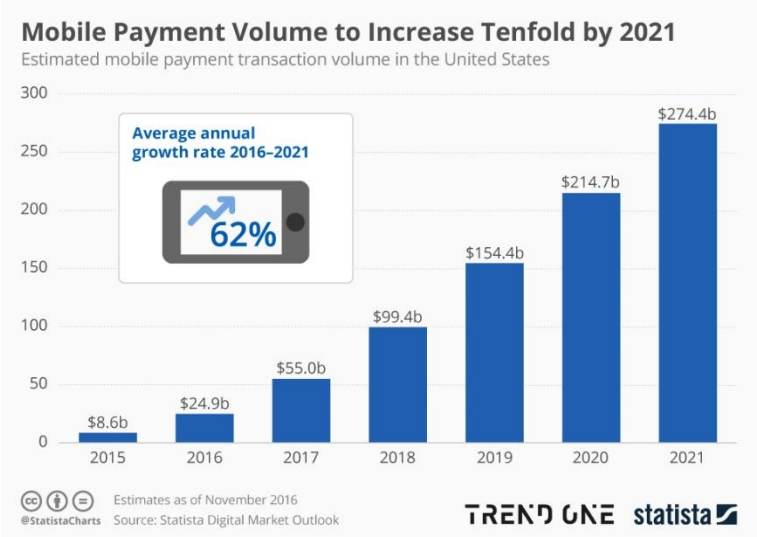
2. Bank cards or mobile phones

From the time that payment card was created and until a few years ago, card payment technology has not alternatives. The ATM and POS network quickly spread across the world and the cards became an integral part of the lives of industrialized nations. With a bank card, almost everything and almost everywhere can be paid. Safe, fast, and convenient. The number of cards increases stabile. The development of these opportunities has allowed many financial

companies with specific payment products to operate on the money market. In addition to the payment products of Visa and Mastercard global operators, more and more countries are creating their own national card payment systems. For example, already in Bulgaria since 2017 work a National card system that operates with its BCard brand.

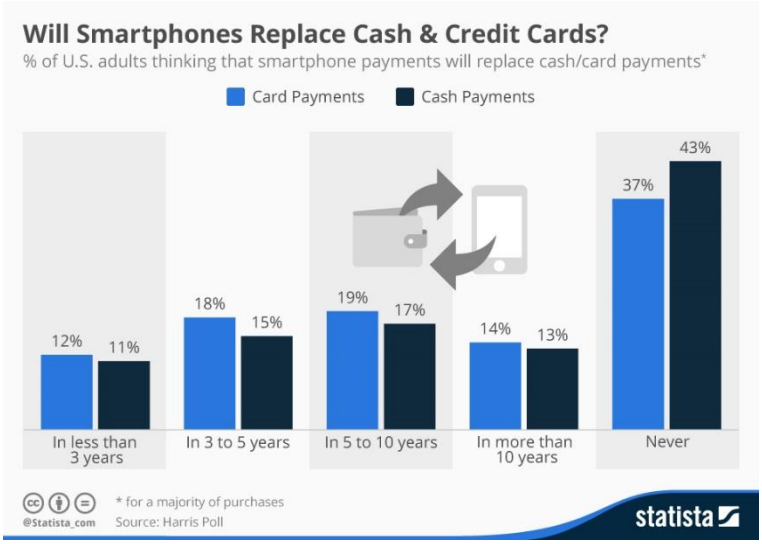
Increasing the computing power of smart phones has made it possible to have a fundamentally new way for cashless payments - mobile phone payments. This change has the potential to fully reverse market developments. The technology allows to safely store bank card data in the phone itself and make a payment with the phone itself without the presence of a plastic card. The smartphone payment technology at a store is similar to a contactless card payment, while having its important advantages - with the same virtual bank card can also be pay in an online store. Mobile payment applications open new opportunities for generating profits for Apple, Google and Samsung who are actively offering their service and becoming important partners for financial institutions.

According to German research group TrendOne of November 2016, mobile payments in the US will increase more than 10 times in the next five years - from about 25 billion dollars for 2016 to about 275 billion dollars in 2020, which is an average annual growth of over 62%.



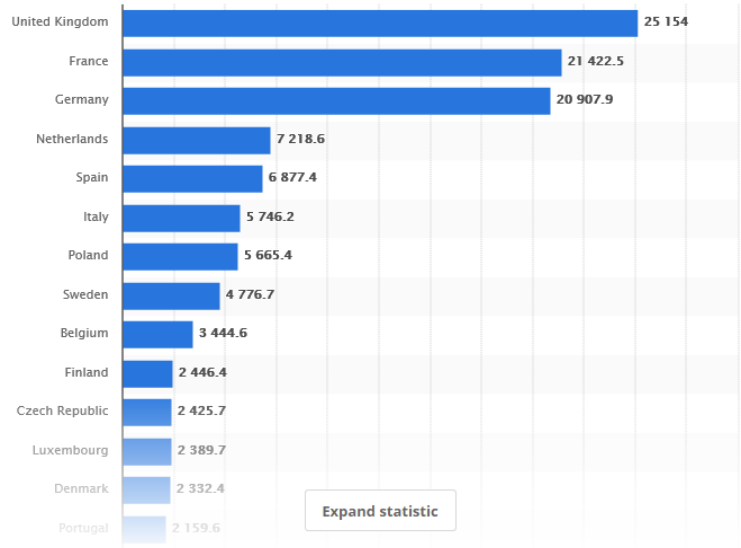
For the time being there is no clear and definite tendency to replace cash with cards or mobile payments. In an online survey by The Harris Poll in February 2015 among 2221 elderly US clients (18-65 years), only about 11-12% of respondents believe that mobile technology will replace cash or bank cards within 3 years. While for 43% of the clients questioned, cash will never disappear, and for another 13% cash will be used for at least another 10 years. According to the same survey, 51% of respondents do not believe mobile payment technology to replace cards earlier than 10 years or ever. Customers told that the key to the spread of technology is the security of sensitive data or the lack of a real good reason to choice a new form of payment.

In Europe, bank card payments also have sustainable growth. Most cards are used as a way to make non-cash payments for goods and services - in the UK (25.154 billion transactions), followed by France and Germany (see the chart below). By comparison, according to BORICA AD in Bulgaria till 31.12.2016 there are 7.8 million active bank cards and 206.78 million card transactions for the entire 2016.



According conducted from study Masterindex Bulgaria 2017 among over 1,000 active cardholders, 67% have a contactless bank card, the main advantages for its use as are convenience (74%) and speed (68%) of payment. Total of 69% of respondents use their card at least once a week, most often with a card being paid in grocery stores - 64% of weekly purchases are there, and secondly online purchases with a 54% share.

EU member states with the most cashless payment transactions in 2016 (in millions)



The most popular mobile contactless payment service at the moment is Apple Pay by Apple Inc. According to the company, over 90% of all contactless mobile phone payments in the world are made using their technology. While it is still available only in few countries around the world - mainly in industrialized countries.

The power of Apple Pay is also visible when compared to other contactless payment options at retailers. In North America, Apple Pay is already the most popular alternative payment method in terms of retail acceptance. According to research from Boston Retail Partners, service was accepted by 36% of North American retailers by December 2016, with another 22% saying they plan to accept it within the next 12 months. Among the major mobile manufacturers, Google's Android Pay with 24% service acceptance is the second, while Samsung Pay is 18% and has a 29% outlook in the next 12 months. Global payment operators Mastercard and Visa are actively developing MasterPass and Visa Checkout mobile technologies in order to displace the mobile payments market for their benefit. Again, according to the Masterindex Bulgaria 2017, study by MasterCard, on the question of mobile payments, 67% of respondents would use a mobile phone to pay for POS at a retailers and 66% would like to have a mobile application for online payment with an existing bank card.

3. Conclusion

The data presented in the survey confirms a clearly outlined trend of the rapid development of new payment technologies without cash. These trends have not yet set out a clear winner in the coming years. All participants, through their own technologies, are fighting for the trust of more customers by continuously investing in innovative solutions and enhancing the convenience and security of cashless payments. The growth of online marketing is a powerful incentive to develop mobile phone payments. The goal is to buy and pay so easily that the sale is guaranteed at the moment the customer's desire for the given good or service.

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Data Warehouse Development Methods Ensuring Key Indicators' System

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Abstract. This paper examines the specifics of data which later is transformed into information to support management decisions in higher education. Proposed and described is a methodology of six methods for data warehouse ensuring the correct data on which base analysis can be used for future improvements in the field of higher education.

Keywords. Methodology for data warehouse, key indicators, higher education

1. Fundamentals of management through key indicators in higher education

The process of collecting data and turning it into information is key for higher education sector. It serves to provide the state budget money for the maintenance of education at the state higher schools, depending on the complex evaluation of the quality of the education and its correspondence with the needs of the labor market.

In the management of the financing of higher education, they are approved by the state obligatory indicators, which all state higher schools are obliged to cover, and on their basis is formed the complex quality evaluation, which determines the amount of financing. The complication in this case is related to the choice of sources of data on which to actually monitor the movement under the criteria.In order to solve the problem of correct data collection, a methodology has been developed to build a data warehouse in time (historical data) and to provide a system of key indicators. The system is designed in a way that can be adapted to different jurisdictions, different set criteria and can be altered in parallel with changes in the environment.

The methodology for building a data warehouse adapted to the needs of higher education institutions and secures the individual subsystems to support decision-making processes, including simple accountability and simple queries, to complex optimization. The data warehouse is built with methods that primarily work on metadata and extract, transform, and load data that has already been processed (ETL). Typically, the data is stored in separate repositories, separated by theme or storage, extracted, transformed, and loaded from the data warehouse (ETL) from the data warehouse, thus solving the problem of the various data format and becoming suitable for analyzing information to be key in decision-making in the management of the higher education institution and especially when planning the financing from the state budget

Key indicators in the field of higher education have a number of peculiarities. One of these features is associated with the need for data to be extracted from an integrated database of different data sources. From a methodological point of view, this requires a special methodology to be used to build a data warehouse to ensure the values of the key indicators.

Generally, depending on the data sources used (fig. 1), the indicators can be divided.

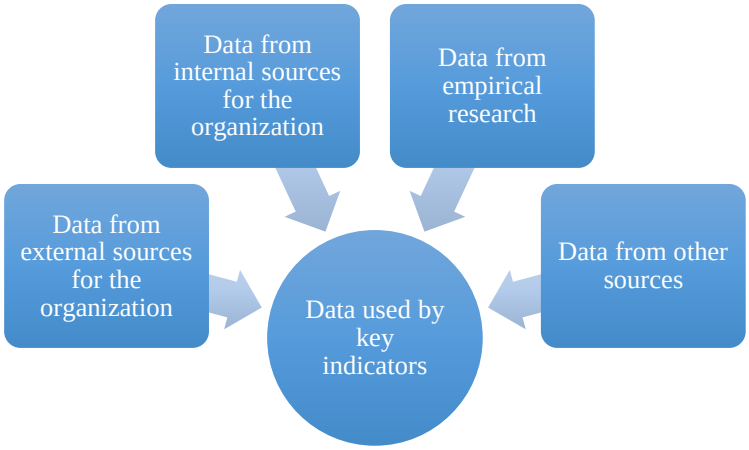


Fig. 1: Sources of data in universities

• Indicators whose data are provided by external sources for the organization. This includes, for example, data from a national reference list, references for reference and indexed editions, etc .;

• Indicators, the data of which are provided by internal sources for the organization. This includes data from specific lecturers and structural units of the higher school, data from the relevant publishing house, library, etc .;

• Indicators the data of which are provided by empirical research (including surveys at the higher school);

• Indicators for which data are provided by other sources.

2. Methodology for developing a data warehouse ensuring key indicators' system

In order to provide accurate data for key indicators, provided by the state, an ETL process should be defined to develop a data warehouse of various structured and unstructured sources.

The methodology consists of 6 methods. It has the following structure (fig. 2):

1) Method for verifying the purpose of the sources and their structure (HiEdu Verification)

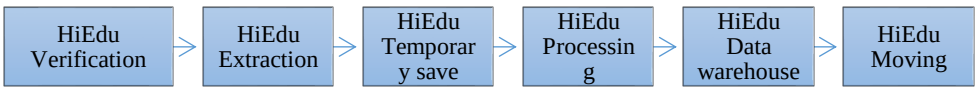
2) Method of Quality Extraction Data Migration (HiEdu Extraction)

3) Method of temporary systemisation and safe-keeping of data (HiEdu temporary save)

4) Data processing method according to the warehouse (HiEdu Processing)

5) Method for creating a thematic organized relational structure (HiEdu data warehouse)

6) Method for moving and storing processed data in the data warehouse (HiEdu Moving)



Method I

a) Heading

Method to verify the purpose of the sources and their structure.

b) Method designation

HIEDU Verification

c) Purpose of the method

The method is intended to determine the appropriate data sources in the context of the complex evaluation. For each of the defined data sources and depending on the type of data stored, a specific methodology for retrieving them is applied. Within the HIEDU test, the sources are analyzed according to different criteria.

d) Description of the method

HIEDU verification is a very important method because if it is not done properly, the subsequent information received would not be useful for planning the funding in higher education.

Practically, the method has been designed to examine possible sources, to include those that contain the necessary information, and then the data from these primates to process for the same logical data.

e) Sequence of conversion tasks

- ✓ Defining a set of sources
- ✓ Analysis of the destination of the sources
- ✓ Structure of data in the sources
- ✓ Data types in sources
- ✓ Data need
- ✓ Classification of data

f) Rationale for applicability

The method is applicable to organizational units with heterogeneous sources of information. HIEDU verification provides a prerequisite for implementing the methodology with a substantially reduced percentage for inaccurate reconciliation between data at the next levels, which improves the quality of the knowledge gained on the latest steps in the methodology.

Method II

a) Heading

Method of quality extraction data migration

b) Method designation

HIEDU extraction

c) Purpose of the method

Depending on the structure of the sources, a different algorithm is used to retrieve the data. HIEDU extraction accepts the presence of a plurality of data mining algorithms. The method is intended to make initial adaptation of primary data to the needs of the methodology.

d) Description of the method

HIEDU extraction is concerned with delivering quality and duly compiled data, which in the following methods will be processed and stored in an easy to analytical form. The method has policies to improve data quality (bug fixes and bug fixes). HIEDU extraction takes care of data being "transported" in their entirety between different systems.

e) Sequence of conversion tasks

- ✓ True extraction
- ✓ Verification of data
- ✓ Labeling of data by source
- ✓ Policies to improve data qualityRationale for applicability

f) Rationale for applicability

HIEDU extraction is appropriate in the case of sources with heterogeneous type and compositional information. It is extremely important to create the transition from one system to another, and if implemented on the paved pavilions, it guarantees higher levels of success at further levels of processing and analysis. The method is set as automatic software, which does not require a high level of IT specialists to handle it, making it suitable for the higher education system, where administrative teams do not have IT skills.

Method III

a) Heading

Method of temporary systematization and save-keeping of data

b) Method designation

HIEDU temporary preservation

c) Purpose of the method

The HIEDU temporary save method has been created to ensure that the data collected from a variety of sources will be stored in a generalized systemic manner until the subsequent methods occur. This shortens the processing time because it saves constant demand in large databases that are not semantically interconnected.

d) Description of the method

The already exported data from the previous method should be temporarily stored until undergoing a basic treatment. Based on the regularly mentioned fact that the data is from a variety of sources, it should be provided with a current repository to undergo finishing activities until they are brought into a form and structure suitable for storage in the data warehouse.

e) Sequence of conversion tasks

- ✓ Check the current status of temporary storage
- ✓ Secondary verification of compliance of data entering temporary storage
- ✓ Systematization of data
- ✓ Optimize temporary storage

f) Rationale for applicability

The practice of creating temporary repositories plays an important role in the current methodology. Such a tool allows quick reaction to the data, while providing a system to systematize data and keep it in that order so that the processing process is not aggravated. This method is distinct from HIEDU processing, despite the similar nature, because the data needed to plan the financing in the context of the comprehensive quality assessment is of a large number and heterogeneity, making it extremely difficult to process simultaneously. HIEDU temporary save prevents data loss before HIEDU processing since immediately after HIEDU extraction they are properly and responsibly placed for systematization.

Method IV

a) Heading

Processing method for data according to the warehouse

b) Method designation

HIEDU processing

c) Purpose of the method

Temporarily loaded data that is not yet stored in the warehouse is processed according to the data source. The cleaned data that has been subject to gaps, duplicate verification, and compliance with the limitations entered to match the data needed to finance funding fall into this method in order to apply specific algorithms for converting information that meets the criteria for in Methodology.

d) Description of the method

HIEDU processing takes the data from the temporary repository by prioritizing them, determines which data and in what sequence should be processed. This is because each method has a certain amount of data that can adapt to the warehouse. Under processing in the case of HIEDU methodology, it is understood that the data are subjected to different algorithms to make them in a form in which they can be loaded into the warehouse.

An important element of HIEDU processing is the data lock function. This is right at the output of the method to prohibit subsequent adjustments after completion.

e) Sequence of conversion tasks

- ✓ Sort
- ✓ Prioritization
- ✓ Adaptation of data according to the algorithm
- ✓ Select algorithm for data processing
- ✓ Applying a data processing algorithm
- ✓ "Lock" data to prevent.

f) Rationale for applicability

The method can be called "basic" in HIEDU methodology. Through the algorithms and functions set in it, the main idea in the creation of an information system for planning the financing in higher education is realized, namely to collect data from various sources and structure and to process them so that at the last levels of the system model to provide new knowledge in the context of a comprehensive quality assessment.

Method V

a) Heading

Method for creating a thematically organized relational structure (data store)

b) Method designation

HIEDU Data warehouse

c) Purpose of the method

This method dynamically builds the warehouse according to certain parameters meeting the needs in the context of financing based on a comprehensive quality assessment in the field of higher education. The purpose of the method is to dynamically maintain the warehouse structure according to the structure and elements of the data sources.

d) Description of the method

HIEDU warehouse is directly related to the actual creation of a data warehouse that is binding on business intelligent systems. During the method the building technology, the data to be entered, the architecture and the functionalities must be chosen. Once the method is complete, the warehouse must be ready to accept and store the data ready for analysis.

e) Sequence of conversion tasks:

- ✓ Choosing technology to create
- ✓ Select a database
- ✓ Choice of architecture

- ✓ Build architecture - databases, together with the functionalities to it
- ✓ Creating a link between the main components
- ✓ Actual construction

f) Rationale for applicability

The effect of using the HIEDU warehouse method is to build a data warehouse structure model that is based on the data source structure and the needs of the information system for condition analysis in terms of complex quality evaluation

Method VI

a) Heading

Method for moving and storing processed data in the warehouse

b) Method designation

HIEDU move

c) Purpose of the method

This last method is designed for the qualitative transfer of data from temporary storage and proper storage in the data store

d) Description of the method

The already prepared data should be moved to the data warehouse created in the previous method. This means data is recorded to consolidate, verify data integrity, verify correctness of the move, etc. The aim is then to extract information from this data to support the planning of funding in higher education according to the criteria are a comprehensive quality assessment.

e) Sequence of conversion tasks

- ✓ Check the warehouse's temporary condition
- ✓ Save locked data
- ✓ Check correct data transfer
- ✓ Delete moving data from temporary storage
- ✓ Optimization of Temporary Storage

f) Rationale for applicability

The effect of using the HIEDU warehouse method is to construct a data warehouse structure model that is based on the structure of the data sources and the needs of the information system for condition analysis in terms of complex quality assessment.

3. Conclusion

When discussing information that serves to make management decisions, it is very important to put the point on the sources which deliver it. Proper data collection ensures that subsequent analyzes will be based on true facts. The proposed methodology consists of detailed methods for the collection of data from unstructured sources and is consistent with the stages in the field of the university environment.

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Building Management Systems/Building Automation Systems communication protocols for higher efficient building

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Abstract. The present paper reviews communication protocols which has been implemented in modern Building Management System/Building Automation System (BMS/BAS) systems. Selected BMS/BAS features, according to customers' requirements are given. The most important BMS/BAS functions are outlined and protocols description is made. Reviewed are different options for selection by vendors.

Keywords. Building Management System, Building Automation System, BMS, BAS, smart buildings.

1. Introduction

The Internet-of-things (IoT) concept brings information technologies to everything. Our surrounding world becomes "smart"-er. There are several IoT mainstreams. One of the most dynamic development area is IoT in homes and offices. IoT market forecasts show that the new technological revolution is already making an impact on the global economy. While estimates of the economic impact during the next five to ten years vary slightly (IDC estimates USD 1,7 trillion in 2020 [1], Gartner sees a benefit of USD 2 trillion by that time [2], and McKinsey predicts growth of USD 4 trillion to USD 11 trillion by 2025 [3]), there seems to be a consensus that the impact of IoT technologies is substantial and growing [4].

At present, buildings' sustainability is mainly based on applied in information technologies. Building Management Systems (BMS) / Building Automation Systems (BAS) increases the share of information technologies in the buildings and makes them "smarter". BMS/BAS systems unite sub systems in one integrated system with one point of management. Communication between BMS/BAS Field Level (sensors and detectors) and the next Automation Level(main controllers, signal input-output units, and various switching equipment) is organized with protocols and there are different kind of them.

The philosophy of BMS/BAS systems is to apply integrated approach of management of all available information technology in the buildings related to the cost efficiency and comfort. The three main parts of each IoT systems are hardware, communication network and software. Hardware and software capabilities of BMS are nearly the same among the international producers, but the important point is that the art of using this capabilities is in the process of designing, programming, installing and especially setting up the system. The above mentioned advantages for this system, specially optimizing energy consumption, reducing maintenance expense, managing heating-cooling and electric facilities, and increasing the level of residents' comfort directly depend on the quality and design of programming and its maintenance, and is also in a direct relation with the scientific level of BMS operator engineers in information analysis [5][6].

The purpose of the present paper is to analyze BMS/BAS and the implemented protocols. A basic review on the BMS/BAS features is made, along with an architectural

model. Comparison between different communicative protocols is presented. At the end, an approach for nomination and selection the proper protocols for BMS/BAS potential user, is proposed.

2. Definition of Building Management System/Building Automation System

BMS/BAS systems implement the technologies in living/working environment. The main functions of these systems are:

- Monitoring – with system of different sensors for real time monitoring of the building and its control and management. An operator, or users, could be informed in real time for the functioning of the utilities;
- Control – BMS/BAS systems reacts to the change of the indicators of the environment and then it takes action to decrease/increase the measurement of the source
- Optimization – based on the monitoring of all data received from all installed sensors and detectors, the system could react in direction cost optimization
- Reporting – based on users' needs BMS/BAS systems could produce different types of reports which could be used to improve building's performance in desired direction - energy consumption, temperature difference, failures, etc.

BMS/BAS systems in their own genesis are integration of electrical, mechanical, safety, security and comfort system installed into the building. In other words, the BMS/BAS integrates the following systems:

1. HVAC system(s) – Heating, ventilation, air-conditioning systems – climate control system;
2. Power supply system – in that number lighting management system and emergency lighting system; consumption measurement system, reporting and billing;
3. Fire detection system;
4. Sprinkler system;
5. Security system;
6. Access control system;
7. Vertical transportation system;
8. Water supply system, consumption measurement, reporting and billing, anti-leakage system, sewage system, green areas watering system;
9. CCTV system – close circuit television system – video surveillance system;
10. Sun protection system;
11. Snow and ice protection system;
12. Alarm system;
13. Sound system;

Those are some of the main system which are usually integrated in the common BMS/BAS system. In some project the scope of integration could be wider, which depends of the developer's strategy and goals.

All integrated systems are managed by one user friendly interface, designed to cover developer's aims and goals.

Above mentioned network topology indicates the 3 fundamental stages of a BMS/BAS wiring strategy. The first stage is field wiring which is used to connect specific sensors and devices back to a field controller. The second stage is an interconnecting fieldbus control network cable which can be used to interlink a number of field controllers with the third stage being the local area network providing interconnectivity between the field controllers, main server and user terminals [7].

BMS/BAS systems architecture can vary considerably, depending on the constraints of a project. However, if early attention is paid to the proposed commissioning strategy, it is possible to arrange the overall architecture to ensure individual systems to operate on a standalone basis without reliance upon a fully completed infrastructure. An example of this would be to ensure that Variable air volume (VAV) units connected to an air handling plant system are all connected to the same BMS/BAS fieldbus and controller to ensure that all devices can be viewed and operated from one location [7].

3. BMS/BAS Protocols

3.1 Internet Protocol

The Internet Protocol is important part of the network communication protocol suite, known as TCP/IP. The main purpose of the Internet Protocol is to route packets over Internet with help of routers. It has an addressing system to make it possible to send a packet from one end computer to another one. This is based on the fact that both end computers have unique IP addresses. Routers on the Internet forward the packets using the address in the header and embedded routing algorithms.

In building automation systems TCP/IP is usually used in the Primary network (Ethernet cabling system, Ethernet switches, and operator working equipment) . Either as pure TCP/IP or letting IP be the carrier to other protocols like ModBus or BACnet.

3.2 ModBus

ModBus is registered trademark of Schneider Automation, Inc [8].. ModBus is a communication protocol used in both industrial manufacturing environment and building automation systems, for communication in a master-slave system. The protocol was originally published by Modicon (now Schneider Electric) in 1979 for use with its programmable logic controllers (PLCs). Simple and robust, it has since become a de facto standard communication protocol and is now a commonly available means of connecting industrial electronic devices.

ModBus enables communication among many devices connected to the same network, for example, a system that measures temperature and humidity and communicates the results to a computer. ModBus is often used to connect a supervisory computer with a remote terminal unit (RTU) in Supervisory Control And Data Acquisition (SCADA) systems. Many of the data types are named from its use in driving relays: a single-bit physical output is called a coil, and a single-bit physical input is called a discrete input or a contact. The development and update of ModBus protocols has been managed by the ModBus Organization since April 2004, when Schneider Electric has transferred rights to that organization. The ModBus Organization is an association of users and suppliers of ModBus-compliant devices that seeks to drive the adoption and evolution of ModBus.

There are different versions of the ModBus protocol:

- ModBus RTU - This is used in serial communication and makes use of a compact, binary representation of the data for protocol communication. The RTU format follows the commands/data with a cyclic redundancy check checksum as an error check mechanism to ensure the reliability of data. ModBus RTU is the most common implementation available for ModBus. A ModBus RTU message must be transmitted continuously without inter-character hesitations. ModBus messages are framed (separated) by idle (silent) periods.

- ModBus ASCII - This is used in serial communication and makes use of ASCII characters for protocol communication. The ASCII format uses a longitudinal redundancy check checksum. ModBus ASCII messages are framed by leading colon (":") and trailing newline (CR/LF).
- ModBus TCP/IP or ModBus TCP - This is a ModBus variant used for communications over TCP/IP networks, connecting over port 502. It does not require a checksum calculation, as lower layers already provide checksum protection.
- ModBus over TCP/IP or ModBus over TCP or ModBus RTU/IP - This is a ModBus variant that differs from ModBus TCP in that a checksum is included in the payload as with ModBus RTU.
- ModBus over UDP - Some have experimented with using ModBus over UDP on IP networks, which removes the overheads required for TCP.
- ModBus Plus (ModBus+, MB+ or MBP) - ModBus Plus is proprietary to Schneider Electric and unlike the other variants, it supports peer-to-peer communications between multiple masters. It requires a dedicated co-processor to handle fast HDLC-like token rotation. It uses twisted pair at 1 Mbit/s and includes transformer isolation at each node, which makes it transition/edge-triggered instead of voltage/level-triggered. Special hardware is required to connect ModBus Plus to a computer, typically a card made for the ISA, PCI or PCMCIA bus.
- Pemex ModBus - This is an extension of standard ModBus with support for historical and flow data. It was designed for the Pemex oil and gas company for use in process control and never gained widespread adoption.
- Enron ModBus - This is another extension of standard ModBus developed by Enron Corporation with support for 32-bit integer and floating-point variables and historical and flow data. Data types are mapped using standard addresses. The historical data serves to meet an American Petroleum Institute (API) industry standard for how data should be stored. Data model and function calls are identical for the first 4 variants of protocols; only the encapsulation is different. However the variants are not interoperable, nor are the frame formats.

Mostly used in the practice ModBus protocols are ModBus ASCII, ModBus RTU and ModBus TCP.

Since the ModBus protocol is developed for master-slave communication it works according to polling principles. That means that the master is asking questions to the slave to detect changes in values or alarms. ModBus is used in both the Primary network and the Field network depending on which version that is used.

Since 2004 ModBus Organization has been handling the ModBus protocol. The protocol is released as open software and all documentation and specifications can be downloaded for free. Members of ModBus Organization can also download development tools and samples of implementations.

ModBus Organization does also perform testing and certification of products developed for ModBus ASCII, RTU and TCP. It is not mandatory to apply products for testing and certification, which mean that products can be sold as a ModBus product without following the standard implement rules [8].

3.3 BACnet

BACnet abbreviation means - Building Automation and Control Networks. The BACnet protocol was developed by ASHRAE (the American Society of Heating, Refrigerating

and Air Conditioning Engineers – LEED certification organization – LEED - Leadership in Energy and Environmental Design (LEED) – sustainable building certification system) it is also ANSI (American National Standards Institute 135-1995 – the original one, and 135-2016 latest revision), and ISO 16484-5 standard protocol. The reason to develop the protocol was to meet the requirements for communication in building automation. The protocol was first released as an ANSI/ASHRAE standard 1995 and since 2003 is BACnet also an international and European standard.

BACnet had an almost immediate impact on the HVAC controls industry. In 1996 Alerton announced a complete BACnet product line for HVAC controls, from the operator's workstation down to small VAV controllers. Automated Logic Corporation and Delta Controls soon followed suit. As of January 2017, 961 Vendor IDs have been issued and are distributed internationally. Those vendor identifiers can be viewed at the BACnet website.

BACnet is an object-oriented protocol triggered by events. This means that there is no communication between devices until something happens or changes. BACnet is mainly used in the Primary network.

BACnet is released under GPL and has no license. BACnet International is the international organization that looks after the interest of BACnet such as future development strategy and popularization [9].

3.4 KNX

KNX is a standardized (EN 50090, ISO/IEC 14543), OSI-based network communications protocol for building automation. KNX is the successor to, and convergence of, three previous standards: the European Home Systems Protocol (EHS), BatiBUS, and the European Installation Bus (EIB or Instabus). The KNX standard is administered by the KNX Association.

The standard is based on the communication stack of EIB but enlarged with the physical layers, configuration modes and application experience of BatiBUS and EHS.

The KNX protocol has different media over which it can be transmitted.

- Twisted pair;
- Power line networking;
- Radio frequency (KNX – RF);
- Infrared;
- Ethernet (also known as EIBnet/IP or KNXnet/IP).

The KNX protocol is event triggered like BACnet. It is used in both Primary and Field network. KNX is designed to be independent of any particular hardware platform. A KNX Device Network can be controlled by anything from an 8-bit microcontroller to a PC, according to the needs of a particular implementation. The most common form of installation is over twisted pair medium.

KNX is approved as an open standard to:

- International standard (ISO/IEC 14543-3);
- Canadian standard (CSA-ISO/IEC 14543-3);
- European Standard (CENELEC EN 50090 and CEN EN 13321-1);
- China Guo Biao (GB/T 20965);

The KNX Association has partnership agreements with more than 30,000 installer companies in 100 countries and more than 60 technical universities as well as over 150 training centres. The access to the KNX specification used to be restricted, however as from January 2016 the access is free assuming you have a free account on the KNX association website.

3.5 The LonWorks protocol

LonWorks (local operating network) is a networking platform specifically created to address the needs of control applications. The platform is built on a protocol created by Echelon Corporation for networking devices over media such as twisted pair, powerlines, fiber optics, and RF [10]. It is used for the automation of various functions within buildings such as lighting and HVAC; see building automation.

The technology has its origins with chip designs, power line and twisted pair, signaling technology, routers, network management software, and other products from Echelon Corporation. In 1999 the communications protocol (then known as LonTalk) was submitted to ANSI and accepted as a standard for control networking (ANSI/CEA-709.1-B). Echelon's power line and twisted pair signaling technology was also submitted to ANSI for standardization and accepted. Since then, ANSI/CEA-709.1 has been accepted as the basis for IEEE 1473-L (in-train controls), AAR electro-pneumatic braking systems for freight trains, IFSF (European petrol station control), SEMI (semiconductor equipment manufacturing), and in 2005 as EN 14908 (European building automation standard). The protocol is also one of several data link/physical layers of the BACnet ASHRAE/ANSI standard for building automation.

China ratified the technology as a national controls standard, GB/Z 20177.1-2006 and as a building and intelligent community standard, GB/T 20299.4-2006; and in 2007 CECED, the European Committee of Domestic Equipment Manufacturers, adopted the protocol as part of its Household Appliances Control and Monitoring – Application Interworking Specification (AIS) standards.

During 2008 ISO and IEC have granted the communications protocol, twisted pair signaling technology, power line signaling technology, and Internet Protocol (IP) compatibility standard numbers ISO/IEC 14908-1, -2, -3, and -4.

The LonWorks protocol can operate according to master-slave principle or directly without a central controller. The protocol is used in the Field network.

The LonWorks protocol itself comes without license requirement and it is possible to implement the protocol to any microprocessor. However Echelon Corporation sells the Neuron chip, which has the LonWorks protocol implemented. In the past it was required to purchase the Neuron chip to be able to use the protocol [10].

3.6 Other building automation protocols

There are a lot of protocols used for building automation nowadays - both commercial and proprietary. There are specific protocols developed for specific goals like only handling the light in a room or a building. Some of the protocols are developed to be specifically used with wireless technology. Some of the more common protocols are listed below.

3.6.1 DALI

DALI abbreviation comes from Digital Addressable Lighting Interface. It was developed for advanced control of lightning in buildings. The protocol is released as an open standard. There are convertors via which can connect DALI networks with for example KNX or BACnet systems [11].

3.6.2 Z-wave

Z-wave protocol has been designed by Sigma Designs. Z-wave is a communication protocol designed for building automation, using radio frequency. It is primarily used in private homes but other applications are also available. The standard is a result of 200 companies in Z-wave Alliance that have agreed on using the same standard for their products.

The products range from lighting, alarms, HVAC, monitoring, locks, irrigation, sunshade, entertainment systems etc. [12].

3.6.3 ZigBee

ZigBee is mostly for small residential buildings. It is using similar technology as Z-wave, based on radio frequency. Examples of products are temperature sensors and electrical switches. The protocol is license free as long it is not used in commercial buildings.

3.6.4 M-bus

M-Bus, which is short for Meter-Bus, is often confused with ModBus. M-Bus is not really a building automation protocol. It is used in buildings to remotely raed the electrical meters and collecting measurement data from sensors. The protocol is designed to mark the data with time stamps and record from what device it origins.

3.6.5 *X-10*

X-10 standard has been developed by Pico electronics. Whether using power line or radio communications, packets transmitted using the X-10 control protocol consist of a four bit house code followed by one or more four bit unit codes, finally followed by a four bit command. For the convenience of users configuring a system, the four bit house code is selected as a letter from A through P while the four bit unit code is a number 1 through 16.

X-10 has been determined as one of the open standard protocols with highest efficiency for home automations. The competitive advantage of X-10 protocol is communication with needed connection devices over public power supply network. Based on this approach there that's how, in this way there is no need already installed cable systems to be amended. To design a smart home by this protocol, you must connect your appliance by a medium to the outlet available at home. In his way, you are able to turn the appliance on and off by a sender adaptable with this protocol, according the set code.

Advantages and disadvantages:

- It is cheap to develop it completely;
- It is adaptable with all brands;
- X-10 remotes are active by RF protocols;
- The maximum number of appliances controllable with

This protocol is noise putting for some systems like TV and radio, and it is noise taking of systems which have electric engine; to reduce the noise several filter must be used [6][13].

3.6.6 *S-Bus*

S-BUS is a closed protocol which has no valid international standard. The advantages and disadvantages of this protocol include:

- It has just one producer (consumer is depended on producer and its products);
- The life cycle of devices is 300000 times (10 times less than KNX);
- There are limited options [6].

4 Conclusion

The building's life cycle presently is fully dependent much more form information technologies rather that the building (construction) technologies themselves. Each and every modern building needs to be equipped with BMS System for integral management of the sub systems. Those systems mains focuses are:

- Operational cost reduction;
- Health and safety;

- Comfort improvement;

The range of the functionalities installed of the subject system could be the competitive advantage of the building and could keep it in the upscale market segment much longer than the competition.

The research firmly proofs that there is no any standardization about usage of protocols in BMS systems.

The main drivers for applying one or another protocol are:

- Buildings' investors strategy for sustainability, cost reduction and comfort;
- Nominated vendors and sub vendors and their technologies applied.

Different protocols could achieve same goal through different technologies. The key is further development of the BMS system in near future also long term sustainability.

The present paper review different protocols and determines KNX, ModBus and BACNet as most appropriate for the modern building management systems due to high security level, easy installation, reasonable price levels and highly compatible with other devices.

Emerging role of IoT concept shortly will change completely the occupancy of the buildings and their features. The buildings needs to be designed and prepared for continuous improvement and upgrade. In all new buildings BMS/BAS systems already is a must and their wide range of available protocols availability will provide further upgrade and development sustainable.

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Development of E-learning – Learning Management Systems and Virtual Laboratories

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Abstract: The article discusses one of the most widely used e-learning environments and existing virtual laboratories. It compares the different functionalities of e-learning environments and the capabilities of individual virtual laboratories. The results are presented in tabular and graphical form. The conclusions of the article show how the functionalities of the e-learning environments would be useful in virtual laboratories and especially in the development of e-learning.

Keywords: E-learning, E-learning environments, Virtual laboratories, Learning management systems

1. Introduction

The rapid pace of information technology development prompts all areas and industries to develop and integrate into their business. One of these areas is educational. Information technology improves the communication between trainers and students, improves access to information as well as the acquisition of practical knowledge by learners. Lessons learned in recent years are done not only with classroom exercises, but also with online exercises, thanks to e-learning and more specifically online courses that are being created. The idea of e-learning is to assist teachers [1, 3, 8, 10].

Due to the fact that the positive aspects prevail, and the fast pace of life required by it, e-learning has established itself as a significant part of the educational sphere all over the world.

2. Virtual Laboratories

A problem that arises with educational institutions is the presentation of practical courses in online courses. They could be represented by video chat, discussed in forums and online chats, but this would only help in some subjects. For others these auxiliary tools are not enough. It comes to the conclusion that multimedia tools play an important role in lecture management and in organizing and conducting exercises, but in given subjects are not enough. The help tool here could be the virtual laboratories that allow the simulation of given experiments on the individual disciplines. Due to the fact that the educational spheres are very numerous and diverse, as well as the subject they are learning, it is concluded that virtual laboratories with simulation exercises will have many and different specifications. A comparison of traditional with virtual labs to see their similarities and differences is shown on Table 1 [4, 7].

Both types of laboratories have their advantages and disadvantages.

While virtual mistakes can occur during traditional exercises, virtual labs provide the opportunity to run the experiment repeatedly and also use simulations that reflect every stage of the work experience. Even if a mistake is made, it could be changed easily.

Virtual labs might be attractive and engaging way for students to learn and acquire knowledge in a particular subject area, but practical exercises in traditional laboratories play an important role in science education, this is due to their impact on the learning outcome of students and on practical training of lecturers.

Table 1: Similarities and differences between traditional and virtual laboratories

Comparison criteria	Traditional laboratories	Virtual Laboratories
Facilities	Teachers can demonstrate demonstration of the experiment.	You can add a video or annotation that will be available multiple times. Multimedia
Requirements	They physically require the equipment needed to conduct the experiment. Students are physically present in the lab	It requires a lot of resources and effort to design. After designing, only an inline connection is required. Students do not need to be physically present.
Freedom to make experiments	Some experiments may be dangerous if they are not done with precision	Can be experimented a lot, in the most varied combinations and variants. It depends on the possibilities provided by the laboratory itself.
Time to conduct experiments	There is no great opportunity for repeat experiments	Experiments can be repeated many times
Experimentation	Limited opportunities for innovation	Provides broader and safer opportunities for innovative experiments
Availability	Limited in time and space	Accessible at any time
Monetary value	Different value of the necessary funds depending on the educational sphere	Almost zero value due to the need for an internet connection

The main advantages of traditional laboratories are that the information is much more contact, training is face to face and work is done with real equipment. The presence and personal reproduction of an experiment is better understood by learners.

The study demonstrates that virtual laboratories could be effective, but the main problem is when it should be appropriate to a particular situation and needs more research and improvements in various educational fields.

Virtual and simulation laboratories offer the opportunity to gain laboratory experience while reducing the financial burden on educational institutions.

Among lecturers there are different opinions about which are more effective – traditional or virtual laboratories. This might become an important issue in the future, because in some educational fields there is a need for training with physical objects at a given time.

For these reasons, it could be argued that there is still not good enough virtual labs in different educational fields and therefore the end result is a laboratory not sufficient

educational experience for students.

The virtual laboratory advantage that you can repeat the experiment at home and everyone can make its own conclusions is great, because in the traditional classroom, the teacher does not have the technical time to repeat many times the same thing.

There are many existing virtual laboratories in various subjects such as physics, chemistry, medicine, electronics, biology, astronomy, anatomy and civil engineering [31], but there are not many in the field of information technologies and in certain subjects - there are none at all. Most laboratories, used in the field of IT, combined different parts from different areas, as it is shown in [30].

It is also difficult to create a virtual lab to simulate certain algorithms or situations, because of the fact that they are being updated very often, as well as many new technologies and tools are used. Maintaining such a laboratory would take a lot of time and resources, and it will stay up-to-date for too short a time. This is the reason why the creation of a laboratory in this area of education is not commonplace, but separate laboratories might be created for the disciplines studied, and they will cover at least the main components of each. Such a lab would also have a visualization of both the overall structure and the individual parts of the algorithms, besides simulation.

The idea of this article is to explore online learning platforms that could be combined and mixed with online virtual IT laboratories.

3. Learning management systems

The most common training systems will be explored, based on different criteria to see which one is most relevant to the educational sphere and which in the future could be combined with a virtual lab [5].

Popular world-class online learning platforms, included in the research are ***Blackboard Learn, Brightstone, Canvas, Edvance360, Grovo and Moodle*.**

These web applications are widely used by the world's leading universities. Their bases include thousands of online courses with millions students participants around the world. Internet technologies lead to globalization of education and access to the courses of world-class trainers and students, as well as the creation of learning opportunities, based not only on new technologies, but also provide a more varied than traditional, training methodology [2].

Comparison of learning management systems include:

- Blackboard e-Education Suite [23];
- Brightstone [24];
- Canvas [25];
- Edvanse 360 [26];
- GROVO [27];
- MOODLE - modular object-oriented dynamic learning environment [21, 22, 28];

These Virtual learning environments have been extensively examined and compared against two major criteria, as well as others that would influence the need to make choices. The study and comparison is done with online platforms containing very large number of e-learning environments along with their parameters and features [9, 11, 20].

The comparison made includes two criteria groups – Basic and Other.

Basic Criteria are:

- Instruction methods (Table 3 and Figure 1);
- Collaboration features (Table 4 and Figure 2).

Other criteria (Table 2) are:

- Customer types;
- OS Supported;
- Accessibility compliance;
- Available languages.

The results of the study are presented below, together with the conclusions to them.

Table 2: Other important criteria

Other criteria		Comparison criteria			
		Accessibility Compliance	*Available Languages*	*Customer Types*	*OS Supported*
e-learning environments	*Blackboard [6, 12,13, 15]*	Scorm	English	Education, Government & Public Administration	Android, iPhone/iPad, Web-based
	Brightspase [15, 16, 18]	Scorm	English, Portugese, Spanish	Education Government & Public Administration Recruiting & Human Resources	Windows, Linux, Android, iPhone/iPad, Mac, Web-based
	Canvas [14, 16, 17, 19]	Scorm	Chinese, English, French, German, Polish, Portugese, Spanish, Turkish	Education	Android, IOS
	Edvance360 [14, 17]	Scorm	English	Education, Small-Medium Businesses	Android, Windows, iPhone/iPad, Mac, Web-based, Windows Mobile
	Grovo [19]	Scorm	English	Banking & Financial Education Information Technology Internet & Telecommunications Medical & Healthcare Sports & Recreation	Cent OS HP-UX IBM AIX Mac OS X Novell SUSE Linux Oracle Linux Oracle Solaris Red Hat Enterprise Linux Windows - all supported versions
	Moodle [12, 13, 18, 19]	MS LTI™, Scorm 1.2. Scorm 4, Mozilla's open badges.	works in multiple languages	Aerospace & Defense Consulting & Business Services Education Government & Public Administration Information Technology Medical & Healthcare	Unix, Linux, FreeBSD, Windows, OS X, NetWare and any other systems that support PHP and database, including host providers.

All the e-learning environments considered, except for training, are suitable and can be used in small and medium-sized enterprises, public administration, banks, medical and health care, information technology and other fields. Using this benchmarking criterion, it is proven that e-learning environments not only enter the educational sphere, but also in many others and soon will be an integral part of our everyday life.

In terms of interoperability features, only Edvance360 is compatible with Windows Mobile. All environments are compatible with Windows and Android. Blackboard, Brightstone and Edvance360 are web based. Moodle in addition to Linux, UNIX and FreeBCD is compatible with any other systems that support PHP and database, including provider's host.

Scorm is the standard for interoperability of e-learning and for this reason all the environments studied have been developed according to its requirements [29]. Only Moodle is distinguished by its compatibility with two other standards - MS LTI ™ and Mozilla's open badges.

With regard to the languages that can be used in these e-learning systems, it is concluded that everyone works in English, but Brightstone works in both Spanish and

Portuguese, also. The most widely available in different languages are Moodle and Canvas, and Moodle is definitely the one that works in most languages.

Basic Criteria

Instruction methods – Six learning methods are selected for criteria:

- E-learning
- Distance learning
- Interactive courses
- Self-study
- Virtual classroom
- Multimedia

Table 3: Instruction methods in examined virtual learning environments

Instruction Methods	Blackboard	Brightspace	Canvas	Edvance360	Grovo	Moodle
Blended Learning	+	+	-	-	-	-
e-Learning	-	+	-	+	+	+
Interactive Courses	+	+	-	+	+	+
Multimedia	+	+	-	-	+	+
Self-Paced	+	+	+	-	+	-
Virtual Classroom	+	+	-	-	-	+

From the study, the following results were obtained. The most widely used training methods are Multimedia and Interactive Courses with 22% of the studied virtual learning environments. The least used learning method is Distance Learning – 9%, with the penultimate place of 13% being a Virtual Classroom. E-learning and self-study fall into the middle of the study with 17% of the surveyed circles

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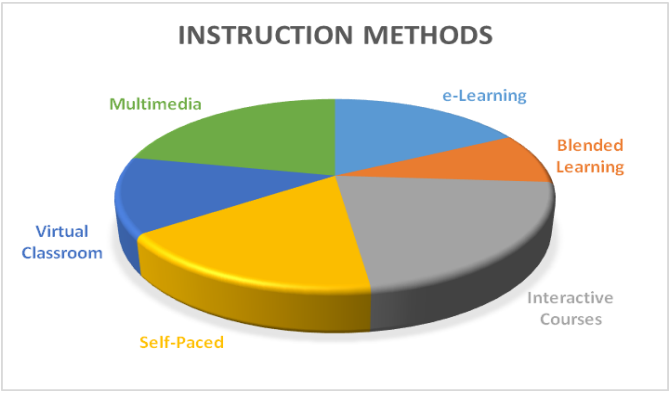

Fig. 1. Instruction methods in research virtual learning environments

Consequently, virtual learning environments are increasingly focus on technology innovation and above all, on visual training. This has led to their unification with virtual

learning laboratories in various subjects and above all for the acquisition of practical knowledge by trainees without the need for them to be in the classroom.

Other criteria for comparing learning environments are Collaboration features, including:

- Blogs
- Collaboration Management
- Discussion Forum
- File Exchange
- Internal Messaging
- Live Chat
- Note Sharing
- Wikis
- Whiteboard

Table 4: Collaboration features in the studied virtual learning environments

Collaboration Features	Blackboard	Brightspace	Edvance360	Canvas	Grovo	Moodle
Blogs	-	+	+	-	+	+
Collaboration Management	-	+	+	-	-	+
Discussion Forum	-	+	+	+	-	+
File Exchange	-	-	-	-	+	+
Internal Messaging	-	+	-	+	-	+
Live Chat	-	-	-	+	-	+
Note Sharing	-	-	-	-	+	-
Wikis	-	-	+	-	-	+
Whiteboard	-	+	-	-	-	-

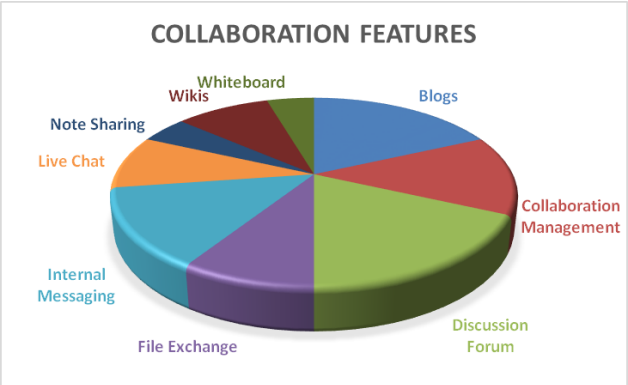

Fig. 2. Collaboration features in the studied virtual learning environments

Due to the large number of functionalities, that could be included in a virtual learning environment, developers have integrated different in each of them. Most preferred as shown in Figure 2 are discussion forums, and blogs with 18%, while the least preferred Whiteboard and Note Sharing by 5%. Immediately after the most preferred are Collaboration Management

and Internal Messaging with 14%, while the three functionalities are with 9% File Exchange, Internal Messaging and Wikis.

4. Conclusion

The rapid pace of IT development leads to their inclusion in all spheres and industries and helps them develop and improve. The study and the comparison of individual e-learning environments and traditional virtual laboratories conclude that their combination is the next stage in the development of e-learning. This combination will make it easier for both learners and teachers. The unification would be achieved only when the virtual laboratories are perfected and a high quality laboratory educational experience that the learners will receive. This would increase supporters of virtual laboratories because they would have become an effective learning tool.

Acknowledgement

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Exploring Methods to Ensure the Reliability of Software Systems

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Abstract: The paper reviews current trends in research on ensuring the reliability of software systems. The methods for ensuring the reliability of software products are analyzed. The problem of developing a reliability assessment after the development of a system leads in many cases to a breach of its safety. The main tendencies for ensuring software quality are related to the study of methods for ensuring the safety of the systems and the preparation of reliability assessment in the main stages of the life cycle of each software system – design, development, exploitation and evolution.

Keywords: Software Engineering, Software Reliability, Software Quality Assurance.

1. Introduction

Today, we live in a modern digital society, and technology is everywhere around us - at home, in the office, in our pocket. If only 20 years ago someone had said that in our pocket we would have a smart phone that would have the computing power of a large computer from the 70s that through it we could connect to anywhere in the world that would we can get the information we need to guide us to reach anywhere in the world, we would not believe it. With the onset of the computer age, calculations play a very important role in our daily lives. Dishwashers, TVs, microwave ovens, washing machines, air conditioners have analogue and mechanical parts that are now replaced by digital devices, processors and proper software. Software production is increasingly evolving as a powerful industry in which industrial laws are in force.

The terms "quality assurance", "quality control", derived from traditional industrial production, are directly transferred to software production. The desire to automate software production still exists when it was born. Increased competition and high development costs have increased the pressure on quantifying the quality of the software and measuring and controlling the quality of the system. Different factors have been identified, depending on the quality of the software. They are presented in standards, methods and tools. ISO standard defines quality as "the totality of features and characteristics of a product or service that bears its ability to satisfy stated or implied needs."

Software reliability is the most important and most measurable aspect of software quality The software reliability is the probability that a given system will operate without failure under given environmental conditions for a specified period of time. The software industry suffers from many challenges in developing high quality, reliable software. Various factors such as timing, limited resources, insecurity in the developing environment, incorrect specification of the requirements, have a negative impact on the development of reliable software systems.

The purpose of this report is to review the most important trends in research related to ensuring the reliability of software systems.

2. Essence of software reliability

Reliability is the property's ability to retain assigned functions, perform its activities, and store its performance within specified limits under certain modes and operating, maintenance, and transportation conditions.

Reliability is a problem that many authors view for optimization. Software reliability is defined according to the IEEE standard as "the probability of failure-free operation for a specified period of time in a specified environment". According to the ISO standard reliability is "the capability of the software product to maintain a specified level of performance when used under specified conditions". The reliability provides a quantitative measure of how closely the proposed project model meets the project objectives and makes it possible to compare different options [8].

Good software quality assurance should cover the entire process from the very beginning - from describing project requirements to software maintenance. This covers a set of different test techniques, but must also be consistent with standards, processes, documentation, and the entire development cycle.

The quality of the software systems is related to the reliability assessment. It is in turn influenced by the properties that determine it. Reliability is a key factor in determining product success. It depends on many factors that have varying degrees of influence over the entire software life cycle. Factors can be divided into two main groups:

- A user's perception of the reliability of a software depends upon two categories of information:
  - The number of faults present in the software;
  - The way users operate the system – known as operational profile.
- The fault count in a system is influences by the following:
  - Size and complexity of code;
  - Characteristics of the development process used;
  - Education, experience, and training of development personnel;
  - Operational environment.

Software reliability is viewed from two perspectives:

- Probability density view point – the number of failures of at appointed time;
- Cumulative distribution view point – known as failure probability – the probability that a device will fail at or before appointed time.

The minimum requirements for the calculation data in one case may be different from the other. Precision in the data collection mechanism may affect differences in reliability estimates or forecasts. The basic information needed to perform the reliability analysis includes the time period for which the software system is in operation and the exact time when the errors occur [5]. A usable alternative may be the abbreviated data that only reports the total number of failures over a period of time. Additional data may be needed if more needs to be done than a product reliability analysis.

Computing systems are characterized by five fundamental properties: functionality, usability, performance, cost, and dependability. Dependability of a computing system is the ability to deliver service that can justifiably be trusted. The Figure 1 showing relationship between Dependability and Reliability. Reliability engineering is a sub-discipline of systems engineering that emphasizes dependability in the lifecycle management of a product.

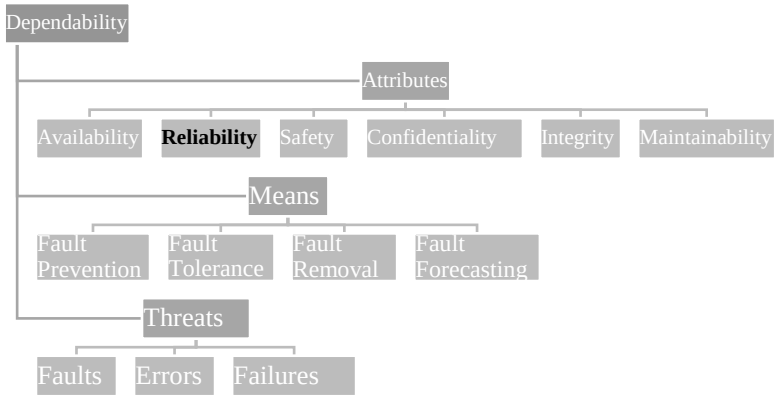

Fig.1 The dependability tree

Figure 2 shows an example of a tree of reliability built on the tree of dependability present in Figure 1.

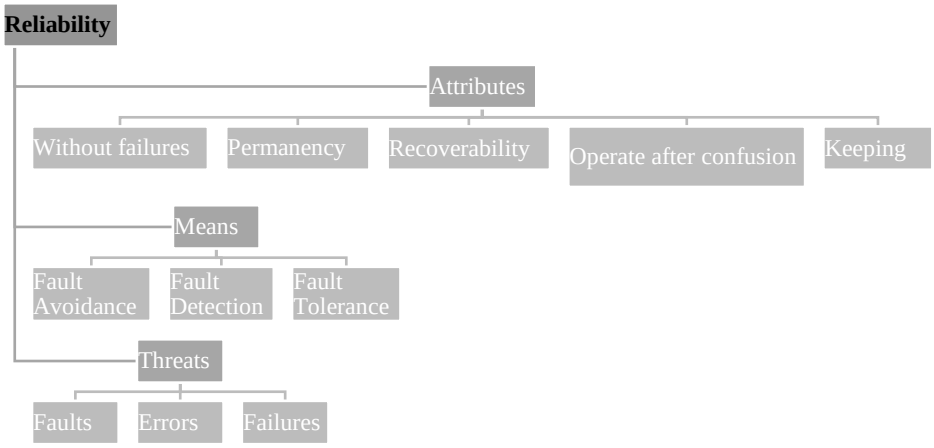

Fig.2 The reliability tree

The figure showing relationship between Reliability and Attributes, Threats and Means. Attributes are a way to assess the reliability of a system. Threats are an understanding of the things that can affect the reliability of a system. Means are ways to increase a system's reliability.

Attributes are qualities of a system. These can be assessed to determine its overall reliability using Qualitative or Quantitative measures. According to the International Standard, reliability includes five basic properties:

- **Without failures –** the product's property for continuously functionality without emergency interruptions at a define time or processing. The without failures is a very important and closely related element in the complete property reliability. The greater the without failures of a product, the greater the reliability and hence the quality of the product. There are three types of without failures:
  - Initial without failures – is measured with time or processing from the beginning of use of the product to the first failure;
  - Self-repairing - measured with time between recover;

- Integral without failures – the integral is the sum between the two.

- **Permanency** – the property of the product retains its functionality with the necessary interruptions for maintenance or recover until the occurrence of the so-called "border condition". Measures time and processing. It is much longer than the without failures. End of permanency sets the boundary condition, which is such a state of the product when, due to total damage, physical wear or obsolescence, recover become technically impossible or economically inexpedient. In unrecoverable production, the permanency coincides with the without failures.
- **Recoverability** – the property of recovery – the feature that characterizes the constructional feature of the product to easily detect the causes of the failures and relatively easy and quick debugging. The better the recoverability, the higher the reliability and the higher the quality.
- **Operate after confusion** – the property of the product retains its functionality after the failure of structural elements and groups included in it, due to the presence of substitute ones. The operate after confusion is a costly property and is set in the most complex systems. Depending on the extent of load, there are three types of stockpile after confusion:
  - Unloaded operate after confusion – the backup elements do not bear any load but are included in case of failure of some of the main elements;
  - Relieved operate after confusion – the backup elements operate at a lesser load and are fully loaded in the event that some of the main elements are unable;
  - Loaded operate after confusion – a number of elements function equal to the basic elements - they carry a full load.
- **Keeping** – the property of the product remains in good working condition both during operation and transportation, keep it and use under defined requirement and for a defined period of time. Keeping characterizes the adaptability of the product to resist unexpected requirements, both in use and during transport and storage. Higher keeping is achieved by a definite processing.

Threats are things that can affect a system and cause a drop in Reliability. There are three main terms:

- **Fault**: A fault (which is usually referred to as a bug for historic reasons) is a defect in a system. The presence of a fault in a system may or may not lead to a failure. For instance, although a system may contain a fault, its input and state conditions may never cause this fault to be executed so that an error occurs; and thus that particular fault never exhibits as a failure.
- **Error**: An error is a discrepancy between the intended behavior of a system and its actual behavior inside the system boundary. Errors occur at runtime when some part of the system enters an unexpected state due to the activation of a fault. Since errors are generated from invalid states they are hard to observe without special mechanisms, such as debuggers or debug output to logs.
- **Failure**: A failure is an instance in time when a system displays behavior that is contrary to its specification. An error may not necessarily cause a failure, for instance an exception may be thrown by a system but this may be caught and handled using fault tolerance techniques so the overall operation of the system will conform to the specification.

It is important to note that Failures are recorded at the system boundary. They are basically Errors that have propagated to the system boundary and have become observable. Faults, Errors and Failures operate according to a mechanism. This mechanism is sometimes

known as a Fault-Error-Failure chain [2]. As a general rule a fault, when activated, can lead to an error (which is an invalid state) and the invalid state generated by an error may lead to another error or a failure (which is an observable deviation from the specified behavior at the system boundary).

Once a fault is activated an error is created. An error may act in the same way as a fault in that it can create further error conditions, therefore an error may propagate multiple times within a system boundary without causing an observable failure. If an error propagates outside the system boundary a failure is said to occur. A failure is basically the point at which it can be said that a service is failing to meet its specification. Since the output data from one service may be fed into another, a failure in one service may propagate into another service as a fault so a chain can be formed of the form: Fault leading to Error leading to Failure leading to Error, etc.

Since the mechanism of a Fault-Error-Chain is understood it is possible to construct means to break these chains and thereby increase the reliability of a system. Three means have been identified so far:

- **Fault avoidance**, aimed at preventing the introduction of faults during the development of the software. In this group are included all the techniques that look into the process of software development: standards, methodologies, etc.
- **Fault detection**, aimed at detecting faults once the code has been developed. These techniques focus on the product obtained rather than in the process.
- **Fault tolerance**, aimed at giving a controlled response for those uncovered faults. These techniques are used in safety-critical software.

Reliability means are intended to reduce the number of failures presented to the user of a system. Failures are traditionally recorded over time and it is useful to understand how their frequency is measured so that the effectiveness of means can be assessed.

Software process is the main object in Software Engineering and can be defined as the set of activities that aims to build software from a set of requirements. The software development organizations must be able to define, use and improve their software development process. Thus, an organization must define a standard process which consists of a set of necessary tasks that can be instantiated in any software development project. This standard process is a basis for defining the processes that are adopted for each project the company. These processes are known as instantiated processes that define how development projects will be executed. The reliability process in generic terms is a model of the reliability-oriented aspects of software development, operations and maintenance. The set of life cycle activities and artifacts, together with their attributes and interrelationships that are related to reliability comprise the reliability process. The artifacts of the software life cycle include documents, reports, manuals, plans, code configuration data and test data.

Software reliability is in general very immature. Software complexity is growing very fast and there is an urgent need for methodologies, techniques and tools supporting the validation of systems with high reliability requirements. Software reliability is still to be integrated in the normal development cycle as any other integral process and cannot be just considered at the end.

A number of analytical models have been presented in literature to address the problem of software reliability measurement. These approaches are based mainly on the failure history of software and can be classified according to the nature of the failure process. The various software reliability models may be categorized as failure rate model, fault count model, software reliability growth models, etc. [6]. Details about these models can be found in Musa et al. (1987), Goel and Okumoto (1979), Pham (2006), Lyu (1996). These reliability prediction models attempt to predict the reliability of the software in the later stages of the life cycle

(testing and beyond). Software systems are changed many times during their lifecycle. The software reliability models are best used for one milestone rather than over the entire product lifecycle [8].

A multitude of models have been proposed in the literature, but each has its drawbacks, some being shared by most models. A common problem with the reviewed models is that none allow for non-existent failure data, i.e., a software usage history with a known duration of time in operational use with no detected failures. Another problem shared by the models is that they support only rather modest reliability claims. There is no solution to this problem in sight.

Existing software reliability models don't take software systems complexity therefore the next step is expected to be the development of a model of reliability software. Things are furthermore complicated because the software under scrutiny never runs alone but is a part of a system consisting of hardware, operating system, interfaces, and possibly other programs. The figure 2 will be the basis of the future model. The software reliability model will specify the general failure rate and the principle factors that affect it:

- **Time;**
- **Fault introduction;**
- **Fault removal;**
- **Operational environment.**

The purpose of the model will be to transfer the properties of the figure 2 in the software system. Identifying key factors for reliable software helps achieve this goal They are:

- Organization culture that expects quality – this comes from the management and the senior technical staff;
- Precise agreement on requirements;
- Design and implementation that hides complexity – structured design, object-oriented programming;
- Programming style that emphasizes simplicity and readability;
- Software tools that restrict or detect errors – strongly typed languages, source control systems, debuggers;
- Systematic verification at all stages of development – requirements, system architecture, program design, implementation, and user testing.

Software reliability models are used for the estimation and prediction of software reliability. Some recommendations can be made on software reliability growth:

- Gather data on every failure:
  - Create a database that records every failure;
  - Analyze every failure:
    - Hardware;
    - Software;
    - Environment;
    - Human (e.g., operator error).
- Analyze the data:
  - Weekly, monthly, and annual statistics:
    - Number of failures and interruptions;
    - Mean time to repair.
  - Graphs of trends by component:
    - Failure rates of disk drives;
    - Hardware failures after power failures;
    - Crashes caused by software bugs in each component;
    - Categories of human error.
- Invest resources where benefit will be maximum:

- Priority order for software improvements;
- Change procedures for operators/users;
- Replacement hardware;
- Orderly shut down after power failure.

3. Software standards related to research of the reliability of software systems

Software standards play a very important role in software quality management.

Because of the importance of reliability as well as related attributes, there are hundreds of standards associated. Some are general but more are specific to domains such as automotive, aviation, electric power distribution, nuclear energy, rail transportation, medicine, software, and many others. Standards are produced by both governmental agencies and professional associations, and international standards bodies such as [9]:

- **The International Electrotechnical Commission** (IEC), Geneva, Switzerland and the closely associated International Standards Organization (ISO);
- **The Institute of Electrical and Electronic Engineers** (IEEE), New York, NY, USA;
- **The Society of Automotive Engineers** (SAE), Warrendale, PA, USA;
- **Governmental Agencies** – primarily in military and space systems.

Table 1 lists selected reliability standards from each of these agencies. Many of the standards deal with the same topic in slightly different ways. Differences depend on domain specific considerations, certification agency requirements, end user requirements, and product or system characteristics.

Table 1. Selected Reliability Standards

Organization	Number, Title, and Year	Domain
IEC	IEC 60812 Analysis techniques for system reliability - Procedure for failure mode and effects analysis (FMEA), 2006	General
IEC	IEC 61703 Mathematical expressions for reliability, availability, maintainability and maintenance, 2001	General
IEC	IEC 62308, Equipment reliability - Reliability assessment methods, 2006	General
IEC	IEC 62347,Guidance on system dependability specifications, 2006	General
IEC	IEC 62628 ed.1.0 b:2012, Guidance on software aspect of dependability, 2012	Software
IEC	IEC 62304 ed. 1.0 b:2006, Medical device software – software life cycle processes, 2006	Medical systems
IEC	IEC 60880 ed2.0 b:2006, Nuclear power plants – Instrumentation and control systems important to safety – Software aspect for computer-based systems performing category A function, 2006	Nuclear power plants
IEC	IEC 62278 Railway applications – Specification and demonstration of reliability, availability, maintainability and safety (RAMS), 2002	Railways

ANSI, IEC, AAMI	ANSI/AAMI/IEC TIR80002-1:2009, Medical device software – Part 1: Guidance on the application of ISO 14971 to medical device software, 2009	Medical systems
IEEE	IEEE Std 1633-2016, IEEE Recommended Practice on Software Reliability, 2016	Software
IEEE	IEEE Std 1044-2009, IEEE Standard Classification for Software Anomalies, 2009	Software
SAE	J1213/2- Use of Model Verification and Validation in Product Reliability and Confidence Assessments, 2011	General
SAE	SAE-GEIA-STD-0009, Reliability Program Standard for Systems Design, Development, and Manufacturing, 2008	General
SAE	JA 1002, Software Reliability Program Standard, 2012	Software
SAE	ARP 5890, Guidelines for Preparing Reliability Assessment Plans for Electronic Engine Controls, 2011	Aviation
SAE	J 2640, General Automotive Embedded Software Design Requirements, 2008	Automotive
ISO	ISO 26262-6:2011, Road vehicles – Functional safety – Part 6: Product development at software level, 2011	Automotive
RTCA	RTCA DO-178, Software Considerations in Airborne Systems and Equipment Certification, 2011	Aviation
U.S. Government	NASA-STD-8729.1, Planning, Developing and Managing An Effective Reliability And Maintainability (R&M) Program	Space Systems
U.S. Government	MIL HDBK 217F (Notice 2), Reliability Prediction of Electronic Equipment, 1995	Defense Systems

When applying standards, better performance is achieved in product manufacturing and service improvement. This meets the expectations of consumers and customers to a greater extent. As a result, reliability increases and the quality of products, processes and services are improved.

4. Methods for research the reliability of software systems

Software engineering methods provide "how-to" techniques to build reliable software. The methods consist of a list of tasks that include requirements analysis, project model, program design, testing and maintenance. This is the goal of *formal methods techniques* [3]. While various software engineering methods try to guide the software development, formal methods attempt to accompany the development with techniques ant tolls for finding and point out potential problems. Formal methods are a collection of notation and techniques for describing and analyzing systems. These methods are *formal* in the sense that they are based on some mathematical theories, such as logic, automata or graph theory. They are aimed at enhancing the quality of systems. Formal specification techniques introduce a precise and unambiguous description of the properties of systems. This is useful in eliminating misunderstanding, and can be used further for debugging systems. Formal analysis techniques can be used to verify that a system satisfies its specification, or to systematically seek for cases where it fails to do so. Formal methods can reduce the time it takes to find design or coding errors. They also significantly reduce the risk of damage incurred by not finding an error in a system before deploying it. The formal methods for software are refer to as software reliability methods.

The methods and needs of software reliability assessment and prediction vary by the phase of software development lifecycle [1, 4]:

- at the requirements and design phases, when no implementation is available, early prediction models can be used. Reliability must be analyzed based the architecture and stated requirements.
- at the implementation and testing phases, software reliability assessment is needed to make the stopping decision concerning testing and debugging: when the mean time to failure is long enough, the software can be released. Models most applicable here are reliability growth models.
- When the software is released, it is ordinary to assume that all observed faults have been debugged and corrected. Thus, after release, a reliability model is used to predict the mean time to failure that can be expected. The resulting reliability estimate may be used in system reliability estimation, as a basis of maintenance recommendations, and further improvement, or a basis of the recommendation to discontinue the use of the software.

5. Conclusion

Software reliability is a key part in software quality. The study of software reliability can be categorized into three parts:

- **Modeling**;
- **Measurement**;
- **Improvement**.

Software reliability modeling has matured to the point that meaningful results can be obtained by applying suitable models to the problem. There are many models exist, but no single model can capture a necessary amount of the software characteristics. Assumptions and abstractions must be made to simplify the problem. There is no single model that is universal to all the situations.

Software reliability measurement is naive. Software reliability cannot be directly measured, so other related factors are measured to estimate software reliability and compare it among products. Development process, faults and failures found are all factors related to software reliability.

Software reliability improvement is hard. The difficulty of the problem stems from insufficient understanding of software reliability and in general, the characteristics of software. Until now there is no good way to conquer the complexity problem of software. Complete testing of a moderately complex software module is infeasible. Defect-free software product cannot be assured. Realistic constraints of time and budget severely limits the effort put into software reliability improvement.

As more and more software is creeping into embedded systems, we must make sure they don't embed disasters. If not considered carefully, software reliability can be the reliability bottleneck of the whole system. Ensuring software reliability is no easy task. As hard as the problem is, promising progresses are still being made toward more reliable software. More standard components and better process are introduced in software engineering field.

Expected in the future to develop a methodology, including a phased approach to the assessment of safety and reliability that is commensurate with the main stages of design, implementation, operation and development of a software system.

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Models and Approaches of Internet of Things in Education

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Abstract. Internet has changed the way people communicate and more recenty, the emergence of Iinternet of Things (IoT), has changed the way items, devices and other "things" communicate. This paradigm is spreading almost everywhere in the last couple of years, including the area of education. This paper reviews harnessing IoT in learning processes. It makes an overview of various areas of application of IoT in education. Several models of integration of IoT in colleges are given. The way information is collected from objects, used in the process of education and the opportunities it presents, are provided.

Keywords. IoT, Education, Virtual academic communities, Intelligent education.

1. Introduction

The human world now is connected more than ever, Internet is everywhere - either by wired networks, cellular mobile network or satellites. As humans interact via the network, machines started also to interact between amongst themselves– the Internet of Things (IoT) was born. During the last couple of years, examples of meaningful and meaningless items communicating each other appeared - from toasters to toilets. The computers, laptops, tablets, and smartphones that constitute the bulk of IoT today, being joined by smartwatches, smart appliances, cars, lightbulbs, and an array of other devices that collect and transfer data, often without any human involvement. As the data is increasing and the technologies are advancing, we are moving from the early IoT of smart connections to a new phase, one of invisible integration [1].

IDC predicts that by 2020, there will be close to 30 billion connected devices [2] Today we define the IoT not only by its ability to connect devices (inside vehicles, buildings, wearables, and more) to a digital network, but also by its ability to directly integrate the physical world into computer-based systems. It is how people interact with this network of things that has become most interesting as the IoT has evolved [2].

Within two years, the IoT will be the single greatest source of data on the planet, but nearly 90 percent of that data will be "invisible" to traditional computing systems. This is where cognitive computing—such as IBM Watson—comes in says Chalapathy Neti Vice President, Education Innovation in IBM . Cognitive computing can process massive amounts of data from a full spectrum of sources and can help businesses makes sense of and act on that data. Cognitive computing is enabling businesses to take full advantage of this burgeoning resource—data—while allowing systems to learn at scale, reason with purpose, and interact with humans naturally [1].

In this paper, we shall look at the particular usage of IoT in the area of education. As Internet (of humans) is broadly used in process of education, IoT just has started to make his own way in this important field.

As of 2015, 73% of all U.S. teenagers had access to a smartphone, according to Capterra [1]. Nearly 100% of all U.S. public schools have Internet access [1]. And 70% of middle school students and 75% of high school students use laptops for educational purposes [1].

IoT in education has a 10-year net present value of US$175 billion, which will be delivered through streamlined and personalized instruction, collection of data for making better decisions, and reducing expenditure on instructional resources [1].

2. Examples of IoT in education

Teaching is not an easy job. Only half of the work involves class time and, depending on where that classroom is located, teachers may have very different objectives. Of course they want students to learn, but a much larger education system and government often dictate the "how."

Microsoft boasts that their newest products can start-up 80% faster, saving teachers time. This is fabulous, but that in itself does not mean a better education [3].

Employees at Bosch have done their part to improve the school "atmosphere." Climate control and energy saving measures are some of the places the IoT will hopefully be affecting students [3].

According Maggie Johnson, Director of Education and University Relations in Google, тhe IoT is already present on most college and university campuses in the form of security cameras, temperature controls, and access to buildings, lights, power, etc [1]. What's more interesting are potential benefits of increased connectivity that enhance teaching and learning or that provide new modes of operation. For example, ubiquitous access to computing power, high-quality online content, and social media and connections can be used to enhance the educational experience. Students can supplement their coursework with relevant video, activities, assessments, and conversations with students and faculty around the world. In addition, opportunities to do academic research on various aspects of the IoT are already under way in many higher education institutions—for example, the "living lab" at Carnegie Mellon University [1].

The foremost example of a tech company that has invaded schools is SMART, which pioneered the world's first interactive whiteboard in 1991 [1]. SMART boards changed the way teachers and students interacted in the classroom by moving lessons away from the dusty chalkboards that dominated education for decades [1].

The Open University in the United Kingdom revamped its undergraduate computer science curriculum and now offers an introductory course, My Digital Life, designed around IoT concepts [4]. My Digital Life places IoT at the core of the first-year computing curriculum and primes students from the beginning for the coming changes in society and technology. Rather than narrowly defining IoT as a technical subject, the course helps students view IoT as a tool for understanding and interrogating their own world, and recognizing their role in realizing IoT's [4].

- Interactive Learning studying today is not limited to the combination of texts and images but beyond that [5]. Most of the textbooks are paired with web-based sites that include videos, assessments, animations and other materials to support the learning. This gives a broader outlook to the students to learn new things with a better understanding and interaction with teachers and their friends;
- Wireless door locks - the security measure of the schools includes the door access control system which verifies visitors before unlocking outside doors for entry. One can unlock or lock doors remotely using mobile devices and also receive the notification for the same when someone has arrived on the door. At Bournville College

in the United Kingdom, Cisco Physical Access Control technology simplifies the process of managing access to classrooms, offices, common areas, school cafeteria and convention center, and more—400 doors total—while monitoring foot-traffic patterns on the main campus;

- Education at anytime and anyplace. Research has shown that access to real-time information and engagement with experts truly impacts learning [4]. One example is the Cleveland Clinic in Ohio, where human biology is taught to secondary schools through video conferencing based laparoscopic surgery [4]. One surgeon talks about the features and functions of the heart and the procedure while another performs the surgery. At the same time, students can ask questions. The result is increased motivation, with more learners aspiring to become nurses, doctors, or medical technicians;
- Environment control sensors. The Council Rock School District (CRSD) is the ninth-largest in Pennsylvania, with 1,400 full-time staff, 12,000 students at 10 elementary schools, three middle schools, and two high schools. CRSD's energy-savings program, "Go Green," helps the district apply monies saved on energy to other areas of its operating budget—funding programs or staff that might otherwise be subject to cuts. Through a state-of-the-art networking infrastructure, the district integrated its heating, ventilating, and air conditioning systems to monitor, control, and report energy use of network devices and facilities equipment. The process enables IT departments to power-off devices and computers remotely at a given time, wake up devices for maintenance work, or turn off devices during holiday and vacation periods. Cost savings generated from this program have been instrumental in helping the district continue to deliver high-quality education to its students. Since the program was launched in 2003, the district has cut power consumption by more than 40 percent, saving $8.8 million in 2012;
- Attendance tracking systems A strong school attendance system helps the teachers to input the necessary information directly into the system [5]. This will help the organization to minimize the time it takes to submit attendance data and allows school officials to send an electronic message to parents. It can also help to track the number of times a student has reported to the doctor and keep a check on student's medical needs and medication they may be taking. It also gives the choice to the student to confirm their meal for the day. IoT has a greater potential to remove all the barriers in education such as physical location, geography, language and economic status.

3. Models of integration and opportunities

As part of research project of Columbian national agency for fostering science, technology and innovation is proposed Integration Model of Virtual Academic Communities (VAC) with real word object thought the IoT [6]. In this model interaction is made in two spaces Physical and Virtual. Students teaches and marital objects such as classroom, laboratory, libraries are part of physical space. A virtual space is a non-physical space specifically designed for interaction of people and information, examples are social network, chat rooms discussion forums and emails. See Figure 1.

Regarding the objects that can be integrated into VAC following classification is proposed to be used [6]:

- Tagged objects – those are object that support some sort of identification and contains a level of information but does not support Internet protocols also known as "Non-IP Objects". Those devises usually communicate via RFID or NFC;

- Smart Objects, such object have some computing capabilities, allows them to sore and communicate data with the world surround them;
- Social objects: this type of object inherits the capabilities of smart object and tanks to them they may be part of a community of objects and are able to relate to each other independently to cooperate in certain activities;
- Virtual objects: they are digital elements that have a specific purpose, comprise a series of data and can perform different actions. They are characterized by a very flexible level of interaction that allows them to interact though interfaces with people, application/services or other objects.

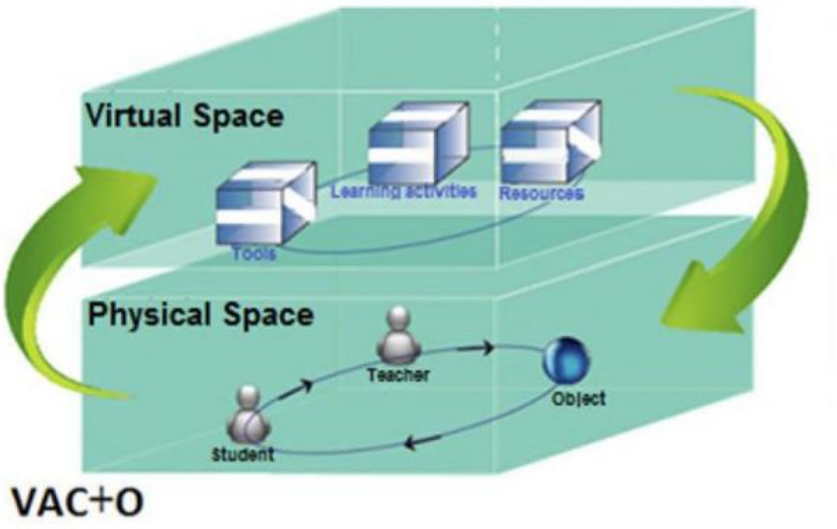

Fig. 1. VAC spaces: virtual and physical.

The integration of smart objects into VAC enables gathering of more data about activities in labs and new ways of interaction between actors in the VAC and objects. The objects go from being passive elements to becoming more involved in supporting the teaching learning process. Information collected will help teaches to understand the learning process in more details. Instructors could use this information to improve their feedback to students and to be more accurate in their advice to students.

Researchers assumes that IoT could help to improve teaching and learning experience enabling interatom between smart objects that are available in educational environments. However, they mentioned that there is still room for approving and optimizing interaction between objects in classrooms and labs.

Another object model proposed by Cisco [4] assumes there are four pillars that support IoT in education

- People;
- Process;
- Data;
- Things.

Actually, Cisco used term Internet of Everything (IoE) as it include IoT and Internet (of human) in next generation of bounding the universe.

People

Today, most people connect to the Internet using multiple devices and social networks. It is too soon to predict the channels people will use to connect to the Internet in the future—what is certain is that through such channels, people will be hyper-connected. The advent of massive open online courses (MOOCs) is another step toward global education. MOOCs are aimed at large-scale interactive participation and open access via the web [4]. Some of the world's leading universities are making their top professors available free of charge, and online forums that are linked to MOOCs will become spaces for new networks to develop and grow, connecting people from all walks of life and giving education to those who do not have access to high-quality content or instructors in their own locale. Therefore, free access to MOOCs and resources like Khan Academy (www.khanacademy.org) will improve the quality of life for many people who cannot afford a formal education. Furthermore, data generated from IP addresses will reveal how much time people spend on the course materials and in forums, which can help determine which factors —demographics, content, and topics — are most appealing and appropriate for a MOOC-type model. Not only will this information be useful to MOOC providers, it will also help other institutions developing both online and campus-based programs to provide a more individualized approach to teaching; and feedback on instruction, methodology, the process of delivering courses, and best practices for incorporating technology into learning. Such information will prevent students from dropping out of degree courses and help educators align curriculum to students' needs and learning preferences.

Processes

With the correct process, connections become relevant and value is added because the right information is delivered to the right person, at the right time, in an appropriate way. Ensuring that young people have access to learning opportunities that meet their needs will make education more efficient, improve time to mastery, and motivate learners. The "Internet of School Things" is one of the first projects to explore this approach [8]. Announced August 2013, the project—which includes eight U.K. secondary schools, grades 11 through 18—is designed to teach learners about the potential of connected everyday devices, using them to bring other subjects to life by collecting data in the areas of transportation, energy, weather, and health. The project is funded by DISTANCE, a consortium of IT companies and universities. Learners are also taught how to build their own products and sensors, easily bring them online, and monitor variables of their choosing. DISTANCE plans to create an information hub in the cloud that will enable the consortium to identify the incentives required to encourage educators, students, and businesses to share certain types of data openly for the first time. A platform and service layer will connect schools with third-party service and application providers, who can then supply Internet-enabled measurement equipment and interpretation software. In addition, DISTANCE will develop a range of apps and data visualizations that can be collected by schools, together with comprehensive curriculum-based activities for pilot schools to trial.

Data

As things connected to the Internet evolve, they will also become more intelligent, thereby providing more useful information. Rather than just report raw data, connected things will soon send higher-level information back to machines, computers, and people for further evaluation and quicker decision making. In addition to ensuring accurate research and working with and manipulating real data, learners could also contribute their content to data banks,

becoming members of expert communities in various research projects—from climate change, species identification, and archaeology to more. Sharing datasets with others around the world will enhance and extend students' learning experience, authenticating their research through active engagement with other researchers.

Things

Things are physical items that can be connected to both the Internet and people via sensors. Sensors give things a "voice": by capturing data, sensors enable things to become context-aware, providing more experiential information to help people and machines make relevant and valuable decisions. For example, smart sensors are being used today in bridges to monitor temperature, structural integrity, and traffic density in real time. In this way, students can learn physics using their portable devices to collect and observe the bridge at peak traffic times. Special education is another area where sensors can have a huge impact. In Australia, sensor gloves are being explored to provide feedback to children learning Auslan sign language from a computer. A learner attempts to sign while wearing the glove; the information is fed back to the computer, which gives the learner feedback on the accuracy of his/her signing.

Other aspect of integration of IoT in education is studied by Yacine Atif and Sujith Mathew in their publication "A Social Web of Things Approach to a Smart Campus Model" [7]. The researchers introduce the Ubiquitous Learning Model in which students are put in augmented reality and receive information Just-in-time personalized according their current needs. Contextual information is central to the effective realization of the smart campus initiatives as it facilitates personalized instruction. Context is formed around a number of roles and multiple data sources, captured through Cloud-based services and intelligent agents as exposed in Figure 2.

For the needs of smart campus scientists enhance IEEE LOM standard in so called Pervasive Learning Object Metadata. PLOM-Annotations ontology provides rich semantic-content to capture user experiences and feedback about the learning resource. PLOMLocation provides a record of how an object can be traced from the virtual space to its physical whereabouts. PLOMCapability ontology recognizes four capability dimensions of candidate pervasive learning resources to be Identity (ID), Processing, Communication, and Storage, referred to as the IPCS capability set [7]. PLOM-Profile matches the standard resource's LOM specification of the learning resources, and also integrates additional variables to enable social and ambient integration. PLOM-Capability ontology mandates the minimum requirement for a physical resource to participate in an ALS to be a unique ID within the application context of ALS. This taxonomy refers to resources as "Smart Learning Resource" when it has all four IPCS capabilities and referred to as pervasive when it accumulates all PLOM specification attributes, including LOM-based profile, location, social and the extensible annotations dimensions, as visualized on Figure 3.

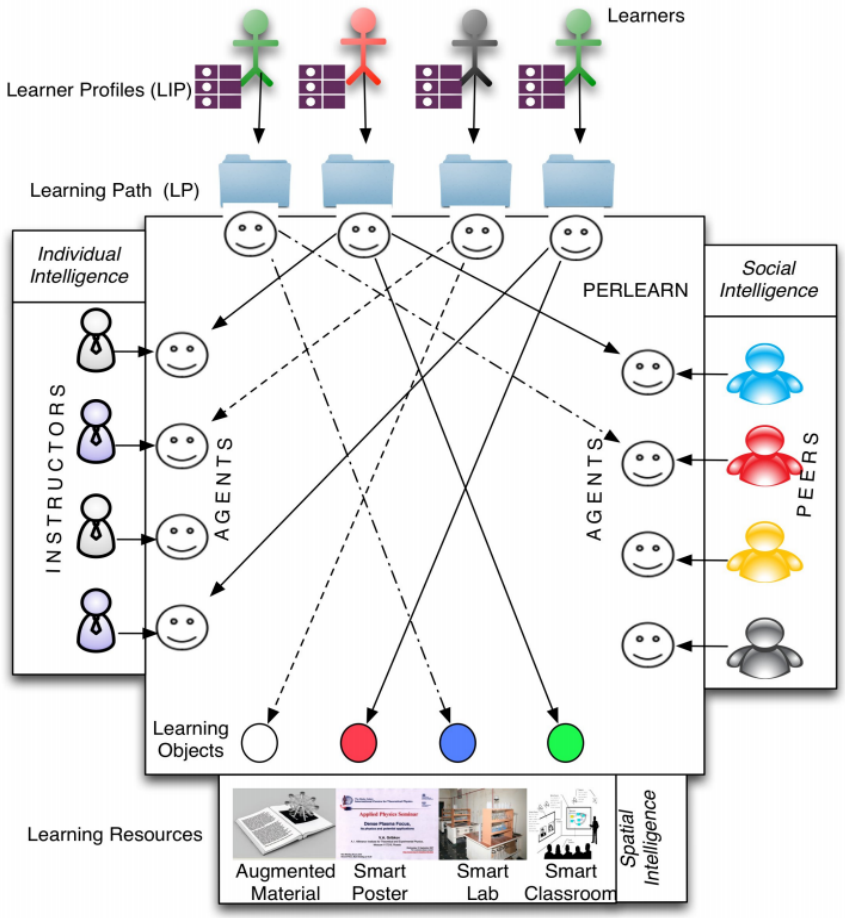

Fig. 2. Pervasive Learning Environment.

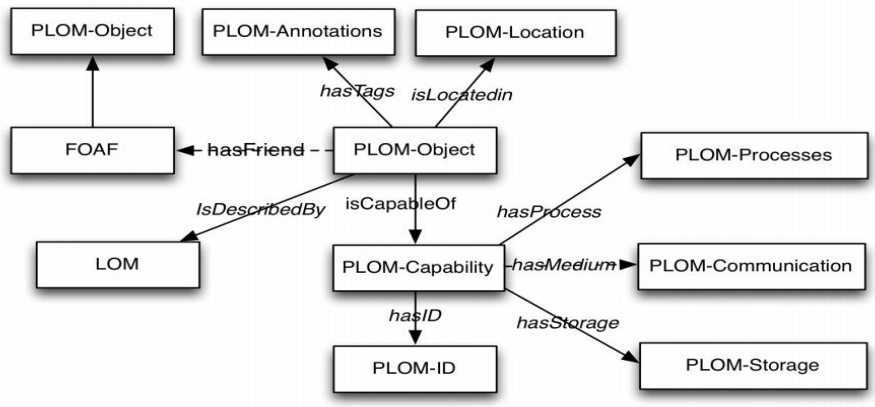

Fig. 3. Pervasive Learning Object Metadata

4. Conclusion

Combination of technology and education not only makes learning faster and simpler but also enhances the impact and quality among the students. There is still tough and long road ahead for the IoT to bring more transformations in the education sector. There are pioneers that are making first steps in this area by trail and failure. Different approaches are used and still moral of the story is being collected. It could say there is no unified approach to integrate IoT in education. The value added is still debate, but for sure in the future the automation of education and processes surrounding it will evolve.

This article is motivated of possible benefits and usage of IoT in education process. No doubt the VAC model could be used for planning and modeling integration of technology into education it gives only the frame and direction how to implement the interaction between different actors from physical and virtual world, but it stops there [6]. From practical approach "Smart Campus" continue to enhance the idea of integration of IT into education directly in the process itself as well as in surrounding environment where students leave and study [7]. All these models could be used as a base for integration of Cisco platform of Internet of Everything in education as provider of hardware [4].

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Technological Issues of Retrieving Information from Unstructured Data

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Abstract: This paper looks at various solutions and approaches that are used for retrieving information from Internet (as source of unstructured data). The paper presents theoretical statements from studied literary sources in field of data mining and web technologies. Finally, the conclusions summarizing the specifics of retrieval information process are presented.

Keywords: Information, Internet, unstructured data, data mining, web crawling

1. Introduction

The constant increase in the data in the global information space poses bigger challenges to information professionals. Due to its exponentially increasing volume and the diverse forms of its storage, it is increasingly difficult to find the necessary data among the vast multitude of scattered data [12]. This necessitates to find solutions to key questions: how to access and retrieve the data in an information environment such as the Internet; how to interpret, transform and record it in a form convenient to analyze. This paper will address two main aspects that answer these questions, namely: ways to extract information from textual data and data mining technologies from the Internet. In his study, Milev is of the opinion, that web scraping could be a part of data mining and web scraping could be defined as a first step within the data mining process, and data mining itself is a part of business intelligence [5].

2. Retrieving information from unstructured data

In this paper we will look at some of the basic approaches for extracting information from text data. Various techniques for this purpose are: machine translation, text generation, speech recognition, text mining, natural language processing [2]. We believe that the latter two are basic and are used in practice to extract information from unstructured data for the corresponding goals. The natural language processing encompasses various techniques that are based on language features: the text is analyzed syntactically using formal grammar information, and the resulting data is interpreted semantically to retrieve information from them. The natural language processing can be applied in depth (thoroughly) by analyzing each part of each sentence and interpreting it, or superficially by analyzing only some passages or phrases in sentences (limited semantic analysis). The natural language processing allows statistical means to be used to distinguish certain words or parts. This approach is used by many systems designed for automatic text translation [11].

Text mining has a very high commercial value. One of the goals of word processing is usually to strengthen the decision-making process and the internal operations of each organization and to generate new useful knowledge. The technique is applicable to knowledge management systems and is used to support the work of information professionals [12]. It is

used in business intelligent solutions with different uses, taking a key place in the architecture of this kind of systems. When it comes to the public sector, there are researches in this area, that describe the specifics of the architectures of their services [3, 4].

In the text mining approach basic analytical techniques related to information retrieval, statistics, and machine self-learning are used. The purpose of this approach is usually not to understand everything or even much of an author's writing, but rather to extract models for many documents. An example of the most elemental form of word processing for retrieving information, also called retrieving text or retrieving a document, is what ordinary search engines perform. In the text mining approach different activities are included, namely: automatic classification of text according to a certain set of categories; grouping of texts by general signs; automatic aggregation; extraction of topics from texts and analyzing thematic trends in textual flows [11]. In fig. 1 is showed process of information retrieving from text.

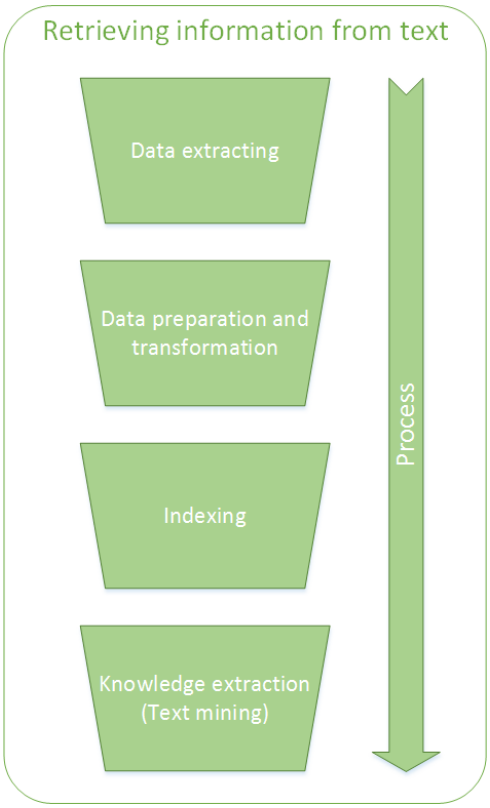

Fig. 1 Process of information retrieving

3. Technological approaches of web crawling

One of the main problems to solve when retrieving information from the Internet (as a huge source of unstructured data) is the physical access to the data. The data from the global network can be extracted by using the so-called web crawler or web robot [1]. The web crawler is software for automatic downloading of web pages. Very often the web crawler is also called a web spider. Web crawlers can be used for different needs, the most important being to index a large set of pages and allow a third party to search in this index. The web robot does not

move through computers connected to Internet, like a virus or intelligent agent. Instead, the web robot sends document requests to web servers whose locations are predefined. In fig. 2 is an exemplary web crawler architecture.

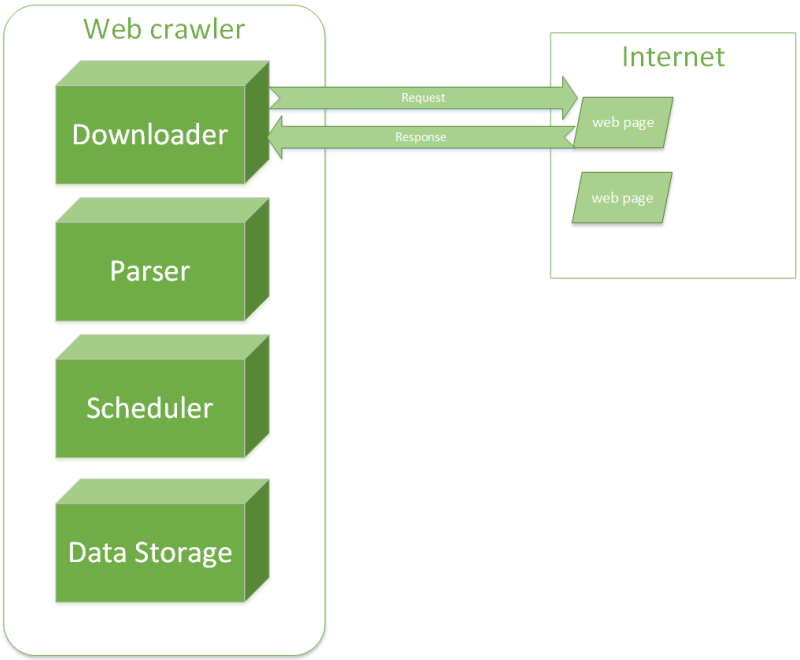

Fig. 2 Web crawler architecture

The process of this type of software is known as web crawling. Web crawling is an important method for collecting data and content in the rapidly growing Internet environment. This method can be defined as a search query (task) in a graph, since the Web is seen (considered) as a large graph, where its peaks represent web pages, and its ribs - web links (so-called hyperlinks). The crawling of pages by a web crawler is graphically represented in fig. 3.

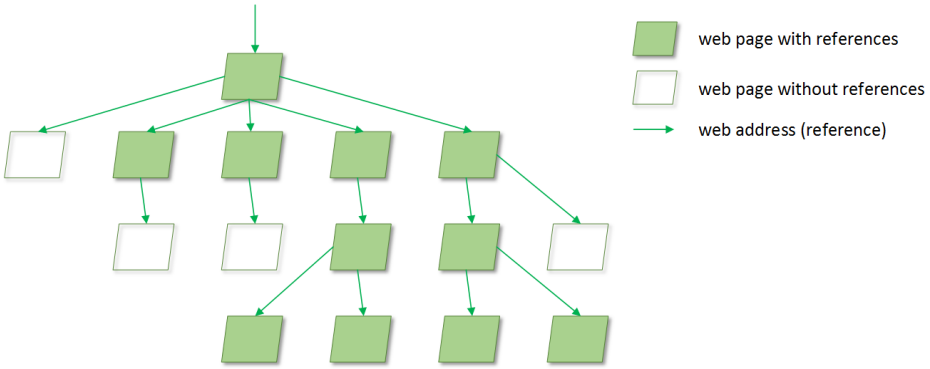

Fig. 3 Crawling of pages by a web crawler

There are different types of web robots. The type of a web robot is determined by the way the web pages are crawled and how successfully the following pages are accessed. There are some popular web robots, namely:

- Breadth First crawlers. One of the most basic types of web crawlers. Page crawling starts from a single web address and goes through the links found on the page without considering any of their characteristics [6];
- Incremental web crawlers. Their algorithms are geared towards optimized crawling of already visited and indexed webpages. The basic idea is to determine whether the content of a page has been changed and, if so, to re-visit and update the index data [1];
- Focused web crawler. A web crawler that works under certain criteria. Its way to crawl web sources is selective and not determined by keywords but by whole themes (or categories) [9]. We believe that the selective approach for extracting information from unstructured data on web-based sources is a key point because it allows to systematize certain groups of pages, and for each group there could be determined models for transformation of unstructured data into a structured form;
- Form focused web crawlers. Web crawlers specialized in crawling pages containing web forms. They access and use certain information [1];
- Hidden web crawlers. Web robots specialized in accessing private pages that are not visible and require completion of a form or any other action. Similar to form focused web crawlers, but unlike them, they have a mechanism for automated forms filling and clicking on web buttons [8];
- Parallel web crawlers. The crawling process is carried out in parallel by independent web robots that crawl through different data sources. The concept of parallel robots is applied to improve the crawling performance of a network [10];
- Distributed web crawlers. The crawl process is performed by parallel robots that synchronize their actions through a centralized server [1].

4. Conclusion

In conclusion, from the presented study of the possibilities of extracting information from unstructured data, it can be said that with the continuous increase of the data volume (mainly unstructured) in an information environment like the Internet, various techniques for accessing and processing data and transformation it into information and knowledge are created. In practice for data extraction various web crawlers are used. They vary in terms of principle of function and purpose. There are different approaches to process unstructured text data, the most common being text mining and natural language processing. Combining the techniques and approaches described above is a key to using the Internet as a data source to business intelligent systems.

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State of the Art JavaScript Application Development with Vue.js

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Abstract: Vue.js is a popular JavaScript front-end framework that was built to organize and simplify web development. It is an open-source progressive JavaScript framework for building user interfaces. Integration into projects that use other JavaScript libraries is made easy with Vue because it is designed to be incrementally adoptable. Vue can also function as a web application framework capable of powering advanced single-page applications. Components are one of the most powerful features of Vue. In a large application, it is necessary to divide the whole app into small, self-contained, and often reusable components to make development manageable.

Keywords. Vue, JavaScript, web application framework

1. Introduction

Vue is a progressive framework for building user interfaces. Unlike other monolithic frameworks, Vue is designed from the ground up to be incrementally adoptable. The core library is focused on the view layer only, and is easy to pick up and integrate with other libraries or existing projects. On the other hand, Vue is also perfectly capable of powering sophisticated Single-Page Applications when used in combination with modern tooling and supporting libraries [1].

Vue is an open-source progressive JavaScript framework for building user interfaces. Integration into projects that use other JavaScript libraries is made easy with Vue because it is designed to be incrementally adoptable. Vue can also function as a web application framework capable of powering advanced single-page applications [2].

A single-page application may retrieve all of the application's HTML, JavaScript, and CSS code on the initial load or may load resources dynamically to update in response to user interaction or other events. Other web apps, in contrast, present the user with an initial page that is linked to parts of the application on separate HTML pages, which means that the user has to wait for a new page to load every time they make a new request [3].

Angular.js is a similar JavaScript framework for building user interfaces that precedes Vue.js and has laid the basic principles of declarative element rendering of web pages. Vue.js is built on the principles of component-based interactive user interfaces introduced by the ReactJS framework.

2. History

Vue was created by Evan You after working for Google using AngularJS in a number of projects. He later summed up his thought process, "I figured what if I could just extract the part that I really liked about Angular and build something really lightweight without all the extra concepts involved?".

Vue was originally released in February 2014 by Evan You. The project was posted on Hacker News, Echo JS, and the /r/JavaScript subreddit the day of its initial release. Within one day, the project reached the front page of all three sites.

More recently, Vue has been rising rapidly in terms of GitHub star count, which makes it among the most popular open source projects on GitHub in general and the second most popular JavaScript framework/library (after React). It has recently surpassed other older and more established libraries such as Backbone.js, Angular 2 or even as of 2017: jQuery and Angular 1.x [2].

3. Reactivity

All variables in Vue are reactive. This means they are observable and can have watchers attached. Variables that change will automatically inform their peers of the change. On the Vuejs side, there is actually a very detailed description of this system.

For quick understanding, compare Vue's behavior to dirty checking in Angular. If something changes in Angular, it will start to search for that change. It will compare new values with old until no more changes are found, and it will update what is necessary. This takes time and eats up resources while correlating with the complexity of the application.

A reactive data system like Vue may need more initiation time upfront, but that is a good price to pay [4].

4. Declarative Rendering

Declarative rendering is the process of writing code with the intention of hiding the implementation details and focusing on the outcome [5].

Fig. 11

A HTML tag element is declared of type “div” with an attribute of type “id” with a value of “app”. Inside the “div” element is a Vue.js template, which specifies the variable message.

In the CSS the “id” attribute “app” has been assigned a color property.

First, we need to include the Vue framework JavaScript and then a new variable called “app” has to be instantiated with new Vue object. Inside the Vue object constructor, we need to pass options as follows: “el” specifies the selector for the HTML element, which will render the contents of our application; “data” specifies the variables, which we are used for the rendering.

The result of the execution is shown on the right side.

Fig. 12.

In the HTML, an element of type „div“is declared a v-bind element attribute. The v-bind attribute is called a directive. Directives are prefixed with v- to indicate that they are special attributes provided by Vue, they apply special reactive behavior to the rendered Document Object Model (DOM). Here, it is saying, “keep this element’s class attribute up-to-date with the color property of the Vue instance.” On the button tag is created a click event. We can use the v-on directive to attach event listeners that invoke methods on Vue instances.

The “Color” property specifies the class, which we use to change the class in the DOM.

In this method, we update the value of the color data property. We use the if statement to toggle the color. On the first click of the button, the color is switched to green, and on the next click, the color is switched back to blue.

The result of the execution is shown on the two figures above.

Fig. 13

5. Comparison

If we would like to implement the same functionality with plain JavaScript, it would be necessary to describe each event in the following way:

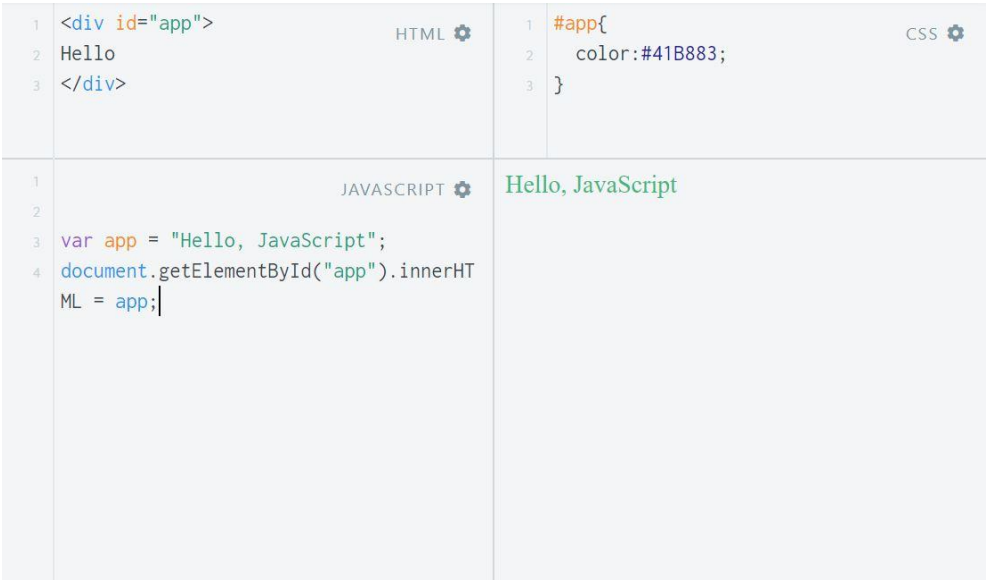

Fig. 14.

In this figure, we change only the text inside in “div” element. The JavaScript changes the text procedurally in contrast to the reactive method shown above.

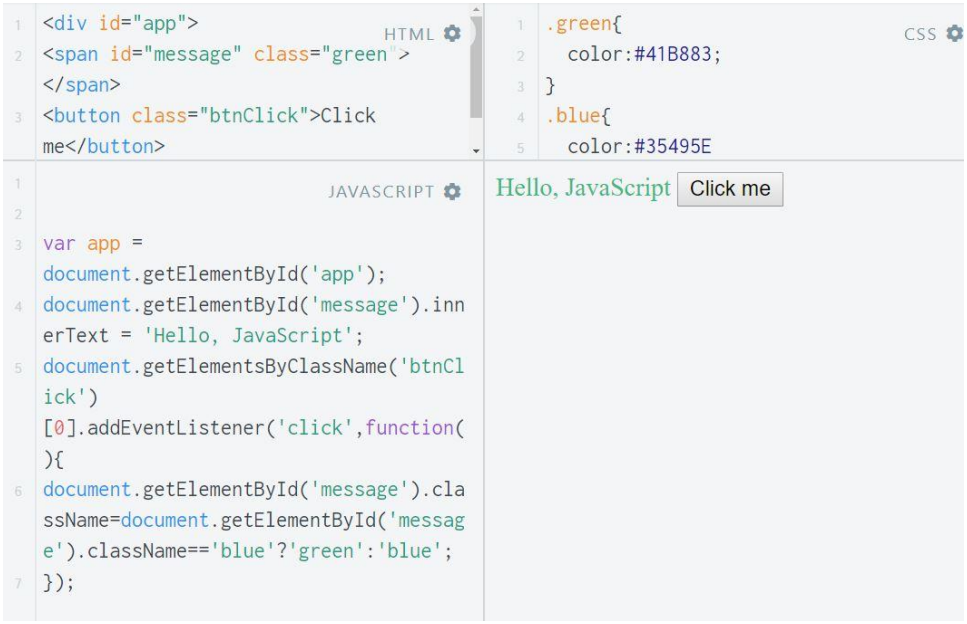

Fig. 15

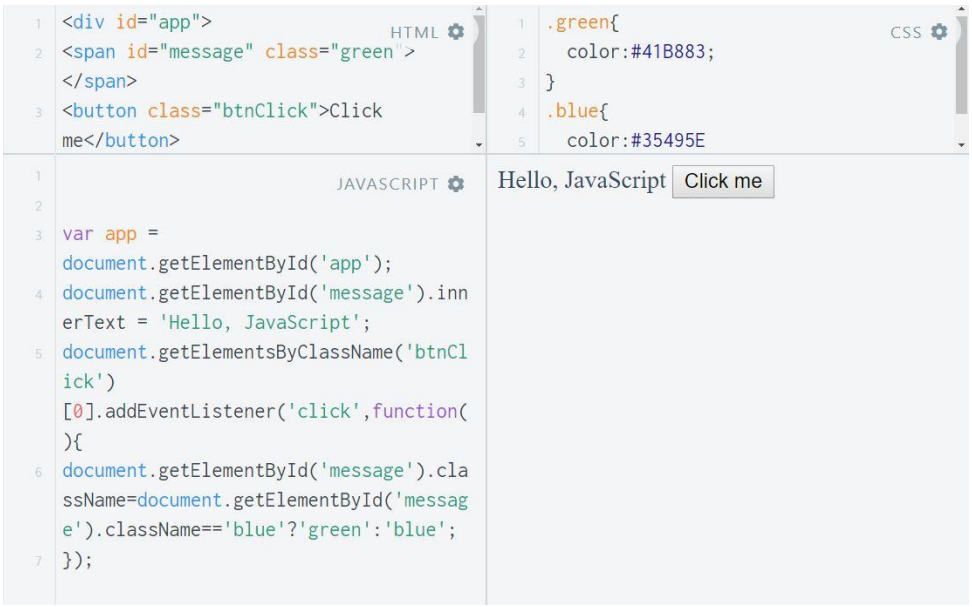

Fig. 16

As shown on the figure, when we click on the button color is changed, but this is plain JavaScript and this is in contrast to the reactive method shown above.

6. Conclusion

Vue.js continues to be a very active project and to be innovative and evolving. Vue works consistently in all supported browsers (IE9 and above). The same applies to plain JavaScript but if we compare them, we will notice that it performs slower than the plain JavaScript, because it includes a whole framework. Vuejs allows for a much better organization of the code and it is easier to maintain and develop. Additionally, the code will be easier to understand in the future. The Vuejs usage might surpass widely used frameworks like Angular and ReactJS.

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Opportunities for Improvement of the Information Systems for Human Resources Management in the State Administration

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Abstract: The paper is devoted to the problems of the improvement and development of information systems for human resources management in the state administration. An analysis of the main challenges facing this type of system is made. Outlining opportunities for improvement and development. The role of regulatory changes and changes in work processes is defined. At last, conclusions are formulated.

Keywords: Information systems, Public administration, Human resources.

1. Key challenges to information systems for human resource management

The management of human resources in the state administration is one of the most complex tasks. In this type of organization, the quality of end-to-end services provided to citizens and businesses depends to a large extent on the qualifications of the employees. In this sense, this paper, under the management of human resources, means the broad meaning of the term, which is related to the qualification of the employees and their motivation (fig. 1).

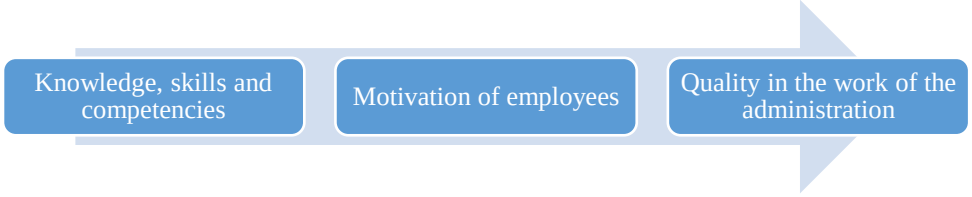

Fig. 1 Quality in the work of the administration

The knowledge, skills, competencies and motivation of employees are in the process of continuous improvement and development. In addition, many other processes are taking place in the state administration, which have an impact on overall work and quality. These are:

- Changes in working processes;
- Changes in job descriptions;
- Changes in the distribution of employee functions;
- Modernization of processes and services, such as those, described by Kirilova [1];
- Enhancing the qualifications of employees;
- Structural changes in administration;
- Regulatory changes;
- Technological changes;
- Changes in pay, etc.

All these changes represent challenges for the development of information systems for human resources management in the state administration. Changes can be classified into two main groups (fig. 2):

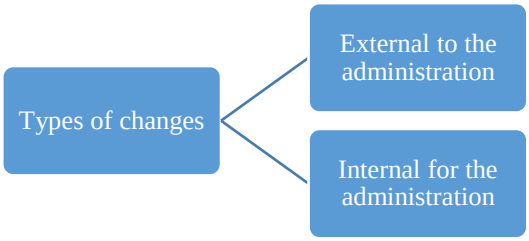

Fig. 2 Types of changes in state administration

In addition to the above classification, the changes that affect the information systems for human resources management in the state administration can be divided into:

- Those with permanent character;
- Cyclical.

These changes have different implications for the functioning and effectiveness of information systems for human resource management. Generally, part of the changes may require changes in system functionality, while others may cause loss of efficiency. Because of these most common challenges, human resources management systems should be subject to ongoing monitoring and risk assessment.

2. The Role of changes on the architecture of the information system for human resources management

The changes described above require changes in the different parts of the architecture of information systems for human resources management in the state administration. On the following architectural components:

- Database and data organization;
- Business logic and data processing rules;
- User Interface and visualization of the resulting information.

The graphical representation of these processes is given in fig. 3.

Permanent reporting of changes is a complex procedure. It requires the application of a specific methodology for reporting changes, analyzing their structure, and making changes to the human resources management information system. For these reasons, a proposal for a common methodology for improving the information systems for human resources management in the state administration is presented below. The methodology consists of the following steps:

- Identifying the range of changes;
- Determining their type and characteristics;
- Determining the architectural component of the system to which they relate;
- Redesigning the corresponding architectural component;
- Programming;
- Testing and commissioning;
- Training users to work with the new functionality.

It is important to note that these stages are exemplary and can be changed depending on the specific features of the state administration, as well as the functionality of the respective system. In fig. 4 is a graphically proposed step sequence.

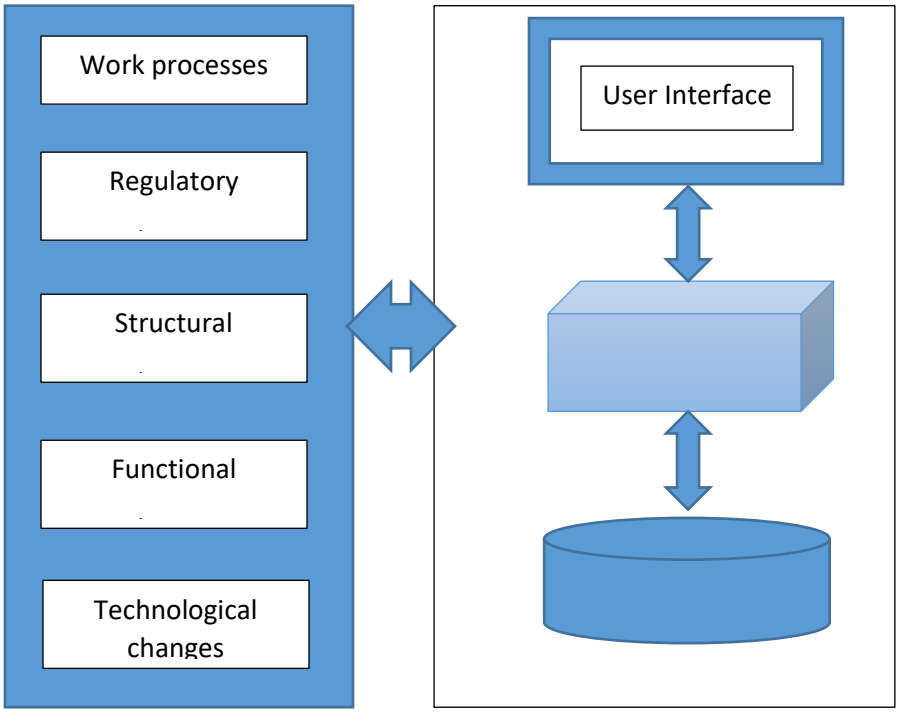

Fig. 3 Changes in the architecture of the information system

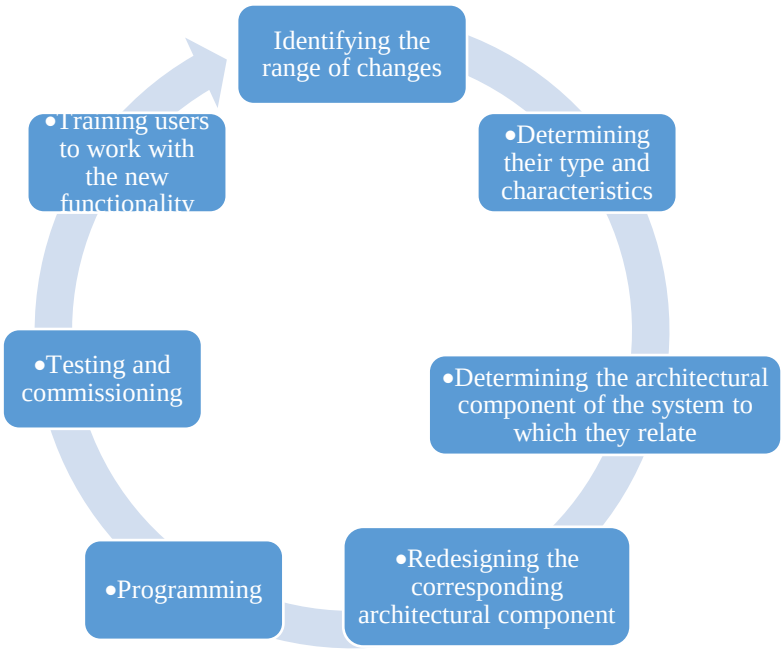

Fig. 4 Methodology for improving the information systems for human resources management

This methodology reflects an exemplary sequence of stages to achieve an on-going level of perfection in the structure and functionality of information systems for human resource management in the public administration.

3. Conclusion

At last, the following conclusions can be drawn:

- The management of human resources in the public administration is a complex and responsible task;
- Adequate information provision is necessary to solve this problem;
- Information systems should periodically be reassessed and updated based on changes in the environment.

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Financial Situations Forecasting Models for Forming the Enterprise's Strategy Subject to Industrial Development Regulations

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Abstract. The paper contains the complex of economic and mathematical forecasting models for financial situations of enterprises operating under conditions of uncertainty based on the concept of self-determination that provides the choice of perspective development alternatives under the threats. We have improved the financial situation diagnostics models of enterprises' economic activity based on recognition, identification and situation prediction, research of the enterprise's performance dynamics, which is the basis for qualitative strategic decisions.

Keywords. Forecasting, Financial situations, Models, Enterprises, Strategy

1. Introduction

Management of financial activity of industrial enterprises is characterized by high level of complexity of economic systems structure, as well as uncertainty and unpredictability of the processes taking place. The problems of developing forecasting financial management systems adapted to the specifics of management at each individual enterprise are qualitatively new, since in a modern market economy an enterprise is an independent subject of management, and national programs of development of branch complexes are not always formed taking into account the transformational processes of production systems development.

Therefore, in the context of the formation and implementation of new open forecasting systems of financial and economic management, the range of unresolved global and local problems is expanding, which necessitates the implementation of a number of functions in the formation of effective tools for forecasting and improving financial management systems, which is an important and necessary condition for increasing the efficiency of management.

The purpose of the article is to develop proposals for the reorganization of the system and management structure based on the development of models for forecasting financial situations for the formation of an enterprise strategy. This enterprise system should promote a reasonable increase in the autonomy of structural units in making decisions, reducing the passage of information flows, and expanding the participation of personnel in enterprise management, i.e. increasing the effectiveness of management in accordance with the selected set of strategic alternatives.

2. Stages of construction and realization of a complex of models of financial situations forecasting

Predictive financial management system of an enterprise should implement management functions and consist of two subsystems (Figure 1): a control subsystem – a

management system that implements management functions and a controlled subsystem – an object of management.

Management of financial activities of an enterprise is a complex multi-step interconnected process, which unites the decision of a set of tasks that need to be solved in the process of organization, management and development of an enterprise. Thus, the implementation of management functions aimed at solving local and global tasks of financial management, which justifies the need to build a set of models of financial management of an enterprise must ensure the continuity of management process, the parallel execution of various tasks, integration into one integrated complex of the whole synthesis of financial strategy, estimation of financial possibilities and efficiency of activity [1, 4, 7]. The development of this complex of models is a central and basic prerequisite for effective management of financial activity of an enterprise in an unstable market environment. The main stages of the construction and implementation of a complex of models of financial situations forecas and development of managerial decisions for the formation of an enterprise strategy development is shown in Fig. 2.

Thus, within the framework of the analysis of financial activity of an enterprise, the following tasks are foreseen: collection and processing of analytical and statistical information, assessment and analysis of financial condition and the results of financial activity.

The first stage of the proposed complex combines the task of defining goals, objectives and strategies for implementing financial activities of an enterprise. According to the priority directions of the financial development of an enterprise, the target programs that can be considered as management measures of the higher-level system and taking into account the external factors, a comprehensive strategy for the implementation of financial activity of enterprise can be formed. [2, 10, 12].

The second stage of the proposed complex is the formation of an information space for indicators for the assessment and analysis of financial activity of an enterprise [4, 15]. This stage combines the following tasks:

- formation of the information space of indicators of evaluation and analysis of the dynamics of financial activity. The result of the implementation is a representative system of financial indicators, for comparative analysis (spatial branch cut) and studying the peculiarities of financial situations of each enterprise (time cut);

- formation of a set of statistical criteria and substantiation of the standards of indicators change used in evaluation and analysis in different control circles. The result of the implementation is a comprehensive assessment of the state of main financial indicators of development based on normative values of indicators in the comparative and dynamic section of the study, adapted to industry standards.

The third stage involves realization of spatially-dynamic estimation of financial activity of enterprises in accordance with the chosen strategy of financial activity and the established system of diagnostic indicators [13, 15], by solving the following tasks:

- formation of groups of homogeneous objects in the implementation of spatio-dynamic sectoral classification of financial situations and competitive positions types, assessment of stability of cluster entities;

- recognition of financial situations of the internal and external financial environment of enterprises on the basis of a complex system of indicators and on separate local components of financial activity;

- assessment and analysis of indicators structure – sectoral qualitative analysis of the dynamics of changes in indicators (ranges of changes) in the selected clusters of states and a comprehensive assessment of financial activity of an enterprise.

At the fourth stage, the following tasks of forecasting the diagnostic indicators of internal and external environment of financial activity of enterprises are solved:

- forecasting of financial indicators of industry characteristics on the basis of tightness of their spatial relationship, allowing to take into account the peculiarities in of development dynamics typical for the enterprises of the industry under the study;
- forecasting of financial indicators of dynamics of an enterprise development on the basis of causal links of dynamics of their development and mutual influence;
- recognition of forecast financial situations and comprehensive analysis of the results of the forecast dynamics of general sector changes and trends of internal environment indicators.

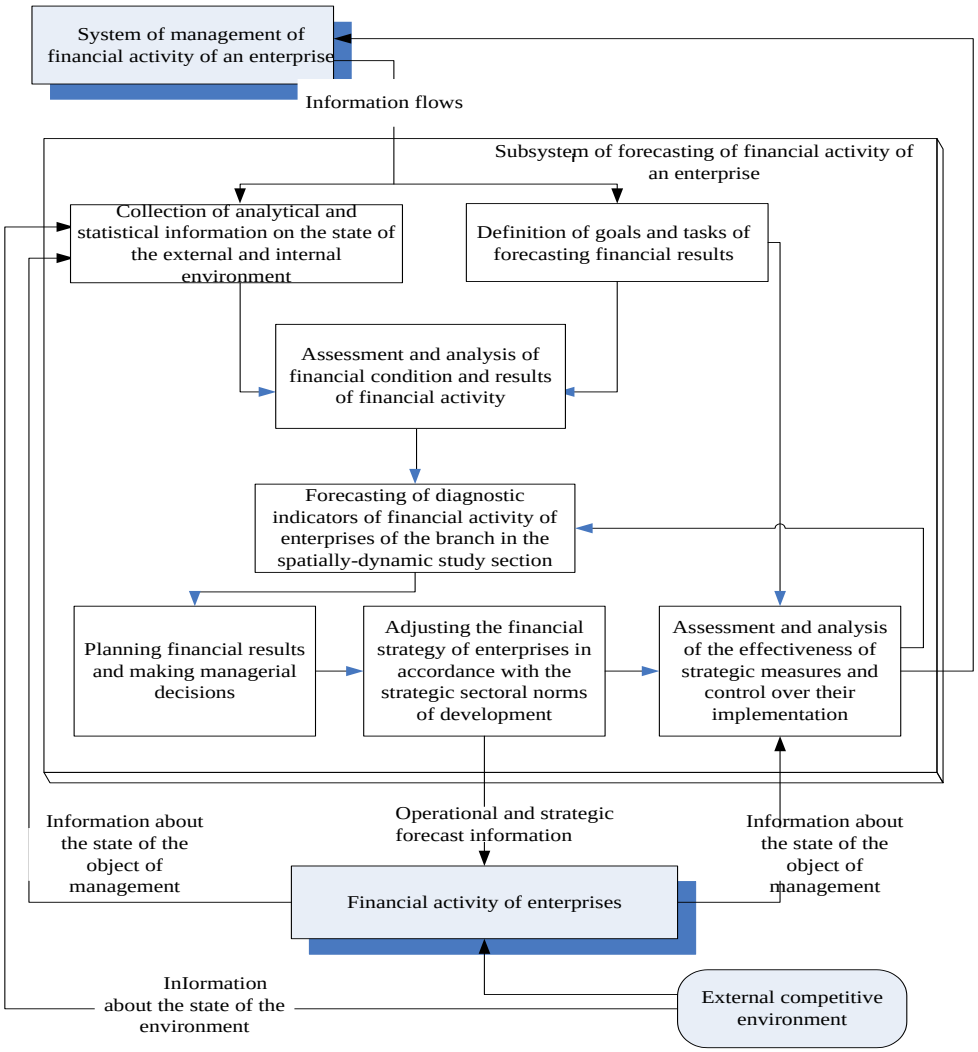

Fig. 1. Proposed structure of the system of an enterprise financial activity forecasting

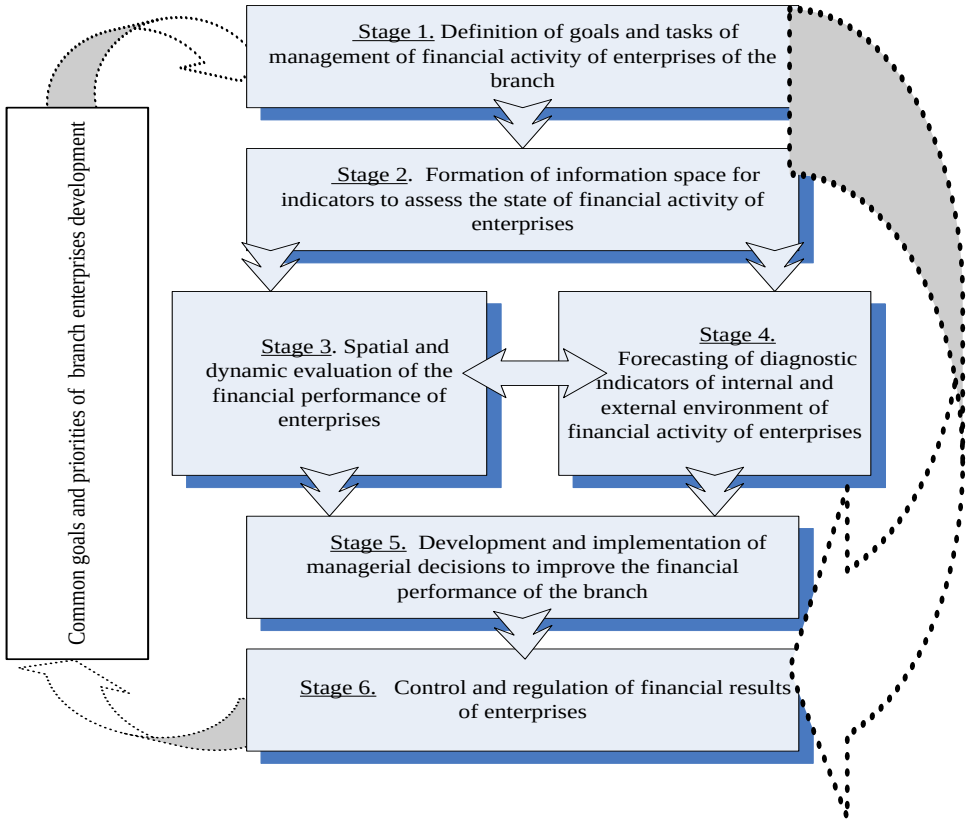

Fig. 2. The main stages of construction and implementation of a complex of models of financial situations forecasting

The fifth stage provides the solution of decision-making tasks for management of financial activity of an enterprise [2, 6]. Based on the prevailing set of financial situations and their forecast estimates in accordance with the general objectives and tasks the follwing activities are carried out:

- formation of a matrix of financial situations of current and predicted states of external and internal environment;
- simulation of management of financial situations and formation of possible scenarios of management;
- optimization of strategic norms of alternative financial management scenarios, according to the chosen criteria of efficiency.

The sixth stage involves solving tasks of control over the results of financial activities and regulation [11, 14]. These tasks are solved basing on the information of managerial decisions on the implementation of financial activities, information on general priority directions of development, target programs and market conditions. The task of control is to verify the correspondence of the results to certain goals and objectives, which may lead to the following situations:

- no deviation - effective management of financial situations, local goals have been achieved;
- deviations are insignificant – regulating tasks are solved, i.e. monitoring the causes

and possible deviations in destabilization of system functioning;

- significant deviation – an in-depth analysis of internal and external competitive environment and adjustment of goals and objectives of financial activity are carried out. On their basis the strategy and means of their realization in financial activitymanagement are reviewed.

Thus, the proposed set of models for forecasting financial situations and management of financial activities of an enterprise, which implements the functions of the predictive management system of financial activities of an enterprise can improve the quality and efficiency of the decisions by improving managerial tools.

3. Formation and selection of strategic alternatives, taking into account industry trends and forecasting financial state tendencies

Tasks of financial activity management of an enterprise require an integrated, systematic solution due to the complexity of financial processes and their interconnection, individual characteristics of each enterprise and their sectoral peculiarities of development, operating in conditions of uncertainty and influence of a large number of factors, need to use many conditions and criteria of management efficiency [1, 12, 13]. The complexity of solution of a set of tasks requires the use of modern tools for economic and mathematical modeling and forecasting. Therefore, the model means of supporting the implementation of the proposed set of financial management models play a crucial role in ensuring the effectiveness of its functioning.

For its effective functioning a financial management system should be based on the use of modern high-performance tools and economic and mathematical methods [11]. The paper proposes a tool for solving the selected tasks, based on the concept of management, on the use of managerial model basis and information technology, presented in Fig. 3.

The realization of the tasks of the first stage is the definition of goals and objectives of financial activity by instrumental methods is not considered in this paper, since the literature offers a large number of different methods and approaches, which are implemented in work [4, 7, 14].

The realization of the tasks of forming a complex system of diagnostic indicators for the evaluation of financial activity (stage 2) should be based on modern tools of formation of a sound system of indices of trends of an enterprise development in space and time [15], which allows a comprehensive methodology of robust statistical evaluation [16], expert [6] and factor analysis [16] to be implemented in work.

The basis of the solution of the tasks of spatially-dynamic evaluation of financial activity of enterprises (stage 3) is the complex use of tools of classification methods (cluster analysis) [16] and recognition (discriminant analysis) [16] in the dynamics of development of the investigated branches of industry, which allows to obtain complex and local assessment of financial activity of enterprises and is the basis for the formation of qualitative strategic decisions.

For realization of tasks of stage 4 – forecasting of diagnostic indicators of internal and external environment of financial activity of enterprises, the tools of econometric modeling [8, 9] and forecasting on the basis of panel data models of branch`s tipical indicators [5] and models of vector autoregression [8] for interrelated time series of indicators of dynamics of each particular enterprise are used.

Implementation of decision-making tasks on financial activity management (stage 5) is ensured by developing a matrix model of financial situations [2, 4] for choosing a strategy and implementation of management scenarios for external and internal environment of an enterprise by agreeing the forecast estimates of trends of the development of the company's

internal financial environment with the development of branches trends [2, 14]. The matrix of financial situations for the formation and selection of strategic alternatives, taking into account the trends of the industry and the forecast of financial state tendencies is presented in Fig. 4.

The matrix-positioning approach [1, 13] the comparison of the results of estimation of predicted and current financial situations and the trends of sectoral changes in the spheres of research is an effective tool for a comprehensive study of trends of financial development of enterprises, since it allows to identify and forecast the dynamics of indicators in general and in individual local areas, to determine characteristic tendencies and interconnections that are the basis of forming a complex of programs and preventive measures of management of financial and economic sectors transformations for different time horizons.

The aggregated characteristic of the proposed strategic alternatives of enterprise activities [7, 10, 12] in the field of mechanical engineering is presented in Table. 1.

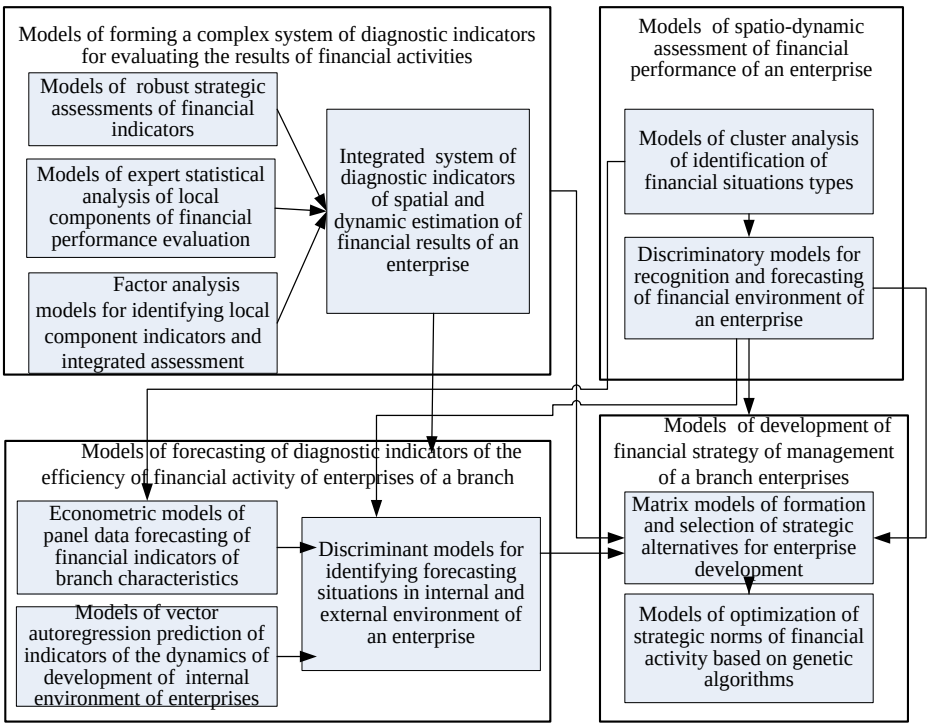

Fig. 3. Model basis for forecasting financial situations and developing a strategy for managing financial activities of enterprises

4. Management measures and decisions on optimization of strategy parameters depending on the type of financial situation

The solution of problem of optimal enterprise management, through the implementation of managerial scenarios aimed at raising the level of financial status and improving competitive positions at work are carried out using models based on genetic algorithms [3]. The genetic algorithm [3] is an algorithm for finding solutions to problems of optimization and modeling by random selection, combining and variation of the desired parameters using mechanisms that resemble biological evolution. Genetic algorithm is a universal method for optimizing multi-parameter functions, which allows to perform a wide

range of control tasks, among which one can distinguish: various tasks in graphs, bioinformatics, optimization of functions, scheduling, game strategies, approximation theory, artificial neural networks, optimization of queries in databases, tasks layout, etc. [3].

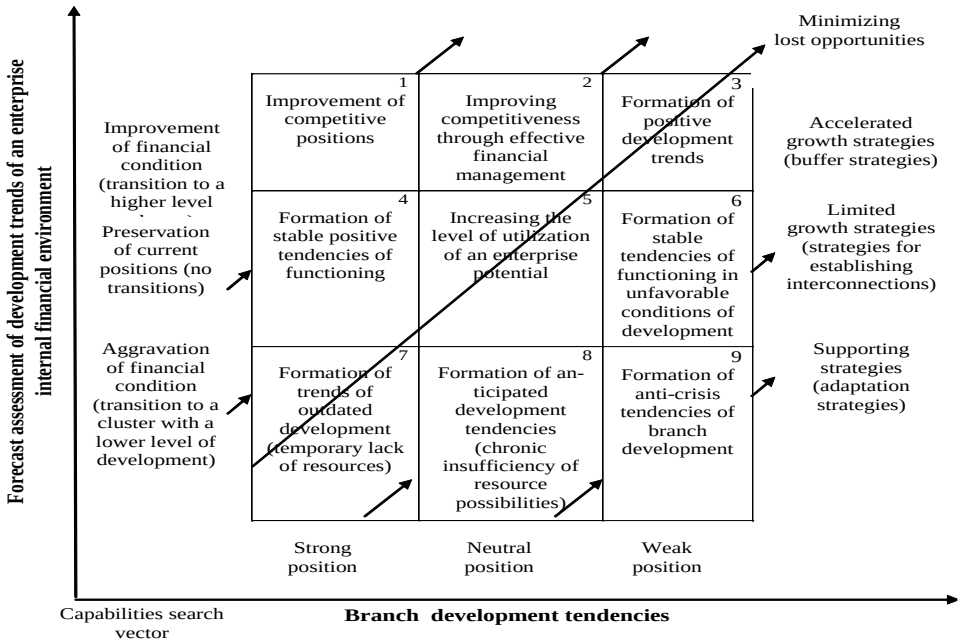

Fig. 4. The matrix of financial situations for the formation and selection of strategic alternatives of performance

Table 1. Characteristics of strategic alternatives of performance

Proposed strategy	Characteristics of strategy	Modification (typical substrategies)
Buffer strategies (accelerated growth strategies)	These strategies are useful when an enterprise gains authority and strives to streamline its own inputs and outputs, as well as during times of fragility in the industry or in periods of major conflicts with the structural units of the environment, when it is important for organizations to maintain their relative independence from some objects of external environment to get freedom in the realization of their own goals.	The strategy of autonomy from the environment, or the strategy of creating reserves, when an enterprise, by storing raw materials, accumulating information, accumulating other resources, becomes independent to some extent (for a certain period of time) from other organizations
		The strategy of strengthening control over the entrance and exit of an enterprise that shows itself primarily in the organization's rigidity with respect to the environment in order to limit itself from the adverse external influences.
		The strategy of expansion, when isolation from the environment is achieved by expanding an enterprise or gaining an increasing share of the market.

		In this case, an enterprise inevitably puts up the resistance to the external environment (at least passive) and very rarely it feels a need for help and cooperation
Strategies for establishing interconnections (limited growth strategies)	The main goal of an enterprise in choosing and implementing strategies for establishing interconnections is to organize the organization's relations exchange, to expand the boundaries of business contacts, to acquire new spheres of influence in external environment. These strategies include the interdependence of different organizations, the control over each other, primarily on the basis of trust. This strategy implements the competitive advantages of management system and management object	The strategy of concluding transactions is the constant desire of an organization to establish new relationships with various objects of external environment, allowing the organization to fit organically into external environment for the expansion of production and a successful balance between the input and output of the system
		The strategy of mutual diffusion consists in an interpenetration of separate directions of activity of several (at least two) enterprises. In particular, it may be a joint implementation of a product, a constant mutual assistance in the search and use of necessary information, a joint research , a mutual financial support
		The strategy of merging or integration is a merge of several enterprises into a corporation or an integrated organization for the most effective activity in external environment. During the implementation of the merger strategies, the most viable and multidisciplinary companies may emerge
Adaptation strategies (supporting strategies)	These strategies are aimed not only at the survival of enterprises in the external environment, which is typical for Ukrainian enterprises, but also for the long-term sustainable development, taking into account the threats and opportunities of internal and external environment. These strategies realize the competitive advantages of management optimization system	Cost-minimization strategies are one of the global strategies for doing business and competition, It involves lowering the full costs of goods production or services provision and, accordingly, selling price-cutting, in order to attract consumers and obtain additional financial resources
		Focusing strategies are the concentration of efforts of an enterprise on servicing a rather narrow segment of the market, which allows to achieve certain competitive advantages at the expense of considerable specialization
		Differentiation strategies involve the production of a larger range of products or the expansion of the range of services provided while maintaining their overall functional orientation
		Rapid Response Strategy involves a high level of use of the principle of a feedback in management, based on a rapid adaptation to changing external and internal environment by minimizing the risk of lost opportunities

Optimization of strategic norms of alternative scenarios of financial activity management in accordance with the chosen efficiency criterion is carried out in the corresponding quadrant of the matrix of financial situations on the basis of implementation of genetic algorithms on neural networks. To select the functional financial strategies of an

enterprise in the field of management of fixed assets, financial stability, liquidity, profitability and business activity, it is suggested to use a three-component indicator of financial situation of an enterprise, which is expressed by the formula

$$FS = \{P, D, S\} \quad (1)$$

where P is an indicator characterizing the current class of states of the internal financial environment of an enterprise; D is an indicator reflecting the class of the forecast state of the internal financial environment of an enterprise; S is an indicator reflecting the class of the forecast state of the external financial environment of enenterprise.

Thus, local indicators can be represented by the following combination:

$$P = (P_1, P_2, P_3); \; D = \{D_1, D_2, D_3\}; \; S = (S_1, S_2) \quad (2)$$

Where P_i is the classes of states of the internal financial environment of the enterprise, which are classified as follows: (1 – strong, 2 – neutral and 3 – weak competitive position of the enterprise); D_i is the directions of the company's transition according to the forecast estimates that are classified according to the following scale: (1 – a transition to the higher class of financial condition; 2 – a lack of transition, maintaining current positions; 3 – a transition to a class with a lower level of financial condition); S_i is the classes of the forecast state of the environment (1 – a favorable external financial environment, 2 – the aggressive effect of the factors of the external financial environment).

The development of directions for the reorganization transformations is an important and necessary condition for the actualization of the financial management system [7, 11]. In order to determine the need for their conduct, an assessment of the adequacy of the development of enterprises to the requirements of the internal and external environment should be made on the basis of evaluation and analysis of the results of functioning of both individual components and the enterprise as a whole and compare them with their own and industry forecast values. If there are negative trends, we can conclude that there is an urgent need to implement certain strategic measures and adjust the development strategy.

Managerial measures and decisions aimed at raising the level of financial situation and improving the competitive position of a branch wich depending on the type of financial situation is presented in Table. 2.

Table 2 – Managerial measures and decisions aimed at raising the level of financial situation and improving the competitive position of a branch

Type of financial situation	Characteristics of the situation	Managerial measures and decisions on optimization of strategy parameters
1	2	3
FS ={1, 2, 1}	The situation is characterized by a strong competitive position of a company, which lasts in the forecast period with an increase in the level of business activity in a branch	A strategy of sustainable growth without changing the current financial strategy parameters (there is no need for comprehensive measures to reorganize activities at a given time period, but it is necessary to plan all possible restructuring reorganizations in the future that will use the active development strategies)
FS ={1, 2, 2}	The situation is characterized by a strong competitive position of a company, which lasts in the forecast period with a decrease in the level of business activity in a branch and the negative impact of environmental factors	
FS ={2, 1, 1}	The situation is characterized by the strengthening of the competitive position of a company due to the effective financial	

	management with positive trends in the development of a branch and the improvement of the environment	
FS ={2, 2, 2}	The situation is characterized by the preservation of the neutral competitive position of a company in case of negative trends in branch development	Sustainable growth strategy based on partial adjustment of current financial strategy parameters (requires a partial reorganization of those areas that are in line with the positive trends of the branch and have the most negative projections (depending on the depth, importance and urgency of the transformation), which will be characterized by the preservation and maintenance of competitive positions)
FS ={3, 1, 1}	The situation is characterized by a weak competitive position, which strengthens in the forecast period with the positive trends in the development of a branch.	
FS ={3, 1, 2}	The situation is characterized by a weak competitive position, which strengthens in the forecast period with the positive trends in the development of a branch.	
FS ={1, 3, 1}	The situation is characterized by a strong competitive position of a company, which it may lose in the forecast period with the positive trends in a branch. The enterprise does not use new possibilities of financial development, which testifies to the inefficiency of financial management	The strategy of accelerated growth by identifying hidden reserves and focusing on the parameters of enterprises of a higher level of development (the situation shows an unevenness and inconsistency in management of resource potential and high decentralization of management functions. In this case, the process of transformational changes in management should be initiated from the top, being conducted urgently and intensively, supporting the priority of development according to the spheres of positive change)
FS ={1, 3, 2}	The situation is characterized by a strong competitive position of a company, which it loses in the forecast period with the negative trends in a branch. The enterprise has a low level of adaptability to the external threats, which testifies to the inefficiency of financial management	
FS ={2, 2, 1}	The situation is characterized by the preservation of the neutral competitive position of a company with the positive trends in a branch. Enterprises do not fully utilize the potential of financial development	
FS ={2, 3, 1}	The situation is characterized by a neutral competitive position of a company, which it loses in the forecast period with the positive trends in a branch. The enterprise does not use the new possibilities of financial development, which testifies to the inefficiency of the enterprise's financial management apparatus	A strategy of limited growth through optimization of resource potential and labor resources while focusing on the parameters of enterprises of a higher level of development in order to maintain and improve the development of a branch in whole (there should be an urgent reorganization of the process of financial and production resources management aimed at preventing the development of crisis situations both at each seperate enterprise and in a branch in general)
FS ={2, 3, 2}	The situation is characterized by the neutral competitive position of a company, which it loses in the forecast period with the negative trends in a branch. The enterprise has a low level of adaptability to external threats because of the inefficiency of financial management	
FS ={3, 2, 2}	The situation is characterized by a weak competitive position, which is maintained in the forecast period with the negative	

	trends in a branch. An enterprise can not withstand the negative environmental factors due to the inefficiency of financial management	
FS ={3, 2, 1}	The situation is characterized by a weak competitive position, which is maintained in the forecast period with the positive trends in a branch. The enterprise does not use the new possibilities of financial development, which testifies to the necessity of reorganization of the financial management system	

Inefficiency in the implementation of managerial decisions is implemented through the implementation of control and regulation, taking into account the individual nature of specific causes in case of significant deviations of results from certain goals of financial activity, which determines the need to study more additional factors of influence and the impossibility of studying the characteristics of the occurrence of financial situations in each enterprise of the industry that are typical for each of them.

5. Conclusions

Successful functioning of industrial enterprises in the branch is possible when they have an opportunity to respond adequately to changes occurring in the internal and external environment, i.e. synchronously, in accordance with the depth and speed of the latter, which requires the internal transformation of financial and economic interrelations, which in a transient transformational environment become an integral part of life. Improving the management of a company's financial activity by introducing the proposed toolkit in accordance with the principles of heterarktion, multivariateness, rationality and diversity, as well as adaptive efficiency of production system will add the necessary flexibility, the possibility of self-development, and create conditions for the effective implementation of the established set of management strategies for each of the local components of financial activity, which function to achieve common agreed development goals.

Thus, the following elements have been improved in the work as a model tools towards financial situations forecasting models for forming an enterprise's strategy taking into account the industrial development regulations:

- the development models for forecasting financial situations for the formation of an enterprise strategy;
- set of models of financial situations forecasting and financial management of an enterprise that implements the functions of the forecasting system of financial management of an enterprise and allows to improve the quality and efficiency of the decisions by improving the management tools;
- the matrix of financial situations for the formation and selection of strategic alternatives, taking into account trends of the industry development, forecast trends and financial conditions.
- the management measures and decisions on optimization of strategy parameters depending on the type of financial situation.

The implementation of the developed modeling tools will improve the efficiency of functioning of the forecasting system of financial activity management of an enterprise, which ensures the implementation of management functions, based on modern economic and

mathematical tools, and improving the management system of financial activities of an enterprise will improve the efficiency and effectiveness of production and economic activity of enterprises and branch as a whole.

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