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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-2018)****, http://icaictsee.unwe.bg/, which took place on November 18-20th, 2018 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 45 published research papers (13 from foreign participants), the explosion of fresh ideas and the establishment of new professional relations.

Dimiter G. Velev
ICAICTSEE-2018 Chair

CONTENTS

Analyzing Emotional Exhaustion of a Medical Center in Taiwan from Viewpoints of Physicians and Nurses

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Abstract. This study applies independent sample t test for mean differences and analysis of variance to observe if physicians and nurses with different demographic variables from a medical center in Taiwan perceive emotional exhaustion differently from the 2017 internal surveyed data based on the Chinese version of the safety attitudes questionnaire. The results show that female employees have significantly higher perceptions in recovering emotional exhaustion than male employees. Physicians are more satisfied than nurses in recovering emotional exhaustion statistically. Employees who are supervisors/managers have higher perceptions in eight out of nine questions statistically. Moreover, employees with different age groups, direct patient contacts, and educations have different perceptions in emotional exhaustion statistically.

Keywords. Emotional exhaustion, Safety attitudes questionnaire, Analysis of variance, Independent sample t test, Bonferroni.

1. Introduction

Emotional exhaustion is one of eight dimensions from the Chinese version of the safety attitudes questionnaire (SAQ) since 2014 [1]. Emotional exhaustion is one of three dimensions from Maslach burnout inventory-human services survey (MBI-HSS) and is the mainstream measure to evaluate burnout [2]. Burnout defined by Shanafelt [3] can be described as losing enthusiasm for work, treating people as if they were objects, and having sense that the work is no longer meaningful. Studies have shown that burnout might have negative impacts on healthcare quality. For instance, Shanafelt et al. [4] concluded that physicians' overwork, stress, and fatigue are contributing factors to medical errors. An increase in nurses' workloads might

result in higher infections because nurse burnout is linked to job dissatisfaction and patient healthcare quality [5].

Physicians and nurses are core staffs in healthcare organizations that have direct contacts with patients [6]. Understanding their attitudes toward the patient safety culture particularly emotional exhaustion is critically important to help hospital management make proper policies and strategies to improve the patient safety culture of healthcare organizations and further reduce the potential medical errors when hospital staffs having higher degree of burnout are found [7,8]. Therefore, it is essential to assess the physicians' and nurses' attitudes toward burnout in order to provide better medical services for patients [2,8].

Lee et al. [2] identified that supervisor/manager, job position, age, experience in organization, and experience in position are critical variables in emotional exhaustion in a regional teaching hospital in Taichung City, Taiwan. Their study also showed that hard work and working with people all day and directly are particularly important items in emotional exhaustion followed by fatigue and emotional drain. In Taiwan, the physicians' and nurses' workloads particularly in terms of the number of patients in medical centers are heavier and busier than those in teaching hospitals. It would be of interest to observe how physicians and nurses in a medical center perceive in emotional exhaustion.

2. Review of Emotional Exhaustion

In Taiwan, the patient safety culture in healthcare organizations is evaluated by the Chinese version of the safety attitudes questionnaire from medical staffs' viewpoints. The Chinese version of the SAQ developed by the Joint Commission of Taiwan is based on the short form of the safety attitudes questionnaire developed by Sexton et al. in 2006, which has six dimensions together with 30 questions [1,7]. The current Chinese version of the SAQ has eight dimensions and 46 questions in total and emotional exhaustion is one of eight dimensions and has been added to assess medical staff's the degree of burnout since 2014 [1,2]. Emotional exhaustion is borrowed from Maslach burnout inventory-human services survey, which is a validated tool to assess burnout with three dimensions (i.e., emotional exhaustion, personal accomplishment, and depersonalization) and 22 questions [7].

Emotional exhaustion has night questions as shown in Table 1. In healthcare organizations in Taiwan, each staff is required to answer all of the questions in emotional exhaustion using a five-point Likert scale which ranges from strongly agree to strongly disagree [1]. All of the questions are negative wordings such that each respondent's answer is adjusted. For instance, the original answer of strongly agree in Question 1 (I feel like I'm at the end of my rope.) indicates the poor perception of emotional exhaustion. In this study, the adjustment is to use numerical value of one to replace the numerical value of five if the original answer is strongly agree. By the same token, the answers from the other items are also adjusted.

Table 1. Nine questions in emotional exhaustion

Question
1. I feel like I'm at the end of my rope.
2. I feel burned out from my work.
3. I feel frustrated by my job.
4. I feel I'm working too hard on my job.
5. I feel emotionally drained from my work.
6. I feel used up at the end of the workday.
7. I feel fatigued when I get up in the morning and have to face another day on the job.
8. Working with people all day is really a strain for me.
9. Working with people directly puts too much stress on me.

3. Research Method

The purpose of this study is to observe how physicians and nurses with different demographic information from a medical center in Taichung City, Taiwan perceive emotional exhaustion based on the Chinese version of the SAQ conducted in 2017. All of the physicians and nurses are required to fill out nine questions in emotional exhaustion by a 5-point Likert's scale, where 1 and 5 represent strongly disagree and strongly agree, respectively. By removing incomplete questionnaires, the number of effective questionnaires is 1036. The physicians' and nurses' demographic variables in terms of gender, age, supervisor/manager, job position, job status, experience in organization, experience in position, education, and direct patient contact are provided in Table 2.

Table 2. Physicians' and nurses' demographic information of this medical center in 2017

Demographic Variable		Frequency	Percentage
Gender	1. Male	205	19.8
	2. Female	831	80.2
Age	1. Less than 20 years old	4	0.4
	2. 21-30 years old	429	41.4
	3. 31-40 years old	336	32.4
	4. 41-50 years old	190	18.3
	5. 51-60 years old	66	6.4
	6. 61 years old and above	11	1.1
Supervisor/Manager	1. Yes	115	11.1
	2. No	921	88.9
Job Position	1. Physician	233	22.5
	2. Nurse	803	77.5
Job Status	1. Full Time	993	95.8
	2. Part Time	32	3.1
	3. Agency	4	0.4
	4. Contractor	7	0.7
Experience in Organization	1. Less than 6 months	98	9.5
	2. 6 to 11 months	29	2.8
	3. 1 to 2 years	185	17.9
	4. 3 to 4 years	143	13.8
	5. 5 to 10 years	219	21.1
	6. 11 to 20 years	281	27.1
	7. 21 years and more	81	7.8
Experience in Position	1. Less than 6 months	117	11.3
	2. 6 to 11 months	29	2.8
	3. 1 to 2 years	212	20.5
	4. 3 to 4 years	145	14.0
	5. 5 to 10 years	236	22.8
	6. 11 to 20 years	244	23.6
	7. 21 years and more	53	5.1
Education	1. Senior High School	4	0.4
	2. College/University	870	84.0
	3. Graduate School	162	15.6
Direct Patient Contact	1. No	10	1.0
	2. Rare	41	4.0
	3. Very Often	985	95.1

The majority of physicians and nurses are female (80.2%), aged 21-40 (73.8%), not in charge of supervisors/managers (88.9%), full time employees (95.8%), with 1 to 20 years in an organization (79.9%), with 1 to 20 years in position (80.9%), with a college/university degree (84.0%), and very often to contact patients directly (95.1%).

To analyze if physicians and nurses with different demographic variables have different perceptions in emotional exhaustion, independent sample t-test for mean differences and one-way analysis of variance (ANOVA) with $\alpha = 0.05$ are applied to nine questions. If the *p*-value is less than $\alpha = 0.05$, post hoc analysis is performed except for gender, supervisor/manager, and job position with only two levels. McHugh [10] stated that Bonferroni method which reduces the probability of a Type I error outperforms Scheffe method. Therefore, Bonferroni method is chosen to perform post hoc analysis in this study.

4. Results

Independent sample t test for mean differences is applied to test if physicians and nurses with different gender, supervisor/manager, and job position perceive emotional exhaustion differently. Female physicians and nurses are more satisfied than male physicians and nurses in emotional exhaustion as shown in Table 3. Physicians and nurses who are in charge of supervisors/managers have statistically higher perceptions on eight questions except for Question 4 (I feel I'm working too hard on my job.) in emotional exhaustion depicted in Table 4. In addition, physicians and nurses who are supervisors/managers have significantly lower perceptions than those who are not in charge of supervisors/managers. From Table 5, nurses have significantly higher perceptions in emotional exhaustion than physicians.

Table 3 Mean differences on emotional exhaustion for gender

Question	Assumption	t	Sig.	Post Hoc
1	Equal Variance	-.2869	0.004	Female > Male
	Unequal Variance	-2.864	0.004	Female > Male
2	Equal Variance	-5.156	< 0.001	Female > Male
	Unequal Variance	-5.124	< 0.001	Female > Male
3	Equal Variance	-4.359	< 0.001	Female > Male
	Unequal Variance	-4.214	< 0.001	Female > Male
4	Equal Variance	-3.595	< 0.001	Female > Male
	Unequal Variance	-3.513	0.001	Female > Male
5	Equal Variance	-5.270	< 0.001	Female > Male
	Unequal Variance	-5.453	< 0.001	Female > Male
6	Equal Variance	-4.703	< 0.001	Female > Male
	Unequal Variance	-4.751	< 0.001	Female > Male
7	Equal Variance	-4.941	< 0.001	Female > Male
	Unequal Variance	-4.839	< 0.001	Female > Male
8	Equal Variance	-3.681	< 0.001	Female > Male
	Unequal Variance	-3.632	< 0.001	Female > Male
9	Equal Variance	-4.046	< 0.001	Female > Male
	Unequal Variance	-4.179	< 0.001	Female > Male

Table 6 shows that age has significant effects on all of nine questions. In general, physicians and nurses who are 21-30 years old report significantly better perceptions than those who are 51-60 years old and 61 years old and above. Physicians and nurses with 31-40 years old report having significantly higher perceptions than those with 51-60 and 61 years old

and above. Moreover, physicians and nurses whose ages are 41-50 years old perceive significantly higher satisfaction than those whose ages are 51-60 and 61 years old and more. Physicians and nurses with different job status do not perceive emotional exhaustion statistically depicted in Table 7.

Table 4 Mean differences on emotional exhaustion for supervisor/manager

Question	Assumption	t	Sig.	Post Hoc
1	Equal Variance	-5.257	< 0.001	No > Yes
	Unequal Variance	-5.516	< 0.001	No > Yes
2	Equal Variance	-4.843	< 0.001	No > Yes
	Unequal Variance	-5.084	< 0.001	No > Yes
3	Equal Variance	-4.912	< 0.001	No > Yes
	Unequal Variance	-5.062	< 0.001	No > Yes
4	Equal Variance	-1.186	0.236	
	Unequal Variance	-1.039	0.301	
5	Equal Variance	-4.568	< 0.001	No > Yes
	Unequal Variance	-4.517	< 0.001	No > Yes
6	Equal Variance	-4.664	< 0.001	No > Yes
	Unequal Variance	-4.556	< 0.001	No > Yes
7	Equal Variance	-6.302	< 0.001	No > Yes
	Unequal Variance	-6.598	< 0.001	No > Yes
8	Equal Variance	-5.082	< 0.001	No > Yes
	Unequal Variance	-5.630	< 0.001	No > Yes
9	Equal Variance	-4.886	< 0.001	No > Yes
	Unequal Variance	-5.392	< 0.001	No > Yes

Table 5 Mean differences on emotional exhaustion for job position

Question	Assumption	t	Sig.	Post Hoc
1	Equal Variance	-2.890	0.004	Nurse > Physician
	Unequal Variance	-2.790	0.006	Nurse > Physician
2	Equal Variance	-6.050	< 0.001	Nurse > Physician
	Unequal Variance	-5.965	< 0.001	Nurse > Physician
3	Equal Variance	-4.913	< 0.001	Nurse > Physician
	Unequal Variance	-4.638	< 0.001	Nurse > Physician
4	Equal Variance	-4.181	< 0.001	Nurse > Physician
	Unequal Variance	-4.145	< 0.001	Nurse > Physician
5	Equal Variance	-5.236	< 0.001	Nurse > Physician
	Unequal Variance	-5.147	< 0.001	Nurse > Physician
6	Equal Variance	-5.266	< 0.001	Nurse > Physician
	Unequal Variance	-5.192	< 0.001	Nurse > Physician
7	Equal Variance	-5.916	< 0.001	Nurse > Physician
	Unequal Variance	-5.728	< 0.001	Nurse > Physician
8	Equal Variance	-4.218	< 0.001	Nurse > Physician
	Unequal Variance	-4.181	< 0.001	Nurse > Physician
9	Equal Variance	-4.523	< 0.001	Nurse > Physician
	Unequal Variance	-4.554	< 0.001	Nurse > Physician

Table 6 ANOVA results in emotional exhaustion for age

Question	F	Sig.	Bonferroni
1	9.878	< 0.001	2 > 5, 2 > 6, 3 > 4, 3 > 5, 3 > 6, 4 > 5, 4 > 6
2	9.571	< 0.001	2 > 5, 2 > 6, 3 > 5, 3 > 6, 4 > 5, 4 > 6
3	10.695	< 0.001	2 > 5, 2 > 6, 3 > 5, 3 > 6, 4 > 5, 4 > 6
4	3.856	0.002	3 > 2, 3 > 6
5	8.381	< 0.001	2 > 5, 2 > 6, 3 > 5, 3 > 6, 4 > 5, 4 > 6
6	8.565	< 0.001	2 > 5, 2 > 6, 3 > 5, 3 > 6, 4 > 5
7	13.781	< 0.001	2 > 4, 2 > 5, 2 > 6, 3 > 4, 3 > 5, 3 > 6, 4 > 5, 4 >6
8	5.701	< 0.001	2 > 6, 3 > 5, 3 > 6, 4 > 6
9	6.314	< 0.001	2 > 5, 2 > 6, 3 > 5, 3 > 6, 4 > 5, 4 > 6

Table 7 ANOVA results in emotional exhaustion for job status

Question	F	Sig.	Bonferroni
1	0.969	0.407	
2	0.732	0.533	
3	0.724	0.538	
4	1.909	0.126	
5	0.451	0.717	
6	0.949	0.416	
7	0.249	0.862	
8	0.163	0.921	
9	0.046	0.987	

Table 8 ANOVA results in emotional exhaustion for experience in organization

Question	F	Sig.	Bonferroni
1	2.922	0.008	4 > 7
2	1.577	0.150	
3	1.664	0.127	
4	3.572	0.002	6 > 1, 7 > 1
5	1.297	0.256	
6	0.765	0.598	
7	2.302	0.033	3 > 7, 4 > 7, 6 > 7
8	2.202	0.041	None
9	2.897	0.008	4 > 7, 6 > 7

Table 9 ANOVA results in emotional exhaustion for experience in position

Question	F	Sig.	Bonferroni
1	2.963	0.007	4 > 7, 5 > 7
2	1.945	0.071	
3	2.507	0.021	3 > 7, 4 > 7
4	2.183	0.042	6 > 1
5	1.341	0.236	
6	1.571	0.152	
7	2.684	0.014	1 > 7, 3 > 7, 4 > 7, 5 > 7, 6 > 7
8	2.397	0.026	None
9	2.290	0.034	4 > 7, 6 > 7

Experience in organization has significant influences on five out of nine questions in emotional exhaustion as shown in Table 8. In general, physicians and nurses who report being in their position with 3-4 years have significantly better perceptions than those with 21 years or more. Table 9 summarizes that experience in position has significant impacts on six of nine questions. In general, physicians and nurse who have 3-4 years experience in position seem to have statistically higher satisfaction than those with 21 years or more experience in position.

From Table 10, physicians and nurses with a college/university degree have significantly better perceptions in eight out of nine questions in emotional exhaustion except for Question 4 (I feel I'm working too hard on my job.). That is, there is no significant difference on working hard on the job when physicians and nurses have different educations. Finally, Table 11 shows that physicians and nurses who have rare direct patient contact have significantly higher satisfaction than those who have very often direct patient contact.

Table 10 ANOVA results in emotional exhaustion for education

Question	F	Sig.	Bonferroni
1	8.264	< 0.001	College/University > Graduate School
2	11.761	< 0.001	College/University > Graduate School
3	13.662	< 0.001	College/University > Graduate School
4	0.195	0.823	
5	11.346	< 0.001	College/University > Graduate School
6	9.626	< 0.001	College/University > Graduate School
7	19.954	< 0.001	College/University > Graduate School
8	15.464	< 0.001	College/University > Graduate School
9	14.638	< 0.001	College/University > Graduate School

Table 11 ANOVA results in emotional exhaustion for direct patient contact

Question	F	Sig.	Bonferroni
1	9.185	< 0.001	Rare > Very Often
2	8.055	< 0.001	Rare > Very Often
3	4.547	0.011	Rare > Very Often
4	3.634	0.027	Rare > Very Often
5	8.659	< 0.001	Rare > Very Often
6	14.149	< 0.001	Rare > Very Often
7	11.147	< 0.001	Rare > Very Often
8	8.488	< 0.001	Rare > Very Often
9	3.565	0.029	Rare > Very Often

Based on the above findings, gender, job position, age, and direct patient contact are the most essential demographic variables to influence all of the questions in emotional exhaustion followed by supervisor/manager and education that have significantly influences on eight of nine questions. Specifically, females, nurses, and employees with rare direct patient contact have statistically better perceptions in emotional exhaustion. Employees who are not in charge of supervisors/managers and have a college/university degree tend to have higher satisfaction in emotional exhaustion as well.

5. Conclusion

This study focuses on emotional exhaustion in a medical center in Taichung City, Taiwan from viewpoints of physicians and nurses by employing independent sample t test and

one-way ANOVA. Gender, job position, age, and direct patient contact are the most critical demographic variables that have significant impacts on emotional exhaustion. In addition, supervisor/manager and education have influences on emotional exhaustion in eight out of nine questions. Generally, females, nurses, and physicians and nurses who have rare direct patient contact have significantly better perceptions in emotional exhaustion. Physicians and nurses who are not supervisors/managers and have a college/university degree tend to have better perceptions in emotional exhaustion as well.

Lee et al. [2] used the same emotional exhaustion dimension of the Chinese version of the SAQ from a regional teaching hospital in Taiwan from the internal survey data conducted in 2014. Their findings showed that supervisor/manager, job position, age, experience in organization, and experience in position are critical variables in emotional exhaustion. In contrast, with different survey years (2014 versus 2017) and different hospital levels (a regional teaching hospital versus a medical center), our study identifies six critical variables to influence emotional exhaustion. Job position, age, and supervisor/manager are the common demographic variables to influence emotional exhaustion. By contrast, experience in organization and experience in position are the two critical variables in the regional teaching hospital, whereas gender, direct patient contact, and education are the three critical variables in the medical center. Hospital management in this medical center needs to pay much attention to gender, job position, age, direct patient contact, supervisor/manager, and education in order to reduce the burnout from viewpoints of physicians and nurses.

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A Longitudinal Study on How Nurses with Different Genders Perceive Emotional Exhaustion from a Medical Center in Taiwan

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Abstract. This study intends to observe how nurses with different genders from a medical center in Taiwan perceive emotional exhaustion from 2014 to 2017. The internal surveyed data with nine questions from emotional exhaustion dimension of the Chinese version of the safety attitudes questionnaire are used for analyses. Mann-Whitney U test is employed to remove the underlying assumption that the data are normally distributed or appropriated due to the smaller sample size of male nurses in this medical center. The results show that there is no any significant difference between male and female nurses in terms of nine questions from emotional exhaustion in 2014 and in 2017. In contrast, four out of nine questions are significantly different in 2015. That is, male nurses have better perceptions in recovering emotional exhaustion in four questions than female nurses. In addition, male nurses perform better statistically in two out of nine questions than female nurses. Further discussions are provided as well.

Keywords. Emotional exhaustion, Male nurse, Female nurse, Mann-Whitney U test, Safety attitudes questionnaire, Longitudinal study.

1. Introduction

Burnout can be defined as losing enthusiasm for work, treating people as if they were objects, and having sense that the work is no longer meaningful [1] or can be described as a loss of passion for work, emotional exhaustion, and feelings of depersonalization [2]. Shanafelt et al. [3] stated that physicians' burnout such as overwork, stress, and fatigue are the

contributing factors to increase medical errors. Cimiotti et al. [4] also depicted that increasing nurses' workloads might result in higher infections because nurse burnout is linked to job dissatisfaction and patient healthcare quality. Therefore, burnout would have negative impacts on healthcare quality.

Wang et al. [5] depicted that nurses' burnout not only threatens their own health but also impair their patients. Thus, it is important to identify risk factors of nurses' burnout to improve their health and to increase healthcare quality. The study conducted by Stimpfel et al. [6] found nurses who worked longer shifts might have higher level of burnout and patient dissatisfaction. Hospital management needs to reduce nurses' workload by respecting nurses' day off and vacation time and allowing nurses to refuse to work overtime without retribution. Houkes et al. [7] further identified that male and female general practitioners (GP) might experience the same jobsite differently and have different responses to occupational exposure. Moreover, their study pointed out that the prevalence of burnout between male and female GP are inconsistent. The interpretations of the differences might be difficult because of an unequal distribution of males and females or the confounding effect of other factors. Furthermore, their study concluded that female GP performed better in emotional exhaustion, whereas male GP performed better in depersonalization and personal accomplishment.

Based on the above discussions, rare studies have been found to study if male and female nurses have different perceptions in emotional exhaustion particularly in a medical center in Taiwan. Hsu et al. [8] pointed out that the turnover rate for male nurses is twice that of female nurses. In addition, their study only invited 178 male nurses in south Taiwan for analyses in 2008 and the questionnaire in emotional exhaustion is not from a popular questionnaire of Maslach burnout inventory-human services survey (MBI-HSS). In contrast, the purpose of this study is to compare whether or not male and female nurses in the same medical center might have different perceptions in emotional exhaustion from a longitudinal study since a longer period of observations can find the possible trends or patterns [9].

2. Review of Emotional Exhaustion

Maslach burnout inventory-human services survey which is the mainstream measure to evaluate burnout has three dimensions including emotional exhaustion with nine questions (Table 1), personal accomplishment with eight questions, and depersonalization with five questions [10]. In 2014, emotional exhaustion has been incorporated into the Chinese version of the safety attitudes questionnaire (SAQ) to assess the patient safety culture in healthcare organizations in Taiwan from medical staffs' viewpoints [11]. The original Chinese version of the SAQ was from the short form of the SAQ developed by Sexton et al. in 2006, which has six dimensions together with 30 questions [11, 12].

Table 1. Nine questions in emotional exhaustion

Question
1. I feel like I'm at the end of my rope.
2. I feel burned out from my work.
3. I feel frustrated by my job.
4. I feel I'm working too hard on my job.
5. I feel emotionally drained from my work.
6. I feel used up at the end of the workday.
7. I feel fatigued when I get up in the morning and have to face another day on the job.
8. Working with people all day is really a strain for me.
9. Working with people directly puts too much stress on me.

The introduction of emotional exhaustion borrowed from MBI-HSS by the Joint Commission of Taiwan is intended to assess medical staffs' the degree of burnout since medical staffs' burnout directly affects patient safety.

Each staff in healthcare organizations in Taiwan is required to answer all of nine questions in emotional exhaustion including nurses. Each question uses a five-point Likert's scale ranging from strongly agree with a numerical value of 5 to strongly disagree with a numerical value of 1 to assess the perceptions of burnout from medical staff's viewpoints [11]. In addition, all of the questions in emotional exhaustion are reversed questions, and each respondent's answer is adjusted for further analyses. For instance, the original answer of strongly agree in Question 1 (I feel like I'm at the end of my rope.) indicates the poor perception of emotional exhaustion. This study uses a numerical value of one to replace the numerical value of five if the original answer is strongly agree. By the same token, the answers from the other items are also adjusted.

3. Research Method

The distribution of the scores from each question for either males or females does not always follow a normal distribution, Mann-Whitney U test for two independent samples test is chosen to determine if male and female nurses have different perceptions in emotional exhaustion. For instance, Figures 1 and 2 show the distributions of the scores from Question 9 of emotional exhaustion by female and male nurses in 2017, respectively. With the sample size of 759 female nurses, the distribution is skewed to the right with the majority of scores fall in 2 (40.7%). In contrast, the majority of scores fall in 2 and 3 with the respective 38.6% and 40.9% for male nurses. Obviously, the distributions in Figures 1 and 2 are not normally distributed. Therefore, Mann-Whitney U test is the approach when the normality assumption does not hold [11]. In addition, to observe the trends and similarities or differences of perceptions from both male and female nurses in emotional exhaustion, a longitudinal study is conducted by using the data sets from 2014 to 2017.

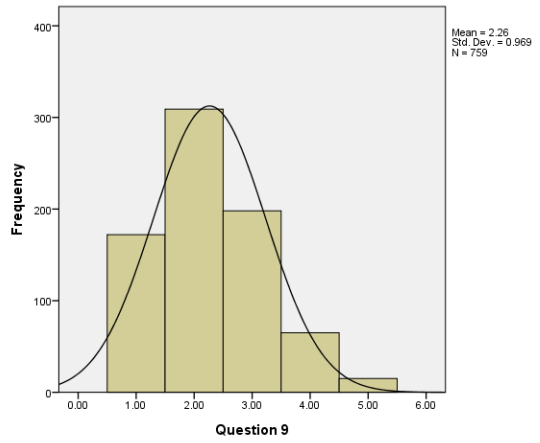

Fig. 1. The distribution of the scores from Question 9 by female nurses in 2017

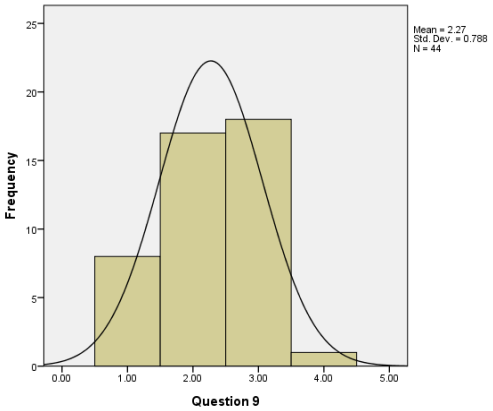

Fig. 2. The distribution of the scores from Question 9 by male nurses in 2017

4. Results

The descriptive statistics by mean rank for both male and female nurses in 2017 is provided in Table 2. The sample sizes of male and female nurses are 44 and 759, respectively. The mean rank indicates that male nurses have better emotional exhaustion than female nurses in Questions 1, 2, 3, 4, 6, 7, 8, and 9 by descriptive statistics.

Table 2. Descriptive statistics by mean rank in 2017

Question	Gender	Sample	Mean Rank	Sum of Ranks
1. I feel like I'm at the end of my rope.	Male	44	422.31	18581.5
	Female	759	400.82	304224.5
2. I feel burned out from my work.	Male	44	423.45	18632.0
	Female	759	400.76	304174.0
3. I feel frustrated by my job.	Male	44	423.76	18645.5
	Female	759	400.74	304160.5
4. I feel I'm working too hard on my job.	Male	44	403.15	17738.5
	Female	759	401.93	305067.5
5. I feel emotionally drained from my work.	Male	44	392.20	17257.0
	Female	759	402.57	305549.0
6. I feel used up at the end of the workday.	Male	44	403.18	17740.0
	Female	759	401.93	305066.0
7. I feel fatigued when I get up in the morning and have to face another day on the job.	Male	44	414.49	18237.5
	Female	759	401.28	304568.5
8. Working with people all day is really a strain for me.	Male	44	430.36	18936.0
	Female	759	400.36	303870.0
9. Working with people directly puts too much stress on me.	Male	44	417.73	18380.0
	Female	759	401.09	304426.0

To further perform Mann-Whitney U test, Table 3 shows that male and female nurses do not have any significantly different perceptions in emotional exhaustion in 2017. By the same token, the descriptive statistics by mean rank in 2016 is shown in Table 4. The sample sizes of male and female nurses are 36 and 706, respectively. Table 5 summarizes male nurses have statistically better perceptions in Questions 5 (I feel emotionally drained from my work.)

and 6 (I feel used up at the end of the workday.) than female nurses in 2016. That is, female nurses tend to be emotionally drained from their work, and feel used up at the end of the workday.

Table 3. Man-Whitney U test in 2017

Question	Mann-Whitney U Test	Z	Exact Sig. (2-tailed)	Post Hoc
1	15804.5	-0.625	0.534	
2	15754.0	-0.652	0.515	
3	15740.5	-0.674	0.502	
4	16647.5	-0.035	0.978	
5	16267.0	-0.297	0.767	
6	16646.0	-0.036	0.973	
7	16148.5	-0.378	0.706	
8	15450.0	-0.876	0.381	
9	16006.0	-0.487	0.628	

Table 4. Descriptive statistics by mean rank in 2016

Question	Gender	Sample	Mean Rank	Sum of Ranks
1. I feel like I'm at the end of my rope.	Male	36	429.33	15456.0
	Female	706	368.55	260197.0
2. I feel burned out from my work.	Male	36	427.79	15400.5
	Female	706	368.63	260252.5
3. I feel frustrated by my job.	Male	36	434.78	15652.0
	Female	706	368.27	260001.0
4. I feel I'm working too hard on my job.	Male	36	399.40	14378.5
	Female	706	370.08	261274.5
5. I feel emotionally drained from my work.	Male	36	442.25	15921.0
	Female	706	367.89	259732.0
6. I feel used up at the end of the workday.	Male	36	452.81	16301.0
	Female	706	367.35	259352.0
7. I feel fatigued when I get up in the morning and have to face another day on the job.	Male	36	418.28	15058.0
	Female	706	369.11	260595.0
8. Working with people all day is really a strain for me.	Male	36	398.53	14347.0
	Female	706	370.12	261306.0
9. Working with people directly puts too much stress on me.	Male	36	415.25	14949.0
	Female	706	369.27	260704.0

Table 5. Man-Whitney U test in 2016

Question	Mann-Whitney U Test	Z	Exact Sig. (2-tailed)	Post Hoc
1	10626.0	-1.735	0.083	
2	10681.5	-1.666	0.096	
3	10430.0	-1.896	0.058	
4	11703.5	-0.839	0.403	
5	10161.0	-2.096	0.036	Male > Female
6	9781.0	-2.399	0.016	Male > Female
7	11024.0	-1.386	0.167	
8	11735.0	-0.818	0.416	
9	11133.0	-1.322	0.188	

The descriptive statistics by mean rank in 2015 is depicted in Table 6. The sample sizes of male and female nurses are 34 and 677, respectively. Table 7 shows male and female nurses have different perceptions in Questions 2, 4, 8, and 9 statistically in 2015. Specifically, male nurses have significantly better emotional exhaustion in Question 2 (I feel burned out from my work.), Question 4 (I feel I'm working too hard on my job.), Question 8 (Working with people all day is really a strain for me.), and Question 9 (Working with people directly puts too much stress on me.). That is, female nurses tend to feel burn out from their work, work too hard on their job, and have the sense that working with people is a strain and puts too much stress on them. The descriptive statistics by mean rank in 2014 is summarized in Table 8. The sample sizes of male and female nurses are 33 and 714, respectively. Mann-Whitney U test as shown in Table 9 points out that both male and female nurses do not perceive emotional exhaustion statistically different in 2014.

Table 6. Descriptive statistics by mean rank in 2015

Question	Gender	Sample	Mean Rank	Sum of Ranks
1. I feel like I'm at the end of my rope.	Male	34	392.93	13359.5
	Female	677	354.15	239756.5
2. I feel burned out from my work.	Male	34	429.94	14618.0
	Female	677	352.29	238498.0
3. I feel frustrated by my job.	Male	34	418.71	14236.0
	Female	677	352.85	238880.0
4. I feel I'm working too hard on my job.	Male	34	452.03	15369.0
	Female	677	351.18	237747.0
5. I feel emotionally drained from my work.	Male	34	406.62	13825.0
	Female	677	353.46	239291.0
6. I feel used up at the end of the workday.	Male	34	396.19	13470.5
	Female	677	353.98	239645.5
7. I feel fatigued when I get up in the morning and have to face another day on the job.	Male	34	401.40	13647.5
	Female	677	353.72	239468.5
8. Working with people all day is really a strain for me.	Male	34	448.53	15250.0
	Female	677	351.35	237866.0
9. Working with people directly puts too much stress on me.	Male	34	428.60	14572.5
	Female	677	352.35	238543.5

Table 7. Man-Whitney U test in 2015

Question	Mann-Whitney U Test	Z	Exact Sig. (2-tailed)	Post Hoc
1	10253.5	-1.117	0.265	
2	8995.0	-2.283	0.022	Male > Female
3	9377.0	-1.892	0.059	
4	8244	-2.939	0.003	Male > Female
5	9788	-1.528	0.127	
6	10142.5	-1.215	0.226	
7	9965.5	-1.365	0.174	
8	8363.0	-2.812	0.005	Male > Female
9	9040.5	-2.220	0.026	Male > Female

Table 8 Descriptive statistics by mean rank in 2014

Question	Gender	Sample	Mean Rank	Sum of Ranks
1. I feel like I'm at the end of my rope.	Male	33	353.98	11681.5
	Female	714	374.93	267696.5
2. I feel burned out from my work.	Male	33	390.29	12879.5
	Female	714	373.25	266498.5
3. I feel frustrated by my job.	Male	33	379.33	12518.0
	Female	714	373.75	266860.0
4. I feel I'm working too hard on my job.	Male	33	335.80	11081.5
	Female	714	375.77	268296.5
5. I feel emotionally drained from my work.	Male	33	331.47	10938.5
	Female	714	375.97	268439.5
6. I feel used up at the end of the workday.	Male	33	307.05	10132.5
	Female	714	377.09	269245.5
7. I feel fatigued when I get up in the morning and have to face another day on the job.	Male	33	393.17	12974.5
	Female	714	373.11	266403.5
8. Working with people all day is really a strain for me.	Male	33	405.82	13392.0
	Female	714	372.53	265986.0
9. Working with people directly puts too much stress on me.	Male	33	420.18	13866.0
	Female	714	371.87	265512.0

Table 9 Man-Whitney U test in 2014

Question	Mann-Whitney U Test	Z	Exact Sig. (2-tailed)	Post Hoc
1	11120.5	-0.568	0.571	
2	11243.5	-0.464	0.645	
3	11605.0	-0.153	0.880	
4	10520.5	-1.081	0.281	
5	10377.5	-1.209	0.230	
6	9571.5	-1.906	0.056	
7	11148.5	-0.541	0.588	
8	10731.0	-0.910	0.366	
9	10257.0	-1.320	0.188	

In general, male nurses tend to have higher mean rank values than female nurses in most of the questions of emotional exhaustion from 2014 to 2017. However, based on Mann-Whitney U test, male and female nurses do not have different perceptions statistically in 2014 and 2017. In 2015, male nurses have better emotional exhaustion in Questions 2, 4, 8, and 9 statistically. In 2016, male nurses have significantly better emotional exhaustion in Questions 5 and 6. Based on the current study, no clear trend has been found between male and female nurses. One possible reason based on statistics viewpoints is that the sample size of male nurses is relatively smaller compared with that of female nurses. Unless the differences between male and female nurses in mean rank values are large enough, no significant differences statistically are found.

5. Conclusion

This study uses a longitudinal study to observe if male and female nurses have different perceptions in emotional exhaustion from a medical center in Taiwan from 2014 to 2017. From

the descriptive statistics, male nurses tend to have higher mean rank values than female nurses in most of the questions. Due to relatively smaller sample of sizes, the majority of differences between male and female nurses are not statistically significant. Specifically, in 2014 and 2017 no significant perceptions in emotional exhaustion have been found statistically between male and female nurses. In 2015, male nurses have better perceptions in four out of nine questions of emotional exhaustion. In 2016, male nurses have better perceptions in two of nine questions. There is no any similarity found for male nurses in 2015 and 2016. Therefore, no clear pattern or trend is found for male and female nurses when a longitudinal study from 2014 to 2017 is conducted.

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The Perceptions of Safety Climate, Job Satisfaction and Emotional Exhaustion in Pediatric Nurses: the Difference between Better and Worse Work–Life Climate

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Abstract. Patient safety culture is one of the most critical issues in healthcare. Nurses in frontline are under stress because of the performance of professionals to child patients and the problems of their parents; also, the perceptions of nurses in work environment are associated to patient safety. Alves et al. (2016) has investigated the perception of nurses in pediatric unit about organizational factors such as job satisfaction and burnout to influence patient safety. However, the degree of work-life balance is important to influence the performance of employees (Profit et al., 2017). This study aims to assess the perceptions of patient safety between nurses who are under low and high degree of work-life balance in their work environment. The results indicated that the perceptions of the work environment are various for two groups of employees and certain suggestions are addressed in management and individual level in this research.

Keywords. Safety Attitude Questionnaire, Safety Climate, Job Satisfaction, Emotional Exhaustion, Work–Life Climate, Pediatric Nurses

1. Introduction

The healthcare employee in healthcare organization is one of the most important components that determine the performance of patient safety since service process is designed and executed based on patient safety strategy (Alfredsdottir and Bjornsdottir, 2008, Slater et al., 2012, Mansour, 2015). In addition, because of the specific characteristic on the occupation,

the healthcare employee is not able to relaxedly enjoy the break time or off time during either working period or the leisure period after work (Sexton et al., 2017). However, in organizational psychology, nurses feel comfortable when the culture in the organization emphasizes work-life balance.

Work environment is concerned as organizational indicator that is relevant with patient safety (Olds et al., 2017). The design of the work environment in healthcare organization influences the care provisions by nurses and thus affect the outcomes of patient safety (Dubois et al., 2013). Regarding to the staffs as inputs in healthcare organization, certain organizational factors such as the retention of staffs, levels of exhausted exhaustion and job satisfaction (Kelly et al. 2012, You et al. 2013) are associated with patient safety (Aiken et al. 2012, Ausserhofer et al. 2013, Kalisch & Xie 2014). Staffs in hospitals with better work environments strengthen their professions and which have more excellent observations on near-misses about patient safety (Flynn et al. 2012). Additionally, safety climate as organizational indicator is relevant with patient safety (Olds et al., 2017). Nurses provide reliable care through their skills and the profession and builds safe architecture (Groves et al. 2011). Thus, the healthcare organization may concern the perceptions of nurses during their work to improve the performance of patient safety (Kalisch & Xie 2014; Fagan et al., 2016).

Among all specialty in a hospital, nurse is often involved in service process and nurses in frontline are under stress because of the performance of professionals to child patients and the problems of their parents. In addition, the perceptions of nurses in work environment are associated to patient safety. In organizational psychology, nurses feel comfortable when the culture in the organization emphasizes work-life balance. Limited study has investigated the perception of nurses in pediatric unit about organizational factors such as job satisfaction, emotional exhaustion and safety climate to influence patient safety (Alves et al., 2016). Sexton et al., (2017) has considered the issue of work-life balance in organizational psychology. Thus, based on past study, this study investigates the perceptions of nurses who are under two side of spectrum of work-life balance in their work environment such as job satisfaction, emotional exhaustion and safety climate to patient safety in pediatric unit of the hospitals in Taiwan.

2. Literature Review

A literature search is conducted to uncover the relationship between work–life balance behaviors and patient safety.

In organizational psychology, three directions enhancing work–family interactions are job conditions, organizational culture and transformation of roles. The work time of employees and the degree of control to a work of finished time are considered in job conditions. The degree of authority to a work is considered in organizational culture. Last, a support for employees to transfer the roles between work and family is explained for transformation of roles (Kossek, 2006)

Work-life balance influences performances of individual and organization. Beauregard and Henry (2009) indicated that work-life balance is able to affect organizational performance. Literature showed that work-life balance improves the performance of individuals such as absenteeism (Frone et al. 1997; Wayne et al. 2004) job malfunction (Whiston and Cinamon 2015) job burnout (Kossek and Ozeki 1998)job performance (Frone et al. 1997; Wayne et al. 2004; Whiston and Cinamon 2015) job satisfaction (Allen et al. 2000; De Simone et al. 2014; Whiston and Cinamon 2015) turnover intention (Wayne et al. 2004). However, work-life conflict may result to psychological distress such as emotional exhaustion (Lee and Kim 2013).

Nurses with their domain knowledge consider both their individual works and the resources of organizations to provide medical services (Allen, 2018). A hospital with sophisticated safety culture leads it to be sustainable development in which certain issues on

patient safety are concerned (Alves et al., 2016). Groves et al. (2011) indicated that healthcare organization requires to build a mechanism that the behaviors of both staffs in frontline level and organizational level are aligned to construct safety environment. Farokhzadian et al. (2015) showed that rough environment such as inappropriate physical space, poor work environment increases the workload of nurses and declines quality of care and patient safety. Nurses in poor working environment, e.g., improper working hours, not only suffer high possibility of medical errors or near missing but also have less willingness to report adverse report and result in poor patient safety culture (Wu et al., 2013). Most of errors in medical services process result from care providers; more specifically, 10 million nurses all over the world are a key role to enhance the performance of patient safety (Groves et al., 2011). Thus, the perceptions of nurses to patient safety in healthcare organization have a critical impact on patient safety.

3. Research Methods

3.1. Data collection procedure

The perceptions of job satisfaction, emotional exhaustion and safety climate from nurses are investigated under two side of spectrum of work-life balance in pediatric unit in a case hospital. The practitioners in the case hospital including physicians, nurses, technicians and administrators response the Chinese version of SAQ by an intra-organizational online survey from 2014 to 2017. The best general and teaching hospital in Taiwan is chosen as a representative case (MOHW, 2015). The score of work-life balance is transformed from 0 to 100. More details are found in Sexton et al. (2017). To focus on the issue of nurse in pediatric unit in the various degree of work-life balance in this study, nurses are separately divided to four group by scaling quartiles on the score of work-life balance and the respondents range from 0% to 100%, which represents positive work–life climate. The percentage reports the degree of good work–life climate. Thus, the employee is in better work–life climate if its percentage is located higher. The A pretesting is performed by surveying fifty hospital members to ensure the accuracy of the questionnaire (Malhotra, 2008). After the process of pretesting, the formal surveys are sent to the respondents in the case hospitald during 2014 to 2017. A total of 155 questionnaires of nurse in pediatric unit are used for the analysis (34 for year 2014, 39 for year 2015, 41 for year 2016, and 41 for year 2017).

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 condition	(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

Note: r: reversed question

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 job satisfaction, emotional exhaustion and safety climate among nurses who are divided into two side of spectrum of work-life balance in pediatric unit in the hospital. Forty-six question items are grounded into nine 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). In this study, the dimension of safety climate, job satisfaction, emotional exhaustion and work-life balance are considered in analysis. Additionally, each question uses a five-point Likert's scale whereas the assessment of work-life balance uses a four-point frequency scale. Eleven questions are reversed to confirm the wording is more accurate (Vandiver et al., 2002). The scores for each of eight dimensions are calculated by summing the scores of the items measuring particular dimension. The degree of correlation among three patient safety culture dimensions, i.e, safety climate, job satisfaction, emotional exhaustion, for overall nurses in pediatric unit are firstly examined by using Pearson correlation analysis, respectively (Cohen et al., 2013).

4. Methods

4.1. Descriptive statistics

For nurses in pediatric unit, safety climate has the highest average value, whereas emotional exhaustion has the lowest average value. In addition, the results demonstrate that all dimensions' Cronbach's α values exceed 0.7 which indicates measuring scales have good reliability and internal consistency (Nunnally, 1978).

Table 1: Average Value and Cronbach's Alpha Coefficient for nurses in paediatic unit

	Mean	α
1.SC	4.07	0.911
2.JS	4.00	0.94
3.EE	2.65	0.926
Total	3.63	0.955

Note: SC: safety climate; JS: job satisfaction; EE: emotional exhaustion; 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 three patient safety culture dimensions. For overall nurses in pediatric unit, safety climate is moderately positive related to job satisfaction and negative correlation with emotional exhaustion. Job satisfaction is negative related to emotional exhaustion, from Table 2.

Table 2. Pearson's correlation analysis for overall nurses

	1	2	3
1.SC	1	.771**	-.444**
2.JS	.771**	1	-.436**
3.EE	-.444**	-.436**	1

Note: * p-value < 0.05; ** p-value < 0.01; SC: safety climate; JS: job satisfaction; EE: emotional exhaustion

For nurses in good work-life balance (quartile four), safety climate is positive correlated to job satisfaction and is negative correlated to emotional exhaustion. Job satisfaction is moderately negative correlated to emotional exhaustion, from Table 3.

Table 3. Pearson's correlation analysis for nurses with good work-life balance

	1	2	3
1.SC	1	.546**	-.526**
2.JS	.546**	1	-.609**
3.EE	-.526**	-.609**	1

Note: * p-value < 0.05; ** p-value < 0.01; SC: safety climate; JS: job satisfaction; EE: emotional exhaustion

For nurses in bad work-life balance (quartile one), safety climate is moderately positive related to job satisfaction but no correlation with emotional exhaustion. Job satisfaction is negative related to emotional exhaustion, from Table 4.

Table 4. Pearson's correlation analysis for nurses with bad work-life balance

	1	2	3
1.SC	1	.773**	-.307
2.JS	.773**	1	-.422**
3.EE	-.307	-.422**	1

Note:* p-value < 0.05; ** p-value < 0.01; SC: safety climate; JS: job satisfaction; EE: emotional exhaustion

4.3 Difference of emotional exhaustion between nurses being top and bottom quartiles work–life climate

In table 3, the result showed bad work-life balance scores were associated with significant differences in emotional exhaustion t=2.038 (p-value=0.045) by applying independent sample t-tests. Table 5 provides data on safety climate, job satisfaction and emotional exhaustion differences between work settings in the first and fourth quartiles of work–life climate.

Table 5. difference on safety climate, job satisfaction and emotional exhaustion for nurses being top and bottom quartiles work–life climate

Dimension	First quartile of work–life climate Mean (SD)	Fourth quartile of work–life climate Mean (SD)	t
Safety climate	74.34 (18.28)	78.85 (12.33)	-1.26
Job satisfaction	73.95 (19.28)	74.08 (14.37)	-0.03
Emotional exhaustion	44.66 (18.34)	35.6 (20.37)	2.04*

Note:* p-value < 0.05; ** p-value < 0.01

5. Discussion

The purpose of this study is to investigate the perceptions of nurses who are under two side of spectrum of work-life balance in their work environment such as job satisfaction, emotional exhaustion and safety climate to patient safety in pediatric unit of the hospitals in Taiwan. The result demonstrates that safety climate and job satisfaction are positive correlated for overall nurses and those who are with better or worse work–life climate scores in pediatric unit. From the perspective of services provider, the mechanism design of patient care including policy, software and hardware of facilities may influence the perceptions of nurses in safety climate. Working in better safety climate, nurses are proud to be a part in the working area and dedicates themselves to show their professional and as a result, the performance of patient safety culture is improved.

The result shows that emotional exhaustion and job satisfaction is negative correlated for overall nurses and those who are with better or worse work–life climate scores in pediatric unit. As if the ability of nurses are divided to high ability and low ability, certain insights are descripted about the results. For the nurses who loves it working area, nurses with either high ability or low ability may feel exhausted and the feeling for the nurses is optimistic and positive. However, the nurses with low satisfaction on it working area may pay less effort into its routine work; thus, it may feel less exhaustion.

The relation between emotional exhaustion and safety climate is negative for overall nurses and those who are with better work–life climate scores whereas which is not significant for those who are with worse work–life climate scores. The one with better work–life climate scores may be sophisticated and genuine nurses and those nurses may possess higher degree of responsibility in patient safety. Therefore, those nurses are more familiar with the policy, service process, etc. which are related to safety climate. Based on Chinese idiom, the one with better ability does more work, nurses may be more sensitive about patient safety in the service process resulting to be exhausted. On the other hand, the nurses with worse work–life climate scores such as novice nurses may not deeply understand work environment such that it may either concentrate on its service or put the based effort on its patient.

6. Conclusion

This study aims to assess the perceptions of patient safety between nurses who are under low and high degree of work-life balance in their work environment. Certain suggestions are addressed as follows. Managers is suggested to consider novice nurse who are under low degree of wok-life balance. Part of those employees may possess good ability in profession and thus have higher degree of perceptions on job satisfaction and emotional exhaustion. However, for those who are passive and low ethic standard on profession, they put the lowest effort in the service process. For the latter one, patient safety may be harmed in long term. Therefore, scheduling sophisticated nurses and novice nurses in a shift may have more excellent observations on near-misses about patient safety and thus patient safety is improved. In sum, the goal in a hospital is to create value to patients and thus patient safety is what the employees should to pay attention. In pediatric unit, service process including patient and its parents is complex in working environment and nurses is suggested to pay more attention on the care process of patient and interact with those parents of patients patient. In management level, the characteristics of each employees are deliberately considered to arrange the shift such that sophisticated nurses complement inexperience nurses in the social and interpersonal working environment. Finally, improvement on both the physical and mental foundation in individuals and organization management are suggested to possess positive reinforcement on improving patient safety in pediatric healthcare.

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Establishing a Monitoring System on Supplier Performance Evaluation of Passive Components

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Abstract. This case study is based on a passive components company in Taiwan that assesses its supplier performance evaluations in accordance with nine criteria from six indicators. Six indicators include supply satisfaction, quality management, hazardous substance free system (HSF), technology, service, and cost, whereas nine criteria consist of delivery on time, feed rejection rate, process rejection rate, corrective action response rate, correction effectivity, HSF testing compliance, sample pass rate, coordination, and excess freight cost with the respective weights of 10%, 10%, 15%, 10%, 10%, 15%, 10%, 10%, and 10%. Except for coordination, the rest of eight criteria have the objective assessments. In order to establish a more objective assessment in supplier performance evaluations, a monitoring system is to be set up by considering the eight criteria to determine if a supplier performance is either underestimated or overestimated. K-means method is employed to classify all of the suppliers into three categories. The results based on the data from four quarters in 2017 show that 4 of 43, 13 of 57, 24 of 58, and 13 of 57 indicate the supplier performance seems to be abnormal, i.e., either underestimate or overestimate, for the first quarter, second quarter, third quarter, and fourth quarter of 2017, respectively. Therefore, further investigations on cooperation criterion can be conducted to understand if the judgment on cooperation is reasonable.

Keywords. Passive component, Supplier performance evaluation, K-means method.

1. Introduction

Ho et al. [1] stated that evaluating the performance of potential suppliers in contemporary supply chain management is critically important. Their study views supplier evaluation and selection is a multiple criteria problem instead of a single factor-cost. For instance, Wu and Tsai [2] used analytic hierarchy process to identify the most essential criteria and sub-criteria in auto spare parts industry. Wu and Chang [3] applied decision making trial and evaluation laboratory for electrical and electronic industries in Taiwan to identify critical dimensions and factors in green supply chain management. Further, Karsak and Dursun [4] proposed an integrated fuzzy multiple criteria decision-making approach to deal with supplier evaluation and selection. Therefore, supplier evaluation in the previous studies has been viewed as a multiple criteria problem.

In practice, each company might have its scoring scheme to evaluate supplier performance. If the score from each criterion is objective, then the performance evaluation is more accountable in supply chain management. In contrast, if one or more criteria have subjective assessments, then the performance results might be somewhat in doubt. In this study, a passive components company in Taiwan uses nine criteria to evaluate supplier performance. Eight out of nine criteria have objective guidelines for suppliers to follow. On the other hand, there is one criterion having subjective assessment in supplier evaluation. In order to monitor

the supplier performance, this study proposes a monitoring system based on eight objective criteria such that the company can identify if a supplier performance could be either underestimated or overestimated when the subjective criterion is taken into account.

2. Review of K-Means Method

Cluster analysis is one of the data mining techniques to divide all objects into appropriate number of clusters based on similarities among the objects [5,6]. The philosophy of cluster analysis is to maximize the intraclass similarities and minimize the interclass similarities [7]. In other words, clusters are formed such that objects within a cluster have high similarity compared with one another but are very dissimilar to objects in other clusters. Self-organizing maps (SOM) and K-means method are the most commonly seen approaches for cluster analysis [8]. SOM which is an unsupervised neural network method uses clustering, visualization, and abstraction to solve problems and market screening [7]. The concept of SOM is to detect strong features in large data sets and then produce two-dimensional arrangement of neurons from a multi-dimensional space [8]. SOM has the advantages over other traditional cluster analysis methods but does not provide measures for validation for the cluster analysis results [7].

In contrast, K-means method is a non-hierarchical method to perform cluster analysis because of its simplicity of implementation and fast execution [9]. K-means method using Euclidean distance has two major steps. First, place the instances in the closest class (the assignment step). Second, re-calculate class centroids from the instances assigned to the class (the re-estimation step) [9]. The major drawback of K-means method is that this method is very sensitive to the choice of a starting point to partition the items into k initial clusters [7]. However, when the number of the cluster is determined, the clustering results generated by K-means method are typically better than those of self-organizing maps [7,8]. In this study, the number of the cluster is set to 3 in term of the needs of this case company. Therefore, this study employs K-means method to perform cluster analysis instead of self-organizing maps.

3. Research Method

There are six indicators and nine criteria to evaluate supplier performance in this study. Six indicators are supply satisfaction, quality management, hazardous substance free system (HSF), technology, service, and cost. Nine criteria consist of delivery on time, feed rejection rate, process rejection rate, corrective action response rate, correction effectivity, HSF testing compliance, sample pass rate, cooperation, and excess freight cost with the respective weights of 10%, 10%, 15%, 10%, 10%, 15%, 10%, 10%, and 10%. The descriptions of nine criteria are summarized in Table 1.

Table 1. Descriptions of nine criteria

Criterion	Weight	Description	Score
Delivery on time	10%	Delivery rate	
		90% ~ 100%	10
		80% ~ 89%	8
		70% ~ 79%	6
		60% ~ 69%	4
		≤ 59%	0
Feed rejection rate	10%	Defective rate	
		0%	10
		0.01%～1.0%	8

		1.01%～2.0%	5
		2.01%～3.0%	2
		≥ 3.01%	0
Process rejection rate	15%	Rejection rate	
		0%	15
		≤ 5%	10
		> 5%～≤ 10%	5
		> 10%～≤ 20%	2
		> 20%	0
Corrective action response rate	10%	Number of unfinished projects	
		0	10
		1～2	8
		3～4	4
		4～5	2
		≥ 6	0
Correction effectivity	10%	Results confirmation	
		No similarity	10
		Similarity: once	5
		Similarity: more than once	0
HSF Testing Compliance	15%	Evaluation item	
		No abnormal in a month	15
		One batch over control in a month	0
Sample pass rate	10%	Evaluation item	
		No abnormal in a month	10
		One batch over control in a month	-2 per time; max: -10
		No sample proposed	8
Cooperation	10%	Evaluation item	
		Deliveryman attitude and cooperation	-2 per time; max: -10
		Abnormal quality handling and response	
		Proposed makeup	
Excess freight cost	10%	Evaluation Item	
		No excess shipping costs	10
		Excess shipping cost ≤ 10,000 NTD	5
		Excess shipping cost > 10,000 NTD	0

4. Results

In order to effectively establish a monitoring mechanism for supplier evaluation and find possible anomalies (i.e. over- or under-estimations), K-means method from IBM SPSS Modeler 14.1 is applied to evaluate the data on the four quarters of 2017 by comparing the original evaluation result with that of the K-means method in terms of three possibly outcomes, i.e., A, B, and C and below. Tables 2-5 summarize the supplier evaluation results by the original evaluation method and K-means method in 2017 Q1, 2017 Q2, 2017 Q3, and 2017 Q4, respectively. The column of "difference" presents the evaluation is either underestimated

(U) or overestimated (O).

Table 2. Supplier evaluations by original evaluation result and K-means method in 2017 Q1

Supplier number	Delivery on time (10%)	Feed rejection rate (10%)	Process rejection rate (15%)	Corrective action response rate (10%)	Correction effectivity (10%)	HSF testing compliance (15%)	Sample pass rate (10%)	Cooperation (10%)	Excess freight cost (10%)	Total Score	Classification	Qualification	Classification by K-means method	Suggested cluster	Difference
1	10	10	15	10	10	15	8	8	10	96	A	Y	1	A	
2	10	10	15	10	10	15	8	8	10	96	A	Y	1	A	
3	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
4	10	10	5	8	10	15	8	10	10	86	C	Y	3	C	
5	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
6	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
7	10	8	10	10	10	15	8	10	10	91	B	Y	2	B	
8	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
9	10	10	10	10	10	15	8	10	10	93	B	Y	2	B	
10	10	8	10	10	10	15	10	10	10	93	B	Y	2	B	
11	10	8	10	10	10	15	10	10	10	93	B	Y	2	B	
12	10	10	15	10	10	15	10	10	10	100	A	Y	1	A	
13	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
14	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
15	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
16	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
17	10	8	15	10	10	15	8	8	10	94	B	Y	1	A	U
18	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
19	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
20	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
21	10	8	10	10	10	15	8	10	10	91	B	Y	2	B	
22	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
23	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
24	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
25	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
26	10	10	10	10	8	15	10	10	10	93	B	Y	2	B	
27	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
28	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
29	10	10	15	10	10	15	10	10	10	100	A	Y	1	A	
30	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
31	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
32	10	10	15	10	10	15	10	8	10	98	A	Y	1	A	
33	10	10	10	10	10	15	8	10	10	93	B	Y	2	B	
34	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
35	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
36	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	

37	10	10	15	10	10	15	10	8	10	98	A	Y	1	A	
38	10	10	10	10	10	15	10	10	10	95	A	Y	2	B	O
39	10	10	10	10	10	15	10	8	10	93	B	Y	2	B	
40	10	10	10	10	10	15	10	10	10	95	A	Y	2	B	O
41	10	10	10	10	10	15	10	6	10	91	B	Y	2	B	
42	10	8	10	10	10	15	8	4	10	85	C	Y	2	B	U
43	10	10	10	10	10	15	10	6	10	91	B	Y	2	B	

Table 3. Supplier evaluation by original evaluation result and K-means method in 2017 Q2

Supplier number	Delivery on time (10%)	Feed rejection rate (10%)	Process rejection rate (15%)	Corrective action response rate (10%)	Correction effectivity (10%)	HSF testing compliance (15%)	Sample pass rate (10%)	Cooperation (10%)	Excess freight cost (10%)	Total Score	Classification	Qualification	Classification by K-means method	Suggested cluster	Difference
1	10	10	15	10	10	15	8	8	10	96	A	Y	1	A	
2	10	8	15	10	10	15	8	10	10	96	A	Y	1	A	
3	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
4	10	10	15	10	10	15	6	10	10	96	A	Y	1	A	
5	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
6	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
7	8	10	10	10	10	15	8	10	10	91	B	Y	1	A	U
8	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
9	10	10	10	10	10	15	6	10	10	91	B	Y	1	A	U
10	10	10	15	10	0	15	4	10	10	84	C	Y	1	A	U
11	10	10	10	10	10	15	4	10	10	89	C	Y	1	A	U
12	10	10	15	10	15	8	10	10	10	98	A	Y	3	C	O
13	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
14	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
15	10	10	15	10	10	15	10	10	10	100	A	Y	1	A	
16	10	10	15	10	10	15	10	10	10	100	A	Y	1	A	
17	10	10	10	10	10	15	8	10	10	93	B	Y	1	A	U
18	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
19	10	10	15	10	10	15	10	8	10	98	A	Y	1	A	
20	10	10	15	10	0	15	8	10	10	88	C	Y	1	A	U
21	10	10	15	10	10	15	10	10	10	100	A	Y	1	A	
22	10	10	15	10	10	15	10	10	10	100	A	Y	1	A	
23	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
24	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
25	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
26	10	10	10	10	10	15	6	10	10	91	B	Y	1	A	U
27	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
28	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
29	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
30	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	

31	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
32	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
33	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
34	10	8	15	10	10	15	8	10	10	96	A	Y	1	A	
35	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
36	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
37	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
38	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
39	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
40	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
41	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
42	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
43	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
44	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
45	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
46	10	8	15	10	10	15	8	10	10	96	A	Y	1	A	
47	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
48	10	10	15	10	10	15	8	8	10	96	A	Y	1	A	
49	10	8	15	10	10	15	8	8	10	94	B	Y	1	A	U
50	10	8	15	10	10	15	10	10	10	98	A	Y	1	A	
51	10	8	15	4	5	15	10	10	10	87	C	Y	2	B	U
52	10	8	15	10	5	15	8	10	10	91	B	Y	1	A	U
53	10	10	15	10	10	15	8	8	10	96	A	Y	1	A	
54	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
55	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
56	10	10	15	10	10	10	8	10	10	93	B	Y	1	A	U
57	10	10	15	10	10	10	8	10	10	93	B	Y	1	A	U

Table 4 Supplier evaluation by original evaluation result and K-means method in 2017 Q3

Supplier number	Delivery on time (10%)	Feed rejection rate (10%)	Process rejection rate (15%)	Corrective action response rate (10%)	Correction effectivity (10%)	HSF testing compliance (15%)	Sample pass rate (10%)	Cooperation (10%)	Excess freight cost (10%)	Total Score	Classification	Qualification	Classification by K-means method	Suggested cluster	Difference
1	10	10	10	8	10	15	8	8	10	89	C	Y	1	A	U
2	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
3	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
4	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
5	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
6	10	10	10	10	10	15	10	10	10	95	A	Y	2	B	O
7	10	8	10	10	10	15	8	10	10	91	B	Y	1	A	U
8	10	10	10	10	10	15	8	10	10	93	B	Y	1	A	U
9	10	0	10	10	10	15	10	10	10	85	C	Y	2	B	U
10	10	10	10	10	0	15	10	10	10	85	C	Y	2	B	U

11	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
12	10	10	15	10	10	15	10	10	10	100	A	Y	2	C	O
13	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
14	10	5	10	10	10	15	10	10	10	90	B	Y	2	B	
15	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
16	10	10	15	10	10	15	10	10	10	100	A	Y	2	B	O
17	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
18	10	10	15	10	10	15	10	8	10	98	A	Y	2	B	O
19	10	5	15	10	0	15	10	8	10	83	C	Y	2	B	U
20	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
21	10	10	15	10	10	15	10	10	10	100	A	Y	2	B	O
22	10	10	15	10	10	15	10	10	10	100	A	Y	2	B	O
23	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
24	10	10	15	10	10	15	6	10	10	96	A	Y	1	A	
25	10	10	15	10	10	10	8	10	10	93	B	Y	1	A	U
26	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
27	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
28	10	10	15	10	15	8	10	10	10	98	A	Y	3	C	O
29	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
30	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
31	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
32	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
33	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
34	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
35	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
36	10	10	10	10	10	15	8	8	10	91	B	Y	1	A	U
37	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
38	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
39	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
40	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
41	10	10	15	10	10	15	8	8	10	96	A	Y	1	A	
42	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
43	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
44	10	10	15	10	10	15	10	10	10	100	A	Y	2	B	O
45	10	10	15	10	10	15	10	10	10	100	A	Y	2	B	O
46	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
47	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
48	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
49	10	10	10	4	5	15	8	10	10	82	C	Y	1	A	U
50	10	10	10	10	10	15	8	10	10	93	B	Y	1	A	U
51	10	10	10	10	10	15	8	8	10	91	B	Y	1	A	U
52	10	10	10	10	10	15	8	10	10	93	B	Y	1	A	U
53	10	10	10	10	10	15	8	10	10	93	B	Y	1	A	U
54	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
55	10	10	10	10	5	15	6	10	10	86	C	Y	2	B	U
56	10	10	10	10	10	15	8	10	10	93	B	Y	1	A	U
57	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
58	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	

Table 5. Supplier evaluation by original evaluation result and K-means method in 2017 Q4

Supplier number	Delivery on time (10%)	Feed rejection rate (10%)	Process rejection rate (15%)	Corrective action response rate (10%)	Correction effectivity (10%)	HSF testing compliance (15%)	Sample pass rate (10%)	Cooperation (10%)	Excess freight cost (10%)	Total Score	Classification	Qualification	Classification by K-means method	Suggested cluster	Difference
1	10	10	15	10	10	15	8	8	10	96	A	Y	1	A	
2	10	8	15	10	10	15	8	10	10	96	A	Y	1	A	
3	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
4	10	10	15	10	10	15	6	10	10	96	A	Y	1	A	
5	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
6	10	10	15	10	10	15	8	10	10	98	A	Y	1	B	O
7	8	10	10	10	10	15	8	10	10	91	B	Y	1	A	U
8	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
9	10	10	10	10	10	15	6	10	10	91	B	Y	1	B	
10	10	10	15	10	0	15	4	10	10	84	C	Y	1	B	U
11	10	10	10	10	10	15	4	10	10	89	C	Y	1	A	U
12	10	10	15	10	15	8	10	10	10	98	A	Y	3	C	O
13	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
14	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
15	10	10	15	10	10	15	10	10	10	100	A	Y	1	A	
16	10	10	15	10	10	15	10	10	10	100	A	Y	1	A	
17	10	10	10	10	10	15	8	10	10	93	B	Y	1	A	U
18	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
19	10	10	15	10	10	15	10	8	10	98	A	Y	1	A	
20	10	10	15	10	0	15	8	10	10	88	C	Y	1	A	U
21	10	10	15	10	10	15	10	10	10	100	A	Y	1	A	
22	10	10	15	10	10	15	10	10	10	100	A	Y	1	A	
23	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
24	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
25	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
26	10	10	10	10	10	15	6	10	10	91	B	Y	1	A	U
27	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
28	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
29	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
30	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
31	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
32	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
33	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
34	10	8	15	10	10	15	8	10	10	96	A	Y	1	A	
35	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
36	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
37	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
38	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	

39	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
40	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
41	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
42	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
43	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
44	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
45	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
46	10	8	15	10	10	15	8	10	10	96	A	Y	1	A	
47	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
48	10	10	15	10	10	15	8	8	10	96	A	Y	1	A	
49	10	8	15	10	10	15	8	8	10	94	B	Y	1	A	U
50	10	8	15	10	10	15	10	10	10	98	A	Y	1	A	
51	10	8	15	4	5	15	10	10	10	87	C	Y	2	B	U
52	10	8	15	10	5	15	8	10	10	91	B	Y	1	A	U
53	10	10	15	10	10	15	8	8	10	96	A	Y	1	A	
54	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
55	10	10	15	10	10	15	8	10	10	98	A	Y	1	A	
56	10	10	15	10	10	10	8	10	10	93	B	Y	1	A	U
57	10	10	15	10	10	10	8	10	10	93	B	Y	1	A	U

From Tables 2-5, 4 of 43, 13 of 57, 24 of 58, and 13 of 57 from the data in the respective 2017 Q1, 2017 Q2, 2017 Q3, and 2017 Q4 show the supplier performance is abnormal. In 2017 Q1, there are 2 overestimates and 2 underestimates. In 2017 Q2, there is 1 overestimate but 12 underestimates. In 2017 Q3, there are 9 overestimates and 15 underestimates. In 2017 Q4, there are 2 overestimates but 11 underestimates. By observing the numbers of underestimates and overestimates, this company has the tendency to underestimate the supplier performance. That is, those suppliers have relatively low cooperation scores. Because there are no clear guidelines to fairly judge the performance of cooperation, further investigations on these abnormal cases particularly on underestimated suppliers can be conducted to understand if the judgement on cooperation is reasonable.

5. Conclusion

Fairly evaluating supplier performance is critically important. In practice, suppliers with better performance should be encouraged, while suppliers with poor performance should be penalized in order to reduce the risk in the supply chain management. In this study, nine criteria are used to assess supplier evaluation. However, cooperation criterion does not have objective guidelines for suppliers to follow. This study proposes a monitoring system by considering eight criteria based on K-means method to determine if a supplier performance is either underestimated or overestimated. Based on the findings, this passive components company in Taiwan has the tendency to underestimate the supplier performance through cooperation criterion which is a more subjective criterion. This study suggests this company to conduct investigations to understand if the scores in cooperation are fair to those either underestimated or overestimated suppliers. In the long-term perspective, detailed guidelines or scoring schemes should be developed in cooperation to reduce the biases of supplier evaluation.

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An Empirical Study of the Development of Patient Safety Atmosphere: The Difference between Medical Center and Regional Teaching Hospital from Viewpoints of Registered Nurses

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Abstract. Hospitals are recently facing competitive challenges in a medical industry, how to build patient safety culture becomes a critical concern for hospital managers to better enhance medical services and patient loyalty. However, the perceptions of patient safety from the viewpoints of registered nurses from different categories of hospitals are limited in healthcare field. The purpose of this study aims to examine the patient safety culture by analyzing Sexton et al.'s [12] Safety Attitude Questionnaire between medical center and regional teaching hospital. For both hospitals, the findings reveal that job satisfaction is the lowest dimensions of patient safety culture. Our study further suggests that healthcare management from both hospitals should put more efforts to key factors such as working conditions, perceptions of management, safety climate, and teamwork climate, in order to develop better patient-oriented implications in medical service industries.

Keywords. Safety Attitude Questionnaire, Patient Safety Culture, Medical Services, Medical Center, Regional Teaching Hospital

1. Introduction

How to enhance patient safety in healthcare organizations has emerged as a critical issue to enhance medical services and quality. Patient safety culture is identified by the European Network for Patient Safety (EUNetPaS) in 2006 as "An integrated pattern of

individual and organizational behavior, based upon shared beliefs and values that continuously seeks to minimize patient harm, which may result from the processes of care delivery"[1]. Evidence reveals that hospital staffs with higher perceptions of patient safety are more likely to create a variety of positive outcomes, such as high job satisfaction, quality medical services, and higher patient loyalty [2-4]. 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

The importance of patient safety culture has been emphasized during medical treatments or delivery of services in hospitals. Research indicated that healthcare organizations with a more open culture and reflective attitude toward patient safety would result in reducing the number of harmful patient outcomes such as accidents, morbidity, readmission rate, and adverse events [7-9]. Huang et al. [3] stated that hospital committee can formulate a more patient-oriented service and implementation by assessing the perceptions of patient safety from medical staffs on a regular basis. Meanwhile, Lee et al. [10] pointed out that medical staffs with higher degree of attitudes toward patient safety are confirmed, healthcare organizations can reduce the potential negative risks such as medical errors and malpractice, and injury rates among staffs. Nie et al. [11] suggested that fewer hospital complications, patient falls, urinary tract infections and lower mortality are significantly correlated to the positive attitudes toward patient safety culture from the viewpoints of medical staffs. Thus, it is critically important for health organizations to identify the factors that influence patient safety in a regular period to continuously improve medical quality.

The Safety Attitude Questionnaire (SAQ), developed by Sexton et al. [12] has been widely used to assess the perceptions of patient safety culture from the viewpoints of medical staffs [13,14]. The SAQ has 30 questions, divided into six dimensions, including teamwork climate, safety climate, perceptions of management, job satisfaction, stress recognition, and working conditions (As shown in Table 1). Teamwork climate refers to relationships and the degree of cooperation among staffs; safety climate refers to organizational commitment to patient safety; job satisfaction is about positive about work experience; stress recognition reflects stress factors that link to work performance; perceptions of management means administrator approval, and working conditions is based on the perceived work-environment quality [12,14,15].

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 condition	(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
	(39) Working with people directly puts too much stress on me(r)

Note: r: reversed question

3. Research Method

A medical center and regional teaching hospital in Taichung City, Taiwan were selected to measure the atmosphere of patient safety, respectively. The Sexton et al.'s [12] SAQ was sent to registered nurses via an intra-organizational survey in these two different categories of hospitals in 2016. The hospitals are selected as a representative example since they are one of the best medical center and teaching hospital in Taiwan [16]. Thirty question items were grounded into six patient safety dimensions. Five-point Likert scales anchored by 1 (strongly disagree) and 5 (strongly agree) were used throughout the questionnaire. A total of 766 valid

questionnaires were issued from the medical center, and 384 valid questionnaires were collected from the regional teaching hospital for the analysis. After data screening, Pearson correlation analysis was sequentially employed using SPSS 20.0 to identify the relationships among the constructs.

4. Results

For nurses in medical center (see Table 2), examination of the sample profile showed that majority of respondents were female (95.2 percent), age ranged from 21 to 40 years (79.9 percent), and education of the bachelor (91.6 percent) or graduate degree (8.1 percent), and more than 5 years working experiences were around 55.3 percent.

Table 2 Demographic information of nurses in medical center

Demographic Variable	Medical center	
	Frequency	Percentage
Gender		
Male	37	4.8
Female	729	95.2
Age		
Less than 20 years old	5	0.4
21-30 years old	346	45.2
31-40 years old	266	34.7
41-50 years old	127	16.6
51-60 years old	22	2.9
Experience in Organization		
Less than 6 months	90	11.7
6 to 11 months	19	2.5
1 to 2 years	120	15.7
3 to 4 years	106	13.8
5 to 10 years	160	20.9
11 to 20 years	225	29.4
21 years or more	46	6.0
Experience in Position		
Less than 6 months	98	12.8
6 to 11 months	34	4.4
1 to 2 years	134	17.5
3 to 4 years	122	15.9
5 to 10 years	164	21.4
11 to 20 years	186	24.6
21 years or more	28	3.7
Education		
Senior High School	2	0.3
College/University	702	91.6
Graduate School and above	62	8.1

For nurses in regional teaching hospital (see Table 3), 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) or graduate degree (3.6 percent). Around one-half of respondents with relevant working experiences were more than five years in the hospital.

Table 3 Demographic information of nurses in regional teaching hospital

Demographic Variable	Regional teaching hospital	
	Frequency	Percentage
Gender		
Male	14	3.6
Female	370	96.4
Age		
Less than 20 years old	11	2.9
21-30 years old	166	43.2
31-40 years old	135	35.2
41-50 years old	61	15.9
51-60 years old	11	2.9
Experience in Organization		
Less than 6 months	49	12.8
6 to 11 months	34	8.9
1 to 2 years	67	17.4
3 to 4 years	48	12.5
5 to 10 years	85	22.1
11 to 20 years	90	23.4
21 years or more	11	2.9
Experience in Position		
Less than 6 months	60	15.6
6 to 11 months	35	9.1
1 to 2 years	73	19.0
3 to 4 years	56	14.6
5 to 10 years	93	24.2
11 to 20 years	62	16.1
21 years or more	5	1.3
Education		
Senior High School	3	0.8
College/University	367	95.6
Graduate School and above	14	3.6

As shown in Table 4, for nurses in medical center, the highest mean score was teamwork climate (4.03), while the lowest mean score were job satisfaction (3.74) and perceptions of management (3.74). On the other hand, teamwork climate (3.88) and job satisfaction (3.52) were the highest and lowest mean scores for nurses in regional teaching hospital, receptively. Additionally, for both hospitals the Cronbach's α values for all the constructs exceed 0.8, which indicated that the scales had great reliability and internal consistency.

As shown in Table 5, we consequently conducted a Pearson's Correlation Analysis to realize the relationships among six constructs. On the basis of perspectives from nurses in medical center, the results demonstrated that perceptions of management was highly significant to working conditions. Safety climate was highly related to teamwork climate, working conditions, and perceptions of management, respectively. However, most constructs had low relations with stress recognition.

Table 4 The Results of Mean, SD, Cronbach's Alpha

Research constructs	Mean		SD		Cronbach's α	
	MC	RTH	MC	RTH	MC	RTH
Teamwork climate	4.03	3.88	0.717	.720	.886	.863
Safety climate	3.97	3.73	0.704	.701	.912	.891
Job satisfaction	3.74	3.52	0.888	.854	.943	.939
Stress recognition	3.75	3.69	0.809	.810	.883	.882
Perceptions of management	3.74	3.59	0.824	.706	.839	.820
Working conditions	3.85	3.59	0.782	.726	.890	.899

Note: MC: medical center; RTH: regional teaching hospital; SD: standard deviation

Table 5 The Results of Pearson's Correlation Analysis in Medical Center (n = 766)

Construct	1	2	3	4	5	6
1. Teamwork climate						
2. Safety climate	0.848**					
3. Job satisfaction	0.786**	0.806**				
4. Stress recognition	0.161**	0.228**	0.127**			
5. Perceptions of management	0.760**	0.802**	0.791**	0.194**		
6. Working conditions	0.785**	0.820**	0.788**	0.180**	0.867**	

Note: *: $p < 0.05$; **: $p < 0.01$

As shown in Table 6, on the basis of perspectives from nurses in regional teaching hospital, the results illustrated that perceptions of management was is highly positive to working conditions. In line with the investigation conducted for the nurses in medical center, the results stated that safety climate was highly related to teamwork climate, working conditions, and perceptions of management, respectively. However, stress recognition had no relations with all constructs.

Table 6. The Results of Pearson's Correlation Analysis in Regional Teaching Hospital (n=384)

Construct	1	2	3	4	5	6
1. Teamwork climate						
2. Safety climate	0.814**					
3. Job satisfaction	0.700**	0.773**				
4. Stress recognition	-0.03	0.420	0.023			
5. Perceptions of management	0.660**	0.764**	0.719**	0.043		
6. Working conditions	0.674**	0.780**	0.702**	0.056	0.824**	

Note: *: $p < 0.05$; **: $p < 0.01$

5. Discussion

Establishing a better atmosphere of patient safety is the goal of every healthcare organization to improve medical services and quality in a highly competitive healthcare industry. This study aims to examine the attitudes toward patient safety from reregistered nurses between medical center and regional teaching hospital. For medical center, hospital managers should pay more attention to job satisfaction and perceptions of management to

increase the development of patient safety culture. Similarly, job satisfaction should be further focused on for improving patient safety culture in regional teaching hospital.

For both hospitals, consistent with those of Huang et al. [3], and Lee et al. [4], our study confirmed that administrator's authorization and support was greatly associated with the quality of working environment perceived by nurses. Additionally, whether or not hospital has commitment to safety climate was highly related to the levels of cooperation among nurses, support from management, and the quality of working environment, respectively. Consequently, we suggest that either medical center or regional teaching hospital should put more efforts on working conditions, perceptions of management, safety climate, and teamwork climate, in order to create a patient-oriented medical services.

6. Conclusion

In sum, patient safety culture is a critical goal of every hospital in a competitive medical industry, to improve medical quality and in turn promote nurse-patient relationship. Several essential relevant factors that dimensions of patient safety culture from nurses at medical center and regional teaching hospital were identified, respectively. The current study has its limitations. The respondents are nurses in Taiwan and the results may not generalize to other countries. It would be useful and interesting to investigate and compare patient safety culture in other categories of healthcare organizations. More insightful comparison could then be drawn.

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The Development and Application of Quadruple Helix Model in Innovation Management

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Abstract. Under conditions of global competition and rapid change in technological solutions, business organizations can no longer rely on traditional competitive advantages such as price and quality, but are looking for alternative sources. They involve the application of innovations in products, business processes, and providing services. Such an approach results in the adoption of innovative management strategies based on the Quadruple Helix model. The Quadruple Helix model brings a new reflection on innovation management and innovation processes in business organizations and the national economy as a whole. The successful implementation of Quadruple Helix model in innovation management is creating a favorable environment for optimizing the use of knowledge to generate innovations, which accelerate economic flows, especially in transitional national economies. The research focus of the paper is to define and analyze the basic determinants of Quadruple Helix model, as a complementary relationship between the university, the industry, the government and civil society, in order to comprehensively understand its contribution to the innovation management.

Keywords: Quadruple Helix model, Innovation management, Competitive advantage, Economic growth.

1. Introduction

Configuring the national innovation environment consists of streams and connections between industry, government, university, and economy. It represents an important economic determinant of a modern society in the field of science, technology and innovation development (OECD, 1996). Understanding the significance of knowledge, technology and innovation for the growth, development and maturation of contemporary society, led to the study of a "knowledge-based economy" (Chen & Dahlman, 2005). A knowledge-based economy implies the existence of a national innovative environment, and the introduction of a Quadruple Helix model. Functioning of the Quadruple Helix model presumes four key actors (university-industry-government-civil society) that act on the principles of open circulation of ideas and knowledge, based on a continuous learning process, communication and mutual cooperation (Carayannis & Campbell, 2009). Such spiral connections result in the capitalization of knowledge, creating new forms (organizations, projects) in the processes of key actors interaction and do not belong exclusively to any of them (Carayannis & Campbell, 2009).

By strengthening the complementary links of "university-industry-government-civil society" relationship, and clearly defining functions in the Quadruple Helix model, the cooperation between universities and industry is facilitated. This affects better satisfaction of mutual needs and greater contribution to the knowledge-based economy. The Quadruple Helix model also represents a convenient environment for the development of academic

entrepreneurship, the use of knowledge, innovation and achievements in all areas of science, research and application of knowledge. It encourages the application of good practice through the co-operation of academic institutions, economic structures, state authorities and society. The concept of innovative environment requires a more intensive approach of science to the market needs, as well as the inclusion of the market in the science world. This can be achieved through the systemic commercialization of knowledge and innovations. Organized synergy between state institutions, scientific and research organizations, economy and society represents the basis of an efficient and sustainable national innovative environment. The application of the Quadruple Helix model stimulates innovative activities and the application of the results of these activities in practice.

2. Conceptual Definition of Quadruple Helix Model

Ever since the 19th and the first half of the 20th century, university, industry and government have been associated (but still independent) and functioned effectively. The internal growth of each of these threads and the changing relationships between them formed a special phenomenon, the fusion of the three entities that are uniquely realized in the Triple Helix model (Shinn, 2002). By upgrading the Triple Helix model, and introducing the fourth element, the civil society, a Quadruple Helix model was created (Cavallini, 2016). The incomplete understanding of the Quadruple Helix model theory interrupts the full potential and significance of the model, as well as its inherent features. In relation to the national innovative environment, the Quadruple Helix model has been introduced with the aim of taking over all the complexity of the innovation process, as the foundation of the knowledge based economy. It has been introduced also with the aim of improving and promoting research and exploitation of the knowledge on conceptual and empirical basis (Höglund & Linton, 2017).

The basic thesis of Quadruple Helix model is that the potential for innovation and economic development in the knowledge society lies in more prominent university role; and in the hybridization of elements from all four entities. Hybridization within Quadruple Helix model would generate new institutional and social formats for the production, transfer and application of knowledge. The successful implementation of Quadruple Helix model represents the foundation of a favorable innovative environment. Favorable national innovative environment would optimize the knowledge use; optimize the process of generating innovations, and thus the revival of industry and business, especially in the transition economic structures.

The development of the Quadruple Helix theory by introducing civil society as the fourth entity completes the originally developed theory of the Triple Helix model. The Quadruple Helix model focuses on reforms, strategies, policies and implementation processes, as well as the transformation of economics, society and democracy (Carayannis & Campbell, 2010; Carayannis & Campbell, 2012; Carayannis & Campbell, 2014).

The Quadruple Helix model is primarily "human-centered", and only secondary "institutional-oriented". The functioning of the Quadruple Helix model has a strong bottom-up approach, precisely because of the fact that the market should serve society; society should serve people and individuals, not otherwise. The role of the individual is supreme (Carayannis & Campbell, 2014). The fourth entity in the Quadruple Helix model is compiled of the following components: public based on the media and culture and civil society. This additional entity can be understood as a dimension of democracy; or dimension of the knowledge based society in the context of democracy.

Inclusion of the fourth entity becomes critical since scientific knowledge is increasingly appreciated through its social power and inclusiveness. Accordingly, the public interest is very

important, and in this context, the fourth entity emphasizes new discoveries and innovations that enhance social well-being. So far, the concept of four-way helicopters has not been widely accepted and used in innovative research and policies. However, when researching innovation literature, we come to the conclusion that there is a wide circle and a long set of concepts that can be classified into a type of innovative concept based on four-helical helicopters (Arnkil et al., 2010). What is common to all QH types of innovative concepts is that everyone involves and joins the fourth entity in the innovation process of the TH Helix model (Arnkil et al., 2010). The transition from the triple to the quadruple Helix model can be attributed to the acceleration of social and technological progress and the need to intensify the production of innovative technologies.

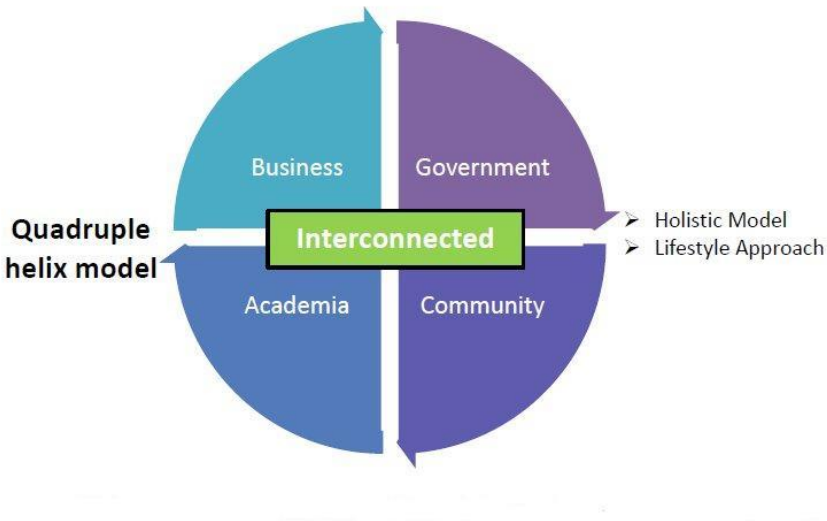

Fig. 1. Quadruple Helix model
Source: Irish Sea Rim, Overview Paper Autumn 2014, (2014). Philip Leigh, University of Chester, https://www.irishsearim.org/wp-content/uploads/2018/10/Irish-Sea-Rim-Overview-Paper-Autumn-2014.pdf

When it comes to the historical development of the Helix model, the insufficiently clarified question concerns the existence of vital differences in the application of Helix model in developed and developing countries, that is, in developed and transitory societies. As knowledge-based innovation systems vary from country to country, extensive empirical studies are underway to study and measure Quadruple Helix relationships and their impact on innovation processes in national and regional systems (Saad & Zawdie, 2011). An additional question and the importance of studying these relationships can be seen in the functional and intellectual evaluation of the application of these models in development and transition economies.

3. The Importance of Quadruple Helix Model for Innovative Environment

The use of scientific achievements for the purpose of creating innovative products and services is highlighted in the latest European Commission framework program, Horizon 2020, which is based on a Quadruple Helix model (https://ec.europa.eu/programmes/horizon2020/en).

Horizon 2020, the European Union's research and innovation support program, sets a new foundation for strengthening collaboration between the scientific and business sectors in achieving concrete results. In the last decades of the XX century, the global economic structure has changed its focus when it comes to sources of innovation. Namely, there has been a turning from the previous individual activities, such as product development in industry, decision-making at government level, creation of knowledge at the university – to interaction of these three spheres as a source of new innovation (Ješić, et al., 2014). The Horizon 2020 creates a new innovative environment that brings together the best minds from across Europe, from universities, from industry, the public sector and civil society. A new innovative environment will offer great opportunities for the European economy, as well as enormous potential for economic growth and job creation.

Global challenges in the information and digital sphere, health care, environmental protection and other areas can be reversed in the chances of economic growth, by implementation and joint complementary operation of the main entities of the Quadruple Helix model. As such, a Quadruple Helix model can create a better way of coordination to improve productivity, production volume and innovation. A positive attitude towards the use of knowledge and innovation can be created by several economic, state and financial institutions interested in investing in innovation, especially in the SME sector (Small and medium enterprises).

The interactivity of universities and all other actors (business entities, state institutions and civil society institutions) in the context of innovation environment can significantly increase the absorption capacity of academic knowledge within companies and other users. A Quadruple Helix model at regional level and local innovation systems can be seen as builders and accelerators of local economic development. The ascent of a modern, innovative knowledge-based economy changes the coordination and cooperation between business, administrative, public and private knowledge institutions. Universities play an important role in this process since they are increasingly involved in business incubation and regional development. This represents a relatively new type of development, which indicates a change in the role of the university and the place they have in the domain of economic development. Changes in university management open new discussions about the collision of old academic and new managerial values, the role of collegiality and the scale of new development priorities when it comes to the process of creating knowledge and new technologies.

Entering into the sphere of commercialization of knowledge, with the good governance of the development and scientific policy, can enable additional research investments in transition countries. The university that nurtures academic entrepreneurship and encourages the creation of spin off organizations increasingly recognizes how to contribute to solving real economic problems, affecting the development of society, and gaining profit from creating and transferring new knowledge. A very important issue, which also opens up a discussion of Quadruple Helix model and academic entrepreneurship, is that an academic scientist, who has the ability and capacity to create new knowledge, can make the most of the entrepreneurial opportunities and opportunities offered by the practical application of knowledge.

The Strategy of scientific and technological development of the Republic of Serbia for the period 2016-2020 sets Serbia as an innovative country in which scientists achieve European standards, contribute to the overall level of knowledge of the society, and improve the technological development of the economy, with a focus on the list of national scientific priorities (http://www.mpn.gov.rs/wp-content/uploads/2015/08/STRATEGION-of-international-international-development-RS-za-period-2016-2020.pdf). One of the goals is to establish a national innovative environment, as a complex network of public companies, industry, universities, research and development institutes, professional societies, financial institutions,

education and information infrastructure. The purpose of establishing a national innovative environment is development and application of scientific and technological knowledge and the establishment of a knowledge-based economy. However, the commercialization of knowledge does not happen spontaneously, and economic and technological progress is not accidental, but is structured in a particular social environment. Such an environment is possible only in modern societies, those countries that have managed to adapt to the demands of technological progress, countries that favor the interaction between the basic entities of the Quadruple Helix model.

In considering the Quadruple Helix model, it is important to emphasize the inclusion of the fourth entity, which is double defined - as an "informed and cultural public" or "civil society" (Carayannis & Campbell, 2009; Lindberg, et al., 2012; Colapinto & Porlezza, 2012) . This approach highlights the understanding of production and the application of knowledge and innovation, which requires the public to be integrated into advanced innovation systems. The public uses and implements knowledge, so users are also parts of the innovation system. In advanced knowledge-based societies and knowledge-based economies, knowledge flows across all spheres of society.

When we talk about the public, in the context of the Quadruple Helix model, we think even more precisely of: informed and cultural public and civil society. In addition, the fourth entity in the Quadruple Helix model also refers to other more specific aspects: culture, innovation culture, culture of knowledge, values and lifestyles, multiculturalism, creativity, media, art, multilevel innovation systems (local, national, global). In other words, the real "innovation culture" is the key to advanced knowledge-based economies. Through public discussions, transmitted and interpreted through the media, top priorities for society, through knowledge and innovation (research, technology and education) can be formed. In the multilevel innovation system, in the context of Quadruple Helix model, the research activities of universities are essential. The diversity and heterogeneity of innovation culture enhances the scope of creativity, which is necessary for the creation and expansion of new knowledge and new innovations.

4. Adoption of Quadruple Helix Model in Transitional Economies

The basic entities of Quadruple Helix model, university, industry, government and civil society, as institutions individually, and in their mutual interactions, are in eternal and infinite transition. The transition process also touches upon the question of the universities role in civil society, as well as the question of the extent to which civil society influences the creation of an innovative knowledge-based economy. Civil society is a generator of demand for products and services for the entire economic system, and at the same time a controlling body that determines the sustainability limit of economic system. A model that interprets transitional changes in civil society is the Quadruple Helix model (Etzkowitz & Leydesdorff, 1999), a spiral made up of interconnected links between university, industry, government, and civil society. The changed relationship between the university, industry, government, and civil society in the process of transition requires a new configuration of innovation systems, either by reducing the negative impact of totalitarian regimes or by establishing island corporations (Etzkowitz, et al., 2000).

A positive example of the new configuration of innovation systems is originated in the United States in the 1980s, following the adoption of the Bayh-Dole Act, which initiated the increase of new high-tech companies (https://www.govinfo.gov/content/pkg/STATUTE-94/pdf/STATUTE-94-Pg3015.pdf). This law has enabled every state-funded scientific institution (university, national institute,...) to simplify patenting of the research results as its own property, that is, co-ownership of its employees and, on the basis of that patent, to profit

through the commercialization of patent's value. Then, it was possible for a scientific institution to sell a patent or to initiate a spin-off venture and turn it into a spin-off firm (Mirales, 2007). The management of a university could invest a substantial part of such funds in the same, similar or new basic research, as well as in education, thereby increasing the standard of its employees, taking care that the patents'authors get a certain awards. Following the adoption of the Bayh-Dole Act in the United States, universities were given the opportunity to transfer technology from their laboratories and scientific centers to the market - while retaining ownership rights over innovations.

When we focus on the Republic of Serbia, as a country that is going through the process of transition, in the previous period there has been a very strong migration of scientific and technological talents to developed countries where there is not enough demographic potential. The greatest talents and best experts are worthy resources, and the strongest economies are trying to hire and retain them in their countries. The Republic of Serbia, which is currently in the final phase of a long transition period, has to invest and enable scientific-research development, stimulate and appreciate researchers, thus preventing the departure of the best scientific research personnel, which has been a trend so far. The complementarity principle in Quadruple Helix model maps interactive, complementing relationship of entities that together contribute to the integrity of a particular phenomenon. Hence, in conditions where the global economy faces significant challenges - unemployment, low or negative growth, increased needs for health services, rapidly growing digital business models, unsustainable environmental changes, there is a need for universities, industry, government institutions and civil society as a whole, to work together to solve all current and emerging challenges. The Quadruple Helix model, properly understood and implemented in practice, creates local and national innovation systems at the national or regional level. In such a way Quadruple Helix model becomes the builder of a stable and sustainable civil society, as well as accelerator of regional and national economic development.

The process of transition implies comprehensiveness and requires the reform of almost all institutions. The transition process requires timely synchronized activities that can be programmed successfully only if they know well all their implications. It is a complex venture that implies the initiation, management and control of multiple processes that must occur simultaneously or in certain mutually conditioned sequences. If we assume a fixed destination as the supreme tendency of the transition process (in most of the countries in the region this is precisely the case) such as the market economy, we are dealing with the basic principle of global economy, change. Instead of such desired state, in the form of transition to market economy, it is better to choose the state of continuous transition by accepting the dynamic and competitive nature of technology development in the global economy. By this attitude towards understanding the transition process itself, we get more than a blind continuation of the creation of new roles and connections between static institutions. States still do not give up entirely the subsidy policy, which gives us a transition to a mixed system made up of market forces and state incentives. Of course, the interconnections between the government, the industry and universities are changing, from previous models of separation and control, to interaction in the form of a Quadruple Helix model whose relatively autonomous spheres overlap with the common interest - the advancement of civil society.

Changes in the sphere of education can not be viewed as separate from the context of social change, which are often influenced by the relations of political actors and other interest groups, as well as the economic potentials of the community. In the current time, a university with a nurturing knowledge increasingly becomes a generator of changes in industry, culture, politics and other areas of social life. With all essential and marginal changes in social factors, scientific institutions were to a great extent the factors of change in society, regardless of the

time in history. The joint connection and the transfer of knowledge, goals and interests between the main entities of the Quadruple Helix model can function catalytically on the entire innovation process. The efficiency of the innovation system can be different if the decision-making power on innovation processes is concentrated at national, regional or local levels. The regionalization of the Republic of Serbia clearly shows the differences in the economic development of the regions, partly due to different innovation policies and systems. The decision-making efficiency of national and regional innovation systems depends on the possibility of more complete and effective use of existing knowledge at a certain level.

5. Conclusion

The Quadruple Helix model is primarily a model for analyzing innovation systems in knowledge-intensive economies. These models explain in more detail the phenomenon of innovation systems, their formation and functioning at different levels in socio-economic systems, at different development stages. Interaction between the entities of the Quadruple Helix model assumes communication between differently encoded value systems, including the risk of potential conflicts and different interests of all entities.

The Quadruple Helix model is used as an access to a local and global innovation system, thus forming important specifications of a modern knowledge society. Accordingly, the influence of the university, as the initiator and creator of an entrepreneurial environment, based on the values of knowledge, is further intensified. Strategic planning should be achieved through cooperation with neighboring regions and harmonization and optimal use of resources. It is necessary to establish links between the public, private and civil sectors in the construction of strategic Quadruple Helix partnerships. This could be achieved through the preparation and implementation of projects that contribute to population's standard in the region, as well as more balanced regional development in the Republic of Serbia. The promotion of regional development is done using local and national resources, as well as the available resources of the international community, attracting foreign investors to the region.

Given the new knowledge that we have, policy implications are aimed at the application of laws and regulations of the governing state institutions, in order to achieve complementary relationships within the Quadruple Helix model, between universities, industry, government and the civil society. It is necessary to define the position of the university on the transfer and commercialization of knowledge. The negative attitude and resistance of universities to commercialization of knowledge can significantly influence the slowdown in the development and implementation of the Quadruple Helix model in practice. On the other hand, the positive attitude of universities will affect the transfer of technology and the production of new values. Policy implications are aimed at the inclusion of universities in local economic development, which places an important pillar of innovation in the region, and increases the competitiveness index at the national level. Ensuring economic growth is to be achieved through start-up activities and spin-off ventures at universities, which increases the survival rate of newly established businesses.

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Classification and Objectives of DDoS-attacks by OSI model levels

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Abstract. The paper provides a classification of DDoS-attacks by the level of the OSI model. The measures of counteraction and prevention of DDoS-attacks by OSI levels are described. Practical application of the above classification of DDoS-attacks by OSI levels is given.

Keywords. DDoS-attacks, Security information, OSI levels, Network security, OSI model.

1. Introduction

The subject of the study is the classification and objectives of DDoS-attacks by OSI levels.

The problem of DDoS has become relevant since 1996. With the development of the popularity of the Internet and its commercial application, the weight and damage caused by such attacks is growing. The issue of countering DDoS-attacks began to be dealt with since 2000. After the hackers once again successfully attacked such resources as CNN, eBay, Amazon, E-Trade, etc.

According to Kaspersky Lab's statistics for 2017, in the third quarter, 98 countries were affected by DDoS-attacks.

There are several ways to counter DDoS-attacks. The effectiveness of their work depends on the type of attack. Therefore, need to consider the most common types of attackers DDoS-attacks. It is necessary to classify DDoS-attacks by OSI levels.

The goal of this paper is a structured presentation of DDoS-attacks by OSI layers.

The result of this work is a structured presentation of DDoS-attacks by OSI levels. Popular DDoS-attacks were considered. Practical recommendations for the prevention or elimination of DDoS-attacks are given.

The paper has the following structure. Section 2 describes the OSI model. Section 3 showing possible DDoS-attacks at each OSI layer. The definition of the basic DDoS-attacks is given. In section 4 showing measures to counter DDoS-attacks at each level of the OSI model. In Section 5, the results are summarized and directions for further research are outlined.

2. The OSI model

A network operating system when performing all tasks follows a strict set of procedures. These procedures are called protocols or rules of conduct. Protocols regulate each network operation. Standard protocols allow the software and hardware of various vendors to interact normally. There are two main sets of standards: the OSI model and its modification, called Project 802. To study the technical side of the operation of networks, it is necessary to have a clear understanding of these models. In this paper, the OSI model will be considered.

Studying the network architecture will allow the information security expert to competently counteract the network attacks at different levels [1].

OSI (Open System Interconnection) - network model of interaction of open systems (reference model). This model is the standard. Manufacturers of network devices, when developing new products, adhere to the OSI model [2].

The OSI network model consists of 7 levels (Figure 1), and it is customary to start the countdown from the lower:

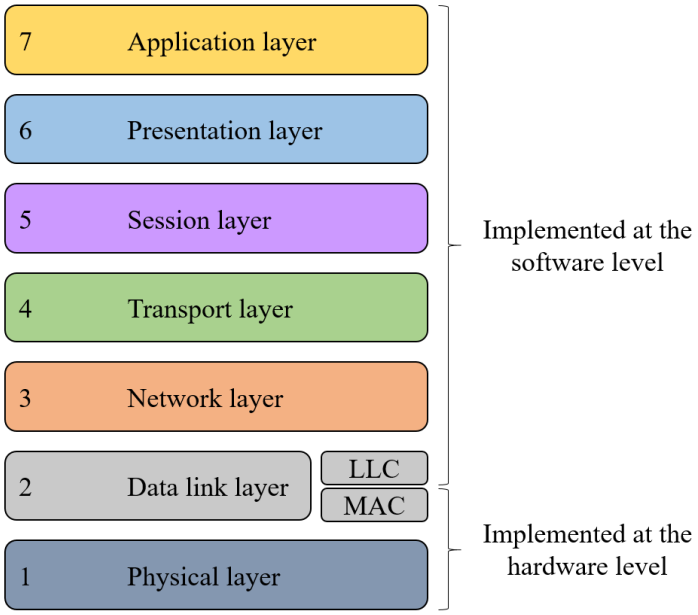

Fig. 1. OSI network model.

7. Application layer

Organizes the interface between applications. It describes the structure of a message understandable to the application.

6. Presentation layer

Here, the data is encoded, compressed, or encrypted. For example, when sending a message, it needs to be compressed beforehand to reduce traffic.

5. Session layer

Creates and manages dialogs and sessions between applications. The application must distinguish between different data streams within a single connection. For example, an application can simultaneously request two files from one server. However, it will distinguish flows.

4. Transport layer

Provides data delivery to a specific application on a workstation or server. At this level, addressing appears - the ports. So, for example, if a message arrives on port 80, then it is passed to the process of the web server that listens to this port.

3. Network layer

Provides data transfer between networks within an area called "internetwork". Where internetwork is the combination of two or more networks with common routing principles (easier to say, a network of networks).

2. Data link layer

Provides data transfer through a physical channel.

1. Physical layer

The data are represented in the form of electrical pulses, light beams, electromagnetic waves, which encode the bits. The task is to create a physical channel for sending bits [3].

3. Possible DDoS-attacks at each level of the OSI model

One of the most common attacks on statistics is a remote network attack. There are various network attacks. The most dangerous and common is considered to be Distributed Denial of Service (DDoS-attacks). This attack is popular with its "ingenious" simplicity, numerous open information about its implementation and small computing resources. The main idea of this attack is that the attacker is trying to make impossible the correct maintenance of the system.

Consideration of DDoS-attacks on the levels of the OSI model is important. This will allow you to study all possible types of attacks, choose the right prevention measures or correctly eliminate these attacks.

L7:

Examples of DoS technologies: PDF GET queries, HTTP GET, HTTP POST (forms of websites: login, uploading photo/video, feedback confirmation). At this level, data is manipulated through user protocols (FTP, HTTP, POP3,SMTP, Telnet, RAS). The consequence of DDoS-attacks here is a total lack of resources for performing the simplest operations on the attacked resource [4].

L6:

Examples of DoS technologies: Suspended SSL requests: checking encrypted SSL packages is very resource intensive, attackers use SSL for HTTP attacks on the victim's server. At this level, data is transferred from the source to the receiver. Used protocols ASCII, EBCDIC, aimed at compressing and encoding data. Most often for attacks at this level, the technology of forged SSL requests is used. Since a significant amount of resources are used to check encrypted SSL packets. Very often their decoding takes place already inside the network of the organization or on the resource server. In other words, in order not to spend considerable time decrypting encrypted requests, the firewall and other security systems simply skip them without checking further through the network. This is often used by hackers, generating their own forged SSL requests, which can initiate unauthorized reloading of services responsible for receiving SSL connections [5].

Another thing that works for the attackers is the fact that the process of decrypting the package requires almost 10 times more resources than necessary for encryption. Attacks made by forged SSL requests can cause significant harm. In this case, the resource costs of the attacker will be relatively small. Approach to protection against DDoS-attacks at this level should be complex: use specialized tools that check incoming traffic (filtering DDoS-traffic), and try to distribute the SSL infrastructure (for example, to place the SSL-terminating functionality on a separate server) [6].

L5:

Examples of DoS technologies: The attack on the Telnet protocol uses the weak points of the Telnet server software on the switch, making the server inaccessible. At this level, there is an initialization of the processes of installing and terminating communication sessions within the OS (for example, when changing users in windows), as well as their synchronization within the same network through protocols RPC, PAP. At this level, network equipment is

attacked. Using the vulnerabilities of the Telnet server software on the switch, attackers can block the ability to control the switch for the administrator.

L4:

Examples of DoS technologies: SYN-flood, Smurf-attack (attack ICMP-requests with changed addresses). The purpose of this level is to ensure stable and error-free data transfer between nodes of the network. In addition, it is at this level that the process of transferring information from the physical to the network layer. Implemented by TCP and UDP.

Types of DDoS-attacks used at this level - SYN-flood, Smurf-attack and others. As a result of such attacks, the number of available connections is exceeded (the channel width reaches its limit), and network equipment outages are possible.

L3:

Examples of DoS technologies: ICMP flood - DDos-attacks in the third layer of the OSI model, which use ICMP messages to overload the bandwidth of the target network. At this level, the data is routed and exchanged between networks by sending packets with information on such IP, ICMP, ARP, and RIP protocols. An example of a DDoS-attack at this level is the ICMP flood. The essence of the attack is that the host is constantly "pinged" by violators, forcing it to respond to ping requests. When a significant number of them arrive, the network bandwidth is not enough, and the answers to requests come with a considerable delay.

L2:

Examples of DoS technologies: MAC-flood - overflow with data packets of network switches. Responsible for the interaction of network elements at the physical level, operating frames using 802.3 and 802.5 protocols through controllers, access points and bridges that use them. An example of DDoS-attack at this level is MAC-flooding - overflow of switches with data packets, which entails blocking of their ports.

L1:

Examples of DoS technologies: Physical destruction, physical obstruction of work or management of physical network assets. The impact of a DDoS-attack at this level will be the destruction or inability to manage (at the physical level) hubs or patch panels using the protocols described above.

In the case of wireless networks, DDoS-attacks at the physical level are characterized by the generation of various types of interference that can disrupt communications between network elements.

4. Countermeasures against DDoS-attacks at each level of the OSI model

L7:

Application monitoring - systematic software monitoring, using a certain set of algorithms, technologies and approaches (depending on the platform on which this software is used) to detect 0day-vulnerabilities of applications (attacks of level 7). Identifying such attacks, they can stop once and for all and track their source. This is done most simply on this layer. The most effective way of countering intruders is by constantly monitoring the state of the system as a whole and software in particularAfter detecting an attack at this level, you can identify the attacker and completely block the possibility of doing any actions.

L6:

To reduce harm, pay attention to tools such as the distribution of the SSL encryption infrastructure (that is, the placement of SSL on an excellent server, if possible) and checking application traffic for attacks or policy violations on the application platform. A good platform

ensures that traffic is encrypted and sent back to the initial infrastructure with decrypted content that was in the secure memory of the secure bastion node.

L5:

To avoid attacks at this level, it is necessary to keep the firmware of the equipment up to date. To prevent the use of "holes" in the software in the future, after each successful attack, the manufacturer necessarily releases a "stub". Using only the current licensed software on servers reduces the level of threats at the session level significantly.

L4:

DDoS traffic filtering, known as the blackholing method, often used by providers to protect customers. However, this approach makes the client's site unavailable for both malicious traffic and for legitimate user traffic. However, access blocking is used by providers in the fight against DDoS-attacks to protect customers from such threats as slowing the operation of network equipment and the failure of services. The most common method of counteracting such attacks is blackholing. This is a method of filtering traffic at the provider level, before it hits private networks. Its essence lies in the fact that in the event of an attack, the network administrator can configure the system in such a way that packets from intruders will be discarded. Blackholing has its drawbacks - with insufficiently accurate filtering parameters, in addition to malicious packets, queries from "legitimate" users that do not have any relation to the attackers can also be cut off.

L3:

To prevent DDoS-attacks at this level, you can completely disable the processing of ICMP requests through the Firewall. And also limit the number of processed requests using the ICMP protocol and reduce the possible impact of this traffic on the speed of the Firewall and the bandwidth of the Internet bandwidth.

L2:

To avoid problems, it is recommended to use modern network equipment - many models provide the function of storing reliable MAC addresses that have been authenticated. Thus, it is possible to restrict and filter requests in accordance with the hardware settings, cutting off unreliable or "fludyaschie" addresses. Many modern switches can be configured in such a way that the number of MAC addresses is limited to reliable ones that are tested for authentication, authorization and accounting on the server (AAA protocol) and subsequently filtered [7].

L1:

As a preventive action that can protect the negative consequences of attacks by intruders at this level, you can recommend systematically check the condition of the equipment. It is also necessary to use a systematic approach to monitoring the operation of physical network equipment. To restore the equipment in the normal mode, its full repair will be required.

5. Conclusion

Preventing network attacks is one of the most difficult tasks in the field of information systems protection. Most modern systems have a distributed structure, their architecture is based on the use of network technologies. And ensuring the operability of such systems depends on the ability to resist malicious acts that are aimed at disrupting the work of both the network itself and the information system functioning within its framework. One of the most dangerous types of criminal activity on the Internet is the so-called network attacks. As statistics show in Internet sources, the number of network attacks continues to grow, the

methods used by criminals are constantly evolving and improving, from single attempts they are moving to corporate development. At the same time, modern systems for detecting intrusions and attacks are not yet perfect and insufficiently effective from the point of view of security solutions. Therefore, working methods in this direction are necessary and relevant [8].

In this paper, DDoS-attacks were classified for each level of the OSI model. Practical recommendations were given for the prevention or elimination of DDoS-attacks. Understanding these aspects is an important fact for further research.

In the future, it is planned to model each type of DDoS-attacks at each level of OSI. Next, a database of all known DDoS-attacks will be created. Based on this database, the neural network will be trained. The neural network will be an integral part of the expert system for protection from DDoS-attacks in real time.

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The Use of Econometric Models in Analyze the Solvency of a Business Entity

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Abstract. In article the characteristics of the methodology used to analyze the solvency of a business entity and its shortcomings is described. The analysis of modern approaches to assessing the financial stability and probability of bankruptcy of an organization (Altman Z-models, discriminant models of Tuffler, Beaver, Argenti A-account) and their limitations are provided. The approaches to the successful application of foreign methods in the Republic of Belarus are proposed.

Keywords. solvency, financial stability, bankruptcy, solvency ratios, solvency and insolvency criteria.

1. Introduction

Solvency is one of the most important indicators characterizing the financial condition of an enterprise, since it is an external manifestation of its economic stability. In fact, solvency characterizes, to a certain extent, the survival of the organization, because if there is a long-term and stable insolvency, it is subject to economic insolvency (bankruptcy) procedures. One of the problems that arise when considering bankruptcy cases is the determination of the financial condition of the debtor, which is determined on the basis of information on the degree of its solvency and property status, obtained from the results of financial analysis according to the methodology approved by the Decree of the Council of Ministers of the Republic of Belarus dated 12.12.2011 № 1672 [1] and the Instruction on the procedure for calculating solvency ratios and analyzing the financial condition and solvency of business entities, approved by the Decree of Ministry of finance of the Republic of Belarus and the Ministry of Economy of Belarus from 27.12.2011 № 140/206 [2]. The source of information for the analysis of the solvency of the organization is the balance sheet with its annexes, completed in accordance with the requirements of the law. Based on this information, economic courts make decisions on initiating bankruptcy proceedings, and subsequently one of two areas of action is chosen - reorganization of the organization or its liquidation. Remediation is a system of measures for the financial recovery of the enterprise, implemented with the help of third-party legal entities or individuals and aimed at preventing the debtor company from declaring bankrupt and liquidating it.

Considering the fact that the reorganization procedure is applied by the courts extremely infrequently and the domestic methodology for analyzing solvency and forecasting bankruptcy does not allow an accurate assessment with respect to specific business entities, analysis of the state and prospects of using modern approaches to analyzing solvency and assessing the probability of bankruptcy in the Republic of Belarus is relevant and allows you to determine ways to solve problems in this area.

2. The characteristics of the applied methodology for analyzing the solvency of a business entity and its shortcomings

The modern Belarusian methodology for assessing the solvency and probability of bankruptcy of an organization is based on the calculation of the following ratios (according to clause 1 of the Decree of the Council of Ministers of the Republic of Belarus No. 1672) [1, 3]:

- current liquidity ratio (K1), which characterizes the overall security of a business entity with short-term assets to repay short-term liabilities and calculated as the ratio of short-term assets to short-term liabilities;
- the ratio of own working capital (K2), characterizing the existence of a business entity own working capital necessary for its financial stability, and calculated as the ratio of the amount of equity and long-term liabilities minus long-term assets to the amount of short-term assets;
- the coefficient of security of liabilities with assets (K3), characterizing the ability of a business entity to calculate its liabilities and calculated as the ratio of total liabilities to total assets.

Further, in the Decree of the Council of Ministers of the Republic of Belarus No. 1672, the normative values for the coefficients K1 and K2 are presented, differentiated by types of activity. The value of the coefficient K3 is not more than 0.85 for all sectors of the national economy. Also, in paragraphs 6-8 of Instruction No. 140/206, the procedure for calculating the above solvency ratios is given and, for the purposes of Article 43 of the Law of the Republic of Belarus "On Economic Insolvency (Bankruptcy)", a further financial analysis is carried out, consisting of calculating the absolute liquidity ratio, composition, structure and dynamics of all groups of the balance sheet (clause 13-15 of the Instruction No. 140/206). This analysis is supplemented by the calculation of profitability indicators (parts 3-4 of clause 15), turnover (clause 16) and financial stability (clause 17).

At the same time, Resolution of the Council of Ministers of the Republic of Belarus dated January 22, 2016 No. 48 "On Amendments and Additions to the Resolution of the Council of Ministers of the Republic of Belarus dated December 12, 2011 No. 1672" (hereinafter referred to as the Decree of the SMRB No. 48) established the following criteria for recognizing a business entity as solvent or insolvent:

- in the presence of K1 and (or) K2 at the end of the reporting period, depending on the main type of economic activity, having values more than normative or equal to them, as well as K3, the value of which is less than or equal to 1, for leasing organizations - less than or equal to 1.2 ;
- if there are simultaneously K1 and K2 coefficients at the end of the reporting period, depending on the main type of economic activity, having values less than normative, as well as K3 coefficient, the value of which is less than or equal to 1, for leasing organizations - less than or equal to 1.2;
- the entity has insolvency, which becomes sustainable in the presence of both K1 and K2 ratios at the end of the reporting period, depending on the main type of economic activity, having values less than normative during the four quarters preceding the preparation of the latest financial statements, and K3 coefficient having a value less than normative or equal to it;
- the subject is in a state of insolvency, which has a stable nature, in the presence of at least one of the following conditions:

1) the presence of both the current liquidity ratio and the ratio of own working capital at the end of the reporting period, depending on the main type of economic activity, having values less than normative during the four quarters preceding the preparation of the latest

financial statements, and the availability of the security ratio at the date of the last financial reporting asset liabilities of more than normative significance;

2) the availability at the date of preparation of the latest financial statements of the asset security ratio, the value of which is more than 1, for leasing organizations - more than 1.2.

According to domestic economists, in this official methodology for analyzing the solvency of a business entity and conclusions on economic insolvency (bankruptcy), formulated on its basis, there are many shortcomings, for example:

- the inaccuracy of the wording of the definition of solvency ratios laid down by the Decree of the Council of Ministers of the Republic of Belarus No. 1672. It states that the current liquidity ratio (K1) characterizes "the general security of the business entity with short-term assets to pay off short-term liabilities" [1]. In many theoretical sources on financial analysis, the current liquidity ratio shows the theoretical ability to pay off your short-term liabilities by selling short-term assets based on their book value at a certain date. At a different date, this ratio may have a completely different meaning, since the performed business operations lead to a change in assets and liabilities;

- mismatch of the name of the coefficient of security with own working capital (K2) to its definition in the Decree of the Council of Ministers of the Republic of Belarus No. 1672. It states that K2 characterizes "the presence of the business entity own working capital necessary for its financial stability" [1]. However, the formula for calculating this indicator characterizes only the availability of working capital and their share in the formation of short-term assets, and not their security. In order to really assess the security of the organization with its own working capital, it is necessary to compare their actual value with the planned need for them, or their minimum value, ensuring the financial stability of the organization. Indeed, the main purpose of using own working capital is "to ensure the possibility of uninterrupted continuation of economic activity when it becomes necessary to simultaneously repay all short-term obligations". Moreover, there is a direct functional relationship between the coefficients K1 and K2, which can be expressed by the formula by mathematical transformation of the coefficients K1 and K2:

$$K2 = 1 – (1 / K1). \quad (1)$$

Based on the formula (1) it can be seen that the coefficient K2 has no additional information compared with the coefficient K1. The presence or absence of working capital can be determined from the value of the coefficient K1. If the value of the coefficient K1 is greater than one, then there are own working capital; if less, then there are none [4]. Similar opinions on the coefficient K2 are expressed by other domestic scientists-economists, in particular N.P. Mytsky and V.A. Mytsky [5];

- the asset security ratio (K3) is calculated by the ratio of borrowed capital to total assets. Based on the name of the coefficient, it should show how many assets are per unit of liability. In this case, this ratio should be calculated as the ratio of assets to liabilities, and not vice versa. In addition, it is necessary to clarify, regarding the characteristics of this coefficient as "the ability of a business entity to calculate its liabilities after the sale of assets", it is necessary to clarify: "based on their book value" [4, 6].

Considering the above disadvantages and the indisputable advantages of the Belarusian methodology, among which are the simplicity of calculating the coefficients and conclusions based on them, the presence of the developed standard values of the coefficients K1 and K2 by types of economic activity, etc., from the point of view of diagnosing the probability of bankruptcy of the organization, this technique has a number of limitations. Assessing the probability of bankruptcy of an organization for three indicators (K1, K2 and K3) does not

provide an objective assessment for a number of reasons. For example, the static nature of these indicators, as they are calculated according to the balance sheet data for a specific date. Such an analysis does not take into account such important factors as the volume of sales of products (goods, works, services), costs, profits. The real picture can only be presented in the relationship of liquidity, turnover and profitability. Therefore, the methodology should organically link the current liquidity ratio, capital turnover ratios and return on assets.

3. Analysis of modern approaches to assessing the financial stability and probability of bankruptcy of an organization and their limitations

In world practice, to assess the financial stability and probability of bankruptcy of an organization, a wider range of financial and economic indicators has long been used, on the basis of which a number of universal and more effective methods have been developed and successfully applied. The most common among them are Altman Z-models, discriminant models of Tuffler, Beaver, Argenti A-score.

The model of the American economist Edward Altman, called the Z-account, was developed by him in 1968 based on statistics from 66 American companies [7]. It was developed to analyze joint stock companies that list their shares on world stock exchanges, and is a five-factor model in which bankruptcy diagnostic indicators act as factors. The Altman Z-score model is calculated by the formula (2):

$$Z = 1{,}2X1 + 1{,}4X2 + 3{,}3X3 + 0{,}6X4 + X5, \quad (2)$$

where:

Z – an integral indicator of the level of threat of bankruptcy;
X1 – the ratio of working capital to the total assets of the enterprise;
X2 – ratio of net profit to the total assets of the enterprise;
X3 – coefficient of the ratio of profit before tax to the total cost of assets;
X4 – ratio of equity to borrowed capital;
X5 – the ratio of sales (net sales) to the total value of the assets of the enterprise.

The level of threat of bankruptcy of an enterprise in the Altman model is evaluated on the scale given in table 1.

Table 1. Evaluation scale for the Altman model

The value Z exponent	Probability of bankruptcy	Bankruptcy probability,%
Z <1.81	Very high	80 - 100%
1.81≤ Z <2.77	High	35 - 50%
2.77 < Z <2.99	Possible	15 - 20%
2.99 ≤Z	Very low	Close to 0

The scientist also developed a simplified two-factor model based on current liquidity ratios and the ratio of borrowed capital to total liabilities, a seven-factor model (1976) that allows predicting bankruptcy with an accuracy of 70% on the horizon in 5 years, and a five-factor model (1983) for companies whose shares are not quoted on the exchange market [7].

British scientists R. Tuffler and G. Tishou in 1977 [8] proposed a four-factor model. When developing it, the following approach was used: at the first stage, statistics was collected on eighty companies, both bankrupt and solvent. Using the statistical method, known as the "multidimensional discriminant analysis," a solvency model was built.

Selective calculation of ratios is typical in determining key company performance indicators such as profitability, working capital adequacy and liquidity. The solvency model, combining these indicators and bringing them together appropriately, reproduces the exact picture of the financial condition of the enterprise. The Tuffler model for analyzing companies whose shares are listed on exchanges has the formula:

$$Z = 0,53X1 + 0,13X2 + 0,18X3 + 0,16X4, \quad (3)$$

where:

X1 – the ratio of profit before tax to the amount of current liabilities (shows the degree of feasibility of the obligations of the company due to internal sources of financing);

X2 – the ratio of the sum of current assets to the total amount of assets (characterizes the state of working capital);

X3 – the ratio of the current liabilities to the total assets (an indicator of financial risks);

X4 – the ratio of revenue to total assets (determines the ability of the company to settle obligations).

A Z-score of more than 0.3 indicates a low probability of bankruptcy, if less than 0.2, then the likelihood of bankruptcy is high. The advantage of the Tuffler model is the high accuracy of the forecast of the probability of bankruptcy of the company, which is associated with a large number of companies analyzed.

The famous financial analyst William Beaver in 1966 proposed his own system for determining the probability of bankruptcy [9]. His five-factor model contains the following indicators:

- return on assets;
- current ratio;
- the share of net working capital in assets;
- the proportion of borrowed funds in liabilities;
- Beaver's ratio (the ratio of the amount of net profit and depreciation to borrowed funds).

The design features of this model are the absence of weighting factors, as well as the ability to determine the threat of bankruptcy over five years. The W. Beaver model does not provide weighting factors for indicators and does not calculate the final probability coefficient of bankruptcy. The obtained values of the indicators are compared with the normative values characteristic of the three states of the company formulated by W. Beaver:

- for successful companies;
- for companies that went bankrupt during the year;
- and for companies that have gone bankrupt within five years.

The Argenti model (named after the English economist John Argenti) characterizes, first of all, the managerial crisis that could lead to bankruptcy of the company [10]. Determining the probability of bankruptcy of a company using this model suggests that:

- the process leading to bankruptcy is already underway;
- this process will continue for several years;
- the process can be divided into three components: symptoms, deficiencies, errors.

J. Argenti identified three components of the process leading to the bankruptcy of the company - flaws, mistakes and symptoms. Almost all companies that are threatened with bankruptcy have flaws for several years (table 2), obvious long before actual insolvency. Due to their accumulation, an enterprise can make a fatal mistake (table 3), leading to bankruptcy (the author of the model assumes that organizations that do not have shortcomings do not make mistakes). Symptoms (table 3) - they show the mistakes made by the company. The approaching insolvency is indicated by the deterioration of financial indicators, cash shortages.

Table 2. A-account method for predicting bankruptcy (deficiencies)

Index	**Assignable score**
Disadvantages	
1. Autocracy in the top management of the company	8
2. The chairman of the board and the executive director are one and the same person	4
3. Passive Board of Directors	2
4. Unbalanced Board of Directors	2
5. Incompetent CFO	2
6. Unskilled management	one
7. Weak budget control	3
8. Lack of cost reduction system	5
9. Slow and not always adequate response to the change in market conditions	fifteen
10. Lack of cash flow reporting	3
Total points	45
Critical score for the group	10

When testing, the indicators in tables 2, 3 must be assigned one of two values - either "yes" or "no". Each stage factor is evaluated in points, after which the aggregated indicator - A – score, is calculated by summing all the points. Intermediate values are unacceptable, that is, it is necessary to evaluate each position in terms of whether the researcher agrees with the given judgment or not. Maximum possible A – score: 100 points. If an enterprise scores up to 25 points in all groups ("passing score"), then the company is stable, if more - in the near future the company faces bankruptcy. The more points scored, the worse.

Table 3. A-account method for predicting bankruptcy (errors and symptoms)

Index	**Assignable score**
Mistakes	
1. High debt	fifteen
2. Overtrading (loss of current liquidity)	thirteen
3. Large unsecured projects	fifteen
Total points	43
Critical score for the group	fifteen
Symptoms	
1.Financial signs of decline	4
2. Incorrect content of accounting and reporting ("creative approach")	4
3. Non-financial signs of decline	3
4. Final signs of decline	one
Total points	12
Critical score for the group	0
Maximum points	one hundred
Critical score for all groups of indicators	25

The main advantage of the J. Argenti model can be considered taking into account non-financial indicators and risks of the company, such as: problems in management, lack of budget control, slow reaction to changing market conditions and others. The disadvantages of the model include the subjectivity of grading, the absence of a final coefficient, and the lack of a statistical base and the dependence of the accuracy of calculations on the source information.

Quantitative models of R. Lis, G. Springate and others are also successfully applied. However, the application of the above models of discriminant and qualitative analysis for enterprises of the Belarusian economy is extremely difficult due to the following circumstances:

- the difference in the statistical sample of enterprises in the formation of the model; the difference in accounting for individual indicators (in the United States, a GAAP accounting system is used);
- the model does not take into account the effect of inflation on indicators, which is extremely important for the national economy of Belarus;
- the difference in the carrying amount and market value of assets, etc.

The most important problems of their use are the obsolescence of the data used for these models, the absence among them of any of the most effective (universal) and the practical impossibility of their application to reflect the real state of Belarusian enterprises. For example, according to the Altman model, insolvent organizations with a high level of X4 (the ratio of equity to borrowed) receive a very high rating, which is not true in our country. Due to the imperfection of the current methodology for revaluation of fixed assets, when old worn-out fixed assets are given the same value as new ones, the share of equity capital unreasonably increases due to surplus capital [4]. Therefore, the models in which this indicator is present can distort the real picture of the financial condition of the organization.

4. Conclusions

Thus, despite the presence of a large number of methods that allow predicting the financial viability of an organization with varying degrees of probability, none of them can be used as universal. Therefore, when diagnosing bankruptcy of an organization, it is advisable to use several techniques at the same time, taking into account the specifics of the situation. The methodology for calculating the weighting coefficients and threshold values of the applied models taking into account Belarusian economic conditions does not allow the absence of statistical materials on bankrupt organizations in the Republic of Belarus, and the determination of weighting factors by experts does not ensure their sufficient accuracy. Nevertheless, economists from many countries, testing the Altman model in practice, agree with its universality and reliability. Adapting weights with coefficients in the model for their states and industries, many economists appreciate its high working ability and statistical reliability. The same can be said of the other models used in the global practice of diagnosing bankruptcy. For the successful application of foreign methods in the Republic of Belarus, weights must be adjusted for ratios and other model indicators taking into account the specifics of the national market economy.

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Information and Analytical System for Clusterization and Hypothesis Testing in Biological Researches

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Abstract. The article analyzes modern tendencies in the development of applied medical-biological information systems. The statistical methods, which are the basis of data analysis during construction of the system, are described. The main problems of medical-biology metrology are analyzed. The general concept of system construction is considered. The results of the UML modeling system are presented. Approval of the system was carried out in the study of the influence of vitamin D deficiency on women's reproductive health.

Keywords. Analytical system, Information and analytical system, Clusterization, hypothesis testing, Biological researches.

1. Introduction

Statistical methods in clinical trials have been used from the 1930s. [1, 2]. During this time the quantitative and statistical approach to the description and analysis of clinical phenomena has firmly established itself in medical and biological practice. It was biostatistics that played a key role in the transition of medical-biological research from the description of individual observations and cases to systematic experimental work using control groups and large-scale randomized controlled trials. This approach has become the standard in quality research.

Any scientific study is ultimately aimed tj obtain reliable information about the objective properties of the surrounding world. Many of the phenomena studied have a statistical nature. It means that they have properties that can either be manifested or not, depending on the set of attendant factors. On this occasion, the detection of the studied patterns is largely determined by the adequacy of methodological tools used during the study. One of the universal strategic methods for increasing the efficiency of any research is the mathematical methods application. Moreover, the more complex the phenomenon is studied, the more advanced is the mathematical apparatus to be used. This also applies to medical and biological research, which consists in revealing the regularities of the response of the most complex, biological system to the action of environmental factors. The level of the hierarchy of such biosystems may be different - the population, the individual, the organism's biosystem, etc. The number of factors that may affect, the degree of the description detail of the response mechanisms can be different as well. Accordingly, mathematical methods can be the most diverse.

The ethical and economic needs of the day dictate the need for a special attitude to the planning and conduct of medical-biological research. In addition, knowledge of information processing techniques makes it more effective to organize the process of output data collecting.

The purpose of this article is to study the main problems of medical-biological

metrology in the context of building an information and analytical system for the analysis and processing of the medical-biological research results. The ultimate goal is to develop the structure of such a system and it work model.

2. The general concept of constructing an information and analytical system for clusterization and hypothesis testing in medical-biology researches

Last years, there has been widespread use of personal computers and various software tools for mathematical data analysis for different sciences, including medicine and biology. However, this does not eliminate the need to possess at least the basics of mathematical statistics. Moreover, the user of such software must correctly select the appropriate statistical procedures, know their capabilities and limitations, correctly and reasonably relate to results interpretation. The arbitrary use of statistical results can lead to erroneous conclusions about the effectiveness of the treatment methods used.

The medical-biological information obtained during the research may be presented in different forms. They define methodical approaches to data processing and interpretation. On the other hand, the choice of information processing methods is related to the goal and objectives of the research. Medico-biological information can be presented in a discrete and continuous form. Almost all laboratory research data is a sets of digits, except for the results of spectral analysis, which may be curves. Continuous signals can be obtained, for example, on electroencephalograms, electrocardiograms, and the like. In addition, images can be obtained as a result of research, such as a roentgenogram or a thermal graph. Most of the discrete medical-biological information is obtained through measurements. Measurements allow to establish the patterns of change of the investigated indicator.

There are direct measurements, at which the result can be obtained directly from the measurement of the value, and indirect, at which the value of the quantity to be found is determined by the known dependence between this value and the directly measured values. The technical means for carrying out measurements (measuring instruments) may be different. The most commonly used measuring instruments in which measurement information is presented in a form that is accessible to the immediate perception by the observer. Metrological requirements for medical devices as measuring devices are quite obvious, since medical or medical-biological measurements, as well as the corresponding measuring instruments, are very specific. This feature highlights in a metrology a separate direction - medical metrology.

The purpose of this article is to highlight the approaches to creating the building concept of an information-analytical service-oriented system for clustering and testing hypotheses in medical-biological research. The system should solve the following main tasks:

- Entering the data from measurement devices or through the keyboard.
- Providing user-researcher the possibility of choosing methods for statistical data processing and reviewing the processing results in a convenient and understandable view for specialist.
- Possibility of convenient adjustment of entered data.
- Possibility of convenient selection and adjustment of data processing ranges.
- Saving processing results.

3. The main problems of medical-biology metrology

During the subject area study of the information-analytical system, such features of conducting medical-biological measurements and fixing their results were established and systematized. Some time the medical-biological measurements are carried out by staff,

technically not prepared for their correct execution. Therefore, it is advisable to create medical devices, graduated in units of physical quantities. Received data are the final medical measurement information (direct measurement). Otherwise, technically trained specialists should carry out the maintenance of medical devices and the information receiving.

1. It is desirable that the measurement time, until the final result is obtained, be the smallest, and the data are as complete as possible. This contradictory requirements are best served for measured complexes that include personal computers.

2. With the metrological valuation of the medical device that is being created, it is important to take into account medical evidence. The physician should determine the accuracy with which the results must be presented so that a diagnostic conclusion can be made. In this case, possible deviations of these indicators in certain patients should be taken into account.

3. Many medical devices display measurements on a device that simultaneously registers this information (e.g., an electrocardiogram), so the errors that are typical of this recording form should be taken into account.

4. Terminological problem. In accordance with the requirements of metrology, in the name of the measuring device the physical quantity or unit (ammeter, voltmeter, frequency meter, etc.) must be indicated. In some cases, the name of devices in medicine and biology does not correspond to this principle (electrocardiograph, phonocardiograph, rheographer, etc.). So, an electrocardiograph should be called millivoltmeter with the registration of indications (or millivoltmeter, which records data).

5. In a number of medical measurements, there may not be enough information on the relationship between the directly measured physical size and the corresponding medical-biological parameters. For example, in the clinical (bloodless) blood pressure measurement method, it is assumed that the air pressure inside the cuff is approximately equal to the blood pressure in the shoulder artery. In fact, this connection is not very simple and depends on a number of factors, including the degree of relaxation of the muscles. Laboratory measurements may differ from the values of the corresponding parameter in the organism.

6. In the process of measurement, medical-biological parameters may vary. At the practice of physical and technical measurements, it is necessary to make several measurements to exclude random errors; it is advisable in those cases where there is confidence in the invariance of the physical parameter in the measurement process.

7. Parameters of the biological system can vary considerably during long measurements, for example, due to psycho-physiological factors (environmental impact: premises, measuring equipment, personnel, etc.) or fatigue of muscles at multiple measurements on a dynamometer. The mobility of the organs or the object itself can also lead to different results in the measurement.

8. When creating medical-biological measuring equipment, it is necessary to take into account sanitary-hygienic requirements, safety issues of measuring instruments, their reliability, etc.

9. Most measurements in medicine and biology are measurements of physical or physico-chemical variables. In quantitative diagnostics - blood pressure, temporal dependence of biopotentials, optical power of the eye, etc. In laboratory tests - blood viscosity, concentration of sugar in urine, etc.

10. During treatment, it is important to know the dose of ionizing radiation, the strength of the current during galvanization, the intensity of ultrasound, etc .; the absence of any information of this kind can not only reduce the therapeutic effect, but also harm patient.

11. Quantitative assessment of environmental parameters surrounding a person (air humidity, temperature, atmospheric pressure) is a necessary condition for the prevention of diseases, climatic treatment.

Different physical medical-biological measurements can be classified either by functional attribute or as belonging to the corresponding section of physics.

There is the physical classification below.

Mechanical measurements: anthropometric parameters of the body, movement, speed and acceleration of body parts, blood, air, acoustic measurements, blood pressure and liquids in the body and air in the environment, measurement of vibrations, etc.

Thermophysical measurements: temperature of organs, body parts and environment, calorimetric measurements of biological objects, foodstuffs, etc.

Electrical and magnetic measurements: biopotentials, induction of the magnetic field of the heart, measurement of the impedance of biological objects with a diagnostic purpose, electromagnetic fields parameters and concentration of ions with a hygienic purpose, etc.

Optical measurements: colorimetric measurements, measurement of optical characteristics of the eye environment for diagnostic purposes, spectral measurements for diagnostics and forensic medical purposes, measurement of characteristics of ultraviolet, infrared and visible light for hygienic purposes, etc.

Nuclear Measurements: Measurement of ionizing radiation (dosimetry), etc.

In addition, you can specify physical and chemical measurements: the quantitative composition of air inhaled by humans, gas composition of blood, and other biological media.

The functional principle of classification of methods of medical-biological measurements can be illustrated on an example of measurement of parameters of the cardiovascular system. Here there are mechanical (ballistocardiography, phonocardiography, blood pressure measurement), electrical and magnetic (electrocardiography, magnetocardiography) measurements, optical measurements (oxy-hemometry). Possible application of other physical methods; for example, by the method of nuclear magnetic resonance determine the speed of blood flow.

There are several large groups of methods for treating medical-biological information:

1. Probability Theory and Mathematical Statistics.
2. Mathematical analysis of curves.
3. Differential equations.
4. Harmonious analysis.

In addition, there are a number of special mathematical methods designed to recognize images, allocation of useful information from the "noisy", etc.

Modern medical research methods can be divided into two main groups - laboratory and instrumental. In addition, instrumental methods include a special group of methods, called surgical methods. The features of this group of methods consist in the fact that instrumental methods are associated with surgical interventions.

Another classification of medical research methods subdivides them into three main groups:

1. Structural diagnostics - methods that detect changes in the construction of organs and tissues (X-ray, ultrasound, heat dissipation, endoscopy - gastroscopy, bronchoscopy, colonoscopy, etc.).

2. Functional diagnostics - methods of studying the functioning of organs and systems by their electrical (electrocardiography, electroencephalography, electromyography, etc.), sound (phonocardiography), mechanical (sfigmography) and other manifestations.

3. Laboratory diagnostics - methods of detecting changes in the cell and chemical composition of biofluids and other biomaterials.

4. Modeling and designing of the information-analytical system of clusterization and testing of hypotheses in biological research

4.1. UML (Unified Modeling Language) system simulation

In the simulation of the developed system, the common standard for graphical software description - the UML (Unified Modeling Language) language was used.

To find out and agree with the customer, users and expert experts, a use case diagrams were proposed, shown in Fig. 1.

Sequence diagrams were used to model the time aspects of internal and external protocols of the software of the system. Sequence diagram of the system administrator is presented in Fig. 2. For a specialist, the sequence diagram has the form shown in Fig. 3.

The structure of object-oriented system applications, their methods, attributes, and relationships were modeled using a class diagram (Fig. 4).

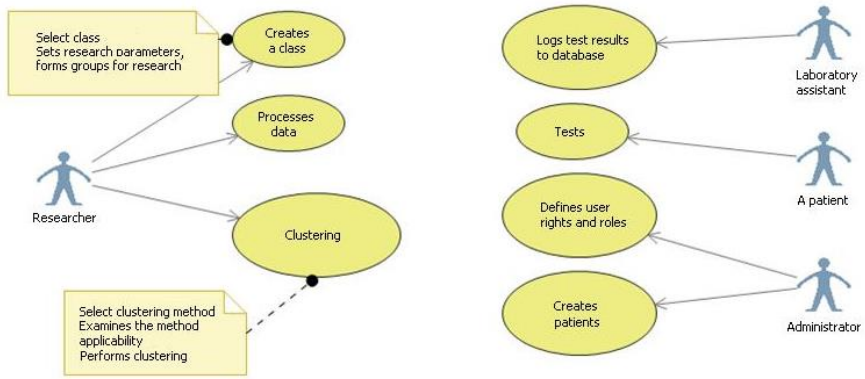

Fig. 1. Use case diagram of the clustering system

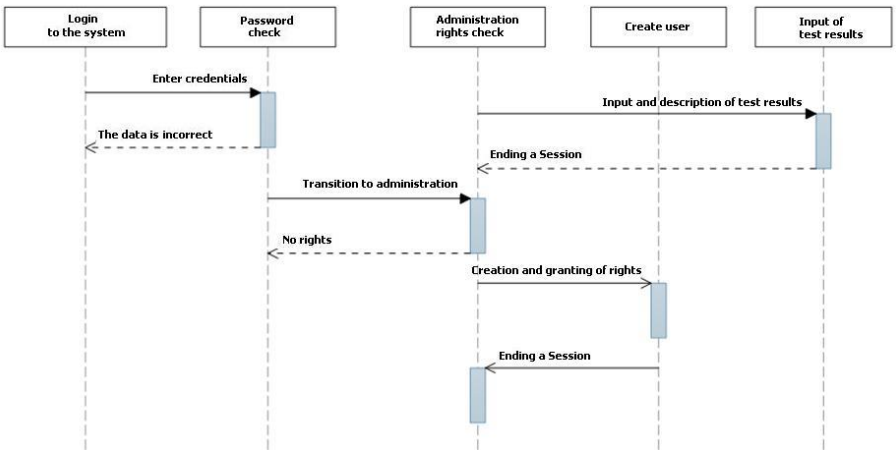

Fig. 2. Sequence diagram of the system administrator

The partition of the projected system into the structural components and relationships (dependencies) between them is shown in the component diagram. Inside, each component can be implemented using a plurality of classes. For the system being created, a diagram of the components is presented, shown in Fig. 5.

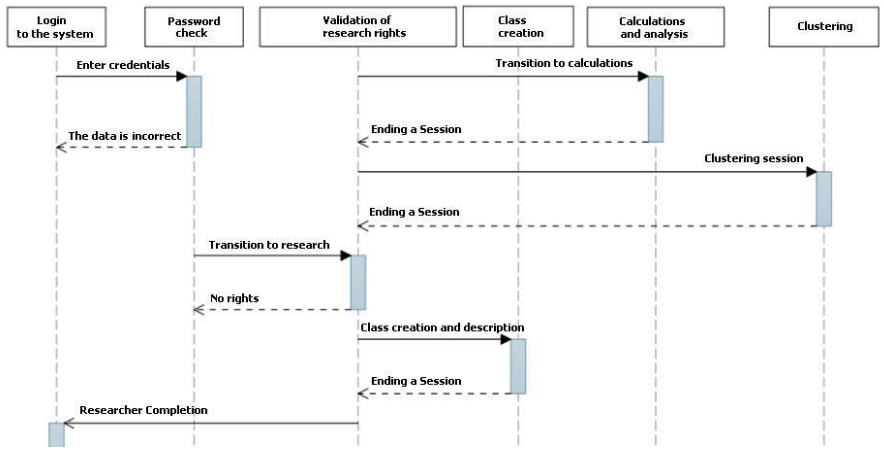

Fig. 3. Sequence diagram of work of the expert

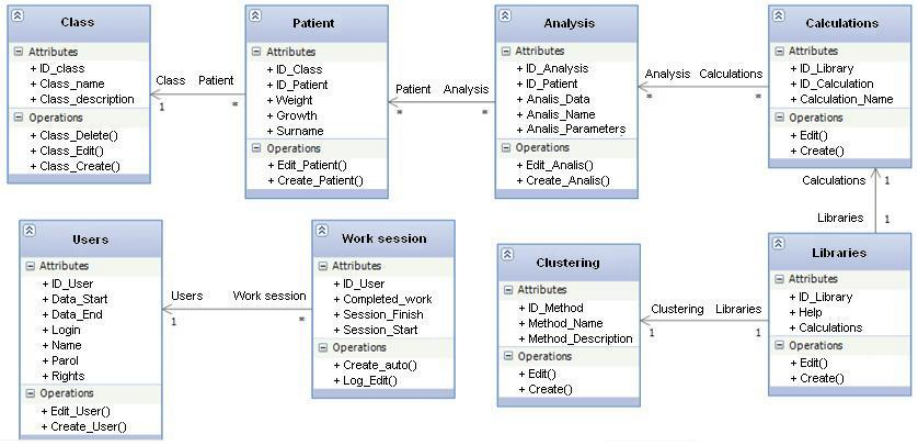

Fig. 4. Class diagram of the clustering system

4.2. Approbation of the system

To study, the problem of vitamin D exposure during pregnancy in women and the impact of this vitamin deficiency on the state of newborns has been selected. Vitamin D (calciferol) is a group of biologically active fat-soluble compounds containing more than 50 metabolites, which are synthesized from sterols under the influence of ultraviolet radiation in tissues of animals and plants.[3-5]. In mammals, vitamin D has acquired the function of a hormone with multiple biological mechanisms due to the regulation of up to 10% of human genes. Vitamin D interacts with provitamin D (VDR) receptors that are localized in the nuclei of bone and cartilage tissue, skin, kidneys, intestines, nervous system, skeletal muscle, lungs, liver, spleen, T-lymphocytes, B-lymphocytes, monocytes , macrophages, stem cells. Therefore, vitamin D is called D-hormone. At the same time, maintaining historical traditions, in the scientific literature, they continue to be called vitamin.

To test the hypothesis in the biomedical research on the D-hormone, one should rely on the classical approach to the use of statistical methods in clinical and experimental studies, which are set out in works devoted to the processing of results in medical research [2, 6].

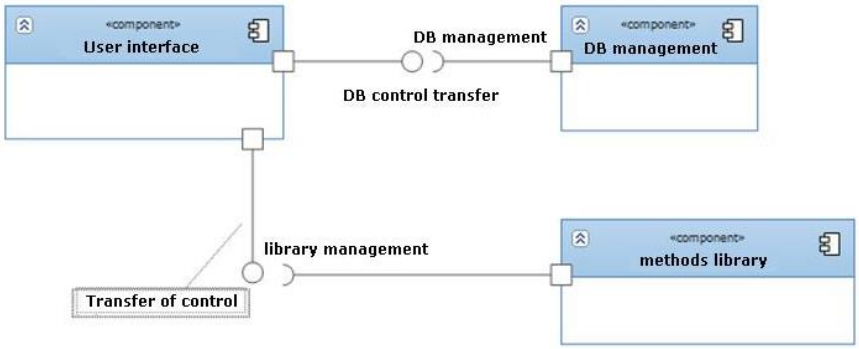

Fig. 5. Component diagram of the clustering system

Usually in scientific research it is necessary to prove the difference between two groups of research objects. It is necessary to compare research and control samples, results of treatment with different medical products, indicators in patients and healthy, etc. The researcher initially proposes a null hypothesis that the groups do not differ. If the probability that these groups are the same, less than 5%, the researcher can safely reject the hypothesis about the similarity of the groups and assert that the groups are likely to differ. This five-percent threshold is called the significance level. In medical-biological studies, the significance level is usually taken to be 0.05; 0.01; 0.001 or 5%; 1%; 0.1%, respectively. Consequently, p is the level of significance or the probability that the studied groups do not differ, or the likelihood of similarity between the main group and the control group. In this case, the value equal to (1-p) is the degree of probability of the difference of indicators or the degree of probability of change between the groups under study. That is, at $p = 0{,}05$ the degree of probability of difference of indicators is equal to 0,95 [2, 6].

The question of the reliability of the difference is solved by means of statistical criteria that are parametric and non-parametric. Parametric criteria are based on knowledge of the parameters of this population. If the law of data distribution is unknown, nonparametric criteria are used. In normal distribution, parametric criteria are more powerful than non-parametric ones. They make it less likely to make a second-class mistake - to accept the null hypothesis that the samples are taken from a single population, when in fact the samples are taken from different sets.

Therefore, in all cases when comparable samples are taken from normally distributed data, parametric criteria must be applied. But with distributions that are different from normal, parametric criteria can not be used. In this case, use nonparametric criteria or modify the sample to a normal law. One of the initial steps in the statistical analysis of medical-byological research is to verify the distribution of data to the normality of the law. In practice, it is difficult to see a normal distribution in clinical trials, because it does not study the normal population as a whole, but only specific samples from it. The normal distribution is based on the mathematical theory and reflects only random variations. Correction in the distribution of the results of clinical measurements introduces many other sources of variation, especially the biological differences between individuals. This means that the similarity of real distributions to the normal distribution curve in clinical medicine, as a rule, is random.

In modeling the system, conducting research and calculating the results, two groups of patients were selected: experimental and control. The first group of people tooked the vitamin D, and the second - a placebo.

The calculations of the basic values for the estimation of statistical indicators (mathematical expectation, average deviations, etc.) for the experimental and control group

were performed. The assessment of the interrelation of the investigated parameters was carried out on the basis of the calculation of correlation coefficients for the experimental and control groups. An estimate of the significant difference in the results obtained is shown in Fig. 6.

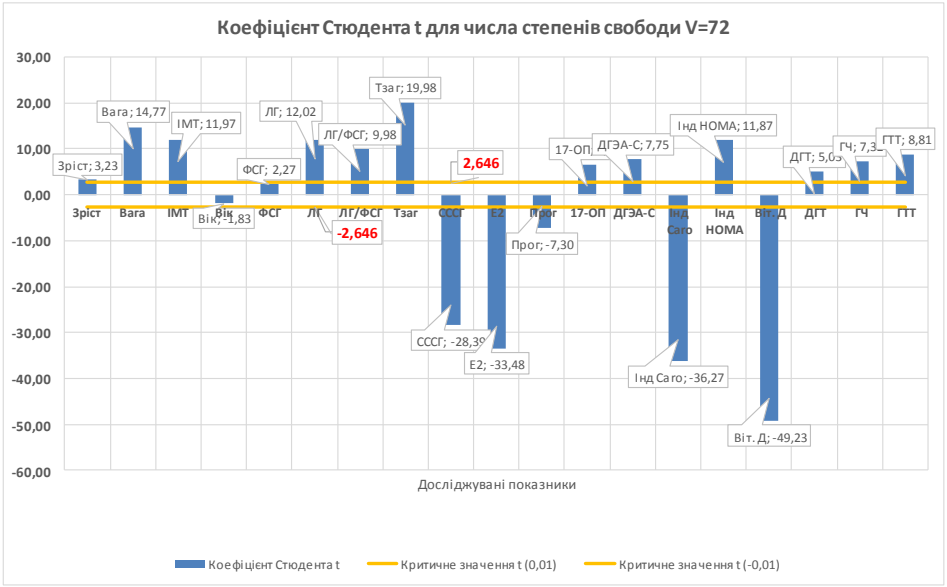

Fig. 6. Estimation of the difference between the results obtained.

The results of the research are provided to the expert in the form of tables and diagrams. It allows researcher to assess the true difference in the values of the indicators for the various groups under investigation, both in digital form and visually. For the example below, the diagrams illustrating the visual representation of the results in the case of comparison of the correlation coefficient for the indicator Growth (Fig. 7.) and Weight (Fig. 8.) is given.

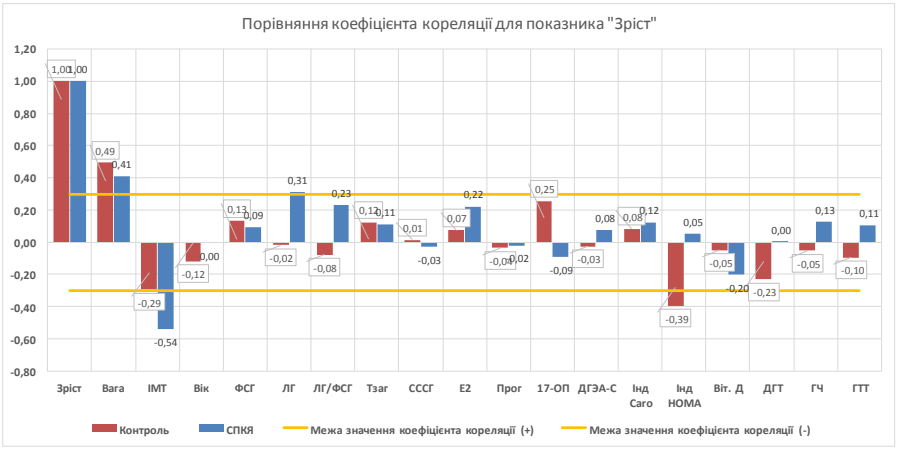

Fig. 7. Comparison of the correlation coefficient for the indicator "Growth".

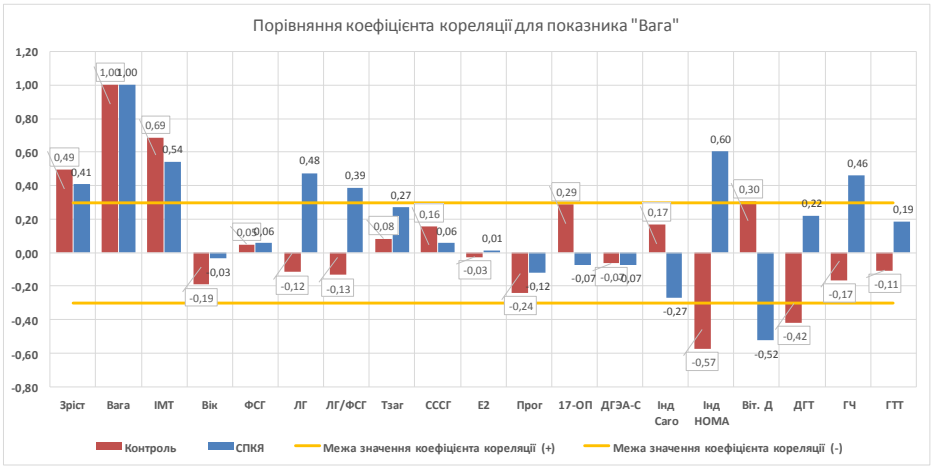

Fig. 8. Comparison of the correlation coefficient for the indicator "Weight".

5. Conclusion

The necessity of introduction of digital technologies during carrying out of medical-biological researches is grounded.

An analysis of biophysical models, methods and technologies of their estimation is carried out. Research methods are selected. Their justification has been fulfilled. Methods were tested on experimental data. The analysis and evaluation of the received results are carried out. Design and modeling of the information-analytical system of clusterization and testing of hypotheses based on medical-biological indicators was carried out.

The results of the research are provided to the expert in the form of tables and diagrams. It allows researcher to assess the true difference in the values of the indicators for the various groups under investigation, both in digital form and visually.

Experimental verification of the system is carried out. For two groups (experimental and control), some calculations were performed (mathematical expectation, mean deviations, correlation coefficients, etc.).

The estimation of interconnection degree of the investigated parameters was carried out based on these calculations. During the study, the effect of vitamin D deficiency on women's reproductive health was identified. In addition, with a high degree of probability these studies confirmed the positive effect of D vitamin intake on women's health.

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Sentiment Impact on Stock Market Returns in Eurozone Countries

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Abstract. This paper studies the impact of Economic Sentiment Indicator (ESI) in the financial markets across 19 countries, members of the Eurozone. This paper contributes to the specialized literature by studying the impact of a survey-based sentiment indicator on the performance of financial markets. Using monthly data across 10 years, the empirical results highlighted the impact of the chosen sentiment indicator across the Eurozone. The analysis shows that the Economic Sentiment Indicator (ESI) has a significant effect on the returns of stocks in the Eurozone, based on an ARDL model.

Keywords. Determinants, Economic Sentiment Indicator, Eurozone stock markets, Investor Sentiment

1. Introduction

The question whether investor sentiment affects financial markets has puzzled academics, regulators and other practitioners for a long time. Traditionally, academics did not consider sentiment as an important factor for asset pricing. Classical financial models such as Arbitrage Pricing Theory [22], Fama-French Model [8] or Capital Asset Pricing Model [24], assume that investors are rational, thus they make decisions based on the calculated costs and benefits of each action. All these methods trace their roots to the efficient market hypothesis (EMH), which states that prices reflect all available information, making it impossible to generate positive alpha.

As we have witnessed over the course of financial markets' history, there were numerous situations in which the EMH was violated. Thus, practitioners started to look for an enhanced model of asset pricing – one that includes the psychological aspect, giving rise to the first behavioral finance theories. One of the pioneer studies in this branch was the Prospect theory developed by Kahneman and Tversky in 1979 [16], which explained the way people make decisions under uncertainty. Basically, the theory states that people take decisions based on the potential value of losses and gains and not based on the outcome.

There have been numerous studies regarding the impact of various sentiment indicators on stock returns. Baker and Wurgler [2], in their research paper 'Investor Sentiment and Cross-Section of Stock Returns' concluded that when the beginning-of-period proxy for sentiment is low, subsequent returns are relatively high for small, young stocks, high volatility stocks, unprofitable stocks, non-dividend-paying stocks, extreme growth stocks, and distressed stocks, while when the sentiment is high, these categories earn relatively low returns. Chau, Deesomsak, and Koutmos [5], argued that sentiment-induced buying and selling is an important determinant of stock price variation. The authors showed that sentiment-driven

investors can trade against the herd and sell when prices are overinflated, and vice versa. Jiang, Lee, Martin and Zhou [15] constructed a manager sentiment index based on the aggregated textual tone of corporate financial disclosures and found that manager sentiment is a strong negative predictor of future aggregate stock market returns. Guo, Sun and Qian [11], developed a sentiment indicator based on users` comments from a popular professional social network and concluded that sentiment data can be used to predict stock price when the stock is highly popular among investors.

This paper contributes to the existing literature by analyzing the impact of the Economic Sentiment Indicator (ESI) on the European financial markets. The Economic Sentiment Indicator (ESI) is a composite indicator made up of five sectoral confidence indicators with different weights. We will describe its construction in more detail in a separate section.

As a working methodology, I insisted on the Auto-Regressive Distributed Lag (ARDL) method, and the selection of lags based on the Akaike Information Criterion (AIK), in order to identify if the Economic Sentiment Indicator (ESI) has any impact on the financial markets in the Eurozone.

The first section of this paper describes the relevance of the study and the existing literature as well as the objective of the study. In the next section we describe the data used and present all the modifications applied in order to satisfy the needs of the research, followed by the descriptive statistics of all the variables, later we describe the methodology and presents the results of the analysis. The last section presents the conclusion as well as the limitations of this research, and the directions for a further research.

2. Material and Method

Developments in behavioral finance prompted various researchers to consider the importance of sentiments in stock markets.

Studies typically examine the effect of investor sentiment on specific group of stocks, stock portfolios, or stock markets. Different scholars use different sentiment indices in order to find if there is any correlation between their movement and the returns of the chosen stocks. Further, we will present the current state of the research in this field and present the contribution of this study to the existing literature.

Baker and Wurgler [2], study how investor sentiment affects stock returns. They formed a composite index of sentiment that is based on six underlying proxies for the sentiment: closed-end fund discount, NYSE share turnover, the number and average first day returns on IPOs, the equity share in new issues, and the dividend premium. The period of their study covering 1962 to 2001. Their findings prove that future stock returns are conditional on the beginning of period proxies for sentiment. So, the main question shifted from: whether sentiment influences financial markets, to which proxies of sentiment are the best determinant of financial markets.

By exploring the optimistic and pessimistic investor sentiments, Tsai [25], confirmed that under favorable market performance, and optimistic investors, their sentiment is not significant, however in a pessimistic situation, the sentiment becomes significant.

Bathia and Bredin [3], analyzed if investor sentiment can capture the impact of size, value, liquidity, and momentum effects in the conditional asset pricing model on the returns of U.S. individual stocks. They concluded that sentiment conditioned asset pricing models, capture significantly better the impact of the aforementioned effects.

There are also numerous studies that analyze sentiments on stock markets as a whole. Chau, Deesomsak and Koutmos [5] - investors are basing their decisions based on survey-based indicators rather than on market-based ones, and that they trade on basis of information

extrapolated from individuals, rather than institutional one. Fang, Yu, and Huang [9] analyzed the influence of the composite index of investor sentiment on the U.S. stock and bond markets. Their results show that the chosen sentiment index has a significant positive influence on the stock-bond correlation.

In his study, Renault [21], implemented an innovative approach in order to derive the investor sentiment from messages posted on social media, and explored the relation between the generated sentiment indicator and U.S. intraday stock returns. The results prove that at intraday level, the sentiment is a significant indicator, and returns are driven by the sentiment of novice traders.

Han and Li [12], analyzed the impact of investor sentiment as a momentum predictor on the Chinese financial market, for the period of 17 years from 1997 to 2013. They demonstrate that investor sentiment in China is a decisive momentum signal at a monthly frequency. In addition to that, they reveal that global investor sentiment cascades to the local Chinese financial market, as it negatively predicts the future returns.

Guo, Sun and Qian [11], developed their own investor sentiment, based on a semantic analysis of user comments on a professional network of the China stock market. They used the thermal optimal path method on daily data of investor sentiment and stock market returns for the period January 2014 to June 2015 and proved that this type of sentiment indicator is significant only in cases when the stock has high investor attention.

Aissia [1], investigated the importance of home and foreign investor sentiment on French stock market return. The investor sentiment being the total investor sentiment of Baker and Wurgler [2]. The author studied the CAC All Tradable index over the period 2003 to 2013, and has proven that both, the home and foreign investor sentiments are strong contrarian predictors of stock returns.

Corredor, Ferrer, and Santamaria [6], studied four European stock markets: France, Germany, Spain and UK. The period covered by them is 1990-2007. Their results show that sentiment has significant impact on returns, however, the results also show that the choice of sentiment proxy is a sensitive matter.

We contribute to the literature by analyzing the influence of the Economic Sentiment Indicator (ESI) on the stock market returns in the Eurozone, by considering other proven variables that impact stock market returns, which will be detailed in following sections. Even though in the existing literature, there have been numerous others who have investigated the impact of different sentiment indicators on returns across U.S., China, and Europe, we prove that the Economic Sentiment Indicator (ESI) is also significant in the determination of stock market returns across Eurozone.

Behavioral finance suggests that sentiment can lead prices to stray away from their fundamental values. Recently there have been numerous attempts to identify the sentiment indicator which can predict the movements of stock market prices, apart from the already traditional factors that influence stock markets. However, there is little research on the impact of Economic Sentiment Indicator (ESI). In this paper, I investigate if ESI has any influence on the stock markets of the Eurozone, taking into account previous, identified, variables that influence movements of the stock markets.

The sample of countries comprises members of Eurozone: *Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, and Spain.* A panel data analysis is conducted over the time span 2009-2019, on a monthly basis. I chose to incorporate the effect of sentiment on financial markets by means of the ESI, as from my point of view this indicator comprises the vast majority of economic actors in the Eurozone, by the means of its construction, as it is derived from confidence indicators coming from five sectors: industrial,

services, consumers, construction and retail. Values above 100 indicate economic-optimism, while values below 100 reflect economic-pessimism. Broadly speaking, it tracks the overall economical sentiment, as it combines the sectoral level confidence indicators.

The data was extracted from Bloomberg and Eurostat and it consists of end-of-month closing prices for the market indices for 19 Eurozone countries for a period spanning from September 2009 to July 2019.The analyzed countries are the following: *Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, and Spain.*

The collected information contains 177 observations per series. The dependent variable is the benchmark stock market return of each country.

Table 1. Description of stock markets of each country

Country	**Name**	**Ticker**
Austria	Vienna Stock Exchange Austrian Traded Index	ATX
Belgium	Belgium Stock Exchange 20	BEL20
Cyprus	Cyprus Stock Exchange General Index	CSE
Estonia	Open Mobile Exchange Tallinn	OMXT
Finland	Open Mobile Exchange Helsinki 25	OMXH25
France	Cotation Assistée en Continu	CAC40
Germany	Deutscher Aktienindex 30	DAX
Greece	Athens Stock Exchange General Index	FTSE20
Ireland	Irish Stock Exchange	ISEQ20
Italy	Financial Times SE Milano Indice di Borsa	FTSEMIB
Latvia	Open Mobile Exchange Riga	OMXR
Lithuania	Open Mobile Exchange Vilnius	OMXH
Country	**Name**	**Ticker**
Luxembourg	Luxembourg Stock Exchange Index	LUXX
Malta	Malta Stock Exchange	MSE
Netherlands	Amsterdam Exchange Index	AEX
Portugal	Portugal Stock Index	PSI20
Slovakia	Slovak Share Index	SAX
Slovenia	Ljubljana Stock Exchange Slovenian Blue-Chip	SBITOP
Spain	Spanish Exchange Index	IBEX35

Variables:

- Stock market prices represent the prices of the selected stock market indices of the countries that I chose to analyze and are a good proxy for the performance of their economy. Mostly these indices are composed of the stocks of large companies listed on the national stock exchange.
- Harmonized index of consumer prices (HICP) is designed by the Eurostat for international comparisons of consumer price inflation. Conceptually, it is a Laspeyres-type price index. There is evidence in the literature of authors using inflation as a control variable when studying stock market returns. The intuition behind this is that inflation reduces the purchasing power of each monetary unit, which results in higher input prices, consumers purchasing fewer goods, lower revenues, profits declining, and economy slowing down. Unexpected inflation`s

impact is even more irrefutable, most notably during economic contractions when it has a positive correlation to stock returns. [13], [17].

- EUR/USD Exchange Rate. Many authors tested the relationship between stock prices and exchange rates. Among them, Gavin [10], concluded that unanticipated aggregate demand shocks tend to generate a negative correlation between stock price and real exchange rate. In addition, other authors also suggest a linkage between stock prices and exchange rates. [7]
- Euribor – Eonia spread is a measure for liquidity and credit risk. Numerous authors have used this variable when dealing with stock markets, like Buchholz and Tonzer [4].
- Gold Price. Theoretically there is an inverse relationship between stock markets and gold prices, as investors who have a rather bearish perspective, usually take positions in gold futures in order to hedge their investments.
- Economic Sentiment Indicator (ESI) is a composite indicator made up of five sectoral confidence indicators with different weights: Industrial confidence indicator (40%), Services confidence indicator (30%), Consumer confidence indicator (20%), Construction confidence indicator (5%), and Retail confidence indicator (5%). All these confidence indicators are arithmetic means of seasonally adjusted balances of answers to a selection of questions closely related to the reference variable they are supposed to track. The ESI is calculated as an index with mean value of 100. In our study we are interested in determining if ESI has any relevant impact on stock market returns in the Eurozone.

Figure 1 depicts the evolution of Economic Sentiment Indicator across eurozone countries during the available period. As we observe, the majority of countries followed the average value and trend of the Eurozone, however there were 2 countries which stood out. Because of the common policies applied in the Eurozone, we would expect that this indicator should follow a common trend across the available period. Outliers which can be denoted are: *Greece* during the period March 2015 – September 2017, which was caused by the political and economic situation at that time, the bailout referendum to decide whether Greece should accept the bailout conditions in the debt crisis proposed by the European Commission, the International Monetary Fund and the European Central Bank, and the legislative election following prime minister`s resignation; *Cyprus* during the period January 2013 – January 2014, which was caused by the Cypriot financial crisis in which banks exposed themselves to the overleveraged property companies, and the downgrade of government`s bond credit rating to junk status.

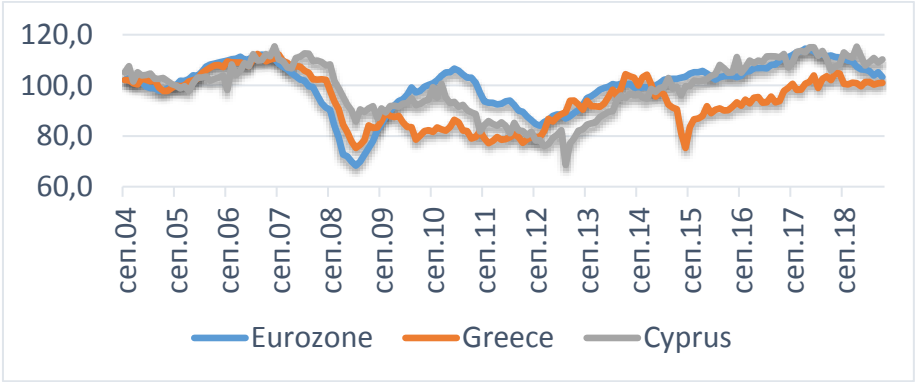

Fig. 1. ESI Evolution

Table 2. Descriptive statistics for all variables

Country	***Market Return***		***ESI***		***HICP***	
	Mean	***St.Dev.***	***Mean***	***St.Dev.***	***Mean***	***St.Dev***
Austria	0.002130	0.064393	101.0287	9.966096	0.001493	0.004582
Belgium	0.001786	0.046937	101.1416	9.792622	0.001466	0.009316
Cyprus	-0.014748	0.119839	99.11910	10.60093	0.001006	0.008491
Estonia	0.007029	0.070670	98.13539	9.713340	0.002508	0.004278
Finland	0.004791	0.052127	100.8506	8.655806	0.001211	0.003167
France	0.002337	0.046550	99.26348	9.281618	0.001122	0.003600
Germany	0.006412	0.051059	102.7410	8.650734	0.001243	0.004578
Greece	-0.009769	0.099669	94.24326	9.985197	0.001149	0.010990
Ireland	0.000697	0.061887	98.76461	11.08628	0.000689	0.004257
Italy	-0.001469	0.059312	98.92247	9.196729	0.001129	0.009546
Latvia	0.006216	0.059217	101.8135	9.759645	0.002532	0.005617
Lithuania	0.006366	0.067885	103.0994	10.57771	0.002220	0.004854
Luxembourg	0.000953	0.059999	98.35393	9.726440	0.001506	0.006796
Malta	0.002955	0.037260	100.5815	10.23159	0.001539	0.012389
Netherlands	0.003195	0.049277	100.0831	10.93580	0.001177	0.005656
Portugal	-0.002159	0.053152	97.91461	10.63588	0.001095	0.006630
Slovakia	0.002177	0.049238	100.0079	10.41395	0.001502	0.003304
Slovenia	-0.000287	0.051750	100.4472	11.34951	0.001446	0.005419
Spain	0.000623	0.054519	100.4180	10.22337	0.001294	0.008131

Variable	***Mean***	***St.Dev.***
Gold Return	0.006842	0.050106
EUR/USD Return	-0.000651	0.028564
Euribor - Eonia	0.000457	0.001888

3. Results and Discussions

To avoid spurious regressions caused by the non-stationarity of data (that could result in high R^2 values, low Durbin-Watson statistics, low standard errors, and invalid *t*- and *F*-statistics because the error terms could be non-normally distributed and auto-correlated) I used logarithmic returns for variables expressed in monetary units (*Stock market Prices, EUR/USD, Gold Price)* and the first difference for the *HICP*. Euribor-Eonia spread, and ESI did not require any transformation as they were already stationary.

The Im Pesaran and Shin [14] unit root tests addresses the homogeneity issue in panel data series unit root testing. The procedure proposed for testing panels is based on taking the average of all ADF tests performed for each individual in a panel.

Financial time series, mainly have a more complex structure than a simple *AR(1)* model. Said and Dickey [23] augmented the basic unit root test to accommodate *ARMA(p,q)* models with unknown orders and this test is referred to as Augmented Dickey-Fuller Test (ADF). The null hypothesis of the ADF test is whether unit root is present in a time series sample. A significant issue for implementation of the ADF test is the specification of lag *p*. If *p* is too large the power of the test decreases, if it is too small then the serial correlation in errors might bias the test.

Phillips and Perron [20] unit root tests differ from the ADF tests, by dealing with the serial correlation and the heteroscedasticity in errors. The PP tests ignore any serial correlation. Another major difference between these two lies in the fact that the user does not have to specify a lag.

Given that each test has its advantages we decided to perform all of them, for having a clearer perspective on the results.

The results of the unit root tests after the aforementioned changes are provided below. Note that for all further specifications: *,**,*** denotes statistical significance at the 10%, 5% and 1% level, respectively.

Table 3. Unit-root tests results

	Euribor-Eonia spread	Gold Return	D(HICP)	ESI	EUR/USD Return	Market Returns
Im Pesaran and Shin	-11.72***	-66.83***	-5.23***	-3.75***	-61.93***	-47.21***
Augmented Dickey-Fuller	220.96***	1969.66***	99.11***	74.97***	1877.11***	1448.42***
Phillips-Perron	1365.03***	1969.93***	1559.09***	62.88***	1876.42***	1567.93***

The results indicate that all our variables are stationary in the way they are analyzed in the study, which will allow us to test if the Economic Sentiment Indicator (ESI) has any influence on the stock markets of the Eurozone.

Given that the unit root tests showed that the series are non-stationary at level, the use of OLS techniques is inappropriate. In this case in order to determine if ESI has any significant impact on the stock markets in the Eurozone, I employed the autoregressive distributed lag (ARDL) model.

ARDL model was developed by Pesaran and Shin [19] and Pesaran et al. [18]. It has some advantages over other traditional cointegration methods. First one is that the ARDL does not require all the variables to be integrated of the same order. Second reason is that by applying ARDL we obtain unbiased estimates for the long-run model. Using the ARDL model, this section addresses the question of whether long-run as well as short run market return is influenced by the change in the economic sentiment indicator.

I chose a maximum lag order of 12, which corresponds to a 1-year period, by using the Akaike Information Criterion, the selected model is ARDL(1,1,1,1,1,1), which corresponds to the following specification:

$$Market\_Return_t = \alpha_0 + \alpha_1 * Market\_Return_{t-1} + \beta_1 ESI_t + \beta_2 ESI_{t-1} + \beta_3 d(HICP)_t + \beta_4 d(HICP)_{t-1} + \beta_5 EURIBOR\_EONIA_t + \beta_6 EURIBOR\_EONIA_{t-1} + \beta_7 GOLD\_RETURN_t + \beta_8 GOLD\_RETURN_{t-1} + \beta_9 EUR\_USD\_Return_t + \beta_{10} EUR\_USD\_Return_{t-1}$$

Table 4. Long Run Specification

Variable	Long Run Equation Coefficient	t-Statistic
ESI	0.0001***	6.85
D(HICP)	-0.8106***	-3.52
Euribor_Eonia	-7.1841***	-11.32
Gold_Return	0.0013	0.04
EUR_USD_Return	0.4452***	7.57

As we denote from the long run equation, all variables apart from *Gold_Return* have a long run influence over the market returns of the countries, members of the Eurozone.

Table 5. Short Run Specification

Variable	Short Run Equation Coefficient	t-Statistic
$Market\_Return_{t-1}$	0.0418*	1.90
ESI_t	0.0044***	7.56
ESI_{t-1}	0.0021***	3.41
$D(HICP)_t$	0.7108***	5.71
$D(HICP)_{t-1}$	0.3859**	2.31
$Euribor\_Eonia_t$	2.8560***	4.04
$Euribor\_Eonia_{t-1}$	0.0112	0.02
$Gold\_Return_t$	-0.0568**	-1.99
$Gold\_Return_{t-1}$	-0.1325***	-4.49
$EUR\_USD\_Return_t$	-0.0293	-0.41
$EUR\_USD\_Return_{t-1}$	0.1208**	2.02

As it has been stated above, the chosen model is ARDL(1,1,1,1,1,1), which in turn implies that there is a causality between the first order lag of all variables and market return. As our data is provided on a monthly basis, we can conclude that the change in one of the factors in the previous month have an impact on the current month`s market return. We observe that *gold_return*`s coefficient has a negative sign, which is consistent with the previous studies that concluded that this variable has an inverse relationship with stock market returns. The positive sign of the D(HICP) is also in accordance with the stated positive correlation between inflation and the stock market return. The sign of ESI is as well in accordance with our presumption, as we stray towards an optimistic sentiment (ESI increasing), we will face higher returns and vice-versa.

4. Conclusions

In this paper we analyze the impact of Economic Sentiment Indicator (ESI) on the returns of stock markets in the Eurozone. The analysis shows that the Economic Sentiment Indicator (ESI) has a significant effect on the returns of stocks in the Eurozone, based on an ARDL model, with the number of lags selected based on the Akaike Information Criterion. However, this conclusion is bounded by the analyzed time period, the selected model, the control variables, and the countries which are part of the sample.

This study is also exposed to potential biases considering the similarity of the Economic Sentiment Indicator (ESI) across the analyzed time frame. A further constraint of the model is the number of control variables which were selected. As we all know there are many other factors which might impact the evolution of financial markets that were not include in our research because of the lack of data. Furthermore, the choice of sentiment proxy is another evident bias. Overall, the obtained results using the Economic Sentiment Indicator (ESI) as a proxy for investor sentiment proved to be a good selection in revealing the impact of investor sentiments measure through surveys in 5 different sectors, on the returns of financial markets.

The direction for future research needs to be towards obtaining data for other determinants of financial market returns and investigating the way other sentiment indicators influence the stock markets. In addition to that, the usage of a better model to test for the investor sentiment indicators impact on financial markets would be needed.

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Problems and Solutions for Information Provision of Clusters by Small and Medium Enterprises

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Abstract. The goal of the current research is to determine what is the level of information provision of the cluster, are there any issues and is its improvement required? The tasks of the research are analysis of the main characteristics of the SME and the clusters in Bulgaria, conducting a survey on the information provision of those clusters, analyzing the results, defining the problems and providing solutions. The methodology in use is a survey including analysis and synthesis. The surveyed participants are only clusters, members of the Association of Business Clusters (ABC) in Bulgaria. The suggested solutions allow the consolidation of information on a cluster level for the goals of the cluster management.

Keywords: Cluster, ERP system, Traditional system, Best practices, SQL queries

1. Introduction

The merging of small and medium enterprises (SMEs) in clusters of a certain type is an innovative solution. It is based on the new, dynamically changing conditions in the business environment.

To increase their own competitiveness, the clusters use modern informational and communicational technologies, e.g. integrated business informational systems, like ERP systems (Enterprise Resource Planning Systems). The problem is, that in the basic functionality of these systems, there is no option for consolidation (aggregation) of information from SMEs on a cluster level, needed for the cluster management.

A model for the development of the ERP system is needed for this purpose, including alternative solutions, like usage of BI (Business Intelligence) platforms (Tableau, QlikView, Microstrategy and others) and technologies of the Big Data group and SQL queries.

This researches includes only members of the Association of Business Clusters in Bulgaria and is expected to establish the level of the informational provision of the management of the clusters, find the issues if there are any and means of their resolution with alternative practices.

2. Characteristics of SMEs in Bulgaria

Characteristics of SMEs in Bulgaria: „The number of the small and medium enterprises in Bulgaria in 2013 is over 300 thousands, which comprises 99.8% out of all enterprises. The most numerous are the micro enterprises with 0 to 9 employees with share of 91.9% out of all enterprises. Follows the group of the small enterprises with 10 to 49 employees – 6.7% and that of the medium enterprises with 50-249 employees – 1.3%“ [1].

The main characteristic of the small and medium businesses in Bulgaria continues to be the presence of a big number of micro enterprises. They have low employment rate (2.0 employed) [1] and relatively low labor productivity which is lower in comparison to both the group of the small and the medium enterprises. According to L. Yaneva: „The big territorial disproportions in the characteristics of the small and medium enterprises in Bulgaria are kept. In a territorial aspect the most prominent for the development of small and medium business continues to be the Southwestern statistical region. On the other hand we have the extremely low structural contribution of the Northwestern region, with its shares moving between 2 to 5% across the different indicators“ [1]. The lack of enough investments for the expansion and modernization of the production of goods and offering of services does not aid the increase of competitiveness of SMEs and creates an environment of uncertainty.

SMEs in Bulgaria are with a relative small employment volume, simplified organizational structure and system of management, minimum investments and short term of development.

Due to the ‘complex credit availability’ and therefore ‘insufficient resources’, SMEs in Bulgaria do not do not have the option to apply the ‘best’ practices in their business processes, e.g. investing in business information systems, which is a risk factor for their competitiveness. One of the solutions to this problem is them merging in branch organizations (clusters) and the execution of re-engineering of their business processes via the usage of systems for resource planning for the enterprise (ERP Systems) and modern informational and communicational technologies. Furthermore, information technologies can provide a higher level of efficiency [2].

3. Cluster Characteristics

According to Marin Ivanov: „The cluster is a gathering of enterprises, suppliers of services, enterprises of similar productions and their connected institutions (government, business organizations, academical communities, financial institutions and others“ [3].

Another definition is provided by Michael Porter „Geographically connected concentration of similar, intertwined or completing each other enterprises with active channels for business relationships, communication and dialog, which use a specialized infrastructure, work and service markets and are exposed to common threats and development opportunities“ [4].

According to Michael Porter, clusters are based on the systematic connections between enterprises, and are related to main or supportive production, technologies, natural resources, qualifications of staff and channels of distribution. The cluster can be classified as a society, which works for a common goal – to help the main business, thus guaranteeing the successful development and work alongside that main business. Apart from that they share problems and solutions for them. Regardless of the terminological variances, it is evident that the cluster is a good willing joint venture, combining enterprises which have a common goal. [4]

In accordance to the type of relationships between the enterprises, the clusters could be classified as:

- vertical,
- horizontal.

In the vertical cluster, the enterprises are on consecutive levels of production and marketing. In this type of cluster the enterprises are from different. An example of a vertical cluster would be the integration between Razgrad’s factory ‘Amilum’, main manufacturer of sweeteners and the manufacturers of corn in Dobrudja (fuel for production) and the industry of fizzy and alcohol drinks.

Contrary for the horizontal cluster the enterprises are from one sector of manufacturing and marketing.

Participants in the cluster

The participants in the cluster could be – legal representatives, traders, nongovernmental organizations, teaching organizations, science units, public administration and individuals. They are organized around one combining product or service and create a network which could be attractive for the local or outside investors. Key factors for the cluster are:

- The cluster needs to be established somewhere. Proximity of the participants turns out to be detrimental for the success of the cluster initiatives.
- The clear concept of the future developments of the cluster.
- One enterprise or organization establishing a leadership role.

Organization and management

Clusters can be characterized with greater flexibility of internal connections between the participants. They are more opened for innovation, new ideas and attraction of new partner for their realization and give to their members wider possibilities for fitting in the global market, simultaneously offering them additional energy and local relationships and networking. An important role in the solution of these issues, as well as in the initiation, creation and evaluation of the separate clusters are the coordinating units or the so called 'cluster advices'. In their creation and emphasis is put on the regional and already established industrial associations and networks. What embodies these advice enterprises in each cluster are the big, small and medium firms, as well as partners that assist with the services. They include experts, whose job is to overseeing for the correct execution, achievement of goals and the realization within the network. The organization schema which is in use for support and coordination of the cluster activity is comprised of small, effective teams of experts, which are working in only one network.

An example for this would be the Association of Business Clusters (ABC) towards the Bulgarian Industrial Association (BIA). The Association of Business Clusters was found in 2009 by leading clusters in the country. At this time in the Association there are 16 clusters which are present from different sectors: IKT, automobiles and electric vehicles, health and tourism, sea industry, mechatronics and automations, textile integrated technologies and systems, brokers, couriers, green freight transport.

Bulgrian Practice

In Bulgaria, the dominant part of the clusters are horizontal type and are presented as a united group of firms, working in a geographic region and in the same sector, which entwine their activities, as to assist and support each other. The goal of the cluster is bigger and better efficiency against outside markets. Entering those outside markets is not possible to be done alone for the small Bulgarian firms because of many reasons – lack of contacts, the owners do not know the other languages apart from their mother tongue, not enough resources (financial, technological, work force), delivery of the ordered goods and others. That is why manufacturers in all sectors are contemplating the creations of clusters as a way of responding to the opposition and survive. This question regarding the clusters is gathering traction more and more as the opportunities provided by being in the European union and having access to European markets, as the small firms do not have the capacity to respond to the
European requirements. The cluster guarantees markets and new technologies. Apart from that working in a team and partnering with others leads to an increase in the quality of the

production, because if one fails the whole cluster fails. Successful attempts at creating clusters can be found in the furniture, decorating and woodworking enterprise – the 'Bulgarian Furniture Cluster'.

In the textile enterprise there are a few successful attempts at clustering – 'Specialized Cluster and institute of clothing and textile – Danube'. The small firms of manufacturing textile and clothing work in internal markets and do not have neither financial nor technological opportunities to export production outside. By general rule of thumb, the orders from outside regarding clothing are big and require a much bigger production capacity. Not all firms have the complete range of machines for all types of clothing, they combine and share the workload. The cluster simplifies the logistic of the western. Some of the pluses of this clusters are that the firms become specialized in a certain specific manufacturing and that allows them to respond to the big volume of orders in a timely frame. For many this is a way of survival, because the small firm does not have capacity to develop itself in so many different ways.

Ore mining and colorful metallurgy in Srednogorie have created a cluster 'Srednogoria Copper Indistrual Cluster'. The Enterprises „Arsal Medet", „Elacite copper", „Bimak Chelopech", „Jumikor copper", as well as KCM near Asenovgrad have developed and working horizontal relationships, providing work places for more than six thousand people as well as forming a noticeable volume in the Bulgarian export sector.

The cooperation between industrial enterprises and the creation of in between firm merging with the participation of the scientific units from the technical universities in Bulgaria are some of the reasons for the creation of the cluster 'Mechatronics and automation'.

Similar examples are present in the automobile sector – the clusters 'Automotive cluster Bulgaria and 'Industrial cluster "Electromobiles", in the transport – the clusters „green freight transport" and „Sea cluster Bulgaria", in the ITK sector – the cluster 'ITK cluster Plovdiv' and 'Bulgarian cluster telecommunications', in the insurance – the cluster „Union Insurance Brokers", in health and tourism- the cluster „Cluster of health regions", in the courier sector – the cluster „National courier cluster" and many more. The goal is to combine the technological efforts of firms in the name of bigger production and creation of a high quality end product. Its obvious that the cluster merging have a future in Bulgaria. This might be an opportunity to prevent or reduce at least the chance of going out of business of multiple enterprises after entering the European Union. the Municipality definitely have gains from the developments of clusters, as they by them they can introduce new innovative solutions on a specific region. The local economic becomes more stable and competitive, a good amount of added value is added, the region is identified by a specific product group or industry.

4. Polling the clusters from ABC (Association of Business Clusters)

A poll was conducted in order to acquire information provision of the clusters on members of the ABC (Association of Business Clusters) in Bulgaria – see Table 1.

The poll was conducted online via e-mail during the period 01.01.2017 to 28.02.2017 comprising from the following question:

Poll

1. How many firms does your cluster contain?

1. Up to 5,
2. From 5 to 10,
3. Over 10.

2. **What type of software does the cluster use?**
    1. ERP system for the cluster,
    2. ERP system(modules) for separate firms of the clusters,
    3. Traditional Systems (accounting, storage, billing, Payroll and Personal).;
3. **What queries do you use for cluster management?**
    1. Accountant balance,
    2. Income and Expenses report,
    3. Equity report,
    4. Monetary flow report,
    5. Turnover payroll, Main Book, expenses ledgers,
    6. Consolidated queries, sales report by region, by category, by clients and more.
4. **How do you create the queries for the cluster management?**
    1. With and ERP system for the cluster,
    2. With and ERP System(modules) for the separate firms in the cluster,
    3. With SQL queries from the ERP system to the system on the cluster,
    4. With SQL queries from the ERP system for the separate firms in the cluster,
    5. With traditional systems (accounting, storage, billing, Payroll and Personal).
5. **How do you summarize the information from the separate firms in the cluster?**
    1. The queries are summarized in Excel by each of the firms in the cluster,
    2. The queries are summarized in Word by each of the firms in the cluster,
    3. Other software probram,
    4. Manually.

Table 1. Clusters, members of ABC in Bulgaria

Clusters from SMEs Bulgaria	**Contacts**
Bulgarian Furniture Cluster	info@furnitureclusterbg.com
Automotive Cluster Bulgaria	office@automotive.bg
Bulgarian Cluster 'Telecommunications' (BCT)	office@btcluster.org
ICEM – Industrial Cluster 'Electromobiles'	office@emic-bg.org
ICT Cluster Plovdiv	office@ictc-plovdiv.org
Cluster „green freight transport"	office@gftcluster.eu

Cluster „Horizontally integrated technologies and systems"	info@hits-cluster.org
Cluster of Health and Tourism	bulgmed@gmail.com
Cluster „Mechatronics and Automation"	info@cluster-mechatronics.eu
Cluster „Union Insurance Brokers – UIB"	office@abclusters.org
Sea Cluster Bulgaria	office@marinecluster.com
National Courier Cluster	couriercluster@gmail.com
Association „Cluster for health and tourism Bulgaria'	vestodent@gmail.com
Specialized Cluster and institute of clothing and textile – Danube	milusheva@online.bg
Srednogorie copper industrial cluster	office@srednogorie.eu
Black sea energy Cluster	bsec@abv.bg

5. Analysis of the results from the poll

After analysis of the poll, received by the clusters, members of the Association of Business Clusters in Bulgaria (ABC), the following conclusions can be drawn:

1. 100% of the clusters in ABC comprise out of more than 10 firms. This means that the firms from each of the sectors are more and more valuing the advantages from the merge into cluster organizations.

2. 70% of them use ERP system, and 30% use traditional systems. The high percentage of usage of an ERP system from the clusters allows the firms access to best practices and already ready know-how, as well as the option to consolidate the information on a cluster level.

3. For the cluster management, 90% from the clusters use the Annual Financial Report - Balance Sheet, Statement of Income and Expenditure, Statement of Own Funds, Cash Flow Statement and Monthly Reports - Turnover, General Ledger, Account Logs, VAT Logs.

Only 10% from the clusters use consolidated queries, like reports for sales by region, by categories, by clients. Since the report from the Annual Financial Reports and the monthly reports are included in the base functionality of an ERP system, getting them on a cluster level, presents the challenge of combining the information of all the firms in the cluster. By using consolidated reports and queries, the cluster management will expand its information provision during the operational management.

4. For the creation of report for cluster management only 10% of the clusters use the options provided by the ERP system, 30% of the reports are made by the separate firms of the cluster. These clusters which use traditional systems make 100% out of the traditional report (accounting, storage, billing, Payroll and Personal). None of the clusters uses SQL queries to the Database of the ERP system of the cluster, although this option provides the opportunity for creating new reports that can extract more relevant or more specific information compared to the one in the base function of the ERP systems.

5. 90% of the clusters prefer to combine their reports by the separate firms of the cluster in Excel, and only 10% prefer to use another software for this. The reason for this is that at the time the ERP systems do not have an option for consolidation of information on a cluster level.

6. Defining the problems

After the analysis of the results collected by the poll conducted on the members of the Association of Business Clusters (ABC) in Bulgaria the following problems can be defined:

1. For cluster management the reports (Annual Financial Report and monthly reports) are created by the separate firms in the clusters. This enforces additional work for their consolidation on a cluster level which, according to Kuyumdzhiev could be a difficult task [5]. This way the management of the cluster cannot take operative decisions for its management, until the data is properly consolidated.

2. For consolidation of information of the separate firms on a cluster level a basic application (for example an MS Excel table) is used, due to lack of opportunities for consolidation of information, missing in the basic functions of the ERP system.

3. The capabilities which the ERP system presents for acquiring consolidated information via SQL queries is not used.

7. Solutions

1. For the consolidation of information on a cluster level, the development of a model for improvement of the ERP system is necessary, including alternative solutions, like using BI (Business Intelligence) platforms (Tableau, QlikView, Microstrategy and more) and technologies from the group Big Data or SQL queries. As the BI platforms and technologies from the group 'Big Data' are very expensive solutions, they are mainly used by big (with combined venture) firms. For the clusters of SMEs in Bulgaria a better alternative would be the usage of SQL queries, as in reality they are free. The ERP system proposes an interface for their creation as well as allowing the option for them to be planned for scheduled run via stored procedures.

2. The small and the middle enterprises need to use sophisticated IT products – business applications as ERP systems, BI platforms and databases. In the past this was a challenge for them – the needs to have data center, to buy hardware and to pay software licenses, to hire competent personal need big investments. The need increase the resources if the IT load increase was able to lead to big expenses. From other side there was also the risk to underutilize the delivered hardware and software. Nowadays the cloud technology helps to avoid these troubles. The companies can lease the needed hardware and software resources (including support personal) by the Cloud Services provider. This means that the cloud service will give access to IT infrastructure, the software and also assure the needed support. The spare data centers will provide the continuity of the IT service in every case of failure in the main data center. It is possible to increase or decrease the used processor, memory and disk power on demand without losing big amount of money. There is no need to hire expensive support personal for the data center. This makes the available the usage of the IT power for smaller enterprises and fully changes the situation in the data processing. This is the reason for the explosive growth of the cloud data centers. The cloud data centers experience their specific difficulties – the permanent growing number of applications and data bases which run there. It is a very hard task to support timely these products – this includes performing tuning, patching, upgrades of the software and other routine support operations. This leads to new kind of software and data bases – the so-called autonomous data bases. This means that using Artificial Intelligence (AI) and Machine Learning (ML) the software will be able to do the support fully automatically. Of course, this is a very hard task and needs (especially the Performance Tuning) specialized Data Base Machines that have big cache devices and

integrated intelligence on the hard disk devices (like Smart Cache and Smart Scan technologies of the Oracle Exadata Data Base machines).

8. Conclusion

The merging of SMEs in Bulgaria in clusters of horizontal type or vertical type could allow access to modern. An example would be systems for resource planning of the enterprise (ERP System) and the ready 'now know', business models and business processes, covering the best practices, which will lead to the reduction of expenses for hiring outside experts and consultants for the re-engineering of the business processes and increasing their competitiveness.

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Improving Identification in Educational Activities Through Two Factor Authentication

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Abstract. Educational activities, especially when related to tests, assessments and exams, carried out in digital way, are prone to forged identities. One example in this direction is a person, different than the one to take the exam, to participate in it. The typical digitalized exam system requires a username and a password to authenticate the student. For such situation, there is no guarantee that another person, and not the one who must take the exam, can use those same username and password. This paper proposes an approach with two factor authentication, using face recognition. Having student photos from the internal administration system, we compare them to the face, standing in front of the exam computer's camera. The presented approaches and algorithms are tested in the domain of a large university and the results suggest that a two factor authentication scheme with a face recognition component is a feasible solution to ensure the authenticity of the participants.

Keywords. Security, Security in education, Two factor authentication, Face recognition

1. Introduction

Information security is one of the most important topics in modern computer and computer network, digitalized society. Almost everything is performed, using computers, computer networks and digital devices. Schools and universities are also digitalized and will continue to be more and more computerized. The complexity and variety of activities at educational organization is ever growing and encompassing almost any aspect of learning and teaching. The final step in the educational process is the exam, or the test. And it is very important to make sure that any attempt to compromise that step is stopped.

The purpose of this paper is to present an approach, which can decrease the danger of impersonating a student/learning person during an exam. The ultimate goal is to recognize the face of the examined student/person and confirm that he (she) is the one that is allowed to take the test/exam and corresponds to the person that has an electronic ID and knows the password for that person.

2. Identification using multifactor authentication

The most common way to authenticate a person in order to use a digital asset (card, system login, locked phone or computer, use of application, etc.) is to use something he/she knows – PIN, some set of digits or password. With the widespread use of networking and on-line services, for many critical assets (like on-line banking) the authentication process has to go over two or more steps - multifactor authentication (MFA) or multistep authentication (MSA). This is a security approach that requires more than one evidence (factor or step) as a method of authentication. For MFA two or more categories of credentials are required in order to verify the user, who is to use the digital system. The typical approach is to combine what

the user knows (for example – a password, PIN), what the user has/owns (security token, card) and what the user is (biometrics – fingerprint, face, etc.). The difference between MFA and MSA is subtle and in many cases it is regarded the same. However, some authors explain the difference as in the case of MFA there is a single-factor plus a software- or hardware-generated token code, or a smart card, while for the case of MSA there is a single-factor plus a code sent to the user out-of-band [1], [2]. So – hardware tokens and One time passwords (OTP) are regarded as MFA, while code send over SMS is regarded as MSA.

The University of National and World Economy (UNWE) uses student cards as student books, and identification cards [3]. This is seen as a factor of identification, which a student has. They also have a password, which is regarded as a second factor. However, there is the possibility that a student may "borrow" a card and a password and go for an exam instead of another student. Verifying a big number of students by looking at their ID cards (with photos on them) and their faculty number on the card may be a very time-consuming process, which can take even hours to complete. So there is a clear need for providing a way, where the verification of the identity of a student is done in a digital way. Such way can be a facial recognition of the student, before starting a test or exam by a camera and matching the face in front of the camera to a face, given in the student database.

3. System design and functional blocks

UNWE has at present the following data bases and IT applications, related to the education of students. At first, there is a student information system, implemented at UNWE. It contains all the necessary data of the students. We shall refer to it as ***DB of IS Student***.

The architecture of the functional blocks in our Application for multifactor authentication (AMA) is shown in Figure 1.

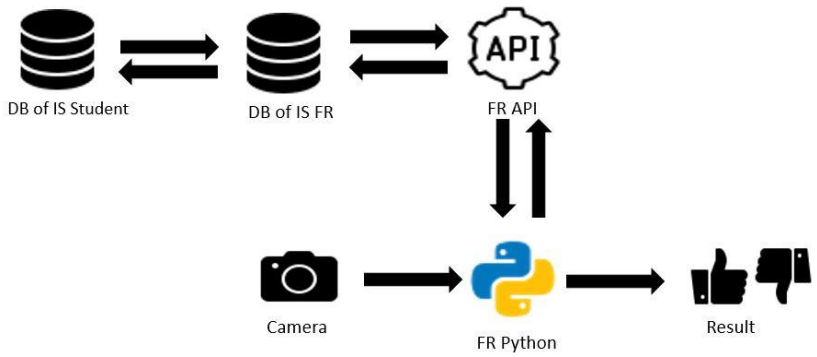

Fig. 1. Flow of data and functional blocks in the AMA system.

Next to the DB of IS Student block is the database for facial recognition (***DB of IS FR***). The two databases communicate using connected tables through the PIN (Personal identification number) of students, they use for their cards. Next (on the right) to DB of IS FR is the Application programming interface (API), which serves for easier connection to the database and for greater security. We name this block ***FR API***. It provides communication between the client (FR Python) and the server part (DB of IS FR).

The next module is a program written in Python. This is the place, where the faces of the users in front of the camera are identified. The camera captures the person standing in front

of it. The photo is then encoded, the python script makes the necessary processing, and then the result is recognizing or not the person standing in front of the camera.

4. System implementation

- **Data bases**

During the enrolment process in UNWE, each student is obliged to present valid photo on paper. This photo is scanned and added to the database of the university information system (DB of IS Student). There are several tables in this database that we need to retrieve student data. One table is for the photos, another one is for the students and a third – for information on students.

We use an "Encodings" table (resides in DB of IS FR) (Figure 2), that contains specific data that does not need to be in the student's information system.

Column Name	Data Type	Allow Nulls
Egn	nvarchar(40)	☐
face_encoding	varchar(MAX)	☐
encoding_number	int	☐
		☐

Fig. 2. Table Encodings - faces from the photos.

This table contains the encodings of the students' faces from the photos. The table contains a key with two columns, which are: "Egn" and "encoding number". The Egn and the encoded numbers do not form a unique pair, because for one EGN there is more than one encoding (i.e. pictures of a face). As one encoding contains 128 numbers, this is an array of numbers that we have divided by "|". This division is necessary for us so that the whole array is one string and written on one line in the database and for better speed. There are alternative approaches such as a separate table containing these 128 rows and being linked to an Encodings table under the 1: N link. Another way is for this Encodings table to contain 128 columns, but these two approaches lead to lower productivity. The connection with the other database and this one is through the students' PIN (personal identification number).

- **Application programming interface (API)**

We use the ASP.Net Core Web API [4] to implement an application programming interface (Figure 3). We use it as one of the latest and fastest growing technology, and also being open source. We also use the C # programming language.

The *FnRequests* class uses strings to get the faculty numbers of students, and there is an opportunity to set a certain range of faculty numbers. In the *Known* class we have a string which keeps the names of the students are taken, as well as an array acquiring the encodings of the students' faces. *SpecRequests* has values - the number of the major for the student and the year of study (course). In the *Photo* class there is a faculty number, PIN and the photo. This class fully corresponds to the "Photo" table in the database (DB of IS Student). In the *WellKnown* class are the students' names. Then comes strings from the PIN, the faculty numbers and the encodings of the students' faces, followed by the string which takes the encodings from the database. All classes are used by a common *StudentController* class, where all actions take place between the database (DB of IS Student and DB of IS FR) and the application programming interface.

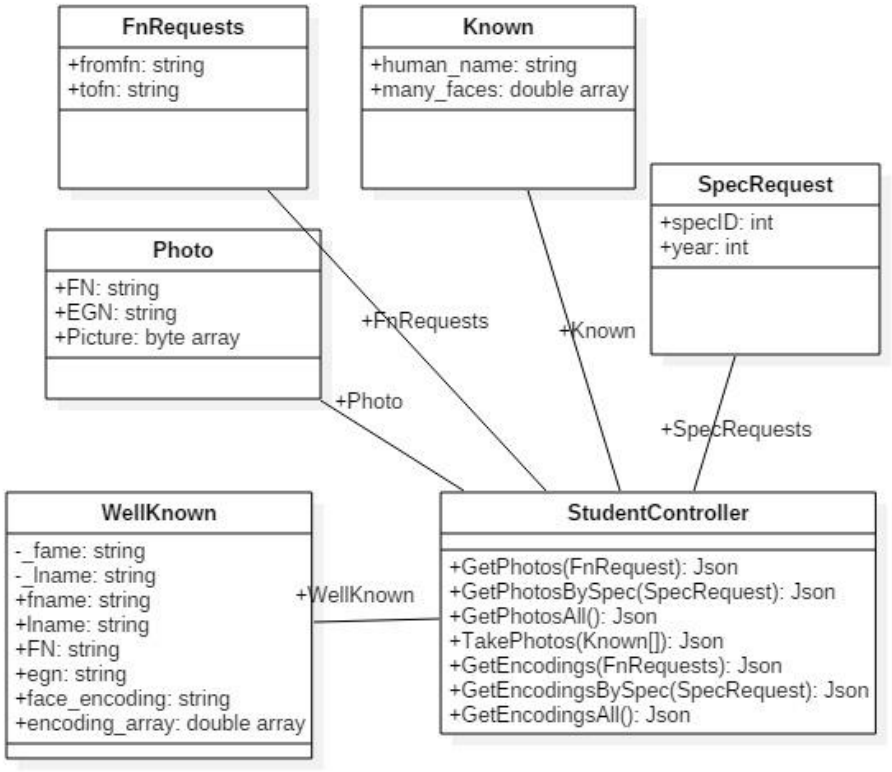

Fig. 3. Structure of the application programming interface.

- **Python module**

This module is programmed in the Python language. Face recognition is performed by a face recognition library "face_recognition". It is built using state-of-the-art face recognition from a software library written in C ++ by dlib, using Deep learning [5]. Dlib is a modern C++ toolkit containing machine learning algorithms [6]. That approach uses a TensorFlow [7] implementation of the face recognizer and is claimed to have 99.38% accuracy on "Labeled Faces in the Wild benchmark" [8]. The library also provides a tool that allows recognizing a face in a folder with images from the command line.

The Python module (PMod) is currently programmed for OS X and Windows.

Dlib has also tools for creating complex C ++ software to solve real-world problems. It is used in both industry and academia in a wide range of fields, including robotics, embedded devices, mobile phones, and large, high-performance computing environments. The open source Dlib license allows it to be used for free in any application [6].

Figure 4 shows the communication path between the Python module and the API module.

PMod requests photos of students from the database (DB of IS Student). The API takes them from the DB and submits them to PMod. At this point, the module is ready to start processing the encodings of the photos. After PMod processes the photos, it returns them processed to the API for storage in the database. Once the students have the encodings ready, the student can stand in front of the camera, where PMod encodes the face in front of the

camera and makes a comparison between the face in front of the camera and the encodings submitted by the API. In case there is a match, the result is positive (i.e. – OK), if there is no match, a result for non-match is given and then comes the next person.

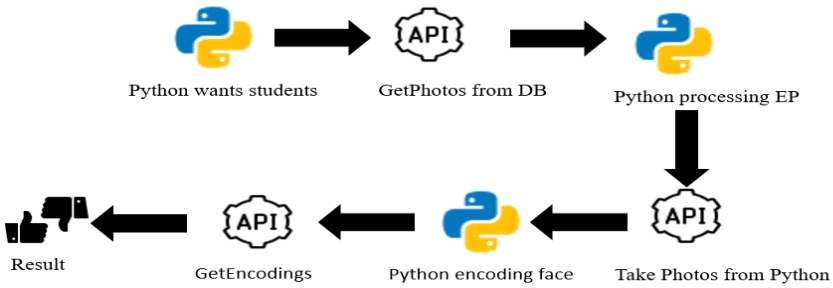

Fig. 4. Communication between Python and API.

Figure 5 gives the algorithm of the entire Python module. It starts with positioning in front of the camera, taking a photo and saving it. Then a comparison is made between the encoding of the photo taken by the camera and the encoding of the photos from the database (DB of IS FR). If there is no match, the application stops. If a match is found, the application is going to the next step - the comparison. If the result of the comparison is high (the faces are as close as possible), it means that photos are of the same person. If there is no match, it means that the person in front of the camera does not exist in our database or exists, but is not among the students indicated in the current context.

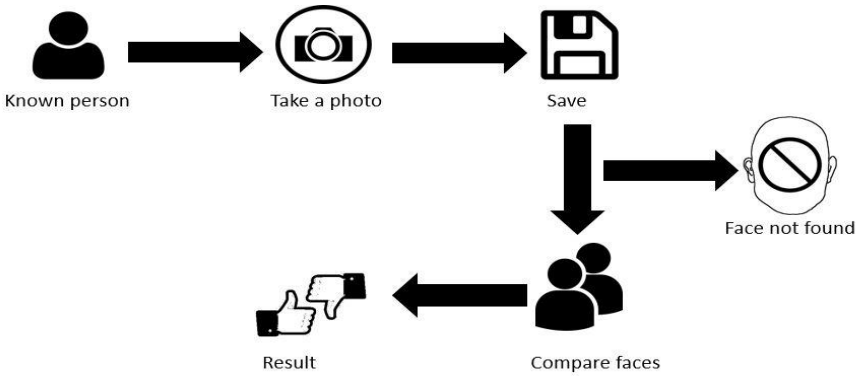

Fig. 5. Python module algorithm.

- **Test results**

We performed some test to look at the speed of work of the application with different number of students (Table 1). In Table 1 and Figure 6 – the parameter denotes the time (in seconds), for which the photos are loaded from the database (DB of IS Student).

Table 1 - Statistical study of loading and recognition time.

Example	Number of students	Charging time	Recognition time
By faculty number	52	00:58.82	00:17.00
By faculty number	200	01:19.09	00:16.13
By specialty	259	02:02.93	00:20.53
By specialty	540	03:37.17	00:30.25

The first test is with 52 students, the next is with 200. The charging ratio is approximately 1:4, i.e. as the number of students increases, so does the time for loading photos from the DB, while the recognition time remains constant (Figure 6 and Figure 7).

When testing the module with 540 students (in a bigger group like Specialty), the charging time is over 3.30 minutes and the recognition time is 30 seconds. Here the recognition time increases by a factor of two, while the charging time increased by almost a factor of four. The overall impression is that the charging time start increasing in almost linear way after 230-250 students, while the recognition time remains almost the same at that point, and after that – also start increasing, even with slower rate (Figure 6 and Figure 7).

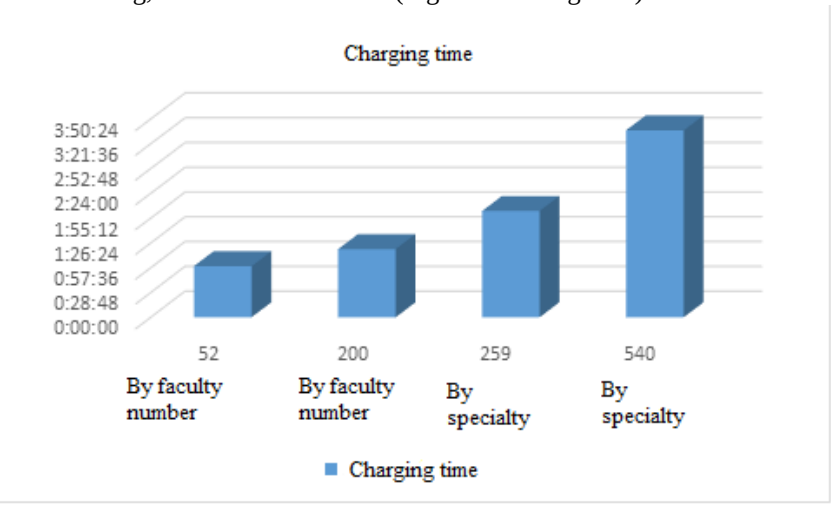

Fig. 6. Charging time (seconds).

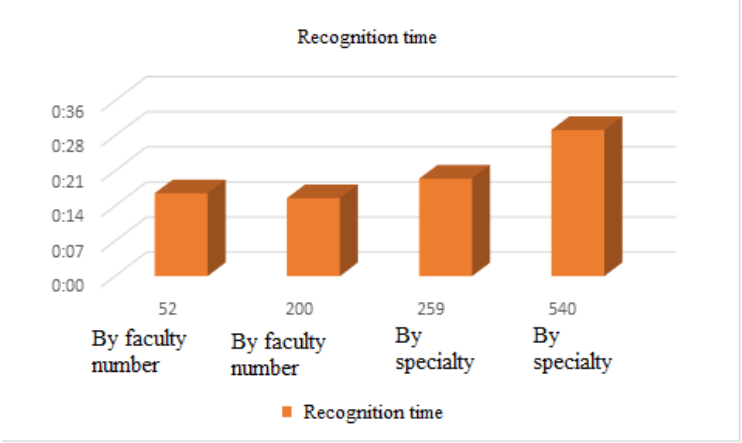

Fig. 7. Recognition time (seconds).

We can conclude that despite the few minutes for loading the photo encodings, the process can be done once for each specialty and also for a certain period of time, because when the photos are loaded for the first time, they are saved and no subsequent loading will be required. The only process to be performed is the recognition one.

6. Conclusion

The multifactor authentication application, described in this work shows that improving security for educational application by recognizing the person, attending an exam with digital card is possible. The application has developed an application programming interface and Python module, using the existing DB for students. The available photos in the DB are encoded and then compared to an encoded face from a picture, taken by a camera in front of a student. An important part of the application is the use of a Face Recognition library tool using Tensorflow [9].

The experiments with the application show that there is a bigger increase in the charging time (i.e. the time required for the photos to be loaded from the database) than for the recognition time.

The system has some limits on the number of students to be recognized, but bearing in mind that on a certain exam/test, only students from one group or stream are present, this limitation is not a serious one.

There are plans and ideas to make the system work on a system-on-chip card like Raspberry Pi and this will be the next step of work and experiment and will be the area of future research.

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Architecture of an Integrated System of Electronic Administrative Services for Citizens, based on the Main Integration Technologies

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Abstract. In recent years, governmental organizations have witnessed major transformations in many countries where administrative processes are being restructured to achieve greater transparency and better service delivery to citizens. These transformations are related to the development of an integrated system of electronic administrative services for citizens. The main purpose of the report is research of technologies for developing an integrated system and presenting a basic architecture.

Keywords. Architecture, Integrated systems; Web services, Administrative web services, Integration, SOA, JAVA.

1. Introduction

In recent years, governmental organizations have witnessed major transformations in many countries where administrative processes are being restructured to achieve greater transparency and better service delivery to citizens. Governments are becoming unified organizations that offer a single entry point for all citizens regardless of their age, belonging or location. This transformation takes place on two levels:

• Transformation in front offices, where a single entry point is formed - a single e-government portal;

• Back-office transformation where all business processes are integrated to bring together, share and reuse information and common components.

This transformation is ensured through the development of interoperable and integrated systems that allow governments to implement their eGovernment improvement strategies and at the same time improve the efficiency of back office and restructure their administrative processes. In this regard, the main purpose of this report is to study technologies suitable for integrating web systems and offering a basic architecture of the system. In order to integrate these systems, it is necessary to implement modern technologies that ensure the integration of heterogeneous institutional systems. Among the integration technologies discussed, SOA and JAVA technologies are distinguished, which will be discussed in more detail in the report. These technologies allow for successful integration. An integrated system can bring many benefits to society.

2. Web Systems Integration based on Service-Oriented Architecture

SOA - Service Oriented Architecture, has established itself as a modern approach, providing effective mechanisms for integration of complex heterogenic administrive systems. The automation of administrative processes is being realized through SOA, when they are

being distributed in the form of services. Emil Denchev (Denchev, 2009) defines the architecture, which combines business processes (administrative processes), realized with separate applications though small modules called "services". This way administrative applications can be used from different groups of users, position in or outside the administration. Since the services are autonomous, abstract, easily findable, with well-documented interfaces, they also allow for easy testing and process error identification. This comes from one of the most important benefits of SOA – their reliability, especially when this is implemented as web services. Reliability is key for communication, providing the capability for network error handling – for example the repeat of a message until a confirmation is received that the initial message was successfully delivered.

In the core of SOA is the capability to decompose software into a set of services, which can be used and re-constructed in new applications, that have a high degree of integration capabilities and reusability. An important aspect of SOA is the differentiation of the service (the "what") from its implementation (the "how"). The interface component creates functional interoperability between services, while the implementation component drives the business logic of the application. In SOA the administrative processes are realized as a service, where every service represents a certain step from the administrative process. In this context the service is "a software component", that can be used repeatedly from another software component or can be access through a standard interface through the network. According to some authors (Zhang, T., Ying, S., Cao, S., Zhang, J., Wei, J., 2006) the Service Component is an abstract and specific computer entity, connected with the services, their provider and their Request, as shown on fig.1:

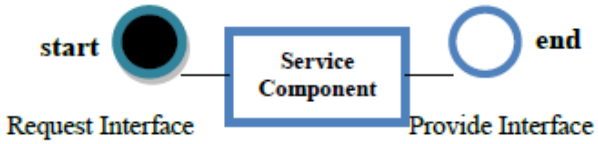

Fig. 1. Component of services in SOA.

The service type "component" is characterized by four aspects:

1) Identification – refers to the name of the offered web service, which is a unique identifier;

2) Interface – specifies the web services that are offered and requires and splits the content of the service from its conversion, thus enabling the content of the web service to be changed without affecting the users of the service;

3) Specification – a brief description of the service that describes how to use the service, the role of the service component, and declaring the content of the service itself (contract);

4) Condition – predefined conditions, post-conditions, and variants of the service component that are used during the web service composing process are determined.

The interaction of these characteristics is presented in fig.2.

Fig.2. Interaction of elements in a component service in SOA.

Web services are characterized by their:

- Autonomy (being self-contained) - meaning that they have their own state;
- Are platform independent (loosely coupled) - they can function on different technological platforms;
- Can be easily integrated and re-combined - meaning any computer configuration, using any computer system, in any program language can get access to SOA for creating new administrative processes.

Fig. 3. Interaction between the main components of web services.

The realization of web services is possible thanks to the usage of XML based technologies for describing the data and making possible it's transfer in a network environment. Behind every component of the web service structure there is a standard which describes the interaction with the rest of the components. The main components are Service Requester/Consumer, Service Provider and Service Broker. Their interaction is shown on fig.3.

Service Provider publish the service and its description based on the WSDL standard in a web-based environment, through a Service Broker based on the UDDI standard. The Service Requester searches for a corresponding service through the service intermediary and receives a service request URL as well as a WSDL file describing the access to the service. To facilitate communication between each other, both the provider and the user use SOAP-based messages.

Service Broker – A service mediator who establishes the relationship between the two parties - the Provider and the Service Requester. Its task is to control Service Providers to adhere to best practices that comply with established laws and regulations. In this way, brokers monitor and sanction suppliers in case of non-compliance;

Service Provider – A service provider that offers complete service solutions with a high level of abstraction to service seekers. It creates the service and transmits its interface with information about it to the Service Intermediary. The provider must decide what category the service will deliver to the broker and what kind of agreements it requires to use the services. ie what kind of contract will be concluded for the use of the services offered by the supplier;

Service Requester – A service requester who may request a service request from multiple vendors, and may then choose from which provider to accept the service based on a Service Register known as UDDI. Requester is a commonly used word replacing Consumer, especially in the web services world. This is a technical term indicating that a service consumer sends a request to a service provider to call a service.

Web services are functionally independent software components that bring interplanar communication to a new level of abstraction that is independent of the programming language

or software platform used. As a result, web services provide interoperability between administrative systems, which is achieved through a set of open standards - UDDI, WSDL, SOAP based on XML technology.

- Universal Description, Discovery and Integration (UDDI) – a standard that is a catalog that lists existing and available web services. It is a platform independent registry of XML based services. According to M. Hacid (Hacid, 2005), it consists of "white pages" that contain data about addresses, contacts, identity; "Yellow pages" that contain industry categorization data based on standard classifiers; and "green pages" that contain technical service information that describes the behavior and supported features of the web service.

-Web Services Description Language (WSDL) – a standard designed for a comprehensive description of how multiple users can call web services. According to Eric Newcammer (Newcastle, 2004), WSDL is an XML format that does not describe the purpose of the web service and the technological parameters that accept and return the methods supported in the message.

- Simple Object Access Protocol (SOAP) – a standard that allows the exchange of information between web services delivered on different IT platforms. It is an XML-based specification to define how to exchange messages between web services. We could define SOAP bidirectionally - both process and content. As a process, SOAP is one-way communication from sending to receiving application. It is implemented in a request-response format. As content - SOAP is an XML document containing the data to be transferred.

As a result of the effective application of the standards UDDI, WSDL, SOAP we have the capability of providing administrative services online. These standards are united by the language XML, which gives us the base for integration between services located in different networks, different systems and different institutions in different cities. The spreading of SOA opens the potential for lower costs and better flexibility when integrating administrative systems. Despite the widespread application of XML technologies for integration between government entities, there is a rise in popularity of the JAVA programming language as a new technology for integration of web systems.

3. Integration of web systems through JAVA technologies.

JAVA positioned itself in 2016 as the best and most used programming language. The integration of web systems is established through Java servlets, JSP (Java Server Pages), EJB (Enterprise JavaBeans) and Java files and archives, all of which can build a common web based system. Java servlets are Java programs that get user input, process them and return as a result a dynamically generated HTML document. JSP are an extension to Java servlets, that allows the incorporation of a dynamic fragment in the HTML page, which can be executed when a web service is requested. EJB provides a framework for executing of the business logic and operations on the data. The integration of web systems through Java can be seen in fig. 4.

The advantage of Java is that it is superior to the old technologies as CGI (Common Gateway Interface) since Java servlets do not create a new process in the operating system, which considerably slows the delivery of the end service. Java uses a virtual machine, that is constantly loaded and when a Java servlet is “called” it is just executed by the virtual machine and the result is being returned to the user without the need of a new process for processing the request. This is being accomplished with JSON (Java Script Object Notation) technology which replaces the old SOAP for building web based systems. On fig. 5 is presented a comparison of the architectures of information systems, based respectively on JSON and SOAP. P. Petrov (Petrov, 2015) points out that despite the fact JSON is rooted in JavaScript it is independent from the implementation of program languages and uses conventions which are familiar to languages like C++, C#, Java, Perl, Python.

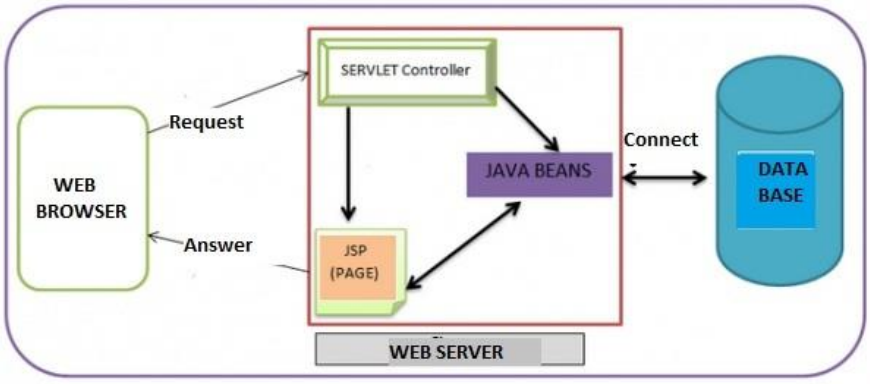

Fig. 4. Integration of web systems, based on Java technology

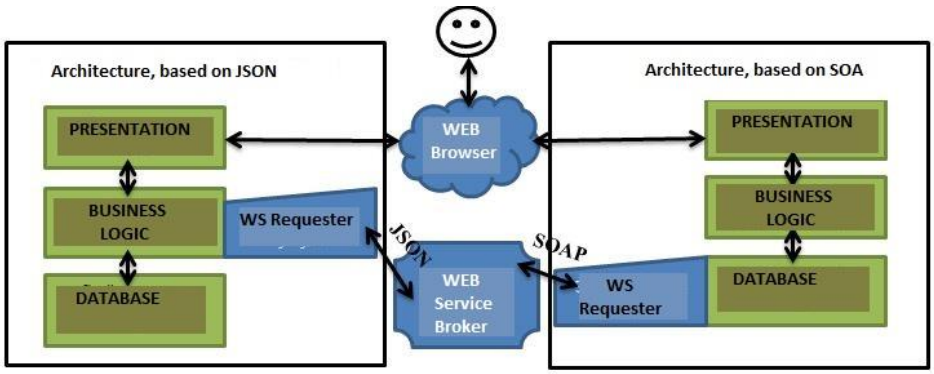

Fig.5. Comparison of Java based architecture and Soap architectures

In the architecture based on Java the component for requests to the web service is being processed in the layer of the business logic, while in the architecture based on SOAP the client itself functions as a component for querying web services inside the database. The component is integrated in the DB through a user defined functions and here the processing of the request is done on the Data layer. JSON is text based open standard that introduces simple data structures and associative arrays, called "objects". It is being used for transferring data between a server and a web application acting as an alternative to XML. On fig. 6 is given an example of authorizing a user based on XML and JSON. JSON is used for communication with the process engine and the requested information is called by a front office on the user portal, which results in activation of back-end processes. In this case JSON objects with the needed information are being send after which they are translated into a unified data model and are interpreted by the front offices.

4. Three layer architecture of an integrated system for electronic administrative services for the citizens

Despite the mentioned advantages, Java technology is still not in the lead for integration of web based systems for administrative services, in comparison with a service oriented architecture. SOA attracts more and more attention as an architectural paradigm that allows re-usability of services, eases integration of complex systems, which makes it more flexible and more adaptive towards the evolution of information systems and thus - the preferred

technology. SOA gives us the ability for integration of functionalities usually provided from heterogeneous systems, resulting in the construct of an integrated Electronic Administrative Service system for the citizens that will be characterized by operational compatibility and platform independence, which in turn will satisfy the requirements posed by the civil society. For the building of an integrated system for EAS we will use both SOA and JAVA. The technologies in question - SOA, WS (WSDL, SOAP, UDDI) and JAVA are the foundation of a successful integration of administrative systems and the web portal and they give us the grounds to look at an architecture of a system, based on these technologies.

XML пример	JSON пример

<?xml version="1.0" encoding="UTF-8"?>
<authentication-context>
<username>my_username</username>
<password>my_password</password>
<validation-factors>
<validation-factor>
<name>remote_address</name>
<value>127.0.0.1</value>
</validation-factor>
</validation-factors>
</authentication-context>
	{
	"username" : "my_username",
	"password" : "my_password",
	"validation-factors" : {
	"validationFactors" : [
	{
	"name" : "remote_address",
	"value" : "127.0.0.1"
	}
	]
	}
	}

Fig.6. Example of user authorization based on XML and JSON technology.

The integrated system can be realized as a multi-layered application in which the presentation layer, the business logic layer and the data layer are separated. On fig. 7 is represented the architecture of web integrated system for EAS. The proposed architecture is based on the traditional three-layer architecture that is also expanded with different SOA and J2EE technologies and standards, which are used for integration of EAS and the building of an integrated web system.

Presentation layer is focused towards the users (citizens) and provides the interaction with the web page of the portal. For building this layer XML, HTML, JSF technologies are used. Java Server Faces (JSF) is a technology for creating web based applications on the foundation of Java Servlet and Java Server Pages (JSP).

Business Logic Layer is the middle layer, which represents the business logic and the rules for using the system. For building it we can use a combination of SOA and JAVA technologies. For the realization of the requested EAS we can use SOAP interface, which provides access to WS and XML based objects through SOAP protocol, while for the interaction between the different components JTA and JNDI technologies are used. When necessary the SOAP protocol can be substituted with JSON standard and in for building the Business Logic layer EJB can be used.This layer represents the integration layer for building the system. An important integrational component is the ESB (Enterprise Service Bus), which is the unifying transport highway, used for standardized relay of data between the different components in the system.

The Data Layer contains all the necessary data for processing of the EAS. The main role of this layer is to optimize the re-usability of the data. The chosen environment for managing the data for EAS is MySQL, which is the most widespread environment for web systems. The advantage of MySQL is that it is open sourced and until recently thi was the only database management environment with Community Edition (CE) for usage of the offered instruments without a licence fee**.**

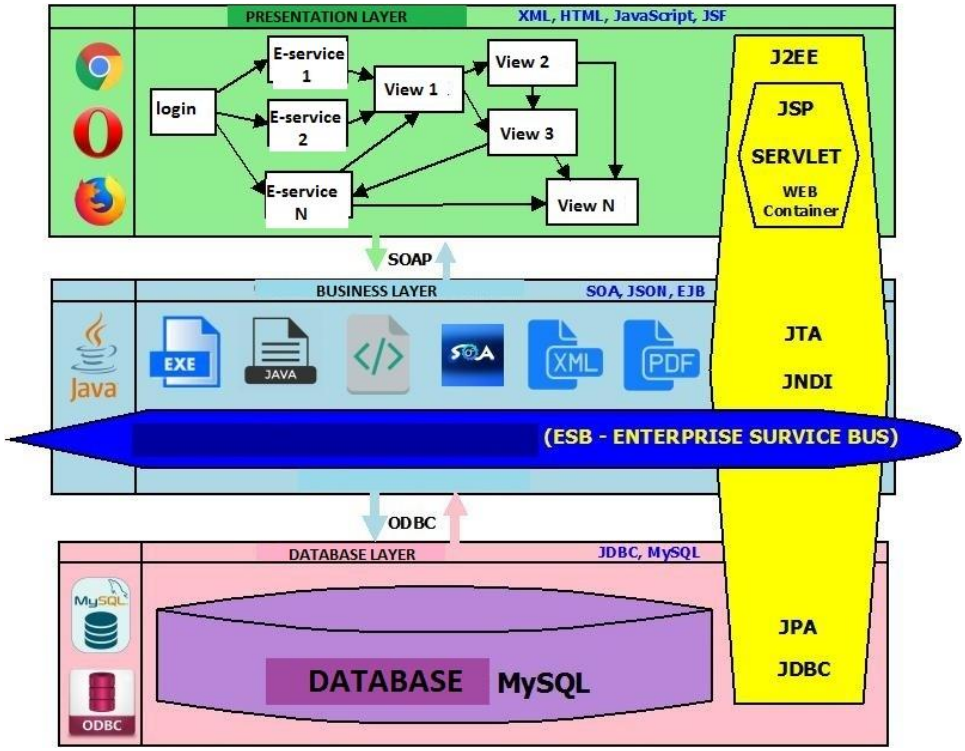

Fig. 7. Architecture of an integrated web system for EAS citizens based on SOA and JAVA technologies

The three-layered architecture is being enhanced with the introduction of J2EE architecture for building the layers of the system. J2EE is an architecture,, based on the JAVA platform for development of web applications and systems and provides data security through EJB, Java Servlets, Java Service Pages и XML technology. The components of the architecture are: JSP (Java Service Page) and Java Servlets, WEB Container is a component of the web server that serves to interact with JSP and Servelts; JTA (Java Transaction API) defines standard Java interfaces between the transaction manager and the participating countries and allows distributed transactions to be multiplied through a Java environment; JNDI (Java Naming and Directory Interface) is a library for directory access and naming services; JPA (Java Persistence API) is a programming interface that describes the management of relational databases in web applications using Java platforms; JDBC (Java Database Connectivity) is a standard interface for dealing with relational databases that enables the business logic layer to be linked to the data layer.

5. Conclusion

We can summarize that the presentation layer interacts with the business logic layer based on SOAP messages and the result of this interaction is visualized in the presentation layer. In turn, the business logic layer interacts with the data layer through ODBC (Open Database Connectivity) by extracting from it the data needed to process the EAS, and the finished results are presented on the presentation layer. In the event of the need for interactive interaction for the realization of a service, the business logic layer asks for more

information about the service. This information may consist, for example, of the name of the service provider, name of the service, technical parameters for communication with the service. Business logic gets the information available, processes it, and transmits it to the presentation layer. It accordingly generates an output to the user based on the received information and transmits the user's data to the interface through which the service will be realized. Wherever it is necessary to verify the identity of the user, business logic performs all necessary checks. In this way the interaction between the individual components of the integrated web system for the EAS of the citizens is realized. Web services such as technology have the potential to revolutionize the industry by providing ways to integrate administrative systems based on open industry standards that we will apply to forming a single EAS portal.

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Dealing with Financial Statement Fraud - Model and Solutions for Bulgaria

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Abstract. This paper gives an introduction on fraud and financial statement fraud and describes a model for an effective dealing with financial statement fraud. The model is based on information collected from the Republic of Bulgaria. It incorporates different stakeholders of the organization, namely management, internal audit, board/directors and external audit and parties in the outside environment in the face of government and supporting institutions. Moreover, the main issues that have been identified in regards to each party have been summarized based on the model and linked with potential solutions that can be implemented in practice. Namely: more independence of board members and audit functions in organizations, limited non-audit services by external auditors, increasing the consequences from such fraud and leveraging the benefits of professional organizations.

Keywords. Fraud, Financial statement, Fraud, Prevention.

1. Introduction

Fraud has been existent in the human environment since most ancient of times. In the broadest sense it is defined as a "wrongful or criminal deception which results in some form of personal gain" (Oxford Dictionary, [1]) or an "intentional perversion of truth in order to induce another to part with something of value or to surrender a legal right (Merriam Webster, [2]). Generally, several conditions have to be met in order to classify a case to be fraudulent. Davia [3] outlines several items that constitute a fraudulent act: there must be a victim (could be one person or many) which are led to a loss via a deceptive act by someone (also called the perpetrator). Moreover evidence about the intent and profit of the perpetrator must be present. Putting it in another way – a fraud could involve one or more individuals which act in secret for their own enrichment by depriving another of something of value. Fraud is more comprehensively defined as a combination of means, a result of man's ingenuity, for obtaining advantage of one individual over another through deceitful proposals or concealment of truth [4], including: fraud-abuse- the difference is in the deliberateness and intention in the actions of an individual who is aware in advance that these actions would be prejudicial for the entity or individual, fraud-error: the difference in this case consists in the presence of intentional act aiming to gain an advantage over others through fraudulent manipulation. Dinev [4] states that fraud is always perpetrated in favor of someone, in favor of an enterprise or for both cases. It could be generated by greed, substantial financial liabilities, unexpected financial needs, unsatisfactory recognition of the work performed, desire for better life, etc.

2. Financial statement fraud and responsible parties

The National Commission on Fraudulent Financial reporting [5] states that fraud in the financial statements is a reckless conduct by act or omission that is likely to result in materially

misleading financials. Other definitions vary but the common thread is that it involves a deliberate misleading or omitting of information in the financial statement in order to misinform misdirect and "injure" the users of this information (investors, creditors, auditors and other stakeholders). Gravitt [6] presents several schemes that are involved in financial statement fraud: 1) manipulation or falsification of the financial information and any supporting documents; intentional misuse of procedures, policies and relevant accounting principles used in the preparation of the financials and deliberate omissions or alteration of events and transactions that have relation to the reporting of the financial position of the company. Razaee [7] expands on the schemes of financial statement fraud by including: the use of aggressive accounting techniques via illegal earning management and using loopholes in the accounting standards that allows the entities to conceal the real situation of the entity.

Financial statement fraud can be caused by anyone having the access and capability of doing it. Taylor [8] points out two parties that have high likelihood of involvement is such fraud:

i) Lower level employees, which are in charge of divisions, subsidiaries; in charge of daily operations of the organization; and other company parts – they commit fraud in order to conceal any slowdowns in performance indicators or to get awarded bonuses and other benefits.
ii) Top level management – those are responsible for the general governance of the company and in the majority of cases the Chief Executive officer and/or Chief financial officer have been found to be involved. Financial statement fraud is generally committed with the knowledge of the management in an organization that is the reason why some authors consider it synonymous with management fraud [9].

3. Model for financial statement fraud prevention and detection for Bulgaria

We propose a new model, which considers the findings of a study conducted in Bulgaria. A visual simplification of the model consisting of one entity is depicted on fig 1.

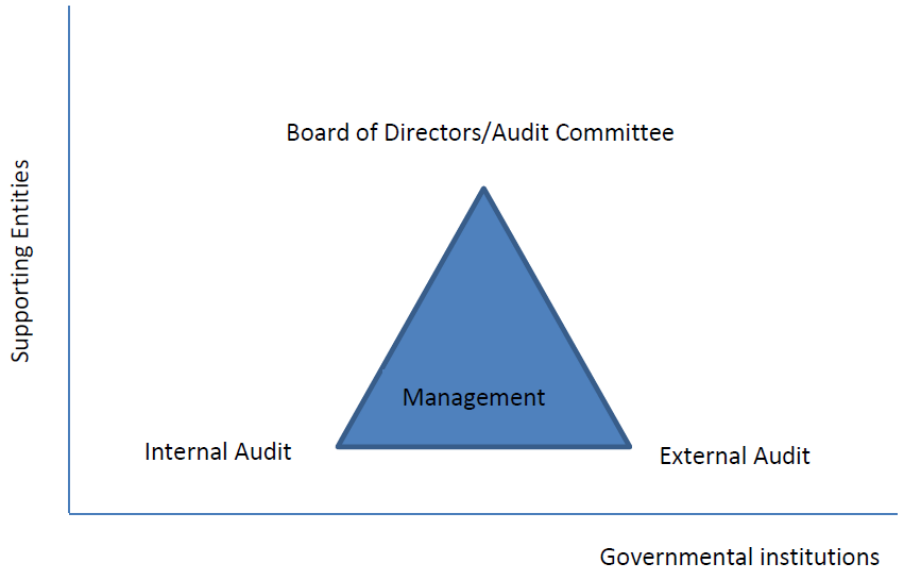

Fig. 1. Model for effective dealing with financial statement fraud in Bulgaria [10]

The model takes into account the environment both on organizational level and environmental levels. The organization level is represented by a triangle in the center of which is the management the organization since they are the party that is involved in committing financial statement fraud. For fraudulent financial reporting it is the mid-high management, for misappropriation of assets it is the mid management that is usually involved. However they are the party that is most efficiently being able to detect and prevent provided with proper motivation due to their daily interactions with the operations of the company and making sure that the prescribed policies are followed.

The three apexes of the triangle represent the three other parties that play, to a different extent, a role in the prevention and detection of financial statement fraud that need to keep management in check – the board of directors/audit committee, internal audit function and external audit. Board of the directors/audit committee set the foundation in the organization in terms of not only tone and ethical culture but prescribing actions to detecting and deterring fraud in the financials in organizations. The internal audit function not only has the responsibility to question the decisions of management but also make sure that all processes in the organization are adhered and followed. External audit is the outside assurance that vouches for the correctness of the financial statements. Special focus needs to be paid on concealed liabilities/expenses, revenue manipulation techniques improper disclosures, improper assets valuations and the red flags associated with them. Table 1 summarizes the main points found by the research that prevents the parties from achieving their role.

Table 1. Organizational Parties [10]

	Board of Directors/ Audit committee	Internal Audit Function	External Auditors
Issues	Participants in the fraud, lack of participation in daily operations, lack of knowledge and experience in managing fraud risks	Lack of independence, lack of experience and contact with the financial reporting process, do not provide assurance of the accuracy of the financials	Lack of independence, "Client is always right stance", collusion in fraud, rarely trained in investigation, understaffing,
Potential solutions	Independent board members with no vested interest, set an example both in and outside the organization on high integrity and educate the community in regards to the benefits of fraud free environment. Make communication easier between them and lower organizational levels.	More independence on the audit function, establish a subdivision that is concerned with the accuracy of the financials, More training on detecting fraud. Ways to report high caliber fraud outside the organization. Red flag detection trainings, Periodic reviews and risk assessments.	Limit non-audit services provided to audit clients, indebt analytical procedures, training in fraud detection and risk assessment, hire more staff. Red flag detection trainings

In the case that all three parties take their role accordingly the management's pressure, opportunity and rationalization to commit fraud in the financials are severely limited.

The outside environment of the model is comprised of the government (and related bodies) on the X axis and supporting institutions on the Y axis. The government is the party that influences the external organizational environment the most, it establishes the foundation and regulations on which firms operate in Bulgaria. The supporting institutions include professional organizations and the media. Professional organization can not only be a used as a means for education on prevention and detection methods of financial statement fraud in organizations but help the governmental ones establish a better legislation and requirements over the financial statement process. Moreover they can used as a means to share experience among different organizational levels and provide training on issues concerning the risk and importance of financial statement fraud prevention. Last but not least specialist from such organizations can be brought in organizations to provide independent valuation and assistance in prevention of such fraud in companies. The role of the media needs to be taken into serious consideration as well - individuals representing different stakeholders in the problem of financial statement fraud can propagate this problem into the community. Table 2 summarizes the main points taken from the research:

Table 2. Parties outside of the organization [10]

	Government	Supporting Institutions
Issues	Lack of consequences for financial statement fraudsters, more enforcement measures, low public confidence in governmental institutions	Not enough involvement by organizations in Associations, not enough leveraging associations' resources in terms of experience and knowledge in dealing with the problem. The media needs to play higher preventive role. More research needed on the problem.
Solutions	Increases sanctions (monetary jail, license revocation), faster and clear adoption of changes in the international accounting standards, taking affirmative stance on the problem, establishing channels for efficient whistleblowers and follow up action mechanisms. Partnerships with the supporting institutions and collaboration with them with the goal of dealing with the problem. Proposing insurance for organizations in case such fraud occurs in them (similar to auditor assurance of mistake in the opinion)	Foster participation and sharing of experience in professional organizations including red flags and risk management techniques. Using them as a source of information and independent consultation even in case where investigation is needed. Education the community by talking about the problem in shows, articles and other means of communication more research on the problem by researchers. Act as in-between intermediary between government and organizations

As seen by the findings combating financial statement fraud in Bulgaria is a group effort needing several parties to keep the risk of such fraud in check. The more tighten up the

ecosystem is and critical mass of factors in place the more likely financial statement fraud is to be detected and most importantly prevented in Bulgaria.

4. Implications and conclusion

The contribution from the findings has a direct implication in several general directions:

i) It enriches the academic literature by shedding light on the state of the financial statement fraud in Bulgaria. Moreover, it proposes a model for a way of looking into the problem of financial statement fraud in Bulgaria plus provides relevant recommendations;

ii) Second are the implication to the external organizational environment represented by government and supporting institutions that desire to decrease the risk of financial statement fraud;

iii) Third it provides potential topics of interest which researchers can use as the basis for future research in the area of financial statement fraud and fraud in general in Bulgaria.

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 analysis on financial statement fraud in Bulgarian context. It is only the first step out of many towards combating financial statement fraud in Bulgaria. It establishes the basis which should be used by the relevant parties that play key role in prevention of such fraud to reduce the risk of this phenomenon occurring.

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Application of Modern Methods for Data Transmission between Hierarchically Located Finite-State Automatons, in Telemedicine, According to NATO Standards with Ensuring High Efficiency and Compliance with the General Data Protection Regulation

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Abstract. The paper reviews current trends in research on application of modern methods for data transmission and General Data Protection Regulation (GDPR) cybersecurity in telemedicine, according to NATO standards. The authors consider model of transmission of biological data living organism with guaranteed high efficiency and using hierarchically located Finite-State Automatons (FSA). A model is proposed as variants of communication networks between separate army hospital units such as Role 1, Role 2, Role 3, Role 4. Data transmission is realized both by cable and by radio - relay channel, digital modems, FSA electronic diagnostic equipment and cyber protected TETRA communication systems with GDPR compliance. The results of the study are promising.

Keywords. Finite-State Automatons (FSA), GDPR, Cybersecurity, Telemedicine, NATO standards, Army hospital units.

1. Introduction

The transmission of biological data from a living organism through hierarchically arranged Finite-State Automatons (FSA) and the protection of personal data (GDPR) of the army unit personnel is of extreme importance and must be carried out according to NATO standards. High quality transmission, high reliability and high cyber-attacks protection are required.

The purpose of this report is to review the possible solutions as a communication approach in telemedicine, in secure processing and transmission of databases, between individual medical units in the army. The ultimate goal is to show the implementation of possible ways of communication in the delivery of health data between medical devices and equipment related to between such as state machines and possible ways to protect the personal data of the military staff.

Much attention is paid to the need to comply with the hierarchical level between individual hospital units as a requirement according to NATO standards described as Role 1, Role 2, Role 3 and Role 4. To perform the above activities is recommended to use the PACS (Picture Archiving and Communication System). It is a medical system that includes software and hardware components, which is mentioned in a number of NATO publications [1, 2, 3, 4].

2. Roles of NATO medical centers - Role 1, Role 2, Role 3, Role 4

According to NATO standardization documents "Allied Joint Medical Support Doctrine" AJP 4.10 (A) and MC 326/2 "NATO Principles and Policies of Operational Medical

Support" for medical provision of combat, peacekeeping and humanitarian operations is envisaged construction of structures on four levels.

The first level, or as it is commonly called Role 1, is an organizational part of the military unit.

The second level of medical support Role 2 is usually a component of a brigade but in operations abroad it can also be given to a smaller military unit.

The third level Role 3 is located in the theater of operations when a significant number of servicemen gather far away from their own country.

Level four Role 4 provides the full range of definitive medical care for the final treatment of patients until their full recovery.

The provision of the necessary communication services in the medical centers - Role 1, Role 2, Role 3 and Role 4 can be done through routers and multi-service platforms for subscriber access, equipped with the appropriate interfaces. For voice services over the telephone line (POTS) FXS- (for a subscriber country) and respectively FXO- (for a central party) - interfaces are required. When using ISDN telephone service, type BRI (2B + D) or PRI (30B + D), and access to subscriber interfaces type NTU / LTU is required. Digital symmetric line type HDSL or SHDSL can provide 30 channels - 64 kbps for telephony. In this case, automatic telephone exchanges can be installed at higher levels in the hierarchy (Role 2 or Role 3 automatic telephone exchanges can be installed).

At the lowest level in the hierarchy (Role 1), access to communication services can be provided by a router with a high-speed (gigabit) interface - 1000Base-T, for connection to the supporting network. The connection to the optical cable is made via the SFP (Small Form-Factor Pluggable) module.

At the Role 2 level, a connection to several Role 1 points is assumed. For this purpose, the communication equipment in Role 2 must have more high-speed backbone network interfaces to the Role 1 and Role 3 points.

The equipment that can provide these capabilities is either a higher performance router or a multi-service access multiplexer. Multi-service access multiplexers offer interfaces to which any subscriber devices can be connected:

- Data interfaces (sync or async) - V.35, X, 21, RS-232, Ethernet - 10Base-T, 100Base-T, 1000Base-T;
- TDM interfaces: G-703 / G-704 (E1); ISDN BRI, ISDN PRI;
- E&M - 2W / 4W and others.

The access multiplexers can be interconnected via the backbone network either via an optical PDH or STM-1 / STM-4 interface, or via an optical Ethernet interface. The equipment in Role 3 is similar to that in Role 2, but assumes a larger number of interfaces and the ability to reserve access lines. The connection of Role 3 with Role 4 should be realized through an access point from the Department of Defense network.

The communication connection with the higher level can be realized both by cable and by radio - relay channel, if the terrain allows it. Given the relatively low transfer rate required for the connection with Role2, digital modems of the HDSL or SHDSL type should be installed at the end points, and the connection between them should be made via a two- or four-wire copper field cable. In this case, the distances should not exceed 3-4 km. If a longer distance is required, repeaters are used. This dull connectivity provides a channel with 2 Mbps speed. Relevant access devices can be installed to the subscriber interfaces of HDSL / SHDSL modems - a router providing the interfaces for the different devices - IP cameras, IP / POTS gateway - for telephone connection, interface adapters for switching on medical equipment a field optical cable is used - single mode or dual mode.

If a higher speed is required for connection to the second level, a field optical cable - single mode or dual mode - can be used.

3. Proposal for Variants of Communication Networks, between Hierarchically Located Finite-State Automatons Used in Army Hospital Units.

The authors propose scenarios as options for communication services between hierarchical FSAs used in military hospital units, as follows:

1. Is proposed a variant of the Communication Network, for using the resources to perform the tasks in Role 1:

A /. Transmission of data from electronic diagnostic equipment (eg digital stethoscopes, etc.) operating in Role 1 to higher levels of medical care (eg Role 2);

B /. Teleconsultations;

IN /. Video connection;

D /. Voice telephone services;

D /. Radio communication with vehicles evacuating patients.

2 Is proposed a variant of the Communication Network, for using the resources to perform the tasks in Role 2:

Services related to the transmission and reception of information for telemedicine purposes, such as:

A /. Digital ECG information;

B /. Ultrasound diagnostics;

C /. Vital signs monitor;

D /. Digital X-ray scanner;

E /. Video teleconferencing / surgical assistance /;

F /. Teleconsultation and voice telephone services;

3. Is proposed a variant of the Communication Network, for using the resources to perform the tasks in Role 3:

A /. Ultrasound diagnostics;

B /. Digital X-ray scanner;

C /. Vital signs monitor;

D /. Video teleconferencing / surgical assistance /;

E /. Teleconsultation;

F /. Digital microscopy

4. Is proposed to use the following forms of Telemedicine for the implementation of tasks such as "Final treatment of patients until their complete cure of the disease ":

A /. Ultrasound diagnostics;

B /. Digital X-ray scanner;

C / .Video teleconference / surgical assistance /;

D /. Vital signs monitor;

E /. Teleconsultation;

F /. Digital microscopy;

5. For successful functioning of the information services between the separate units - Role1, Role2, Role3 and Role4 it is necessary to ensure sufficient bandwidth of the communication channels.

We assume that for the different levels of medical care the number of users is:

Role 1 - users of voice services - 9; users of data services - 3; video users - 6;
Role 2 - users of voice services - 38; users of data services - 15; video users - 8;
Role 3 - users of voice services - 100; users of data services - 42; video users - 15;

The required minimum bandwidth of the communication channels, calculated according to an accepted methodology, is:

Role 1 - others: 0.85 Mbps;
Role 1 - Role 2: 2.8 Mbps;
Role 2 - Role 3: 3.78 Mbps;

6. The communication connectivity at the different levels of medical care can be realized in the following ways:

A. For connection with vehicles for transport and evacuation of victims. This connection can be realized through "wearable" and "movable" Short waves / Ultra short wave - radio stations. Broadband digital radios can also be used, allowing voice and data transmission. We propose to install on vehicles the so-called "movable" radio stations with a power of 20 W, which provide a connection with the "wearable" stations. They usually operate in the frequency range from 30 MHz to 512 MHz. These stations operate in public and classified mode and have the ability to transmit GPS coordinates.

B. The provision of digital voice services between the different levels may be via copper field cables (2W / 4W), optical field cables or digital radio relay channels.

C. To ensure the data transfer necessary for the operation of applications such as: correspondence - e-mail, file transfer, video image exchange, remote access to medical equipment, video conferencing, high resolution video cameras, etc. it is necessary to build broadband communication channels. The realization of broadband digital channels can be achieved by optical cable or digital radio relay channel.

4. Proposal for management of the communication system in telemedicine and cybersecurity in the context of GDPR

One possible option for medical data communication between the teams in the vehicles and those in the points Role 1, Role 2, Role 3 and Role 4, is to provide it through mobile and portable terminals, such as digital radio stations or the so-called TETRA systems.

The TETRA communication system is a cellular system for terrestrial communication on a radio channel. Through an advanced feature set, it provides reliable voice and data transmission over a digital radio channel.

TETRA is an acronym for TErrestrial Trunked RAdio and is an ETSI standard for defining communication interfaces to various voice and data transmission systems. Unlike the standard PMR (Private Mobile Radio) system, which operates in half-duplex mode, TETRA is a trunk system and it provides two-way communication (full duplex), and through a digital control channel, communication channels are automatically provided between groups of users or between two separate users.

TETRA terminals have an additional interface to other voice (or data) communication systems, such as the telephone network (PSTN), to mobile networks (GSM / UMTS / LTE). For example a call to another radio station or to a subscriber of the telephone network can be made via a TETRA terminal.

In practice, the protection of the information transmitted on the radio channel is carried out through various methods of encryption / decryption. The encryption of medical data in the specific case under consideration is a method of protection in which the information is encrypted at the source and can be accessed (or decrypted) only for a user who has the correct

encryption key. Encrypted medical data is illegible to users who have gained access without permission [5].

The protection of transmitted medical information through encryption algorithms can be divided into two main groups - symmetric and asymmetric algorithms. In symmetric algorithms, the same key is used for both encryption and decryption of messages. Typical symmetric algorithms are DES, 3DES and AES.

In asymmetric algorithms, the encryption and decryption of the medical message will be performed with a pair of keys - public and private, the encryption is performed with the public key, and the decryption - with the private key of the recipient. Typical asymmetric algorithms are: Diffie-Helman, RSA, DSA and others.

The differences between the two types of algorithms in the organization of the proposed communications between the points Role1, Role2, Role3 and Role4 are:

1. Symmetric algorithms:

• only one key is needed, both for encryption and decryption;

• the size of the encrypted text is the same or smaller than the original text (before encryption);

• the encryption process is faster;

• can be used when it is necessary to transmit larger volumes of medical information;

• Symmetric algorithms can only ensure the confidentiality of medical information.

2. Asymmetric algorithms:

• two keys are required - one for encryption and another for decryption;

• the size of the encrypted text is the same or larger than the original text;

• the encryption process is slower than with symmetric algorithms;

• can be used when larger volumes of medical information are transmitted;

• asymmetric algorithms provide not only confidentiality, but also authenticity and the so-called "Non-rejection" / certification;

Common symmetric methods for encrypting information messages that can be used to transmit medical data in the specific network proposed for construction are:

• Data Encryption Standard (DES) - uses a 56-bit data encryption key. DES is considered insecure for use in many applications due to the 56-bit key size;

• Triple-DES - uses three consecutive DES operations, thus providing more reliable encryption than DES. The algorithm is considered to be practically secure;

• Advanced Encryption System (AES Advanced Encription System). Uses 128, 192, or 256 bits to encrypt and decrypt data in 128-bit blocks;

Asymmetric methods for the proposed communication solution for health data transmission between Role1, Role2, Role3 and Role4 can be encryption via a key pair (public key and private key).

Messages will be encrypted using the recipient's public key and can only be decrypted with the recipient's private key. This method eliminates the need for the sender and recipient to share secret keys over a secure channel. All communications use only public keys, and the private key is not transmitted or shared. Examples of systems that use this type of technique include:

- RSA - used for both encryption and authentication;
- PGP (Pretty Good Privacy) - mainly used to protect e-mail;

When building and configuring secure information channels between Role 1, Role 2, Role 3 and Role 4, the most common approach can be used, which is VPN (Virtual Private Network) configuration.

Encryption methods should also be used in carrying out the proposed communication for the transfer of medical data. In this case, the main purposes of encryption will be achieved as a method of converting data from a readable format to a format that does not allow them to be read (encoded format or ciphertext). Encrypted data can only be read or processed after it is decrypted using a decryption key or password. Only the sender and recipient of the data should have access to the decryption key.

Of course, when choosing this approach, it should be borne in mind that data encryption can be vulnerable to attack from several directions:

1. It is possible to access encrypted content by using computer programs to break encryption algorithms. Stronger encryption methods require a huge amount of computing resources to break the key;

2. In the transit of medical data over the communication network, such data may also be vulnerable. Devices through which data transits can be infected by malicious software that, figuratively speaking, eavesdrops on them as they are transported through the networks;

3. Encrypted data may be compromised both by malicious software installed on a storage device and by unauthorized users who have gained access to user passwords or keys.

Nevertheless, data encryption generally prevents hackers from gaining access to sensitive information and is essential for building most security strategies. However, it should be immediately noted that the information security strategy should not rely solely on encryption. The most common encryption methods that should be analyzed for appropriate implementation are:

DES (Data Encryption Standard)

DES is an outdated symmetric encryption algorithm - the same key is used to encrypt and decrypt a message. DES uses a 56-bit encryption key (8 bits are for parity control and reduces the full 64-bit key) and encrypts data in 64-bit blocks. Nowadays, these dimensions of the key and the blocks are insufficient and are not recommended it as a suitable protection for the transfer of medical information, especially in the army.

Triple DES

Until recently, 3DES was the standard symmetric encryption algorithm. Triple DES uses three separate keys with 56 bits each. Thus, the total length of the key increases to 168 bits, but according to most experts, the effective power of the key is only 112 bits. It can be used to protect the medical information exchanged between Role1and Role2.

RSA

RSA is a common asymmetric public key encryption algorithm. It uses a key pair: a public key to encrypt the message, and a private key to decrypt it. It can be used to protect the medical information exchanged between Role 1, Role 2, Role 3 and Role 4.

Blowfish and Twofish

Blowfish is a symmetric cipher that divides messages into blocks per 64 bits and encrypts them one by one. Blowfish is an algorithm inherited from the Twofish method and is still effective. Twofish is a method based on the use of a 256-bit key. Twofish is used in many software and hardware solutions. It is fast, freely available and not protected by patents. It can be used to protect the medical information exchanged between Role1, Role2 and Role3.

AES (Advanced Encryption Standard)

This encryption algorithm is a standard currently accepted by many organizations. AES works well in 128-bit format, but can use 192- and 256-bit switches. AES is considered

resistant to any attacks. We recommend it to protect the medical information exchanged between Role1 and Role4.

5. Conclusion

In conclusion, the model proposed by the authors as variants of communication networks between medical system units in Role 1, Role 2, Role 3 and Role 4 according to NATO standards, includes software and hardware, through secure data transfer between digital devices, workstations and central storage server considered as Finite-State Automatons. In addition all PACSs (Picture Archiving and Communication System) are DICOM (Digital Imaging and Communications in Medicine Standard) compliant.

Main functions, systems, software applications, devices and data as: Device programming, Image compression module, Statistics module (complete statistics by devices, number of patients, number of images, used contrasts, etc.), Telemedicine module (possibility to view tests outside the hospital with access control), Connection with hospital information system), Automated system for recording on external media (CD / DVD), System for import of tests from other hospitals, power supply units (UPS), Specific technical parameters, specific data applications in the health institution, data about the available equipment, the type and volume of the examinations, the patient flow, the specialists and their level of qualification are protected in compliance with GDPR.

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Build Up of a Suplementary Communication Channel between Hierarchically Located Finite-State Automatons and General Data Protection Regulation Cybersecurity

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Abstract. The paper reviews the need to build an additional shortwave channel as a backup communication. The connection is made point to point as the transmitter and receiver are devices in the form of a Finite-State Automatons (FSA). The methodology of calculating and building a suitable antenna based on public available software is examined and experienced. The information about the critical frequencies is taken from the Bulgarian Academy of Sciences - Geophysical Institute. A way about information protection in order to apply General Data Protection Regulation is also suggested, as type of encryption and using a password.

Keywords. Shortwave, Antenna, Frequency, Finite-State Automatons (FSA), GDPR, Cybersecurity.

1. Introduction

The choice of ways of communication should not be limited to a single channel. It is often necessary to use two or more ways of communication. This will increase the security of the transmission and correct the shortcomings of the other channel. Determining the risk of permanent interruption of communication, provision should be made for communication in all possible situations, especially in the case of disasters and accidents or actions on the battlefield. This also applies to the hierarchical transmission of data between two devices (state machines) even if only by voice. In this sense, short waves (SW) are extremely reliable for transmission as a last resort and at any cost. Designed for monophonic broadcasting with amplitude modulation for SW in the frequency range 2300 - 26100 kHz (2.30-26.10 MHz) shortwave cover long distances mainly at night, due to its reflection in the upper layers of the ionosphere. This allows shortwave to be used for broadcasts on international communications. The implementation of the shortwave emission as point-to-point communication allows for transmitter or receiver to be used different stations and equipment, which are essentially Finite state machines (FSA). Because short waves propagate freely in space, there is always the danger of being intercepted and manipulated. Therefore, protection before the transmission of the transmitted data by all known means is of highly importance.

Shortwave (SW) covers the range from 10 m to 160 m. The surface wave of the SW can cover several tens of kilometers. The main mode of broadcasting of SW is through the spatial wave between the earth's surface and the ionosphere. When reflected once from the ionospheric layer F, the radio wave covers 3500-4000 km. In the case of a single reflection from the ionospheric ES layer, the limit distance is 2000 km. In the case of repeated reflection from the ionospheric layer SW can provide radio exchange between random points on the earth's surface. The shortwave range makes it possible to achieve a high directional action of the antenna (<300). SW range allows to provide radio exchange between mobile objects

(vessels, aircraft, and spacecraft). The value of the maximum frequency that can be used for radio exchange by a single reflection from a layer with a certain ion concentration is called the Maximum Applied Frequency (MAF). Accordingly, the uptake of SW increases sharply during the day. The lower the frequency, the greater the uptake. During the day, SW is used in the range of 10 to 30 m. At night, radio exchange can take place on SW in the range of 30 to 100 m. In order to carry out the SW radio exchange, it is necessary and sufficient to fulfill two conditions: the frequencies used for communication must be lower than the MAF, ie. the wave must be reflected from the higher ionized region.

The short waves broadcast mainly in the form of an Ionospheric Wave (IW). In this range the earth's surface is semi-conductive and the attenuation for the Ground Wave (GW) is large. GW subsides at several tens of kilometers. When using IW, short waves can be used for long-distance communication by reflection in the ionosphere. Ionosphere absorption decreases with increasing frequency (as opposed to terrestrial absorption) [1, 2].

2. Methodology for Determining the Shortwave Characteristics

The degree of absorption is characterized by the multiplier $e^{-\delta\lambda}$ which enters the expression for the voltage field, where δ is coefficient of absorption and λ is elements of the wave trajectory. The ionosphere is an inhomogeneous medium, therefore the value of the coefficient δ at different points of the trajectory is different. The total absorption along the entire trajectory is determined by the integral expression

$$e^{-\int \lambda \delta \lambda} \tag{1}$$

In the expression, the integral must be extend along the entire path that the radio wave passes in the ionosphere.

The absorption coefficient is determined as:

$$\delta = \frac{\omega}{c}.p = \frac{2\pi}{\lambda}.p \tag{2}$$

where: ω -circular frequency, $\nu = \frac{c}{n}$ is speed rate and n is number of reflections;

$$\mathrm{P} = \sqrt{\frac{\varepsilon_u + \sqrt{\varepsilon_u'^2 + (60\lambda\sigma)^2}}{2}} \tag{3}$$

ε_u' is dielectric permeability of the ionized gas.

$$\varepsilon_u' = 1 - 3190.\frac{N}{\omega^2 + \vartheta^2} \tag{4}$$

$$\sigma_u = 2{,}82.10^{-8}.\frac{N}{\omega^2 + \vartheta^2} \tag{5}$$

σ is electronic concentration, i.e. the number of free electrons in l m^3 air;

ϑ is the number of electron strikes with neutral molecules in l sec;

The values of N and ف in the different regions of the ionosphere are such that the displacement current density is significantly higher than the conductivity current. This allows the SW range to be saved that:

$$60\lambda\sigma_{u} << \varepsilon_{u}^{'}$$

$$p = \frac{60\lambda\sigma}{2\sqrt{\varepsilon_{u}^{'}}} \tag{6}$$

$$\delta = \frac{60\lambda\sigma}{\sqrt{\varepsilon_{u}^{'}}} \tag{7}$$

$$\varepsilon_{u}^{'} \approx 1 - 80{,}8.\frac{N}{\int^2} \tag{8}$$

The value of the formula is obtained taking into account that in the range of KB $\omega^2 \gg \upsilon^2$ and υ can be neglected. Moreover, for oblique rays $\varepsilon'_u \approx 1$ and only at the point of reflect i.e. at the top of the trajectory $\varepsilon'_u < 1$. Therefore:

$$\delta = \frac{60\pi\sigma}{\sqrt{\varepsilon_{u}^{'}}} \approx 1{,}35.10^{-7}.\frac{N\vartheta}{f^2}, \qquad \left[\frac{1}{m}\right] \tag{9}$$

The resulting expression for the absorption coefficient according to this formula has the following meaning:

a) The absorption coefficient in the ionosphere does not increase, but decreases with frequency and it is inversely proportional to the square of the frequency.

b) At a given frequency, the degree of absorption is determined by the product of the electron concentration and the number of strikes.

Experiments of measurements in the ionosphere show that in the daytime the maximum electron concentration and the number of shocks have certain values

At these altitudes from the atmosphere, the number of shocks is commensurate with the circular frequency and the value in formula (5) and (9) cannot be ignored. This shows that the absorption coefficient does not change inversely proportional to the square of the frequency. However, it varies with frequency, but not to the same extent as in formula (9)

In order to make the radio connection of SW it is necessary:

(a) The frequency used shall be less than the maximum frequency specified for the given line and the given ionization of the reflecting region.

b) At normal transmitter and antenna powers, the field voltage at the point of reception should be sufficient for reliable signal reception.

When considering the conditions for the spread of SW, it should be borne in mind that in summer days with maximum solar activity, the ionization can reach a high degree in the daytime.

The design of SW radio routes is radically different from the design of radio connections in other bands due to the strong diurnal and seasonal changes in the conditions for propagation of radio waves. The main task of the design is to find the Optimal Operating Frequency (OOF) for different parts of the day. In order to find the OOF, the diurnal course of the Maximum Applicable Frequency (MAF) and the Lowest Applicable Frequency (LAF) for the given route must be determined. The OOF should not be lower than the LAF, because the attenuation will be unacceptably high. The OOF should not be higher than the MAF, because

the rado waves will not be reflected by the ionosphere. OOF is chosen to be 15% lower than the MAF or OOF = 0.85 MAF.

In addition, the broadcasting of SW is characterized by phenomena such as: echo, fading, zone of silence, etc., which may have a certain significance for radio communication and must be taken into account when designing radio lines in the SW range.

Calculation of the radio line is performed on the basis of application of the methodology for calculation of the design parameters of the specific HF radio line or SW radio range.

3. Application of the Methodology for Design Parameters of the Specific Shortwave Line

3.1. Choosing an antenna to build a shortwave line

Each signaling system consists of three main parts, a transmitting device, a receiving device and an intermediate unit. In our opinion, for the construction of an additional communication channel, the most important thing is to build the intermediate unit, ie the antenna. The choice of suitable antennas must take into account several factors:

- the set operating frequency range;
- the technical data radio station and the antenna selection diagram (for example quite used in the army radio station as AN / PRC 150C is chosen)
-the length of the radio line.

Taking into account the above factors, we choose the receiving and transmitting antennas as follows:

- for the transmitting radio station - V-shaped antenna 2x46m - for operation in the subband 10 - 30 MHz raised on the mast 12m;
- for the receiving radio station - V-shaped antenna 2x46m - for operation in the subband 10 - 30 MHz raised on the mast 12m;

The V-shaped antenna is used for long-distance operation in the propagation of ionospheric waves. Determination of the field strength created by the ionospheric wave at the point of reception

The field strength at the receiving point is quite difficult to calculate for the following reasons: In the most general case, the field at the receiving point is created as a result of the interaction of all rays that have had a different number of reflections. As a result, the field voltageis calculated by the formula:

$$Eg = \sqrt{\sum_{i=1}^{m} Eg_i^2} \tag{10}$$

where: m is the number of reflected rays not exceeding 3;

The field strength for each of the interacting rays is determined by the formula:

$$Egi = \frac{222\sqrt{PkwD}}{4r}(1+R).R^{n-1}.e^{-\sum_{j=1}\Gamma_j}, \qquad \left[\frac{m\ v}{m}\right] \tag{11}$$

where: r - the distance between the transmitter and the receiver measured on the ground surface;

D - coefficient. the directional action of the antenna;

R - modulus of the coefficient of reflection from the earth's surface;

N - number of reflections from the ionosphere;

Γ_j - coefficient. of absorption in j layer.

The number of reflections for the first rays is determined by the formula:

$$n = r / 4000 = 1710/4000 = 0.0455 \quad (12)$$

as the number obtained being rounded to the nearest whole number, in this case r = 0 = 0455

The number is closer to the integer 0, from which it follows that for this distance there will be no reflection from the ionosphere, or the connection will be made entirely at the expense of the ground wave. The absorption coefficient at the i-th height is determined by the formula:

$$\Gamma j = \Gamma d + \Gamma e + \Gamma f1 + \Gamma f2$$

For this it is necessary to calculate the value of the angle of incidence of the wave at the lower end of the ionosphere φ_0

$$tg\varphi_0 = \frac{\alpha.\sin\theta}{h_g + \alpha(1-\cos\theta)} \quad =1710/222.4=7,688 \quad (13)$$

where:

α is radius of the ground (= 6.37.106 m);

θ is geometric angle;

h_g is height in the area

Determines the field strength created by the ground wave based on the work of Sommerfeld, Schuleikin and Van der Paul, convenient calculation formulas are given, which are later summarized and graphically presented. In their decision, the field intensity at the receiving point is defined as:

$$E = \frac{245\sqrt{P[kw]}G}{r[km]} F \quad (14)$$

The attenuation factor F is represented as a function of the quantity χ called the normalized distance. For vertical polarization it is calculated from the expression:

$$\chi = \frac{r}{S} = \frac{\pi r}{\lambda}\left|\frac{\varepsilon^2}{\varepsilon - 1}\right| \quad (15)$$

Where S is called the scale of distances. The distances for which the Shuleikin-Van der Pol method can be used are limited by the sphericity of the Earth and are determined by the approximate expression (for m): r_{max} [km] <λ [m] i.e. in this case r_{max} [km] <1710 [km]

The attenuation factor F with sufficient accuracy for engineering calculations can be determined by the formula of the Russian scientist V.F. Fok and is given by the formula:

$$F = 2\sqrt{\pi\chi}\left|\sum_{s=1}^{\infty}\frac{e^{jxt}}{t_s + q^2}\cdot\frac{W_2(t_s + y_2)}{W_2(t_s)}\cdot\frac{W_2(t_s + y_2)}{W_2(t_s)}\right| \quad (16)$$

Here q depends on the wavelength and soil parameters ε_r and σ, and W_2 (t) is an Airy function. For some cases, the formula is simplified, ie. at long distances, when the condition r_{max} [km] <λ [m] is not fulfilled, the receiving antenna can be considered to be in the shadow area. As r increases, the order for F mentioned above becomes faster and faster, and it is sufficient to take only the first term of it, i.e.

$$F = 2\sqrt{\pi x}\left|\frac{e^{fxt_s}}{t_s + q^2}\right|$$

Only the distance r, the frequency f and the soil parameters ε_r and σ participate in this expression. This makes it possible to draw graphs according to this formula. For transmitter power 1KW and G = 1.5, which coincides with the data from the project reference and. In this case, the effective value of the field strength E is derived from the expression:

$$E = \sqrt{\frac{P[kw].G}{1,5}}.10^{\frac{E_0[db]}{20}}, \quad \left[\frac{\mu V}{m}\right] \tag{17}$$

Where Eo is read from the indicated graphs, and its value for λ = 148.148 m and distance 1710 km is E_0 40 dB. From here, replacing my known values, we get:

$$E = \sqrt{\frac{1[kw].1,5}{1,5}}.10^{\frac{40[db]}{20}} = 316, \quad \left[\frac{\mu V}{m}\right] \tag{18}$$

The resulting field strength at the point of acceptance contains the absorption coefficient F, which for European soils is 0.202. Thus, the energy calculation of the radio line is completed.

3.2. Protection of personal data and transmitted information

Almost all currently known ways of information protection can be apply to the chosen method of communication. It is best to provide protection before the message is transmitted via the shortwave radio. Classical encryption and decryption methods can be used. The use of passwords as call signs is also mandatory.

The cryptographic algorithms used can be symmetric cryptographic algorithms - the two parties exchanging information have a pre-acquired, identical key. Asymmetric cryptographic - the two parties exchanging information have two own keys - public and private. They are generated simultaneously by a certain algorithm, and for data encryption it is necessary for the correspondents to exchange their public keys [3].

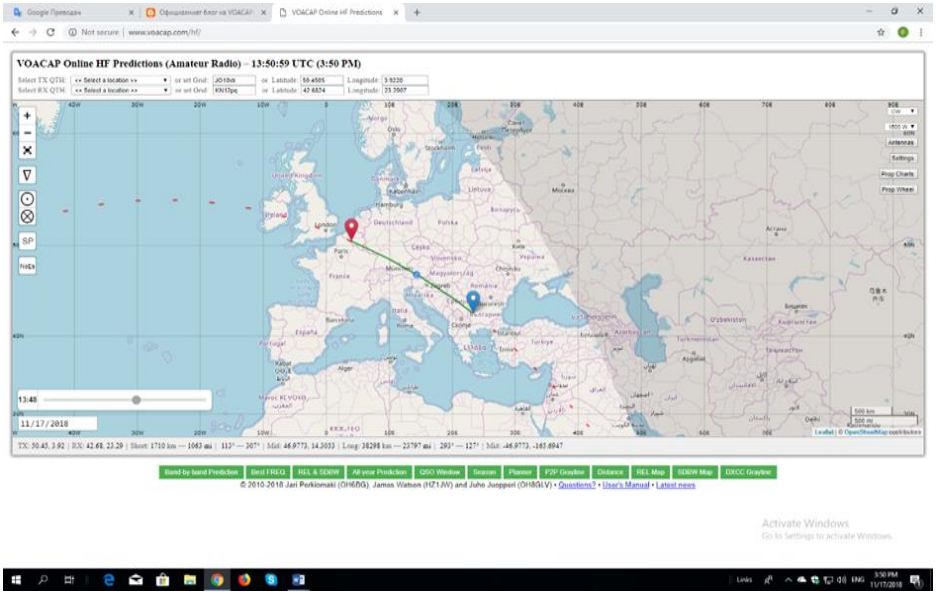
Asymmetric keys differ from symmetric keys in that the algorithms use separate keys for encryption and decryption, while the symmetric key algorithm uses one key for both processes. Because an asymmetric algorithm typically uses longer keys, the cryptographic processing takes longer than the symmetric key algorithm.

As possible modes of operation of cryptographic algorithms could be applied Electronic Code Book (ECB) Mode.

- Cipher Block Chaining (CBC) Mode.
- Cipher Feedback (CFB) Mode.
- Output Feedback (OFB) Mode.
- Counter (CTR) Mode

4. Project Automation and Presentation of the Results

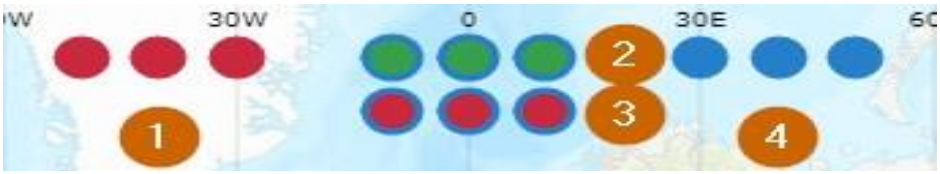
To automate the calculation and properly visualize the results, specialized software for calculating and predicting the propagation of HF ionospheric radio waves is developed by the National Telecommunications and Information Agency (NTIA) and the Institute of Telecommunications Science (ITS) in the United States is used. [4] The two points for transmission and reception, which we set as state machines, are Sofia and Mons Belgium.



The software product can be downloaded free of charge from http://www.voacap.com/, and accordingly it is possible to perform the calculation and visualization online from the same web address. [4]

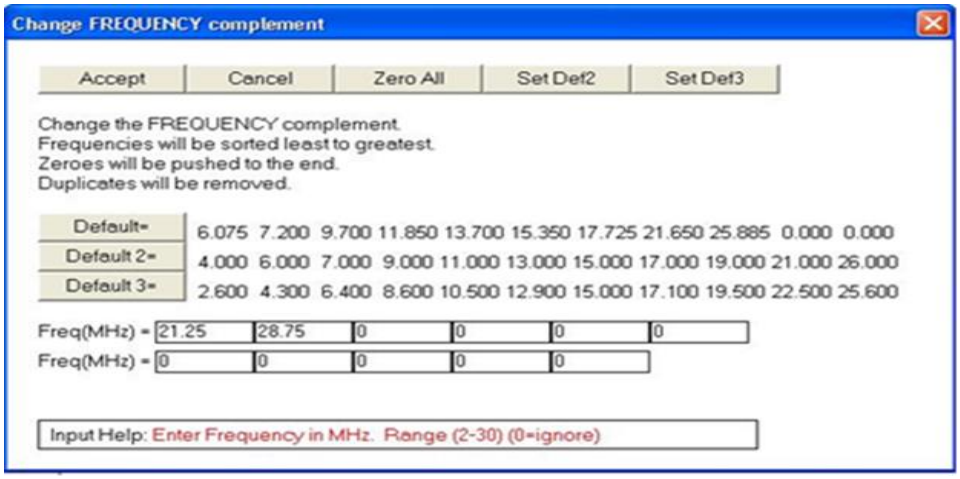
The initial smooth and coordinated entry of the online card for the transmitter (TX) and receiver (RX) is one of the most important design features of VOACAP Online. The red marker indicates the location of the transmitter (TX) and the blue marker indicates the location of the receiver (RX).

The three sections of circles (colored red, green and blue) at the top of the interactive map offer sunrise and sunset times in the transmitter, in the middle (short path (first row) and long path (second row) and receiver respectively in a given day.

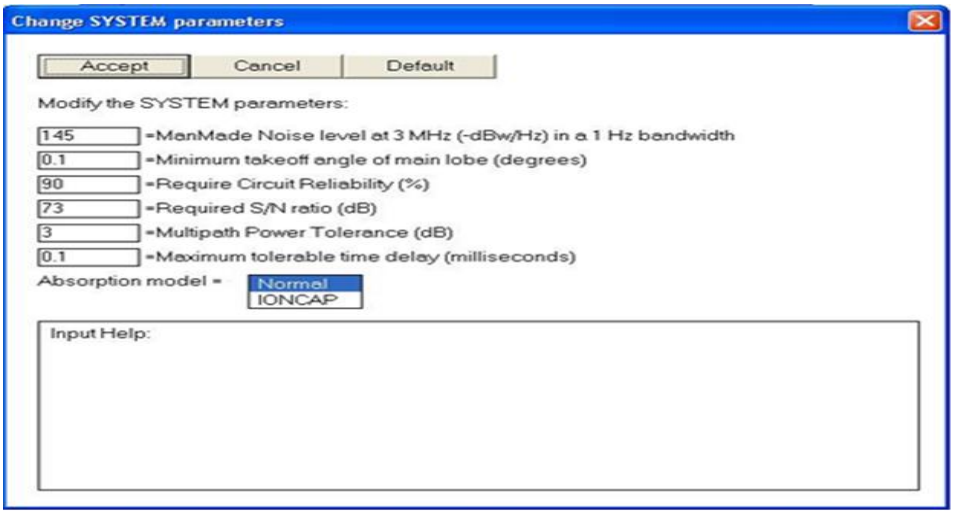


1) Transmitter;
2) Midpoint of the circuit (Short-Path);
3) Midpoint of the circuit (Long.Path);
4) Receiver.

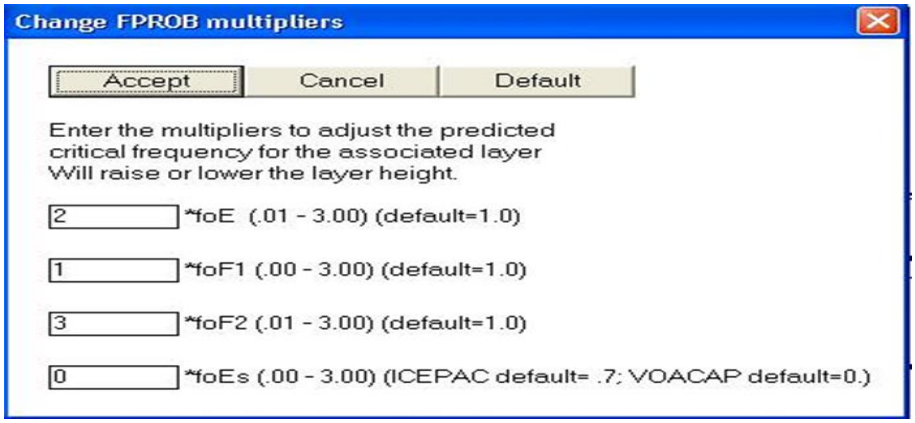
The year (2018) is selected and the time is selected by setting it locally or universally. The month is also determined and the number of sunspots for the selected date is taken into account. Information on the number of sunspots for November 2018 is taken from the address of (National Oceanic and Atmospheric Administration's, USA). The coordinates of the Transmitter and the Receiver are displayed on the map online. The following is the determination of the frequencies:



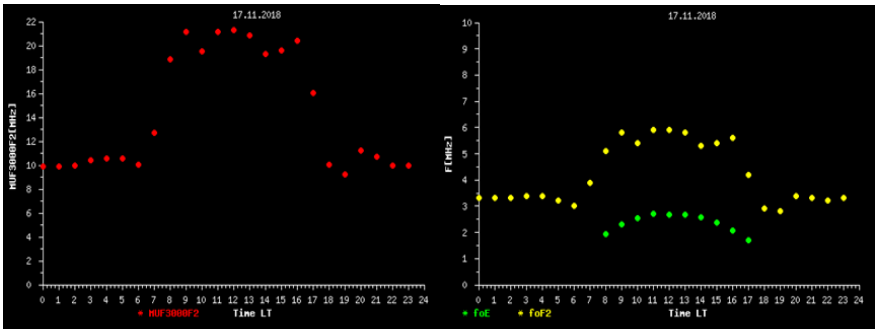
The requirements for the quality of communications can also be selected by default, as shown:



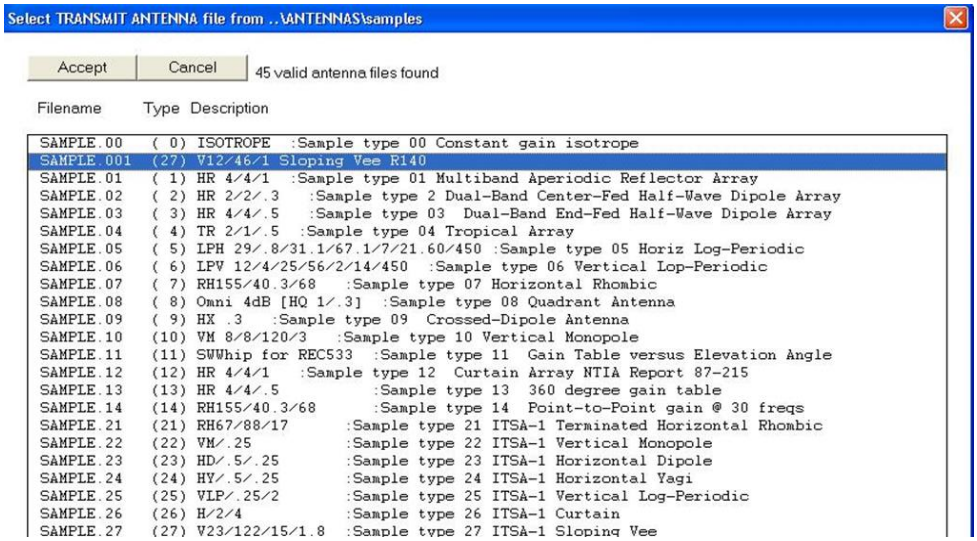
The following is the setting of the critical frequencies for the ionospheric regions (Fprob). In this case, the regions E and F2 are of only importance for the calculation of SW ionospheric waves.



The information about the critical frequencies in the fields E and F2 is taken from the Bulgarian Academy of Sciences - Geophysical Institute.

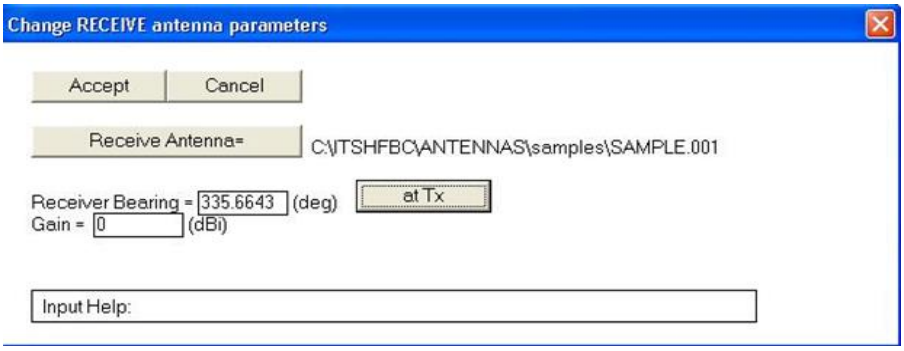


To select an antenna, it is necessary to select an antenna from the existing database in the software product or edit the existing ones in the program. For this purpose we start the HFANT program. We choose a V-shaped antenna (Sloping Vee),



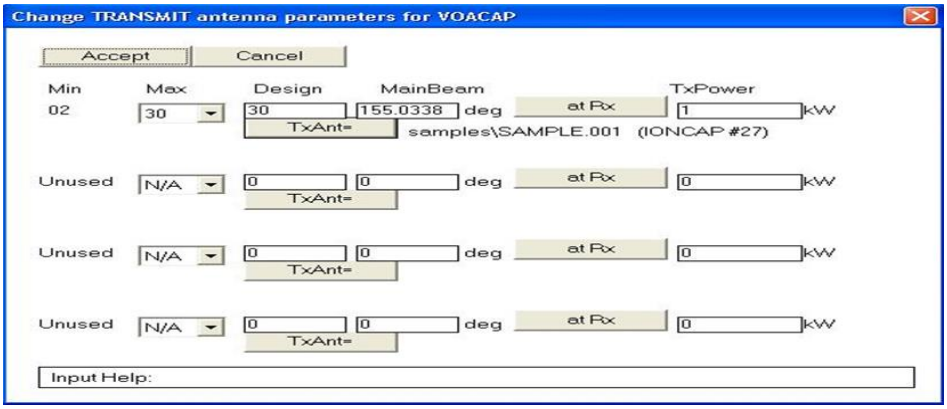
We record the antenna thus created with the corresponding description and name, then in the software product "voacap" we select the thus transmitted transmitting antenna (Tx Antenna). This is the description of the antenna "V12 / 46/1 Sloping Vee R140".

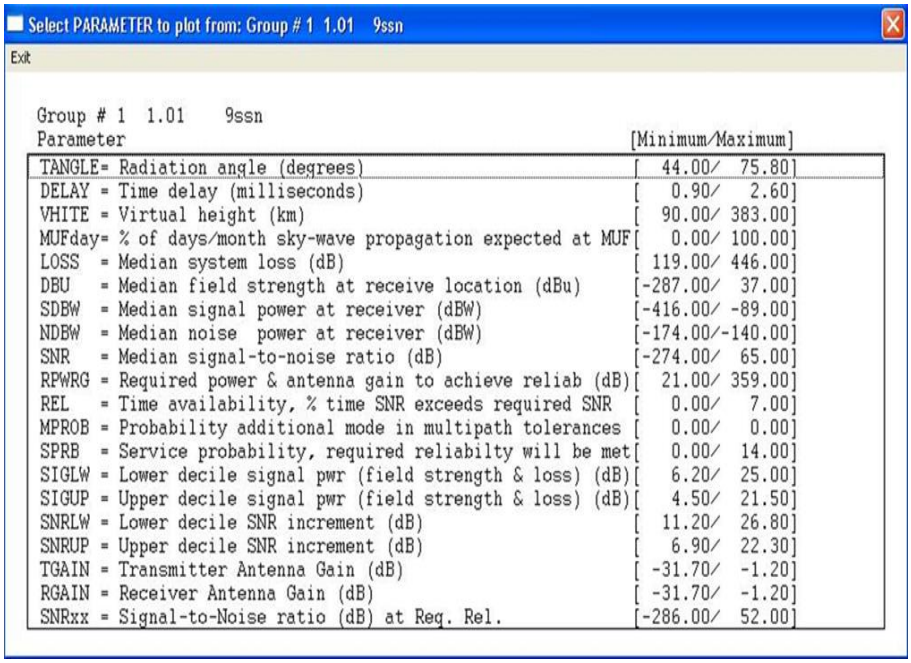
The maximum frequency, the direction of the antenna and the power of the antenna are also determined. The receiving antenna is selected in the same way. The final visualization of the results is done from the menu.

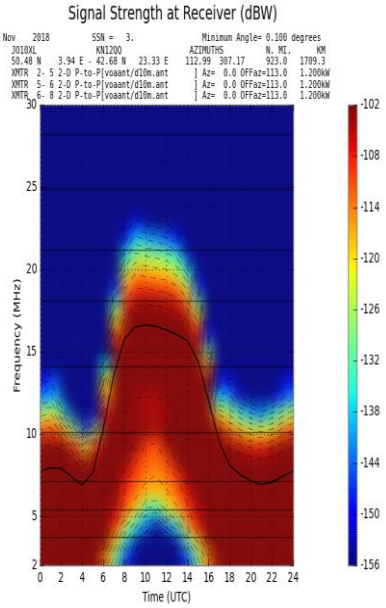


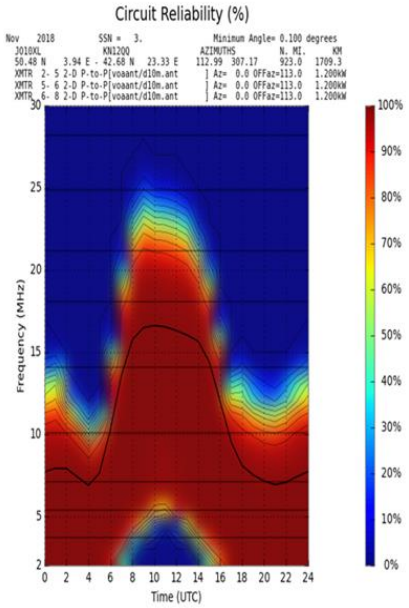
The maximum frequency, the direction of the antenna and the power of the antenna are also determined. The receiving antenna is selected in the same way. The final visualization of the results is done from the menu: **Run>Graph**

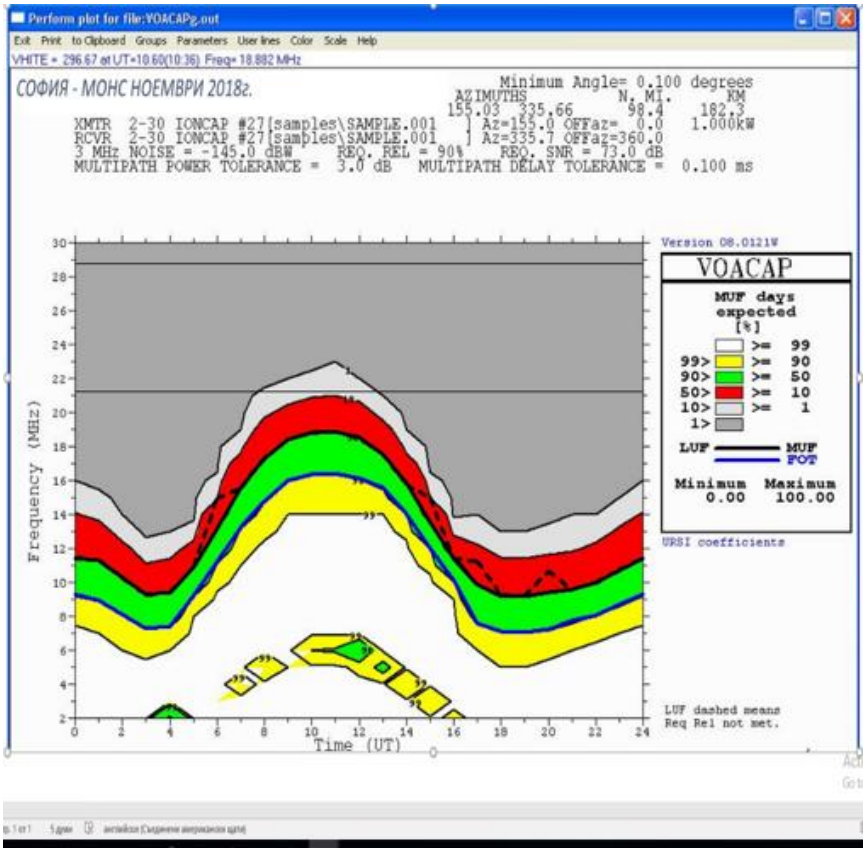
After the calculation from the software product, a screen for selecting a specific parameter for visualization is displayed






Signal Strength at Receiver (dBW)
Frequency (MHz)
Time (UTC)


Circuit Reliability (%)
Frequency (MHz)
Time (UTC)


Perform plot for file:VOACAPg.out
Exit Print to Clipboard Groups Parameters User lines Color Scale Help
WHITE = 296.67 at UT=10.60(10:36) Freq= 18.882 MHz
СОФИЯ - МОНС НОЕМВРИ 2018г.
Minimum Angle= 0.100 degrees
AZIMUTHS N. MI. KM
155.03 335.66 98.4 182.3
XMTR 2-30 IONCAP #27[samples\SAMPLE.001] Az=155.0 OFFaz= 0.0 1.000kW
RCVR 2-30 IONCAP #27[samples\SAMPLE.001] Az=335.7 OFFaz=360.0
3 MHz NOISE = -145.0 dBW REQ. REL = 90% REQ. SNR = 73.0 dB
MULTIPATH POWER TOLERANCE = 3.0 dB MULTIPATH DELAY TOLERANCE = 0.100 ms
Version 08.0121W
VOACAP
MUF days expected [%]
>= 99
99> >= 90
90> >= 50
50> >= 10
10> >= 1
1>
LUF MUF FOT
Minimum 0.00
Maximum 100.00
URSI coefficients
LUF dashed means Req Rel not met.
Frequency (MHz)
Time (UT)

As can be seen from the figure, the software product has the ability to visualize a large number of parameters of the radio path, as for each individual parameter is displayed and the maximum usable frequency (MUF - Maximum Usable Frequency), the lowest usable frequency (LUF Lowest Usable Frequency) and optimal possible frequency (FOT Optimum Traffic Frequency). Each of the parameters is displayed on the graph which shows the frequency range from 0 to 30 MHz with raised set operating frequencies (22.25 and 28.75) and the operating time 0-24 h. In the right part of the working window the information about the elected parameter is displayed in different color.

From the program and the graph at the set parameters of the radio track and when using the set frequency band and the selected antenna from the composition of the radio station AN / PRC 150 C - the maximum frequency used during the day between 08:00 to about 14:00 is in the range 17-18.8 MHz, as the possibility for construction of the radio line at the set parameters in the working range is between 1/10%.

5. Conclusion

As seen from the calculations made with the set parameters as well as restrictions of the radio line Sofia - Mons and if quite used in the army radio station as AN / PRC 150C is chosen, it can be concluded that in the set frequency band f = 21.25MHz - 28.75 MHz, for the period November 2018 the situation for radio communication is not quite favorable.

Regardless of this conclusion, in our opinion, the connection should be built, if there is no possibility for other communication. When it comes to rescuing people in disasters, accidents or on the battlefield, a bad connection is a hundred times better than the missing one.

Also, in communication with protection of personal data, in addition to the proposed ones, it is good to carry out some organizational actions. They can be procedural actions which are expressed in personnel management, physical security of the stations, as well as keys and encryption devices, stored in secure rooms with controlled access. It also is mandatory to build a system for response to violations and recovery.

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Personnel Material Motivation and Its Effect on Enterprise Economic Processes

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Abstract. The indicators system characterizing the personnel financial motivation and enterprises economic processes is improved. These indicators unlike existing fragmentary indicators take into account wages efficiency indicators such as profitability / yield payroll, the cost of wages and wages level (in total production costs) next with the established directions of productive resources usage for quantitative and qualitative evaluation of the state of these phenomena at the macro level. The developed methodical approach to the calculation of personnel material payouts involves the determination of additional pay on the bases of proposed labor contribution rate, which takes into account labor costs without the use of invariant scales and size of incentive and compensation payments by a corresponding coefficient whose value depends on value of certain assessment factors, which makes possible to create conditions for wages part objective formation.

Keywords. Enterprise economic processes, Management decisions, Material payments, Payment of labor, Personnel material motivation efficiency, Production resources, Set of interrelated phenomena of economic character.

1. Introduction

The current economic situation in Ukraine requires companies developing new approaches to management, the use of which should ensure not only survival, but also improving competitiveness. One aspect of this task is staff financial motivation, as salary is most of the total income of industrial enterprises staff and is one of the most important places in the formation of motives for effective work.

However, the economic activities of Ukraine machine-building enterprises indicates insufficiently effective stuff motivation, that is accompanied by the lack of compliance of stuff motivation to maximize the results of their work, and reduction in real salary. Under these circumstances, the enterprise policy in the staff financial motivation should lead to the rational use of productive resources through the system of more advanced methods, the result of which is to increase the level of development of enterprise economic processes.

2. Analysis of the recent research and problem definition

Investigation of personnel motivation as a component of enterprise management is highlighted in the papers of such scientists: Volgin M.O. [1], Doronina M.S. [2], Yeskova O.L. [3-5], Kulikov G.T. [6-7], Semikina M.V. [8-9] and many others. Fundamental bases for studying various aspects of economic processes in the enterprises activities are considered in the papers of Kalinina A. E. [10], Savitskaya G.V. [11], Popovych P. Ya. [12], Fayer O.V.

[13], Budzishevsky S. [14] and others. Analysis of scientific publications and business practices indicate the need for proper methodological support for effective material motivation.

3. Research results

The systematization of existing approaches to the definition of the essence of material motivation of the personnel makes possible to consider it as a source of newly created value of the enterprise and personnel income on the basis of the establishment of forms and sizes of wages, dividends payment. The paper substantiates the interrelation of the categories defining the influence of personnel motivation on the corresponding object. The starting point is the goals, as well as the setting of tasks for which the methods of personnel material motivation can be used. In this case, the main effect of the method is determined by compliance with the principles of material motivation. The method of motivation which is chosen and used in this paper contributes to direct or indirect influence of management activity on the enterprise final results.

On the basis of the development of theoretical positions in the direction of the study of the enterprise economic processes, it is proposed to consider them as a set of interrelated phenomena of an economic nature to achieve a certain result by transforming the "inputs" through the resources usage in the "outputs". Based on this definition, "input" is represented as a motivational impulse, economic processes as directions through which the transformation of "inputs" into "outputs", and the final result of the enterprise activity is "output". This approach is oriented on considering economic processes as ways of ensuring the final results of enterprises economic activity on the bases of usage of productive resources (capital, material, labor, financial, information, innovation, management).

In accordance with the task of indicators increasing that provide the enterprises results and staff salaries size, the organizational and economic principles of the formation of effective personnel material-based motivation, which involve three stages:

1. analysis of the status of staff material motivation effectiveness;

2. development of decision for increasing the influence of material motivation on the enterprise economic processes;

3. adoption and implementation of the decision.

The identified stages are the theoretical preconditions for the development of methodological support for the implementation of the company's motivation policy.

The system of indicators was developed for assessing the effectiveness of staff material motivation and productive resources utilization; the level of influence of personnel material motivation on the aggregate of the phenomena of economic character of the enterprises is determined and estimated.

The formation of the system of indicators for assessing the staff material motivation effectiveness and the development of enterprise economic processes in terms of productive resources usage is carried out on the basis of implementation of the stages of selection of indicators (Fig. 1). The selection of indicators was carried out in the presence of their compliance with certain criteria and taking into account the expert evaluation results.

The evaluation of the personnel material motivation effectiveness was carried out on the basis of the existing system of indicators in the context of substantiation of the relevant criteria and conditions (Tab. 1).

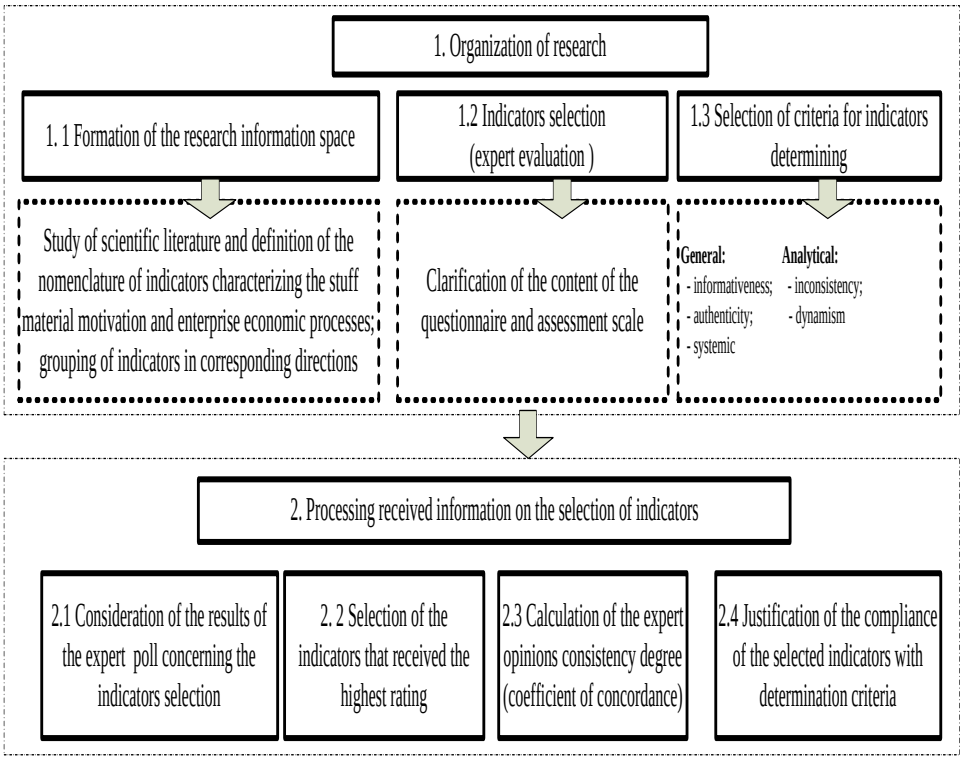

Fig. 1. Stages of the analyzed indicators selection *[developed on the bases 1, 2, 3]*

Table 1. Indicators, criteria for evaluation and conditions for staff material motivation effectiveness

Indicator	Criteria for evaluation	Condition
Yield / Profitability of the wage fund and other material payments to staff	Relevance of the stuff means of motivation to the task of maximization enterprise income / profit	Net income / profit of enterprise should be greater than the value of the salary fund and other personnel material payments
Wage cost index	Compliance with the growth rate of the wage growth rate of labor productivity	The growth rate of labor productivity should be higher than the growth rate of payroll
Specific weight of labor costs in the total enterprise costs	Reduction in the share of labor costs in total production costs	Labor costs should be reduced due to the relative savings of the wage fund in the context of increasing labor productivity and the wage fund per employee

Via cluster analysis (k-means method), the personnel material motivation effectiveness according to the standardized data of 13 machine-building enterprises was estimated. As a result, the following information was obtained (Tab. 2).

Table 2. Interpreting and profiling clusters according to efficiency level of stuff material motivation

Cluster characterizing effectiveness level of staff material motivation	Cluster profile and *k*-medium scale intervals			The number of observations per cluster
	Yield / profitability of the fund of wages and other material payments	The cost of wages	Wage level (in total production costs)	
	[-0,76; 0,46] – low (0,46; 1,68] – average (1,68; 2,9] – high	[-0,76; 0,46] – high (0,46; 1,68] – average (1,68; 2,9] – low	[-0,76; 0,46] – low (0,46; 1,68] – average (1,68; 2,9] – high	
Cluster 1 (high level)	High / High	High	Average	6
Cluster 2 (low level)	Low / Low	Average	Average	18
Cluster 3 (average level)	Low / Low	High	Low	28

On the bases of the analysis, the minority of observations (about 12%) belongs to the first cluster (group) with a high level of staff material motivation effectiveness. Enterprises of the third and second clusters have a low profitability / wage earnings, but the standardized *k*-average values differ by this indicator: the average level of material effectiveness corresponds to the value of 0.127 and the low is -0.76. The index of labor costs, which has a high level for enterprises of the first and the third groups, is almost twice less than the value of enterprises with an average level of staff material motivation effectiveness.

Estimation of values of indicators characterizing the enterprise industrial resources usage was carried out in a similar way, which makes possible to solve a number of main tasks in further research: firstly, to provide the prerequisites for determining the level of influence of personnel material motivation on the enterprise economic processes by reducing the size of the data by classifying the values of indicators for qualitative features of three levels: high, average, low; and secondly, to set priorities in indicators increasing for each group of companies by the level of material motivation effectiveness; and thirdly, to determine the probable state (high, average, low) of economic processes development for each group of enterprises.

Variance analysis is used for determination the level of influence of personnel material motivation on a set of interrelated phenomena of economic nature (economic processes). The level of influence of personnel material motivation is estimated on the basis of the obtained value of the factor variance (σ^2). Subsequently, two-factor variance analysis is used for determination the level of consistent impact of personnel material motivation with each of the economic processes in turn. In this case, the calculated general level of influence has a qualitative estimate, which is obtained by grouping the values of the factorial variance over the established interval scale. The results of the calculations show that about 71% of the indicators characterizing the economic processes of the enterprise, the level of influence of personnel material motivation is low or very low, about 19% is below average and average, about 10% is high or very high.

Reserves of indicators growth characterizing economic processes taking into account the state of the external environment are determined. The methodical approach to making management decisions in the field of material motivation is proposed; the methodical approach to calculating the material payments in terms of wages is presented; the probability of changing the enterprise economic processes development in 2017 year is determined.

Functioning of an enterprise as an economic entity in a market environment requires the consideration of the state of the environment for determination the reserve for increasing the enterprises indicators. A number of steps were implemented for this:

1) gradation of the scale of evaluation of the indicators level by the maps of U. Shuhart with boundaries determination (optimal, warning, control), corresponding to different environment states (active, neutral and passive);

2) determination of optimal values of the corresponding indicators in conditions of different state of the environment by the method of nonlinear programming. In this case, the objective function *y(x)* involves maximum targeting, and as the limitations for each indicator, the values of their boundaries are used: the optimal, warning and control (optimization criteria). The effective indicator is the sales volume per one employee, which characterizes the market situation;

3) the reserves of increase of indicators are determined by comparison of their real and optimal simulated values.

The results of determining the reserves for increasing the indicators for representative enterprises of each group by the level of material motivation effectiveness are: for JSC "Frunze Plant" (1 cluster) are the reserves for increasing the coefficients of inventory turnover (x_6) and rate of unfinished production turnove (x_7), financial stability coefficient (x_8) and financial autonomy coefficient (x_9); JSC "Melitopol Machine Building Plant" (2 cluster) has reserves of the following indicators: coefficient of extensive equipment loading (x_2), coefficient of working time usage (x_5), coefficients of inventory turnover (x_6) and rate of unfinished production turnover (x_7), financial autonomy (x_9); JSC "Kharkiv Machine-Building Plant "Miner Light"(3 cluster) can increase the intensive loading of equipment (x_1), rate of unfinished production turnove (x_7) and the coefficient of working time fund usage (x_5).

The proposed methodological provision of the formation of the influence of the personnel material motivation on the indicators of enterprise final results is based on the substantiation of each of the stages of management decisions implementation.

Thus, at the first stage, the analysis and comprehensive justification of the reasons of problem situation towards the formation of personnel material motivation effectiveness testifies to the possibility and expediency of its solution through the appropriate methods usage.

At the second stage, the peculiarities of the solution are considered in the following way:

1) restrictions are determined – a group of enterprises on the level of personnel material motivation effectiveness: high, average, low.

2) corresponding decisions were generated by distinguishing the general (basic) and specific (separate) methods of personnel material motivation, considered as an alternative impact on each of the provided economic processes.

In the third stage of the adoption and implementation of the decision on the application of appropriate methods of personnel material motivation, first of all, the consideration of criteria is done, namely: the level of influence of personnel material motivation on economic processes on the scale of the intervals of the factorial dispersion must be in the range below the average - very high ([0,351: 0,67]). In addition, it is necessary to take into account the

availability of reserves for increasing the enterprise economic processes indicators under the existing conditions of the external environment.

Decision-making depends on the achievement of the greatest interrelation between the personnel material motivation effectiveness level as a defining limitation and indicators characterizing the investigated processes. Economic-mathematical model solves this problem, namely: for each group of enterprise we select model of linear regression, for which the value of the correlation coefficient is maximal, and the relationship is statistically reliable.

The resulting model has the following form:

1. for enterprises of the fitst group – with high personnel material motivation effectiveness level (JSC "Frunze Plant")

1.1 $y_7 = 30 + 8.7PMV-13.66U-61.35P$ (r = 0.88) (turnover of working capital)
where y_7 - rate of unfinished production turnover;

PMV - profitability of the wage fund and other material benefits;

U - index of labor costs;

P - share of the wage fund in total production costs;

1.2 $y_8 = 0.47\ PMV - 0.53\ U$ (r = 0.95) (accounts payable usage)
where y_8 is the coefficient of financial stability.

2. for enterprises of the second group - with low personnel material motivation effectiveness level (JSC "Melitopol Machine-Building Plant"):

2.1 $y_7 = 7{,}36PMV - 0{,}36U + 6{,}8P$ (r = 0,97) (turnover of working capital)
where y_7 - rate of unfinished production turnover;

2.2 $y_5 = 1{,}004 + 0{,}37\ PMV - 0{,}06U$ (r = 0,90) (working time usage)
where y_5 - coefficient of working time usage.

3. For enterprises of the third groups – with average personnel material motivation effectiveness level (JSC "Kharkiv Machine-Building Plant "Miner Light"):

3.1 $y_5 = 0.8 - 0.072\ U + 1.49\ P$ (r = 0.95) (working time usage)
where y_5 - coefficient of working time usage.

These models usage makes possible to choose the optimal solution by applying the most appropriate specific methods of personnel material motivation, which ensure these indicators impact on the enterprises final results. So, for the first and the second cluster of enterprises we recommend to set a premium of 0.5% for each percentage reduction in working capital balances. For the 1 cluster enterprises it is expedient to use the increase of the premium for reduction of payables (as a percentage of the official salary).

For enterprises of the second and the third clusters we recommend to establish a wage increase ratio due to the full usage of working time; wages correction depending on the level of production normative tasks realization taking into account their tension. At the same time, at the enterprises of each group it is necessary to improve and use the general methods of personnel motivation: the establishment of scientifically justified ranges of marginal rates of the tariff net, payment of 13 salary, payment of dividends, participation in the enterprise profits.

The personnel material motivation at industrial enterprise is becoming an increasingly complex process, which requires, along with the application of existing methods new ones, which depend on economic opportunities and the social orientation of the enterprise. In this regard, the paper proposes a methodical approach to calculating the material payments of personnel in terms of remuneration, which is based on the determination of two developed indicators of their formation such as the indicator of labor input and the coefficient of incentive

and compensatory payments. This approach in comparison with existing alternatives provide the following main benefits:

- fragmentation of the stimulated indicator scale (the indicator of labor input) at infinitesimal intervals to achieve a continuous motivation to save labor costs, which eliminates the establishment of constant premium amount when overproduction if their various values are at the same interval calculated scale;

- determination of the real level of personnel material motivation (setting the amount of the premium on the basis of additional wages) for the worked period, taking into account the actual results (profit and savings of material and raw materials resources) at the corresponding labor costs without distribution of the planned fixed amount of funds for current bonus;

- differentiation of the establishment of incentive and compensation payments for personnel on the bases of the availability of the most significant groups of factors for the staff: 1) the staff position factor (responsibilities, work effectiveness, status and prestige); 2) personal factor (family income, presence of debts, number of dependents); 3) other factors (availability of housing, rental costs, housing location, etc.).

Ensuring the influence of the personnel material motivation on the enterprise economic processes is illustrated by determining the probable change in the level of development of economic processes (using the theory of Markov chains), taking into account the personnel material motivation efficiency for the period of 2017, which solves the prediction of their qualitative state.

The defined vector of finite probabilities for achieving a qualitative state of certain economic processes is presented in Tab. 3.

Table 3. The probability of achieving a qualitative state of development of economic processes (high, average, low) in enterprises with different efficiency levels of staff material motivation

Effectiveness level of stuff material motivation	State of development of working capital turnover			The state of development of the process of using payables			The state of the development of the use of working time		
	2014	2017	Probability of change in 2017	2014	2017	Probability of change in 2017	2014	2017	Probability of change in 2017
High	H	H	0,32	H	H	0,34	-	-	-
		A	0,68		A	0,66		-	-
		L	0		L	0		-	-
Low	L	H	0	-	-	-	A	H	0,12
		A	0,55		-	-		A	0,54
		L	0,45		-	-		L	0,34
Average	-	-	-	-	-	-	A	H	0,71
		-	-		-	-		A	0,28
		-	-		-	-		L	0,01

So determination of economic processes development level of machine-building enterprises in 2017 makes possible to conclude that enterprises with average level of personnel

effectiveness with high probability (0.71) will be able to achieve high level of development of the process of working time usage. For enterprises with high level of staff material motivation effectiveness, there is a greater probability (0.66) for the achievement of the average level of development of the use of accounts payable and is almost the same (0.68) of the turnover of working capital. For the enterprises of the second group, the indicators show high probability of reaching the average level of the development of the circulating capital turnover and working time usage (0.55 and 0.54, respectively).

The usage of the management these theoretical and methodological approaches enables reasonable and systematically determine and evaluate the personnel material motivation effectiveness and its role in ensuring the development of the enterprise economic processes and, accordingly, coordinate the activities in the necessary directions, by applying methods of personnel material motivation.

4. Conclusion

Thus, the leading role in motivation of work belongs to the personnel material motivation as a source of the newly created value of the enterprise and the income of the workers on the basis of the establishment of forms and sizes of wages, participation in profits, and payment of dividends. For completeness of understanding of the motivational component of management, it is necessary to define its goals, tasks and methods, which must be based on the appropriate principles for ensuring the impact on the object - the enterprise economic processes.

In order to determine the object of influence of the personnel material motivation, the content of the category "enterprise economic processes" is disclosed as a set of interrelated phenomena of economic character for achievement of a certain result by transforming the "inputs" with the help of resources into the "outputs". It has been established that economic processes can be considered as ways of ensuring the final results of the enterprises activities on the bases of all resources types' usage.

For assessment the effectiveness of the material motivation and the level of development of productive resources usage, the system of indicators has been formed, the selection procedure of which was carried out in two stages: 1) organization of research (formation of the information space of the research, selection of the method of indicators choosing - expert assessment and criteria for determining indicators); 2) data processing (taking into account the results of expert surveys, justification of the compliance of selected indicators with the proposed criteria).

The estimation of the level of personnel material motivation influence on a certain set of interrelated phenomena of economic character on the scale of the intervals of the factorial dispersion, made it possible to find out that the majority of the indicators that characterize them, the level of influence is in the range [very low – low]. The obtained results are the necessary information base for making managerial decisions when implementing the motivation policy at the enterprise.

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The Measurement of the Impact of International Financial Institutions on the basis of the Cenosis Theory

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Abstract. The work grounds a variant of measurement of the impact of the international financial institutions on the transition countries. Based on the analysis of the world financial system, it presents the indicators characterising the sustainability of the economies of different countries. Due to the fact that the formalisation of these indicators is mostly troublesome, it is proposed to introduce some additional indicators based on the cenosis theory, according to which the economic system is considered as a cenosis and its changes allow measuring the impact of the international financial institutions on the structure of the economy of different countries. The possibilities of application of the cenosis theory to the research task are analysed in terms of terminology and diagrams.

Keywords. Transition countries, International financial institutions, Indicators of economic development, Economic sustainability, Economic cenosis.

The international financial institutions were created for the regulation of the international economic relations pursuing the primary goal — to develop the international cooperation and to ensure the sustainability of the world economy.

Nowadays the majority of transition countries are making the switch from the administrative-command economy with centralized planning to the market one after the economic shocks of the late 80s and early 90s of the last century as a result of the break-up of the USSR and the social system.

The Republic of Moldova, as other transition countries that are in the process of integration in the network of the world economy connections, has become a component of the international financial system. The country's membership of the respective structures of the international financial institutions allows it to use their financial resources to intensify this transformation process. The 2008 world economic crisis became the motive of the serious rethinking of both the whole system of the world economy and its financial part.

In order to fulfil financial and economic tasks inherent to the transition period, related to the stabilisation of the economic system during the periods of slowing down of the economic growth and crisis effects, and in order to intensify the economic growth when the world economy is rising, transition countries benefit from financial, economic, scientific and technical, consultative and other kinds of aid offered by international financial institutions (IFI) for these purposes. The IFI include the following organisations: International Monetary Fund (IMF), Bank for International Settlements (BIS), the World Bank group comprising the International Bank for Reconstruction and Development (IBRD), the International Development Association (IDA), International Finance Corporation (IFC), Multilateral Investment Guarantee Agency (MIGA), International Centre for Settlement of Investment Disputes (ICSID).

The globalisation processes in the world determine the increase of the role of IFI that have at their disposal the respective resources and authority for fulfilling the tasks of

international cooperation on ensuring the sustainability of the world economic system. Transition countries are in the process of integration in the network of the world economy connections and international financial system. At the same time, IFI proved to be insufficiently prepared to prevent the crisis effects, especially in transitions countries, which was illustration by both the world economic crisis of 2008 and some local instability processes of the world economy, especially by the volatility and regular depreciation of some national currencies. In the time of acute crisis effects these very countries find themselves in the most difficult financial and economic situation.

Having limited resources in comparison with the leading advanced countries, transition countries, during the period of reforms and formation, undoubtedly need the support of IFI as regards the loans on acceptable terms and the recommendations on the development of their economic system concerning these loans. And here the most important thing is the measurement of the impact of the international financial institutions on the economic system of the transition countries by valid, in terms of economics, efficiency indicators, which makes the issue under review most **actual** and determines the topic of the present research**.**

The gist of the author's approach is that, in order to measure the impact of IMF on the economy of developing countries, one needs to fulfil the following tasks:

- to analyse the system of the key indicators characterising the economic sustainability and development of transition countries;
- to consider the possibility of applying these indicators for practical purposes of the analysis of the efficiency of using the finances of IFI;
- to offer additional indicators of the sustainability of economies of different countries on the basis of the cenosis theory, which considers an economic system as an economic cenosis;
- to formulate the recommendations and methods of increasing the efficiency of using the financial resources of IFI for the development of the economic systems of transition countries.

The main difference of this author's approach from others consists in the fact that the indicators of the sustainability on the basis of the cenosis theory haven't been introduced by other researchers before. In this approach, one expects them to be calculated on the basis of scientifically grounded formulas and to better describe the gist of the objective of measuring the sustainability of an economy. Or, in any case, they will become an additional tool for increasing the objectivity of the results.

There are different complex characteristics and indicators of the sustainability of a country: the index of sustainable economic welfare [1, 2], the index of economic welfare [3], the index of genuine savings [4], the index of sustainable net profits [5].

In 1993 the United Nations Commission on Sustainable Development (CSD) elaborated the most complete system of indicators of sustainable development of countries. Later in 2001 this set of indicators was amplified and revised. The indicators were divided into the main groups: social, economic, ecologic and institutional. The economic group of indicators of sustainable development comprises 26 indicators [6].

According to the decision 2015/216 of the United Nations Economic and Social Council, the report of Inter-agency and Expert Group on Sustainable Development Goal Indicators was presented. It contains the final list of the recommended sustainable development goal indicators [7].

The United Nations Economic Commission for Europe in the "Conference of European Statisticians recommendations on measuring sustainable development" has proposed its set of indicators of sustainable development of countries [6].

Despite a big number of the efficiency indicators, they all have a particular character, and it is difficult to formalize them due to the lack of the mathematical models for the calculation of their numeric values by formulas with the purpose of measuring and comparing.

Moreover, one needs a complex indicator which could simultaneously measure the impact the substantial part of economic efficiency indicators of the influence of IFI on transition countries. And accordingly, it is reasonable to analyse the efficiency of the structure of an economy in general on the basis of the cenosis theory that considers an economic system to be a cenosis — a self-organising multigeneric community of organizations of different industries of a singled out territorial and administrative formation (region), characterized by a different extent of connections (strong, medium, mostly weak), united by the joint use of natural, technologic and social resources and economic niches, demand for production, goods and services, where interspecific and intraspecific selection operates" [8].

For the analysis of cenosises one usually uses the mathematical framework based on non-Gaussian statistics and model of hyperbolic N-distribution [9]. This mathematical framework of the cenosis theory allows measuring the state and efficiency of development of economic cenosises. As the object of the research of an economic cenosis one chooses some certain companies (financial and other organisations) that have their own economic indicators, e.g. sales revenue, service revenue, net profit etc.

Then, on the basis of the selected parameter, by which the cenosis analysis will be made, rank parameter distribution is formed. For this purpose one selects a certain period of time, makes a list of companies and determines the parameter by which the cenosis research will be made; the selected companies (organizations) are numbered and ranked in descending order in terms of the value of the analysed parameter.

The development and sustainability of an economic formation is analysed within the frames of its being part of the community of the economic cenosis. Basing on such features of cenosises as structural and topological dynamics, continuous reproduction and self-organisation, one can study sustainability and development of entrepreneurial formations of a cenosis kind. And for their description one uses the mathematical tools of non–Gaussian statistics in the form of their specific and rank parameter distribution that are compared with the ideal classical hyperbolic N-distribution [10]:

$$P(r) = P_1 / r^{\beta} \quad (1)$$

Here P (r) – an economic parameter of a company (organization) with the rank r, P_1 - is a constant value equal to the maximum value of this parameter (it corresponds to the 1st rank, β – is the rank coefficient that determines the degree of the curvature of the hyperbola of N-distribution. The higher is β, the more curved is the hyperbola and the bigger is the difference between large companies and other organizations of the business system. Parameters P_1 and β unambiguously determine the form of the curve of the function of N-distribution.

The statistical research made over many years shows that rank parameter distributions of cenosises in the process of formation, self-organization and reproduction of cenosises in the conditions of market competition will tend to the optimal, from the cenosis standpoint, model — hyperbolic N-distributions with rank coefficients within the following interval $0{,}5 \leq \beta \leq 1{,}5$ [8]. And the most stable states of any cenosises will occur when the following condition is true for the parametric distribution: the ratio of the aggregate economic indicator of 10% of the companies with the highest value of the parameter to the aggregate indicator of 10% of the companies with the lowest values of this parameter should not exceed 10 [10].

The correlation of the obtained empiric data of an economic system to the criteria of the N-distribution (1) consists in verifying if the two hypothesises are fulfilled: a great number

of data doesn't obey to the standard law; the data is interrelated in terms of their value. In this case one can suppose that the object of the research in an economic cenosis. In order to verify the conditions of inconsistency of the obtained data with the normal distribution, one usually applies Pirson's chi-squared test, and the coefficients of Kendal rank correlation and conformation serve as the criterion of the interrelation of the components of an economic cenosis [11].

The analytical stage of the rank analysis consists in making rank parametric distributions on the basis of the accumulated database. In the cenosis theory a model of hyperbolic N-distributions (1) is used for the illustration of rank distributions.

Figure 1 shows an example of curves of a hyperbolic N-distribution – P(r) with different rank coefficients β.

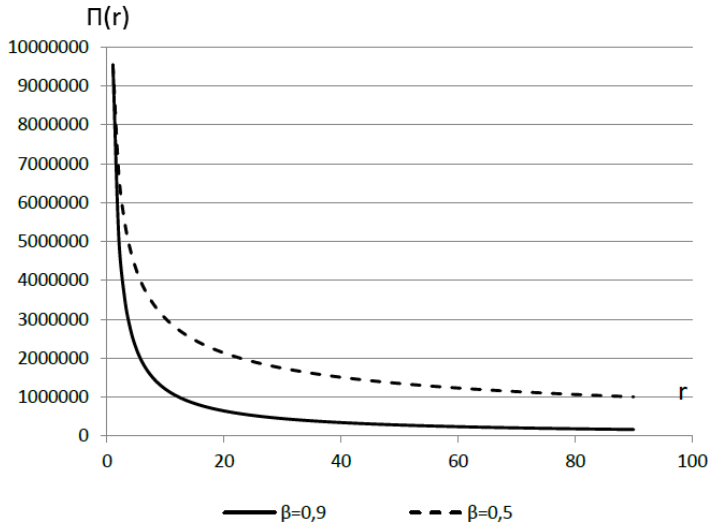

Fig. 1. N-distribution curves P(r) with with different rank coefficients β.

In order to make a cenosis analysis of the data of an economic cenosis and the formed empiric rank distributions, one carries out an approximation by using their models of hyperbolic N-distributions (1).

The essence of the process of approximation consists in determining parameters P(r) and β of the formula (1) for each parametric distribution, and these parameters completely determine the analytical aspect of the function of the hyperbolic N-distribution, which illustrates the totality of the empiric points of rank distributions in the best way [12].

Accordingly, the sustainability model of an economic system must include the following steps:

1. Identifying an economic cenosis from the historical data of companies of the economic sector available from the economic statistics.

In the process of identification one analyzes a lot of companies of the economic system and their financial and economic figures at each time period of their activity.

2. Forming a database on the known history of economic figures of the selected economic cenosis, making up a rank parametric distribution for each stage and each parameter and verifying if they pertain to the cenosis.

In order to do that, one analyzes the available economic statistics of the region on the companies of the entrepreneurial system for some period of time, e.g. for the last few years. Then,

from this statistics range, one selects those financial and economic indicators that are the most functionally significant ones, being also physically measurable and easy to analyze. At the same time, these parameters must adequately reflect the economic activity: revenue, net profit, free cash flow, etc. Parametric description of the economic system is made in the form of the respective database that contains the most complete, systematized and standardised information of the companies of an economic cenosis.

On the basis of the formed data base structured by time, one builds rank parametric distributions for each time period (usually a year) and the economic parameter. A rank distribution is a correlation of the value of the parameter with the sequence number – rank in the process of ranging the values of the parameters in descending order. For a better presentation and a subsequent analysis all these rank parametric distributions are given as charts and diagrams that reflect the table data.

Thus, we can make a conclusion that despite the fact that a big number of indicators of sustainable development of countries have been introduced to measure the impact of International Finance Institutions on transition countries, it is difficult to use these indicators for practical purposes due to the problems with their formalization and interconnection into a general numeric value. That is why it is reasonable to propose some complex indicators of the sustainability of an economic structure in general on the basis of a cenosis theory, which considers an economic system a cenosis. And in this approach the structure of the model of the sustainability of an economic system is defined in the form of certain procedures for the calculation of numerical indicators.

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The Situation-Semantic Modeling of Complex Economic Systems

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Abstract. The paper deals with various aspects of modeling of complex economic systems on the example of the specialists' training system. The paper describes the creation of the multi-level situation-semantic model for the further development and improvement of the specialists' training system. The proposed model is the basis of the procedure for making managerial decisions in the specialists' training system. The proposed model allows to predict the future volumes of educational services, specialists, the number of enterprises of different levels and specializations, that is, the trends of development and improvement of the specialists' training system; to determine the most optimal parameters of the information flow of the training process on the basis of training models and the models of future specialists.

Keywords. Specialists' training system, Situation-semantic model, Modeling of specialists' training system

1. Introduction

Formulation of the problem. The current state of such a complex system as the specialists' training system (STS) does not meet the requirements of the labor market, therefore, for its development, it is necessary to more actively use the mechanism of managerial decisions making on the basis of analysis and forecasting of the corresponding actions.

The appropriate model should become the theoretical basis for such a mechanism. The authors propose to reduce the problem of making managerial decisions regarding STS to the problem of determining the paths in a situation-semantic model (SSM) [1].

Analysis of recent scientific studies and publications. K. Petri, J. Peterson, D.A. Pospelov, V.F. Khoroshevsky, Y.L.Yushchenko, AA Petrov, O.L. Perevozchikova, AD Mishkis, IG Pospelov, AA Shananin, L.Ya. Rosenblum and others studied the processes of modeling complex systems.

The purpose of the work – the creation (development) of a multi-level SSM for the development of the STS, which is the basis of the procedure for making management decisions in the STS.

2. Presentation of the main material

SSM is a tool for studying the processes of modeling and analysis of complex economic systems, which include the STS. Using the STS model, you can get new knowledge about the system, predict its functioning, and identify the required management solutions, avoiding danger and significant costs.

Under SSM we will mean five N = (P, T, F, S, SP), where P – set of positions (places, meaningful vertexes), T – set of transitions (ports); S – a set of situations in which it is possible to make progress in the arc, SP – set of semantics of vertexes P; (P≠Ø, T≠Ø, S≠Ø, SP≠Ø), F (PxTxSxSP) (TxPxSxSP) – set of arcs. Elements of the set P T are the knots of SSM.

The modeling of STS with the help of SSM is carried out at the level of events according to certain situations and semantics of the peaks. It determines what actions occur in the system, what situations (conditions) led to the implementation of these actions, and into what states (situations) will pass the STS after the execution of the corresponding action. The SSM should describe the structure and functioning of the STS.

Simulation of STS is carried out on the basis of SSM usage. Components of the STS and their actions act as events. Examples of events can be: decision-making on the chosen specialty, decision-making on the course / program / term of training, form, type and training technology, the range of educational services, the definition of the SSM path, according to which the preparation, calculation of the criteria values that determine the situation that occurs in the STS snd the management decision on the choice of the STS company are performed.

Requirements to the model are determined by its purpose. The model should be: reliable; adequate; purposeful; simple and understandable to user; complete; trusty; the one can be modified. The level of accuracy of the model should provide a reliable comparative assessment and ranking of the quality of alternative management options for the STS.

The functionality of the STS can be enhanced by modeling the behavior of each pupil by a separate model. The presence of vertical synchronization means that transitions of the same name can only work simultaneously.

This means synchronizing the following actions: the arrival of a future specialist in the system, the creation of embedded models of concrete future specialists in the SSM, the selection of the training module and the beginning of the training process, the completion of the preparation process and the selection of tests, the completion of the testing process and passing to the evaluation, the decision making on the basis of the test results. The usage of nested models expands the possibility to model the STS, in particular its educational information systems, and allows conducting previously unavailable research.

3. Conclusion

The proposed model allows to predict the future volumes of educational services, specialists, the number of STS enterprises of different levels and specializations, that is, the trends of development and improvement of the STS; to determine the most optimal parameters of the information flow of the training process on the basis of training models and the models of future specialists.

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Teaching Statistics – Approach Upgrade is Needed

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Abstract. Each generation reacts to the life events depending on many factors but maybe the most important is the environment (time, place, family, etc.) in which it raised. The modern fast-paced communications cradle generations who need to process a large amount of information for a very short time trying to filter the disinformation and data 'garbage'. Using the old-fashioned teaching approaches such as the white-board writing and the frontal speaking not only 'stimulates' the passiveness of the students but makes the lecturer to look like a person that is 'too old to be listen to'. It is not adequate to expect that people, raised in the 21st century, can focus their attention more than 45 minutes on any topic that is presented in a reading-text style with no real-life and up-to-date entertaining examples. But a modern multimedia presentation will work but it won't be enough. The active participation of the students has a crucial role in the process of the developing of the students' critical thinking. Splitting the hard-to-digest material of Statistics in small and easy to absorb 'bites' of information, presenting the information using modern approaches incl. online video materials, Excel real-life examples, etc. and assigning easy-to-solve tasks, grant us a chance not only to adequately give knowledge to the next generations but to keep the 'connection' alive.

Keywords. Teaching, Statistics, Approaches, Information, Technologies.

1. Introduction

The educational process is a 'play' in which not only the actors change but also the means of expression (communication) and the scene (environment) evolve, while the main goal stays the same – transfer of knowledge [9].

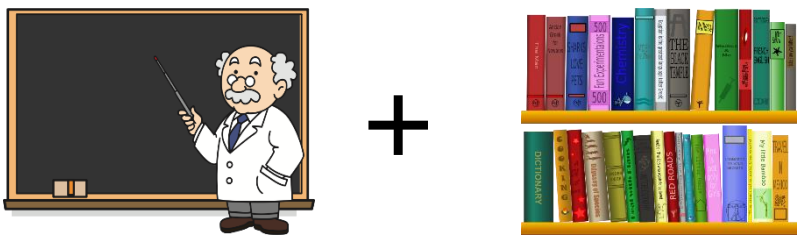

Fig. 1. 'Traditional' approach
(The images are downloaded from the open clipart community site *Openclipart*.)

Only a few decades ago, before the computer age, it was common for the most of the university lecturers in Statistics to present the material they teach in a frontal-speaking (sometimes even reading-text) style using the blackboard (later the whiteboard) to present the main ideas - formulas, calculations, etc. [6] of the subject. In the times when the books were the main source of information about the matters of Statistics it was normal to expect the

students to keep their attention on the 'presentation' for long periods of time especially when they struggle to 'survive' in the 'jungle' of Statistics. In those days, when the main home entertainment were the TV and radio, people needed to be more active in order to find clearer and better explanation of the difficult to digest matter, usually visiting more than one library. The 'old-school' approach continued its existence even few years after the millennium started.

Starting from a hall-based factory machines to became pocket sized multifunctional devises, computers came and brought a revolution in every aspect of our lives. As standalone devices they were useful tools but not as much as when they became connected. Internet made our planet 'smaller', our life easier and the knowledge always-available. This environment changed not only the way people communicate but also the way they think, react and 'process' information. Nowadays everyone can find explanation (in most cases more than one) for every subject that he or she is interested in, usually in an entertaining and an easy to 'absorb' form. The generations of the new millennium [1] are raised in the fast-paced environment that floods their minds with 'tons' of information (websites, social medias, blogs, vlogs, podcasts, videos, online platforms, digital books, banners, ads, etc.) most of which have a questionable quality or sometimes even 'poisonous'. The constantly popping 'notifications' and instant 'messages' of the 'important' life events in the common informational avalanche made millennials social network addicts and short-time focused listeners.

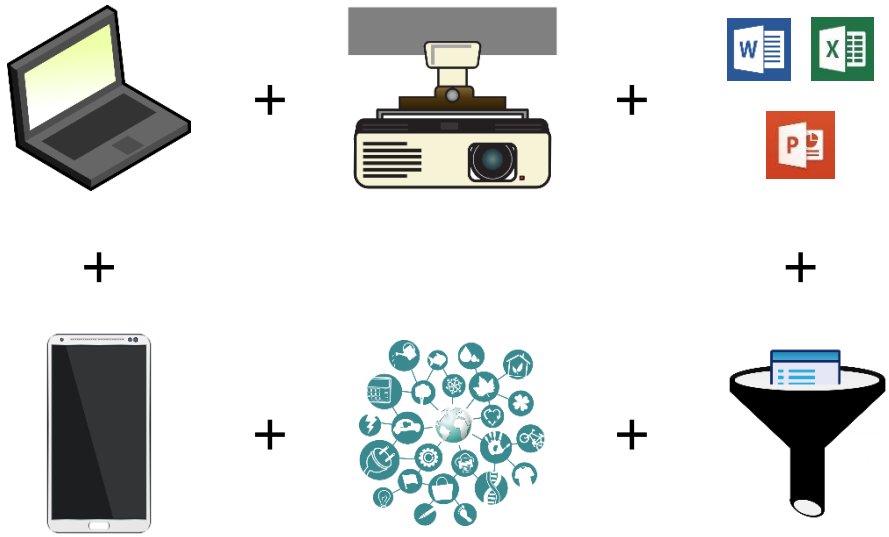

Fig. 2. 'Modern' approach (The images are downloaded from the open clipart community site *Openclipart* and *Microsoft Corporation* site.)

Today the main struggle is not to find information but to filter the 'garbage' of the 'big' data. In these 'modern' times the purpose of the educator is not be one of the many sources of extra information burden, but to guide the student through 'debris' of knowledge. Now it is the time when the teacher has to become mentor and partner in the educational process and benefit from the (mostly free) 'tools' that digital boom era offers – online video streaming, interactive webpages, rich media presentations, educational platforms, cloud services, easy-to-use spreadsheet software, etc., available for our pocket 'buddies' too.

2. Teaching Statistics - upgrade possibilities

Although the participants in the educational process are the same – lecturer, students and the subject of Statistics, but the interaction between them changed [4]. As it was already mentioned, the digital technologies altered us and the world around us. In order to be adequate to that changes the teaching of the Statistics should evolve too.

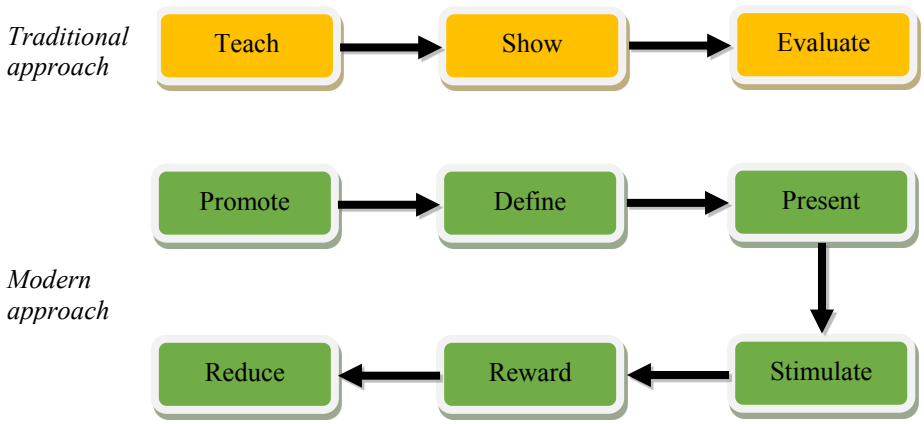

Fig. 3. 'Traditional' vs 'Modern' features

The main *upgrades* to the 'traditional' system of teaching Statistics - teach theory, show the solving of "real-life" problems and evaluate the students' knowledge the end, could be as follows [2]:

1. *Promote* the reason why students should study the subject of Statistics (what is their benefit) at the first lecture. If the millennials [3] do not understand the practical side of the matter and do not find any real benefits for them, they will 'filter' the following lectures.
2. *Define* clear rules (lecture style, assignments, main topics questionnaire, points, score, grades) from the beginning. The 'digital survivor' generations will try to gain results with minimum possible efforts (sometimes at the edge of the legal) so clear defined rules will stimulate them to 'follow the right path'.
3. *Present* the main idea of a given topic (theory) of Statistics in a short and simple style, accompanied with a real-life example and using rich PowerPoint presentation (pictures, animations, diagrams, videos, etc.) in an entertaining fashion.

   The ideas should be presented from the point of view of a researcher (a Statistician from the practice) not as a theoretical scientist.

   The material of the course 'Statistics' should be split in small and easy to absorb 'bites' of information. The lectures should be focused on the most important issued of each subject studied and should not exceed total duration 45 minutes. To make sure that the audience is 'alive' and to keep their attention even more focused the lecturer should ask simple questions that do not need too much competence.

In order to provide additional sources of useful information the educator could use a dedicated website (incl. additional materials in digital format), a blog, a forum or even a preferred social network.

4. *Stimulate* the participation of the students by making it a 'real-life' situation based [5]. Every student or a group of students should solve a practical problem using up-to-date tools. An example for such tool could be MS Excel (or open source spreadsheet alternatives) which is versatile and wide-spread in the basic statistical analysis practice. Using the basic functions of Excel each student can analyse real-life data (e.g. from a survey) and reach the 'goal' using minimum efforts while gaining good practical skills.

   The results of each group could be uploaded in a dedicated learning management system such as Moodle, Canvas, Google Classroom, etc.

   Because the analytic skills of the students should also be developed, that is why the calculations should be accompanied by short conclusions about the results. The provision of a sample project with calculations and analyses will be useful too.

   The educational burden should be approximately evenly spread throughout the semester in order to provide the students with enough time to absorb the specific matter of Statistics. That is why the homework should be easy-to-accomplish and to cover the main topic of every lecture.

   Usually the so called 'digital natives' (students) haven't got enough patience to follow the detailed instructions for the practical implementation of the Statistical methods. More appropriate could be online videos (e.g. YouTube) which present the elaborate statistical procedures in easy-to-follow steps that can be watched over and over many times, fast forwarded and stopped at the 'right' moment.

5. *Reward* the students' efforts every time. The generations of the instant prizes and fast deliveries are used to it (take for example the points in the computer games and the number of likes in social media). Every small effort of each student or group member could receive a small reward (e.g. points) for the homework done, participation during the lecture, etc [7].

6. *Reduce* stress by giving the final evaluation less weight in the final score. All the points 'won' during the semester could be accumulated and could contribute for example 70% of the final score and the rest 30% - for the final test. By using this strategy students are stimulated to evenly distribute their efforts in time, practice the methods they study at the right moment and not to postpone the 'work' for the last possible moment.

   The grade scale should stimulate the students to gain points from all available sources during the semester not at its end when there are less options.

   To reduce the stress even more the usage of the statistical formulas at the final exam should be allowed because it's better for the students to know how who use the information that is already available (e.g. in Internet) not to memorize it mechanically.

   For those students who need to practice the final testing procedure, a sample online test could be provided too (e.g. a quiz in the Google Forms).

3. Conclusion

The (r)evolution in the human communications is evident and evitable. The boom in the technologies educated new ways of interaction but also changed the way we see the world and learn new things. There is a great need for an upgrade of the educational approach in order to follow adequately those changes. The 'traditional' methods for tutoring the audience lead to indifference, boredom and induced undereducation. To the contrary, entertaining interactional computerized education could keep the students engaged in the knowledge 'absorption' process.

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Architectural Approach Application to Building a System during Emergency Medical Examination, Protection of Personal Data and Finite-State Automatons Architecture

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Abstract. The report considers the application of the architectural approach for building a system for processing a health database during an emergency medical examination. An exemplary architecture of an Initial Screening Center (ISC) COVID-19 Pandemic has been developed, presenting the organizational structure and process management. For this purpose, a variant of operational and system architectural views has been developed according to the NATO architectural framework - NAF and Department of Defense architectural framework - DoDAF. Processes are represented as a systemic sequence of related steps, in which each stage follows without interruption or delay the previous one and ends just before the next one begins. The fully automated process on time during which documents, information or tasks are transferred by one participant to another to perform the corresponding actions consists of a finite number of logically successive stages characteristic of the control processes in each Finite State Machine (FSA). The need for the protection of the personal data of the studied subjects (GDPR) is also discussed.

Keywords. Architecture, configurations, diagrams, Finite-State Automatons (FSA), GDPR, cybersecurity, Pandemic.

1. Introduction

The architectural approach in its essence is a structured aggregation of knowledge and actions for the successful implementation of changes in the form of initiatives, endeavors, missions, activities, creation of products, services and other goals in harmony with the environment. The Architectural Approach (AA) unify knowledge on how to achieve the goals, what methods are needed to achieve them, the concepts and possible models for the rational behavior of the individual, social groups and society, the decision-making methodology, leadership and management.[7] On the other hand, the AA is a tool for achieving a balance between the necessary implementation of control and policy in order to effectively manage innovation processes within the three inalienable needs - resources, knowledge, and power.

At the same time Finite-State Automatons (FSA) receives input signals (inputs) through the processes inside it and output signals (outputs) are generated. In many cases in the system there could be an intermediate memory of used architectural approach and a control unit for the operation of the system.

According to IEEE STD 610.12, the architectural approach is the construction of a structure of organically connected elements using common design and management principles. When looking for the specifics of military or business communication and Information Systems (CIS), the application of the architectural approach allows to determine the elements of the system, the relationships between them and the framework within which they interact.

The exact definition of the elements in the system depends on the level of detail of the system. This can be a functional element of command and control at the highest level, as well as the individual user or performer.

On the other hand, the decomposition of the architectural approach leads to the separation of three interconnected architectures: operational, system and technical The three architectures have two common elements – Architectural Views (AV): summary of information (AV-1) and integrated vocabulary (AV-2). As a link with other approaches to system building, as well as in the context of the development of C4ISR systems in BA (Bulgarian Army), the architectures can be described as follows.

2. Architectural approach – configurations and views

2.1. Architectural configurations

The Architectural approach is used to define information infrastructure of organizations various models and architectural configurations that are used. For the architectural configuration NATO Technical Reference Model (NTRM) is applied and for the system design defining of Information infrastructure components the NATO Common Operating Environment Component model (NCOECM) is used. NATO Technical Reference Model (NTRM) is related to the necessity of realizing twelve system services. Eight functional configurations possess such capabilities, for example, terminals, workstations and servers, which are practically the main elements of information infrastructure. The component model defines the services content. These configurations must have available functional capabilities at different levels: networking, infrastructural and others belonging to basic services and applications. [5]

As a whole the architecture of informational infrastructure comprises a unity of its components, the relations among them, the principles and rules that govern their design and development. The architectural description includes all the products defining the architecture. The architectural development requires modeling which helps us understand the connection between the requirements on the one hand and the architectural concept on the other hand. The requirements must be presented in a chart format for easier perception.

To facilitate this requirements transformation the different parts in the chart must provide a connection and transition from functional to technical a finally to application concepts. These charts or schemes are called: Functional Configuration (FC), Technical Configuration (TC) and Software Configuration (SC). [4]

The Functional Configuration is actually a logical unity of functional components which as a group can carry out a number of services. For example, the components of the informational infrastructure could be user workstations, database servers, e-mail servers and web-servers.

When Architecture is being developed, modeling is required that can help to understand the relationship between the requirements on the one hand and the required architectural concepts on the other. The goals will have to be transformed into architectural "building blocks" that will make easier to describe the Comprehensive, Reference and Target Architectures. So that there are no problems during this transformation process, these building blocks must provide the way for interaction from functional, through standard, technical and even to the final software concepts. Thus, it turns out that the building blocks of these phases are Functional Configuration, Technical Configuration and Software Configuration.

- Functional configurations are composed of applications, basic services and functional interfaces between them.

- Technical configurations are a collection of components and standards that interact with other technical configurations through interoperability profiles.

- Software configurations are a physical collection of software products and segments that provide software interfaces with other software configurations.

All configurations are models and should be considered as a common template, which can be presented with different functionality in terms of functional configuration, different technical solutions for the Technical configuration, as well as different product solutions for the Software configuration. The decomposition of the architectural approach leads to the separation of three interconnected architectures: operational, system and technical.

2.2. Operational, functional, system and technical architectures and views

Operational architecture

The Operational architecture is a set of functionally related elements, describing: the tasks, activities, structures and information flows required for the maintenance of the system (for example, the Bulgarian army management system).

The operational architecture (OA) shall determine the nature of the information exchange to a sufficient extent to ensure interoperability requirements [1, 2, 3].

The definition of OA serves as a basis for the design, construction and commissioning of CIS and includes:

- High-level operational concept schedule (OV-1);
- Description of the connections between the operational nodes (OV-2);
- Operational information exchange matrix (OV-3);
- Map (scheme) of the operational connections (OV-4);
- Operational activity model (OV-5);
- Model of operational rules (OV-6a);
- A description of the change in operational conditions (OV-6b);
- Description of the change in operational events (OV-6c);
- Logical information model (OV-7).

Functional architecture

By definition, functional architecture involves defining participants and their tasks in an operation. In order to be able to perform or maintain the defined tasks, the information flows are determined (by type and direction). The functional connections between the sources and the recipients of information are also revealed. They are defined in great detail: all participants, their tasks and the information they need to use (formations, type and amount of information they need), as well as the necessary information outside the operation (global GPS, intelligence, etc.). The information flows for both use and exchange of information are also determined, as for each information, flow the time of existence, the need for it as well as the need for direct or indirect exchange of information are identified. The functional architecture, as such, allows to determine the relationships between the individual elements and objects involved in the operation, the mode of exchange and the type of information. It is important to note that the functional structure and information flows do not always correspond to the functional and administrative structures as such.

In principle, the functional architecture does not depend on the technical capabilities of the CIS. However, it is a leader in the technological development of the system. In practice, there are a number of cases in which certain functions performed by elements and objects in the operation can be taken over by technology. In these cases, the technology has a significant impact on the functional architecture.

The interaction is determined by the functional relationship between the elements, which is usually defined in the form of doctrines, procedures or processes. The standards and technologies describe the framework of interaction in the system. It can definitely be said that the architectural approach in the planning of military communication and information systems

allows the system to be designed so that it corresponds to the combined requirements of the command and control system and the internal system requirements of the CIS itself. This is often described as an opportunity to decompose planning into three areas:

- Functional architecture - planning of necessary capabilities of the system for the operation;
- System architecture - system structure planning;
- Technical architecture - planning technical capabilities of the system;

System architecture

The system architecture is determined by operations internal architecture. In essence, it is a description of the systems and connections that provide or support the functions of the OA. System Architecture (SA) shows the interaction between the systems. It contains the specific set of services, physical connections and location of its nodes and networks, as well as such parameters of the individual components as average time between failures, maintainability and survivability. According to DoDAF [1], the system architecture includes the following system views (SV):

- Description of system interfaces (SV-1);
- Description of system communications (SV-2);
- System matrix (SV-3);
- Description of system functions. (SV-4);
- Matrix of transformation of the functional abilities-OA into functions of SA ;
- Matrix of information exchange of the system (SV-6);
- Matrix of behavior of system parameters (SV-7);
- Forecast of systems development (SV-8);
- Forecast for technology development (SV-9);
- Model of system rules (SV-10a);
- Description of the change of the states of the systems (SV-10b);
- Matrix of conversion of events in the system (SV-10c);
- The physical data model (SV-11).

If we analyze the nature of the CIS, we see that it is a complex system of many subsystems in the area of operation, with large spatial parameters, as well as the presence of a control system with a probabilistic nature of events in it. Through the system architecture, the planning authority can acquire the properties of the system, and using the theory of complex systems, to understand whether these properties meet the requirements. In fact, this makes the functional architecture leading.

The system architecture itself, in the whole range of all phases of the operation, must remain relatively unchanged. Only the systematic approach determines the state of the CIS in the entire spatial, temporal and functional range of the operation. The system itself is presented as a complex system with the characteristic features of communication - information system such as: multifunctionality, the presence of a large number of subsystems and elements, probabilistic nature of the processes in it; large spatial parameters; availability of management system, etc.

The specific architecture always includes a representation of the physical connections, the location of the elements, nodes, networks, etc. located in the area of operation. They are determined by the application structures, the main parameters of the system that are critical for the operation, such as throughput, reliability, stability, etc.

Technical architecture

The technical architecture defines the rules for the construction of SA. It includes a set of technical standards, conventions, rules and criteria that help to regulate the system services,

interfaces and interconnections for SA by connecting to a specific OA. From the point of view of system-system compatibility, TA (technical architecture) outlines (describes) the criteria or "rules" for technical implementation, which the system must adhere to as set out in the SA. TA in practice ensures the interoperability of the systems horizontally and vertically. The important goal of TA is to determine the standards and rules that govern SA and the functioning of CIS.

This includes the minimum number of rules, norms, standards and interfaces allowing the subsystems and elements to exchange information in accordance with the requirements. The technical architecture is the basic list of specifications, standards, rules and criteria that govern the services in the system, the interfaces and the interaction between systems, as well as the form in which the information is presented. The technical architecture defines the set of standards, rules and norms allowing the functioning of CIS.

The profile of the technical architecture is determined, which should correspond to the type and capabilities of the platforms building the individual systems. The technical architecture should allow for embedding new elements in the system with new standards, gradually excluding the old ones, while it should approach to the commercial standards. The technical architecture is the main limiting factor in the planning of CIS. Requirements for the adopted standards, norms and procedures allow unimpeded interaction between the systems, as well as act restrictively on the possibilities for development and installation of new systems. TA also influences the functional architecture in the course of immediate planning.

The greatest influence on the technologies used in military affairs is exerted by commercial technologies. Applying their principles of compliance with international standards, providing opportunities for the completion and development of systems and the use of commercially integrated solutions, provides significantly greater flexibility in the planning of military CIS.

a. General Data Protection Requirements

The protection of personal data in the process is an absolutely mandatory action, both by law and from a moral point of view:

Privacy by Design - healthcare providers are required to include data protection measures at the outset of new systems. The personal data that are collected must not exceed the data necessary to perform their duties.

Data Protection Officer - introduction of a new role in the organizations dealing with medicine, whose main activities require work with large amounts of personal data, which is responsible for internal rules, data storage and compliance.

There must also be explicit consent to the provision of personal data to patients or other users of the health service.

In order to protect health data, anyone who processes such data must perform a GAP analysis. GAP analysis is an audit of the current situation, which determines whether the existing technological and organizational measures meet the requirements of GDRP.

3. Architectural Model of Initial Screening Center (ISC) COVID-19 Pandemic – Architectural Views

For the construction of the communication and information systems it is necessary to use the architectural description of the systems, applying a number of models and approaches for defining their architectural frameworks. The description of the system architectures can be done in accordance with the architectural frameworks as US Department of Defense Framework (DoDAF), the Zahman Architecture Framework, the NATO Architecture Framework (NAF), The British Ministry of Defense Architecture Framework (MODAF). In

accordance with, the development trends of software applications for Enterprise architecture modeling, there are a number of specialized programs such as System Architect by Popkin Software - USA, Enterprise Architect by Sparx Systems - Australia and others [1, 2, 11, 12, 13].

Architectural Views of the Model of Initial Screening Center (ISC) COVID-19 Pandemic should be created by a tool for developing a modern integrated Communication and Information System (CIS). That is why an appropriate software application, such as "Enterprise Architect" has been chosen. It provides the Department of Defence Architectural Framework and MODAF approach [6] in order to build up a modern CIS.

Enterprise Architect is a visual software platform for designing and building software systems, which is applicable for both business process modeling and more general processes. Enterprise Architect is based on the latest version of the Unified Modeling Language (UML). UML is an open standard that provides a rich language for describing, documenting, and modeling information systems in general. Enterprise Architect is a tool that covers all aspects of the development cycle, providing full traceability from the initial design phase through the development, maintenance, testing and control of the system. Enterprise Architect (EA) is a tool to make the most of the power of UML 2.4 to model, design and build a variety of systems in a clear and fully understandable way [15].

3.1. Operational Views

The Initial Screening Center (ISC) COVID-19 Pandemic Operational View (OV-1), which was developed by usage of the Enterprise Architect (EA) software program, is shown on Figure 1. As it was already mentioned, OV-1 represents the ISC High Level Operational Concept. This OV-1 formally describes the system functions and mainly consists of UML's use-case diagrams, which present the basic main system functions, and all the users (internal and external) as well. [14]

These use-case diagrams contain notations (graphic images) depicting main functions of the ISC during a pandemic, as they follow:

- Three use - cases/functions (Patient Registration, Clinical Examination, Laboratory Examination);
- Five users/actors (Registrar, Patient, Doctor, Nurse, Laboratory Assistant);
- Eight relationships/connectors between them (arrows).

The Initial Screening Center (ISC) COVID-19 Pandemic Operational View (OV-5), which was developed by usage of the Enterprise Architect software program, is shown on Figure 2.

As it was already mentioned, OV-5 represents the ISC Operational activity model of the organizational processes. This OV-5 formally describes the system processes, activities and events and consists of UML's activity (behavioral) diagrams, which present the basic main system processes, and their separation by structures/ partitions and consequences.

These activity diagrams contain notations (graphic images) depicting main organizational structures with conducting activities of the ISC during a pandemic, as they follow:

- Partitions (Registry, Clinical Examination cabinet and Clinical Laboratory)
- Start and End notations
- Activities in each partition (patient registration, electronic register etc,)
- Connectors

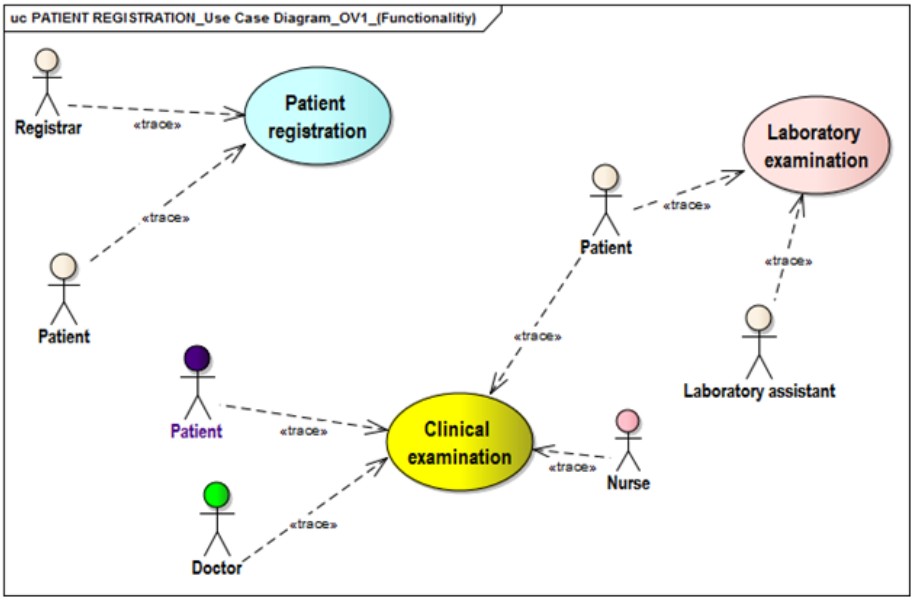

Fig. 1. Operational View OV-1 - High Level Operational Concept of Initial Screening Center during a Pandemic

3.2. System view

The Initial Screening Center (ISC) COVID-19 Pandemic System view (SV-1), which was developed by usage of the Enterprise Architect (EA) software program, is shown on Figure 3.

As it was already mentioned, SV-1 represents the Description of system interfaces of the ISC informational infrastructure. This SV-1 formally describes the system interfaces and connections and mainly consists of UML's deployment (structural) diagrams, which present the basic main system of the CIS and their interfaces.

These deployment diagrams contain notations (graphic images) depicting main system interfaces of the ISC during a pandemic, as they follow:

- Nodes (software and hardware components)
- Connectors between nodes or systems/subsystems interfaces

Additionally, according to the technical reference model system services necessary for the information infrastructure of organizations should be defined. Functionalities needed by users and based on system services are also identified using reference models like specialized workstations, servers- e health server, Database Server, terminals, printers and others which are connected in an integrated information infrastructure of the Initial Screening Center (ISC) COVID-19 Pandemic. A specification of the technical and software configuration of the automated information systems and networks is offered as part of the system design of the information infrastructure which guarantees interoperability in cyber space. This also can be seen as a prerequisite for improving human-machine interfaces in Cyber security.

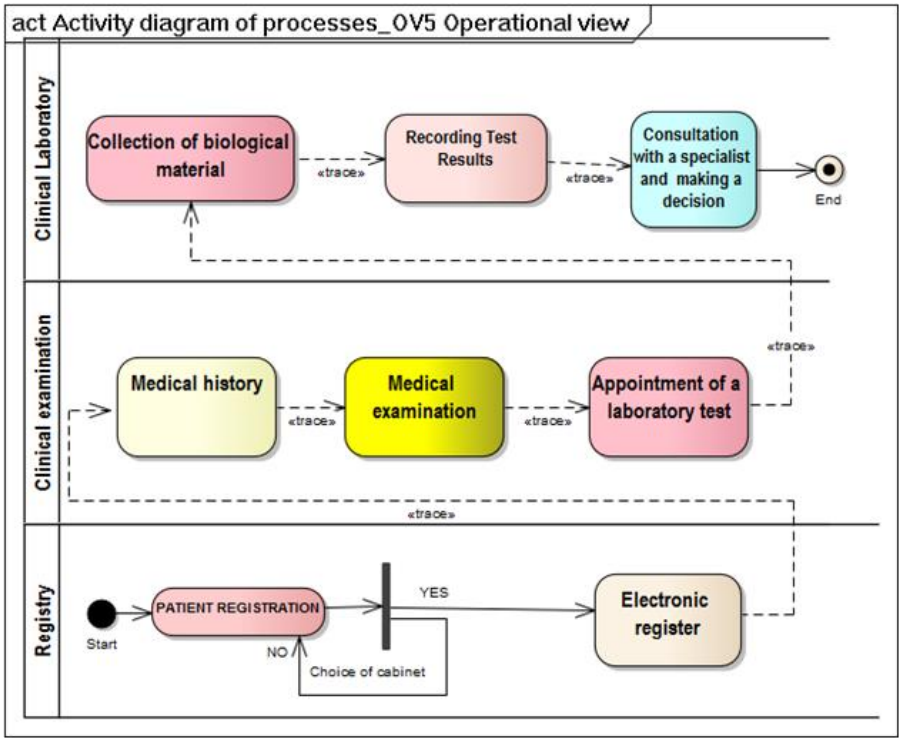

Fig. 2. Operational view OV-5 - Activity diagram of processes

4. Practical use of the architectural approach in Finite-State Automatons (FSA)

The automated execution of procedures over information or its carriers aim to meet the information needs of decision-makers. During this process we propose to apply a systematic architectural approach and to automate not the solution of the individual task but the procedures and operations of the objects in the information system.

In practice, this can be successfully achieved by using different devices in the human machine system such as state machines through which the activities separated in the information system should be subjected to automation. In this way, when determining the object of automation, the data will be separated from the applications that use them and providing a logical view of the data, regardless of the physical details of their storage, providing access only to the data necessary for individual users and applications. [9, 10]
In our opinion, in practice this can be achieved with the help of finite state machines, which are integrated with the help of a database architecture model on three levels:

- Conceptual schema that gives a logical view of the entire database;
- External schemes provide application - or user-specific views;
- Internal schemas provide information on data storage details that have very little to do with the logical content of the data.

It should be noted, however, that the realization of these views is not enough for the base management system to know how they are interconnected, but how they are projected relative to each other. For example, the components of the internal circuit will be represented at the logical level by components of the conceptual circuit. It is necessary to be able to

reorganize the physical database without changing its logical content (conceptual scheme), or to be able to change the conceptual scheme without changing the existing external schemes.

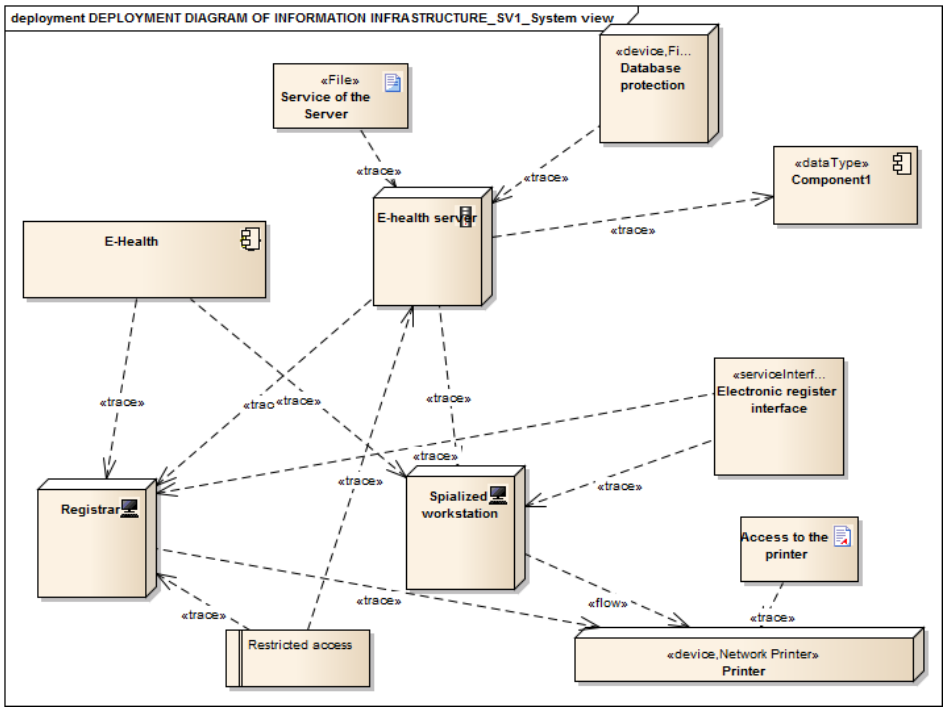

Fig. 3. System view SV-1 - Deployment Diagram of Information Infrastructure

It may also be necessary to add additional fields that contain details of the health of those reviewed in records where there were none. In this sense, in the proposed organization of reviews, the change of the conceptual or internal scheme does not affect the existing external schemes, which are not interested in these data. Also, in order to increase efficiency, it may be decided to reorganize the storage characteristics in the database, which is also allowed by the proposed organization scheme, although this could affect the internal schemes, it will not affect neither the conceptual nor the external schemes.

When choosing a management system for a database, it must be determined to which of the three types they belong depending on the constraints they impose. These types correspond to three different models of data structures - network, relational and hierarchical. In this sense, the model for processing the health database is the type of structure that is most suitable for the purpose. In the case we considered the following:

- The conceptual scheme is the definition of this model through the language for defining the data of the respective database management system;
- Network and hierarchical models express relationships through connections;
- The relational model expresses a connection through a relation.

5. Conclusion

The main principles in building system architecture are: maximum compliance of the qualities of the structure with the goals and objectives of the operation, compliance between the functional capabilities of the CIS structure with the functional interactions between the

participants in the operation and their tasks, determination of the interaction points and interfaces between different CIS systems based on their structure, as well as the system structure corresponding to the technical characteristics and capabilities of the system components.

It can be summarized that the Architectural approach in the planning of military communication and information systems is a strict sequence of steps in the planning process. It is above all a way of thinking and a philosophy in understanding the complex interactions between human-machine systems in modern military conflicts. [8] The architectural approach allows us to look at CIS as a whole, of organically connected elements, functions and technology and could be applied for building other business systems architectures as architecture of an initial screening center during a pandemic.

In conclusion it could be said that the authors have presented the application of Architectural approach to develop architectural model of Initial Screening Center (ISC) COVID-19 Pandemic. Protection of the personal data is also considered. Various tools have been used such as architectural views and UML diagrams. This presentation of the architecture is not very popular among developers' teams, especially in the field of Finite-State Automatons architecture design. We hope the topic would be interesting because the defining of the information infrastructure and its architectural views could successfully be used to improve the system design, finite state machines implementation and human-machine interfaces in order to meet the challenges of Cyber security. For these reasons the described architectural model is a promising area for future research.

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Opportunities for Building a Student Electronic Portfolio

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Abstract. The present study examines the problems of building information systems for the career centers of the higher schools. The main objective is to present the opportunities for developing the concept of applying for placements for work placements. In the current practice, students apply for similar positions by providing a CV. The study proposes a technological solution for building a student electronic portfolio. At last, conclusions are drawn.

Keywords. Electronic portfolio, Software platform, Information technologies

1. Challenges to the creation of an e-student portfolio

The present study is based on the experience and the main directions of development of Interuniversity center for career development (ICCD) at the University of National and World Economy. A thorough analysis of the Center's activities over the past few years, as well as changes in the labor market, was carried out in 2018. As a result, some key development guidelines were formulated, namely:

- Development, approbation and implementation of a new communication policy towards the students, with an individual approach to the needs of each student;
- Building a unified electronic portfolio of activities, competencies and practical experience of each UNWE student, to which registered employers have access to search for individual positions;
- Training of students in terms of activities, competencies and practical experience from the point of view of their applying for separate job positions;
- Exploring the possibilities for validation of the digital competences of UNWE students and using this validation in the process of their career development;
- Establishment, maintenance and development of the Unified Register of Employers of UNWE;
- Construction, maintenance and development of a new ICCD site.

Part of this policy is the vision for the development and technological implementation of a single electronic portfolio of activities, competencies and practical experience of each UNWE student, to which the registered employers of the University of National and World Economy have access to search (Fig. 1).

Fig. 1 shows the significant difference in the application for positions for internship and work with a standard CV and a student electronic portfolio. It demonstrates the need to verify students' digital competences and include them in search capabilities.

There are many studies in the literature on the supply of public electronic services. Some of the latter in this direction are the elaborate plays by Kirilova [1]. The main focus of these latest research is to extend the e-services offered on the basis of reengineering of the work processes. On the one hand, it is part of the common policy of the Interuniversity center for career development at the University of National and World Economy to expand the

offered public electronic services. On the other hand, the concepts and technologies for searching for web content have developed very strongly in recent years [2]. In this direction, the introduction of e-student portfolios will greatly increase the efficiency of career centers.

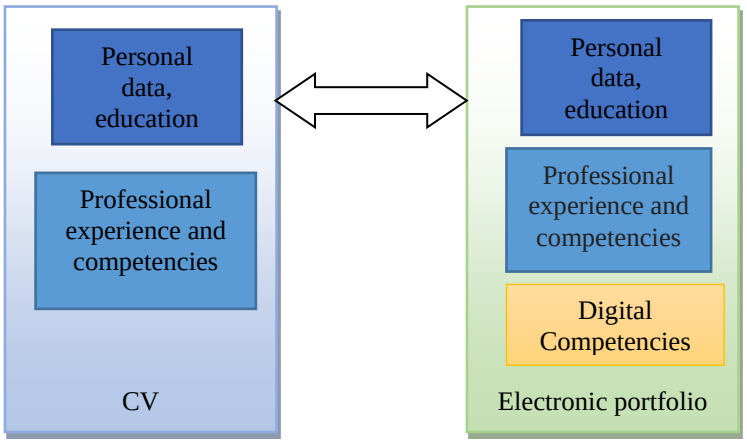

Fig. 1 Differences between standard CV and e-portfolio

2. Process of creating the student electronic portfolio

The process of creating the student electronic portfolio should go through the following stages:

- Structural analysis of existing databases;
- Main features of the e-portfolio;
- Change to existing database;
- Creating a user interface;
- Student electronic portfolio (fig. 2);

The five key stages defined are indicative. Depending on the specific features and features of existing systems, they can be modified and adapted.

3. Technological realization of the student electronic portfolio

The technological realization of the student's e-portfolio is a module from the entire web-based system of the Interuniversity center for career development [3] at the University of National and World Economy. This module provides an opportunity for each student to fill in their CV as well as information about their digital competences. The issue of their certification and verification is important as an element of providing information in the career development process. When filling in all the e-portfolio fields and the student's consent, employers can search across different criteria. From the architectural point of view, the student electronic portfolio module includes the following components:

- Database for storing data on students' competencies;
- Business logic providing the computational procedures used;
- Web interface for data input and search.

It is a question of the module's technological realization to ensure data synchronization for students based on their real status. This is done with procedures regarding the student status system. An important challenge for building such modules is to provide the appropriate mobile application for the convenience of students. A screen from the web system of the Interuniversity center for career development is presented in Fig. 3.

The web-based system provides opportunities for student and employer registration, job posting, internships, competitions and scholarships. Each student can freely apply through their profile for each of the published job advertisements to employers and get a chance for successful career development.

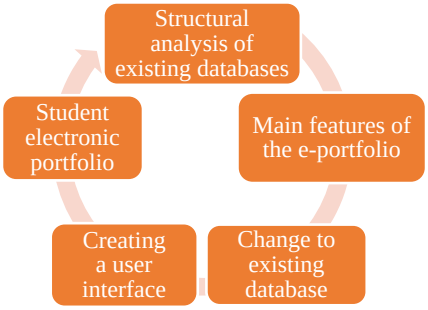

Fig. 2 Steps of the process of creating a student electronic portfolio

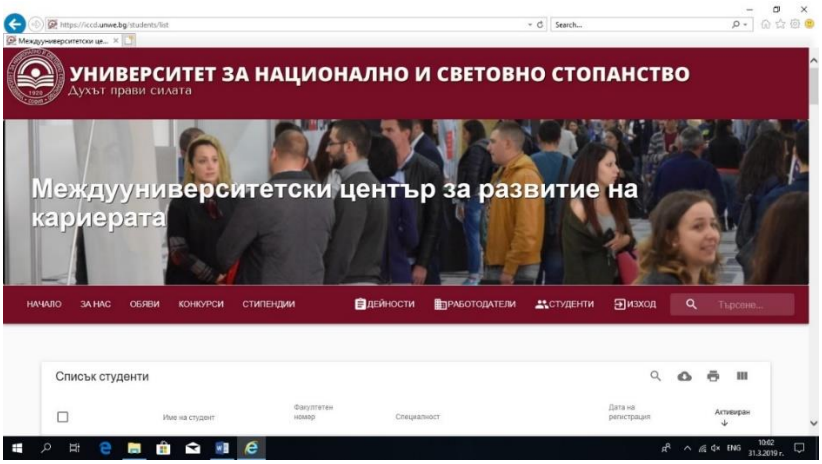

Fig. 3 Screen from web-based system

4. Conclusion

Because of the research we can draw the following conclusions:

- Creating a student's e-portfolio is part of the challenges related to the digital competencies of students;
- Implementing such a module into active career development systems will allow far greater search capabilities on certain criteria;
- From a technological point of view, it is important to provide students with opportunities to use mobile applications in connection with their career development.

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Conceptual model of information system for career development of students

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Abstract. The present study examines the problems of creating a conceptual model of an information system for career development of students. Here are the main sources of data that are relevant to career development. The architectural components of the general conceptual model, as well as the possibilities for its practical realization, are analyzed. At last, conclusions and recommendations are formulated in the implementation of the conceptual model.

Keywords. Conceptual model, Information technologies, Career development

1. Introduction to the career development of students

Career development of students should be turned into one of the main tasks of each higher school. The completion of graduate students is an important assessment of the level of knowledge, skills and competences acquired through education. In these processes, higher education institutions should have clearly defined objectives and tasks in the following areas:

- Establishment and institutional development of structures to participate actively in the career development processes of students;
- Career development should be a primary task in view of the successful realization of the students on the labor market;
- Higher education institutions should achieve a high level of awareness among students about the requirements and opportunities of the modern labor market;
- Active participation of all university structures in the processes of successful career development;
- Establish sustainable and durable mechanisms for employers in selecting students with proven knowledge, skills and competencies;
- Increasing inclusion of students in the labor market;
- Improving the quality of education by providing opportunities for acquiring practical experience and improving practical skills for students;
- Realizing a new approach to practical training of students as a part of the career development lifecycle.

These main directions give grounds to seek technological opportunities for design and implementation of a comprehensive conceptual model for information provision of the career development of the students. In order to achieve this important goal, it is necessary to formulate a number of tasks, some of which are related to the reengineering of key processes related to career development. As far as the career centers of the higher education institutions are mainly aimed at offering services of a public character, the interest of the present study is the characteristics of the public services. There are numerous studies in the literature that describe the relationship between processes and their characteristics and the characteristics of the public

services provided. Some of the latter in this direction are the elaborate plays by Kirilova [1]. The main focus of the latest study is the understanding that before the creation of efficient public services it is necessary to perform analysis and modeling of the working processes. Part of the modeling of the processes is also the study of the main information sources.

2. Main sources of data in managing career development of students

The main sources of data to be taken into account when creating a common conceptual model for career development are (Fig. 1):

- Student data;
- Employer data;
- Information about offered job positions in the labor market;
- Information about offered internship programs;
- Information about Main career forums, etc.

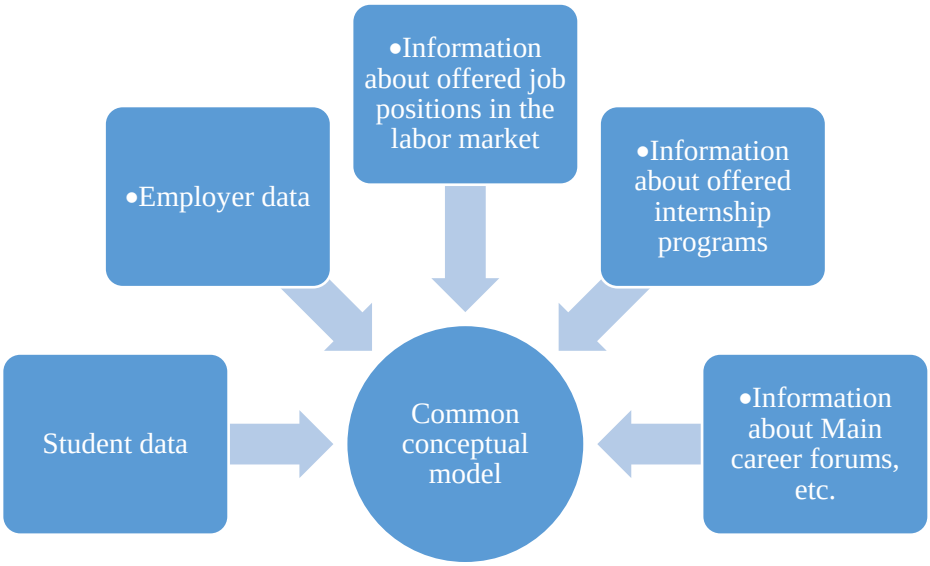

Fig. 1 Main sources of data

The information sources described can be expanded according to the changes in the employers' requirements and the specificities of the labor market. To enable these data sources to be efficiently used, the following tasks are also required:

- Periodic communication between career centers and other structural units of higher education institutions;
- Formation and implementation of a common policy in the field of career support and professional development of students;
- Analysis and reporting of the specifics of the individual professional fields and specialties;
- Periodic analysis of changes in the labor market;
- Preparation of periodic analyzes of the achieved values of key indicators in the activity of career centers.

These peculiarities give grounds for exploring the technological possibilities of building a common conceptual model for the career development of students.

3. Architectural components and common conceptual model for career development of students

The general conceptual model for the information system for career development of students is presented in Fig. 2. It includes the following systems and components:

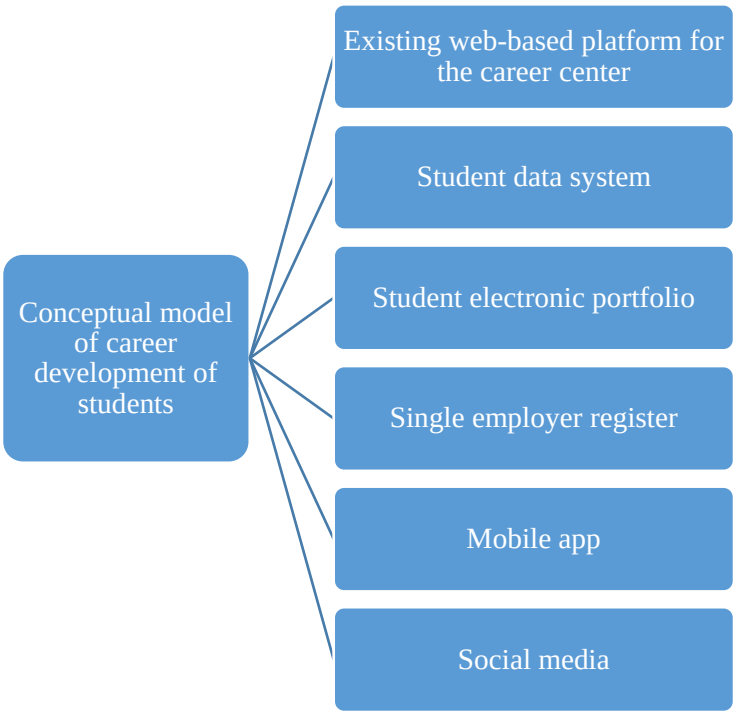

Fig. 2 Component of the information system for career development of students

- Existing web-based platform for the career center. This is a major component of the model. It includes a system for registering students and employers, opportunities for publishing internship placements, job, competitions and scholarships. This system is the core of the general model of information provision for the career development of students;
- Student data system. It is a component that manages all the information about the student status of current students at the university;
- Student electronic portfolio. This component builds on and develops the concept of digitization of all processes of student performance in front of employers. Practically, with its development, it provides opportunities for searching for web information about the students' digital competences. This is a modern way to search for information on the web. There are many studies in this direction. One of the latest of them is published by Milev [2], who also offers a data model to provide search processes;

- Single employer register. It is an autonomous module that provides a single-entry point in the higher school for each employer;
- Mobile app. It provides opportunities for mobile access for all students to the services provided by the Career Center. This component provides maximum convenience for students who can apply directly to job positions and internships;
- Social media. They are a compulsory component of the general conceptual model for information provision of the career development of students. Includes link to Facebook, Twitter, Instagram and LinkedIn;

The main possibilities for future development of the presented model are in the direction of further inclusion and integration of other university systems and resources. At the same time, it is important that the e-services provided to students are going to be expanded and popularized.

4. Conclusion

Because of the research we can draw the following conclusions:

- The peculiarities of career development of students are clarified;
- The main goals of the higher education institutions in managing the career development of the students are stated;
- The main sources of data that are used in the creation of the common conceptual model are clarified;
- The architectural components and the common conceptual model for the career development of the students are presented;
- Some of the possibilities for future development of the proposed model are shown.

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Application of Information Technologies for Business Analysis

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Abstract. This report presents the model of analysis of enterprise's return of equity with regard to the return of total assets and the financial leverage effect. The methodology for analysis is a topical matter due to the fact that the equity to borrowings ratio results in different values of profit attributable to owners, as well as to different return of equity. The study outlines a model of the direct factors' effect on the dynamics of return of equity. It provides guidelines for the use of information technologies for analysis of the return of equity.

Keywords. Return of equity, Debt ratio, Financial leverage effect, Methodology, Analysis

1. Introduction

The question of capital structure is topical at all phases and stages of the enterprise's development. The general structure of the capital is characterized by the relative shares of own funds and borrowings in the amount of the whole capital invested by the enterprise, as well as by the ratios between the different sources of funds – equity and borrowings.

The ratio between equity and borrowings invested in the enterprise's business shows the amount of equity that covers one Bulgarian lev of the enterprise's borrowings. In general, this is the financial autonomy ratio. The reciprocal ratio of borrowings to equity is the enterprise's debt ratio. The value of this indicator determines the amount of borrowings that covers one Bulgarian lev of equity.

The ratio between enterprise's equity and borrowings results in different amounts of profit available for the owners, as well as in different rate of return of equity. This means that the values of the enterprise's financial autonomy and debt ratios have impact on the equity rate of return. Therefore, the use of borrowings for the enterprise's business may be a factor that has positive impact on the rate of return of equity and results in its increase. This impact is related to the effect of the financial leverage.

This publication studies the effect of the financial leverage that determines the impact of funding enterprise's business with borrowings on the change of equity rate of return. The extent and the direction of this effect are influenced both by the changes in the enterprise's debt ratio, i.e. the changes in its capital structure, as well as by the dynamics of difference between the aggregate assets' rate of return and the internal interest rate.

The subject matter of this publication is to study the dynamics of equity rate of return under the influence of the direct factors describing the financial leverage effect.

The aim is to present a methodology for analysis and evaluation of industrial enterprises' equity rate of return in relation to the financial leverage effect that is theoretically justified, practically feasible and useful for the financial management.

The objective is to outline a model of changes of the direct factors' values and to analyze their impact on the dynamics of the return of equity. Based on the above, it is possible

to use advanced information technologies for analysis and assessment of the return of capital with regard to the return of total assets and the financial leverage effect.

2. Model for Analysis of Return of Equity

References [1] show a model for analysis of return of equity based on the relationship between the indicator and the return of total assets and the financial leverage effect. [2]

This model for analysis and assessment of return of equity can be outlined with the help of three equations. The first one is the equation between the asset and liability in the balance sheet that shows that the assets of every enterprise may be presented as a sum of equity and borrowings. The second reference equation refers to the interest expenses, which are calculated as a product of the average amount of borrowings and the internal interest rate. The third equation refers to the return of total assets, which is calculated as a percentage of the sum of balance sheet profit and interest expenses to the average amount of enterprise's assets. Being presented in this way, return indicates the return of total assets, provided the enterprise does not charge and does not pay interest expenses for the used borrowings.

Return of equity (ROE) is calculated as a percentage of the balance sheet profit (Pf^n) to the average amount of the enterprise's equity ($\bar{E}$) with the following formula:

$$ROE = \frac{Pf^n}{\bar{E}} \times 100 \quad (1)$$

The balance sheet profit is calculated with the help of the above three equations by means of mathematical transformations. The resultative formula for the balance sheet profit substituted in formula (1) to calculate the return of equity. As a result, we obtain a new formula for the return of equity:

$$ROE = ROTA + K^d \times (ROTA - I\%) \quad (2)$$

This formula contains two common factors. The first one is the return of total assets (ROTA), and the second – the effect of financial leverage (E), which is calculated with the following formula:

$$E = K^d \times (ROTA - I\%) \quad (3)$$

In the last formula, K^d is the debt ratio expressing the ratio between the enterprise's borrowings ($\bar{L}$) and equity ($\bar{E}$). This indicator characterises the total structure of capital and is calculated with the following formula:

$$K^d = \frac{\bar{L}}{\bar{E}} \quad (4)$$

In this formula, $I\%$ indicates the internal interest rate.

Financial leverage effect describes the influence of the enterprise's business funding with borrowings on the changes that occur in the return of equity. The power and direction of this effect depend both on the value of the debt ratio and on the value and direction of deviation between the return of total assets and the internal interest rate. If return of total assets is bigger than the internal interest rate, i.e. than the price of borrowings ($ROTA > I\%$), than the financial leverage effect is positive and the return of equity is higher than the return of total assets. However, if return of total assets is less than the internal interest rate ($ROTA < I\%$), than the financial leverage effect is negative, and the return of equity is less than the return of enterprise's total assets.

Formula (2) shows that at first level the dynamics of the enterprise's return of equity is influenced by three factors, and at the subsequent detail levels – by their derivative factors (Fig.1).

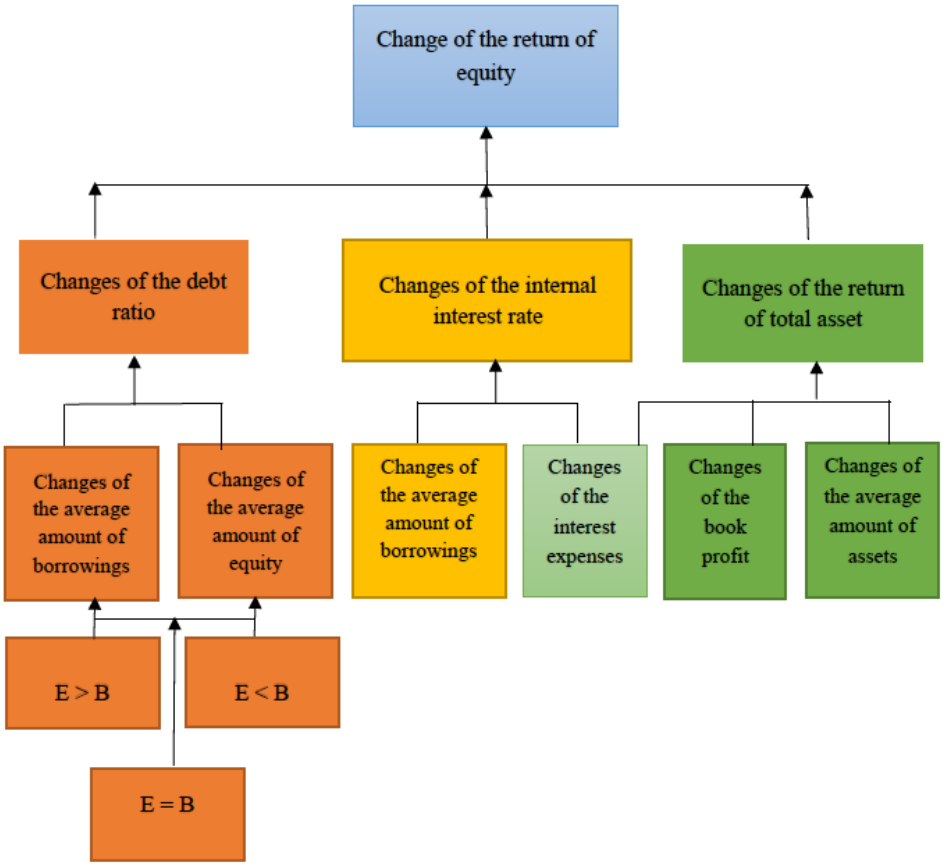

Fig. 1. Factors affecting the dynamics of the return of equity

The first factor – changes in the debt ratio, describes the change of the general structure of capital and is relevant to the enterprise's financial risk level. The increase of the debt ratio above one means that the enterprise has low capital structure where the share of equity is less than the share of borrowings. This results in increase of the financial risk. At the same time, the increase of debt ratio may result in increase of return of equity, however the financial leverage effect needs to be positive in this case. Enterprise's financial management needs to implement measures to achieve and maintain balance between the debt ratio change rate and the difference between return of total assets and internal interest rate.

The second factor refers to the changes in the internal interest rate. The internal interest rate expresses the price of the enterprise's borrowings and varies among enterprises. This percentage is calculated as a ratio of loan interests to the average amount of all borrowings (long-term and short-term borrowings). Therefore, the value of internal interest rate is less than the loan interest rate.

The third factor refers to the changes in the return of total assets. As stated above, the return of total assets is calculated as a percentage of the sum of book profit and interest expenses to the average amount of assets. In this form the indicator describes the capitalization rate of assets, provided no interests are paid for the borrowings. This means that the enterprise carries its business by using interest-free capital only.

Analysis may go deeper to identify the reasons causing the positive or negative effect of each of those three factors on the change of return of equity for the time period in question.

3. Approbation of the Model for Analysis of Return of Equity

Return of equity with regard to the return of total assets and the financial leverage effect is analyzed and assessed on the basis of the data about the business of the enterprise Vector AD. The input information necessary for the analysis is presented in table 1. This table also summarizes the calculations of the values of additional indicators required for the analysis and assessment of the return of equity.

The table shows that the return of equity calculated in accordance with formula (1) – model 1, and formula (2) – model 2, has equal values. This means that the model for analysis of the return of equity with regard to the return of total assets and the financial leverage effect is theoretically correct and applicable in business practice.

We can see that in comparison to the previous year, the return of equity has increased by 1,4116 points. Such increase has been under the effect of the three direct factors mentioned above: changes of the debt ratio; changes of the internal interest rate; changes of the return of total assets. The influence of the factors may be identified by the subsequent substitutions method. Such influence is summarized in table 2.

The increase of the debt ratio by BGN 0,0423 has resulted in increase of the return of equity by 0,5955 points. The increase of the internal interest rate by 1,8409 points has resulted in decrease of the return of equity by 1,0691 points. Therefore, as a result of the changes of the capital structure and of the price of borrowings, the return of equity has decreased by 0,4736 points [(+0,5955) + (1,0691)]. The analysis needs to go further to study the rate of change of the debt ratio and of the internal interest rate.

The increase of the return of total assets by 1,1926 has resulted in increase of the return of equity by 1,8852 points.

As a result of the complex influence of the factors, the return of equity has increased by 1,4116 points, which is equal to its change as set out in table 1.

The data in table 1 show that the financial leverage effect is positive for the two years, and during the current year, this effect has increased by 0,2190 points in comparison to the previous year. This means that the return of equity is bigger than the return of total assets, a fact proved by the data in table 1.

4. Modelling of the dynamics of the return of equity

Good management of the capital structure and the efficiency of the use of assets require the enterprise's financial management to model the changes that may occur in the return of equity under the effect of the changes of the direct factors specified above.

We can specify different situations for the values of direct factors that would cause the respective changes in the return of equity.

To our opinion, the more important situations that may occur in business practice and that are relevant to the changes of the enterprise's capital structure, and therefore, to the debt ratio (K^d), can be systemized in the following way (see table 3).

More important situations that are relevant to the difference between the return of total assets and the internal interest rate are summarized in table 4.

Table 1

Indicators	Previous year	Current year	Difference
Input data, BGN'000:			
1. Average amount of assets, including funded with:	36120	37250	1130
a) equity	23478	23565	87
b) borrowings	12642	13685	1043
2. Balance sheet profit	6035	6390	355
3. Interest expenses	510	804	294
Additionally calculated indicators:			
4. Debt ratio, BGN (ind. 1b : ind. 1a)	0,5385	0,5807	0,0423
5. Return of total assets, % [(ind.2 + ind.3) : ind.1] x 100	18,1202	19,3128	1,1926
6. Internal interest rate, % (ind. 3 : ind. 1b) x 100	4,0342	5,8750	1,8409
7. Financial leverage effect, % Ind. 4 x (ind. 5 – ind. 6)	7,5848	7,8037	0,2190
8. Return of equity, %			
a) model 1 (ind.2 : ind.1a) x 100	25,7049	27,1165	1,4116
b) model 2 (ind. 5 + ind. 7)	25,7049	27,1165	1,4116

Table 2

Factors affecting the difference of ROE	+	-
1. Changes of the debt ratio	0,5955	
2. Changes of the internal interest rate		-1,0691
3. Changes of the return of total assets	1,8852	
Factors with positive effect	2,4806	
Factors with negative effect		-1,0691
Factors with complex effect	1,4116	

We can see that depending on changes that occur separately in the return of total assets and the internal interest rate, the financial leverage effect has different values affecting the dynamics of the return of equity in different way. In practice, the values of factor indicators

used for the model of analysis of resultative indicators' deviations change simultaneously and in different directions.

Table 3

Situation (all other things being equal)	Change of the factor	Change of the return of equity
Situation 1 Equity > Borrowings	$K^d < 1$	
a) equity increases but E > B	K^d decreases	ROE decreases
b) equity decreases but E > B	K^d increases	ROE increases
c) borrowings increase but E > B	K^d increases	ROE increases
d) borrowings decrease but E > B	K^d decreases	ROE намалява
e) equity decreases and E = B	$K^d = 1$	Situation 3
f) equity decreases and E < B	K^d increases	Situation 2
g) borrowings increase and E = B	$K^d = 1$	Situation 3
h) borrowings increase and E < B	K^d increases	Situation 2
Situation 2 Equity < Borrowings		
a) equity increases but E < B	K^d decreases	ROE decreases
b) equity increases but E < B	K^d increases	ROE increases
c) borrowings increase but E < B	K^d increases	ROE increases
d) borrowings decrease but E < B	K^d decreases	ROE decreases
e) equity increases and E = B	$K^d = 1$	Situation 3
f) equity increases and E > B	K^d decreases	Situation 1
g) borrowings decrease and E = B	$K^d = 1$	Situation 3
h) borrowings decrease and E > B	Situation 1	Situation 1
Situation 3 Equity = Borrowings		
a) equity increases and E > B	Situation 1	Situation 1
b) equity decreases and E < B	Situation 2	Situation 2
c) borrowings increase and E < B	Situation 2	Situation 2
d) borrowings decrease and E > B	Situation 1	Situation 1

Possible changes may be modelled by using the capabilities of the advanced information technologies. This enables the enterprise's financial management to have real time information about the behavior of the resultative indicators' values under the effect of the changes that occur in the values of the direct factors that affect their dynamics.

Table 4

Situation (all other things being equal)	Change of (ROTA – I%)	Change of return of equity
Situation 1 ROTA > I% (positive effect)	(ROTA – I%) > 0	ROE > ROTA
a) ROTA increases	(ROTA – I%) > 0	ROE increases
b) ROTA decreases, but ROTA > I%	(ROTA – I%) > 0	ROE decreases
c) ROTA decreases and ROTA = I%	(ROTA – I%) = 0	ROE = ROTA
d) ROTA decreases and ROTA < I%	(ROTA – I%) < 0	ROE < ROTA

(negative effect)		
d) I% increases, but ROTA > I%	(ROTA – I%) > 0	ROE decreases
e) I% increases and ROTA = I%	(ROTA – I%) = 0	ROE = ROTA
f) I% increases and ROTA < I% (negative effect)	(ROTA – I%) < 0	ROE < ROTA
g) I% decreases, but ROTA > I%	(ROTA – I%) > 0	ROE increases
Situation 2 ROTA < I% (negative effect)		
a) ROTA increases, but ROTA < I%	(ROTA – I%) < 0	ROE < ROTA
b) ROTA increases and ROTA = I%	(ROTA – I%) = 0	ROE = ROTA
c) ROTA increases and ROTA > I% (positive effect)	(ROTA – I%) > 0	ROE > ROTA
d) I% increases, but ROTA < I%	(ROTA – I%) < 0	ROE < ROTA
e) I% decreases, but ROTA < I%	(ROTA – I%) < 0	ROE increases
f) I% decreases and ROTA = I%	(ROTA – I%) = 0	ROE = ROTA
g) I% decreases and ROTA > I% (positive effect)	(ROTA – I%) > 0	ROE > ROTA
Situation 3 ROTA = I%		
a) ROTA increases and ROTA > I%	(ROTA – I%) > 0	ROE > ROTA
b) ROTA decreases and ROTA < I%	(ROTA – I%) < 0	ROE < ROTA
c) I% increases and ROTA < I%	(ROTA – I%) < 0	ROE < ROTA
d) I% decreases and ROTA > I%	(ROTA – I%) > 0	ROE > ROTA

On this basis they can make timely and justified decisions for the increase of equity by means of issue of shares, for the use of borrowings to fund their business, for the optimization of the capital structure, for the improvement of the equity structure, for the increase of the turnover rate of the whole capital, including of equity, borrowings and fixed capital, for the improvement of the return of enterprise's total assets.

5. Conclusion

„The increased requirements to the accounting disclosure of information and the guidelines for the information analysis within the existing competitive environment and … the new forms organization's capital investments establish conditions and opportunities for improving such organization's business, capital adequacy and liquidity, solvency and financial stability." [3] Thus, the accounting information system of the company should be developed in such a way that it is highly flexible. In order to overcome problems in this field, a lot of efforts should be made for increasing the speed and improving the contents and structure of working information flows in the company through the use of contemporary information technologies. [4]

The resultative information is useful for the industrial enterprises' management to consider and make effective management decisions for the purposes of improving the efficiency of the business in operating and strategic aspect. This is an objective prerequisite for the successful development of the enterprises, the increase of their competitive power and their good position on a dynamic market.

The usefulness of the resultative analytical information confirms the significance of the management function *Analysis* within the governance system of every enterprise. The information needs of the management may have opposite effect with regard to expansion,

building-up and improvement of the methodology for analysis and assessment of the enterprises' return of equity.

This is further verified by the identification of the power and direction of the direct factors' impact on the dynamics of the return of equity with regard to the return of total assets and the financial leverage effect. Enterprise's management pays attention to different problems that need to find their theoretical solutions.

The methodology for analysis of the return of equity allows to identify and systemize the weaknesses and strengths with regard to the enterprises' business funding and the effectiveness of the use of their assets and capital, on the basis of which specific measures and actions for improvement of the business efficiency may be developed and proposed.

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Guidelines for Data Model Selection and Use in Web Applications for Data Analysis

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Abstract. The paper examines some features of modern data models. The paper discusses issues related to the functionality of web applications for data analysis. On this basis, an appropriate data model for such software solutions is proposed. The conclusion outlines some trends in data model selection and use in web applications for data analysis in the context of the critical role of the data model.

Keywords. Data model, Web application, Data analysis

1. Introduction

The data model that is used in an information system is critical to its proper functioning, performance, security and development capabilities. More specifically, the subject of this study are web applications for data analysis. A characteristic feature of these systems is the availability of many sources of information to be analyzed. For the purposes of this study, we will look at the different data sources under a common denominator and their information units will be online publications. Otherwise, these publications could be news, topics and posts in forums and blogs, posts and comments in social media and more. The purpose of this study is to examine the data models that would be suitable for use in web applications for data analysis in terms of their applicability, efficiency, occupation and performance. Such software solutions are increasingly part of the systems of many business organizations that use different types of data analysis daily in their work. There are many studies by authors working in this field [1]. A large part of the public sector is also interested in or is already using data analysis applications. Issues related to data analysis systems for public services have been investigated by different authors [2, 3].

2. Traditional data models in field of data analysis

Web applications for data analysis usually consist of different modules. In this study we will look at the data models that concern the storage of the information to be analyzed. All such systems, which aim to analyze the content of different publications, have the so-called dictionary with keywords. In theory, this is not required because the known database management systems offer the so-called full-text indexes, but maintenance of such functionality takes a lot of system resources and imposes restrictions on its functionality. There are different types of data models with the participation of such a dictionary through which the relevant data analysis is possible. Fig. 1 illustrates a traditional relational scheme of a physical data model for data analysis. This physical model should have at least four tables that have the following features:

- Dictionary has at least two attributes – identifier and text (keyword);
- Publication has at least three attributes – identifier, date and link;

- Source has at least two attributes – identifier and name;
- A keyword can participate in many publications and one publication can have many keywords;
- One source may have many publications, but one publication belongs to a specific source.

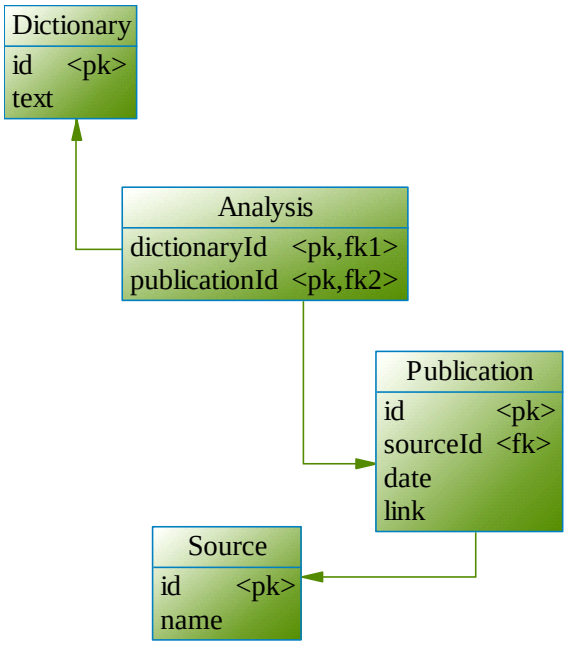

Fig. 1 Traditional relational data model

The relational model provides many benefits, among which the most significant are:

- Data integrity;
- The independence of the data from the software that uses it;
- Relatively easy extraction of data using SQL language;
- Minimum disk space with a normalized database, etc.

The drawback of this model is the potentially large number of tables that we should go through to generate data analysis from different sources. At some point, with a very large number of records, the generation times of data analysis are expected to be significant. Nowadays, due to the many available information, applications for data analysis often use a data warehouse. A data warehouse is a system used to store information for use in data analysis. Fig. 2 illustrates a relational scheme with several dimensions of a physical data model for data analysis. This model is known in theory and practice as a star schema. There are two types of tables available in a star schema:

- Dimension tables – they are used to describe the stored data;
- Fact tables – they contain the data that is going to be included in analysis, based on values within the related dimension tables.

This physical model should have at least five tables that have the following features:

- Dictionary (dimension table) has at least two attributes – identifier and text (keyword);
- Publication (dimension table) has at least two attributes – identifier and link;

- Date (dimension table) has at least four attributes – identifier, day, month and year;
- Source (dimension table) has at least two attributes – identifier and name;
- Analysis (fact table) has links to all dimension tables in the model.

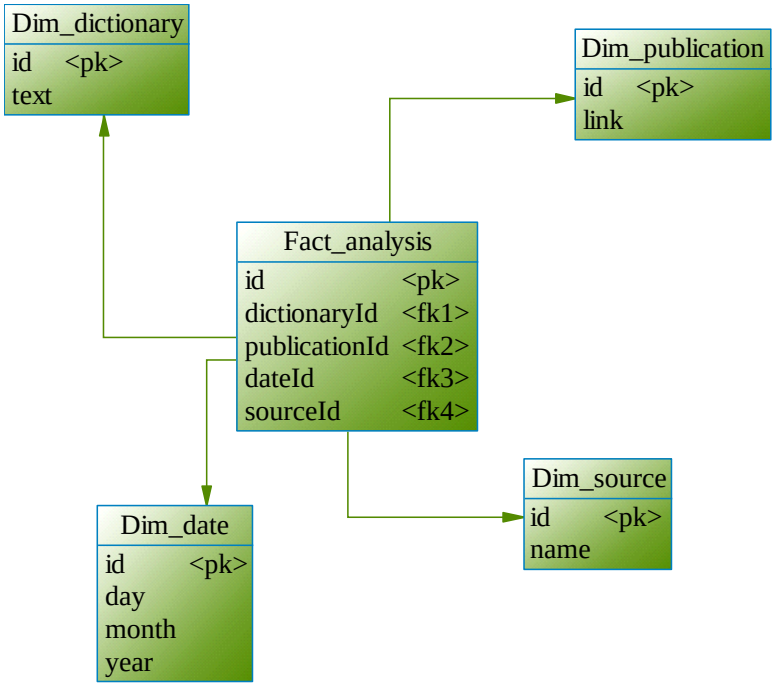

Fig. 2 Traditional dimensional data model (star schema)

With this model, at the cost of a certain compromise on efficient disk space use, it is possible to reduce the number of tables that need to be merged to execute a request and ultimately reduce the time required to execute the request. The benefits of using the dimensional model are mainly the ability to use optimized queries to the database management system and hence to achieve better times for data analysis.

3. Data model for data analysis with an additional table

Web applications for data analysis occupy a specific niche in the system of software solutions. In this sense, the data models used in these applications may differ to some extent from traditional solutions. This study offers a data model that resembles the dimensional snowflake model and physically has an additional table to optimize the generation of data analyzes based on keywords that participate in multiple publications. Fig. 3 presents this model and has the following features:

- Dictionary has two attributes – identifier and text (keyword);
- Publication has two attributes – identifier and link;
- Date has four attributes – identifier, day, month and year;
- Source has two attributes – identifier and name;
- Analysis has links to dictionary, date and reference;
- Reference serves as a many to many relationship between analyzes and publications;

- One source may have many publications, but one publication belongs to a specific source.

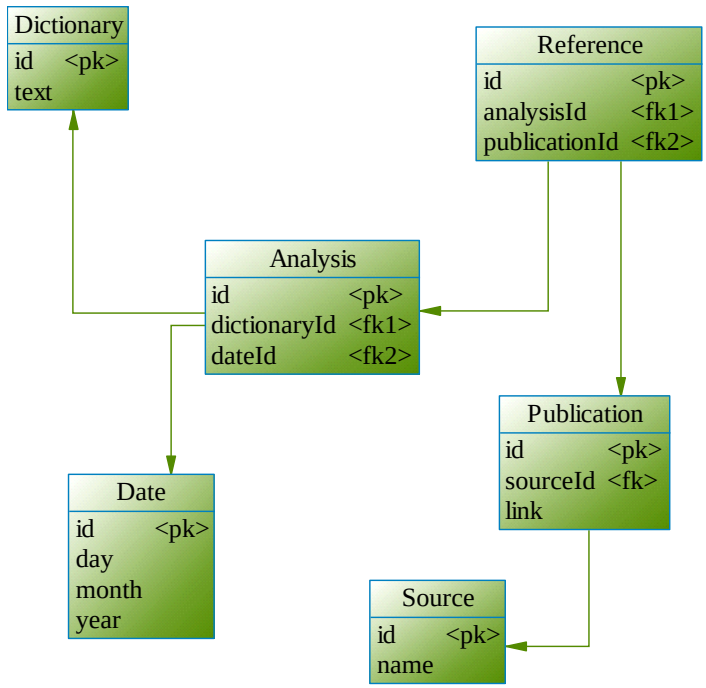

Fig. 3 Approach for data model with an additional table

The data model presented in the paper is very similar to the snowflake model and has some key benefits for data analysis purposes, namely:

- Significant increased performance of the keyword search that is present in many publications due to the availability of the additional table for many to many relationship between analyzes and publications;
- Lack of repetitions of the data, which is a drawback of the dimensional star schema model;
- Ability to select the number of publications, which contains a concrete keyword, with only one SQL COUNT query to the database.

4. Conclusion

In conclusion, it can be said that the data models of web applications for data analysis are specific and need to be tailored to the business needs and functional requirements of the relevant analysis.

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Technological Approaches for Presentation of Data Analysis in Web Applications

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Abstract. The paper examines some features of request processing models in web applications. The paper discusses issues related to the functionality of web-based information systems for presentation of data analysis. On this basis, an appropriate request processing model for data analysis in web applications is proposed. The conclusion outlines some trends in development of data analysis systems in the context of the critical role of request processing models.

Keywords. Web application, Data analysis, Request processing

1. Introduction

Some of the most used applications today are those that provide a variety of data analysis. Leaders in the IT industry have their own software solutions in this area. Many of these applications are business intelligent systems with multiple data sources. Most end-users of such applications prefer access to relevant analytics online using their web browser. This concept does not require users to install any additional and specific software products on their computers. Also, many users nowadays want access to a different web application using a tablet or other mobile device. For corporate users, the situation is different. For most of them, it is not a problem to install any specialized software systems to access data analytics. For all types of users, however, it would be convenient to be able to access different data analytics through a web-based information system that has the necessary real-time visualization capabilities. Although the traditional synchronous and asynchronous request – response models are the most common way of communication between a web browser and a web server in web applications, there are also other technological approaches, which are used in more specific web-based information systems. They usually add additional behavior to the processing of some specific requests, including data analysis. In this sense, the purpose of the paper is to present the traditional request processing models of web-based software solutions and to propose a model with an additional functionality, which would be appropriate for implementation of web platforms for presentation of data analysis.

2. Traditional request processing models

The traditional web application architecture consists of three layers – presentation (using a web browser), business logic (using a web server) and data (using a database management server). In this sense, the traditional logical architecture of web applications for presentation of data analysis has the characteristic of architectural features of three-tier architecture – the most popular architecture for the development of web-based information systems. With this architectural model, the presentation layer requests are typically run on the server-side, and the server is the component that has access to the data and can create the corresponding data analysis visualization. Fig. 1 presents a traditional model of request

processing in web applications, which includes:

- Request from the presentation part of the web application, which triggers a server-side system event;
- Server-side code (script), which contains all the functionalities of the web application, including data analysis algorithms;
- Database (storage), which is accessible from the server-side part of the system and manages all the stored data of the web application, most probably with the presence of a database management system (DBMS);
- Response to the presentation part of the web application, which includes visualizations of data analysis requested.

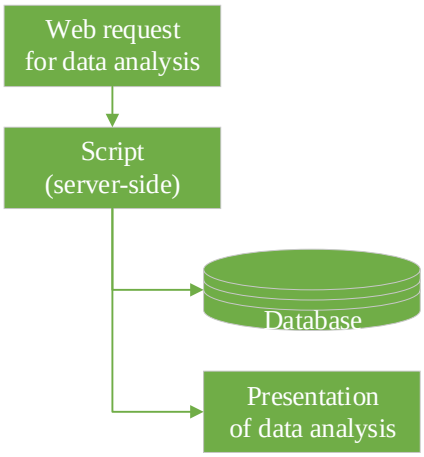

Fig. 1 Traditional model of request processing in web applications

Modern web technologies support a request processing model where the presentation layer requests are initially executed by a client-side script and subsequently asynchronously by a server-side. In these cases, the server-side part is used to access the data, but the client-side part has the capabilities to create the appropriate data analysis visualization. Otherwise, this would increase the performance of the web application. Modern ways of using technologies to change systems performance have been investigated by some authors in their researches [1]. Fig. 2 presents an asynchronous model of request processing in web applications, which includes:

- Request from the presentation part of the web application, which triggers a client-side system event;
- Client-side script (most likely JavaScript), which is capable of asynchronous communication with the server-side part of the web application without affecting (disturbing) the current state of the presentation part (user interface) of the system;
- Server-side code, which contains most of the functionalities of the web application, including data analysis algorithms;
- Database, which is accessible from the server-side part of the system and manages all the stored data of the web application;
- Asynchronous response to the client-side part of the web application, which includes either already generated visualizations of data analysis requested or all the necessary resources (most likely in JSON format) for visualization of data analysis requested by means of JavaScript.

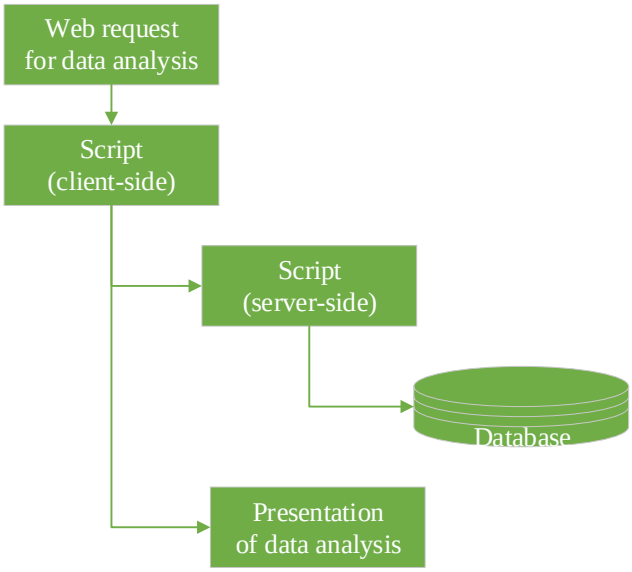

Fig. 2 Asynchronous model of request processing in web applications

The advantages of the asynchronous model of request processing in web applications are the lack of reloading of the page until the corresponding data analysis are generated and the fewer requests to the server-side part, which should save time for web application users.

3. Request processing model with an additional application server

Web applications for presentation of data analysis can be referred to a specific kind of web-based information systems. In this sense, such software solutions may also have some additions to their architecture. Many of the web applications of public sector are also relevant to data analysis capabilities. Issues, related to web-based information systems for public services have been investigated by different authors [2, 3]. The paper supports the idea of implementing an additional architectural layer that specifically takes care of making data analysis for the needs of these specific web applications. In this sense, the logical architecture of such software solutions could be related to multi-tier architectures. Fig. 3 presents an approach for web request processing with an additional application server, which includes:

- Request from the presentation part of the web application, which triggers a client-side system event;
- Client-side script (JavaScript), which creates an asynchronous (AJAX) request to the server-side part of the web application;
- Server-side part, which handles the request and contains most of the common functionalities of the web application, including capabilities for communication with a background service for handling a specific data analysis request;
- Background service, which serves as an application server and includes data analysis algorithms;
- Database, which manages all the stored data of the web application and it is accessible from both the server-side part of the system and the background service;
- Asynchronous response to the client-side part of the web application, which includes all the necessary resources in JSON format for visualization of data analysis requested by means of JavaScript.

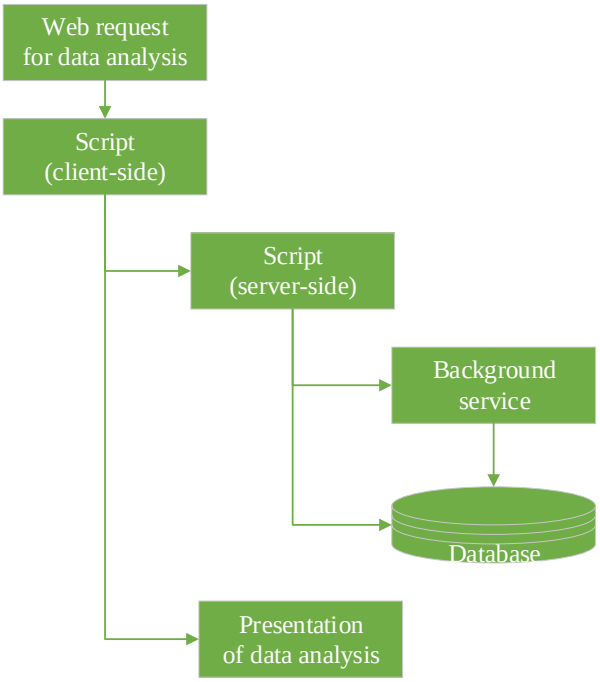

Fig. 3 Approach for web request processing with an additional application server

The advantages of the presented approach for web request processing with an additional application server could be summarized as:

- There is no need to reload the page while generating data analysis from the additional application server;
- There is no timeout risk on the web browser when it takes more time to generate data analysis;
- The ability to use the web application as a SaaS, due to modern trends, that allow the web application to provide data analysis to other systems;
- Separating the data analysis part into an additional application server, which can be physically elsewhere and work independently of the common business logic of the web application.

4. Conclusion

In conclusion, it can be said that the model of request processing in web applications for presentation of data analysis might have differences in comparison to traditional (common) web applications, basically in their business logic, due to the presence of an additional independent tier for processing of data analysis.

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Some Ideas about Student Projects in the Subjects Informatics and Information Technologies in Secondary School

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Abstract. The paper discusses some issues related to the development of practical projects in seminars on informatics and information technologies. Some examples of inclusion of Content Management Systems (specifically WordPress) as learning systems for 16-19 year old students through the creation of learning projects have been explored. There are also some ideas for direct and active inclusion of students in the learning process of principles such as "Learning by doing" and "Pupils experiencing students".

Keywords. Projects, Active inclusion of students in training, Content Management Systems, WordPress, LearningApps, e-Learning materials.

1. Introduction

Today's students differ greatly from their predecessors 20-30 years ago because they require learning lessons to be more successful and fun at the same time. This is due not only to the evolution of humanity, but also to the widespread deployment of information and communication technology (ICT) that have led to the emergence and development of the information society.

Starting from the concept of "Education" related to the concepts of "learning", "development" and "innovation" [1], we think that many useful examples of such an innovation regime are the following interdisciplinary teaching projects: "Ten IT Green nuances", "The Karst teacher", "Testing program for C# tasks "C#HaHa", "C#(fs)²", "Analysis of the students' success in mathematics".

As stated in [2] "The determining factor for the effective use of the rich seats of ICT in education is the willingness of the teacher to apply these opportunities in their professional activity." The existence of this problem is confirmed by the fact that the ten IT Green nuances project was the first of its kind at the school, where students are trained in three profiles: Informatics, Information Technology, Biology.

Following the realization of the project, the following conclusions were made by the teachers: In classes in the school should be integrated not only activities, but also skills of different people (which is one of the tasks of the good business manager); Students should be encouraged to think independently, but at the same time develop skills in teamwork, not only to think as part of a whole, but also to enjoy such collective work (having fun and playing).

2. Integration of ICT and Biology project

The learning project, called by its creators, "Ten IT Green nuances", integrates: the capabilities of today's content management systems (CMS) [3], (in particular WordPress [4]), their application in student education information technology; expand their horizons; the cultivation of pupils (and teachers) by acquiring additional knowledge and skills; emotions from working together because students "think together as a whole better than alone". The

latter statement describes the desire, satisfaction, and emotion expressed by all students, participants in this and other projects presented here, that together they have done something wonderful.

The solution to the two-sided issue: active participation of pupils in the process of education < - > work on useful for school (and society) projects we found in the following: students from both profiles Informatics and Information Technology can easily and successfully participate in such projects, helping their teachers to implement, for example, e-Textbooks (ET) and other e-Learning materials (ELM) for various subjects, including textbooks and tests in Informatics and Information technology for smaller classes.

Why e-Textbooks and ELM and can students at all over the world make e-Learning materials? Of course, it can be under the guidance of the lecturer. Today, a vast majority of students use ICT every minute. On the other hand, current students - these are the children "from birth" know how to use ICT and extremely freely create by means of ICT. For them, it is very easy and very natural (and on the other hand extremely interesting) to compile electronic tests in the form of games and ELM by means of such systems as Content Management Systems (as WordPress [4], etc.) and LearningApps.org [5] and [6].

The creation of an ET of students and the support of educators on an educational site, as taught here, helps not only the other students, but also the authors of the project. At the first aim of the project was to make lessons and training easier and more entertaining. But after attending the project in a school conference organized by Institute of Mathematics and Informatics of Bulgarian Academy Sciences, high school students "have set a second goal": to show their teachers that and thus may be involved students more actively in the learning process, to fuel and develop creative skills in them. And that is very important: the students are satisfied with the significance of the realized educational project and are happy that they have done something useful.

The first lesson of the project was based on Edward de Bono's methodology "Six Thinking Hats" [7]. The idea of the project described in details in [8] arose from the fact that at the same time the students did not do the lessons and tests of Biology. It was therefore decided to make ET on textbook Biology [9] and in particular on studies at this time the "Organism and Environment", which had to be extended with drawings and short films on the topics and also with quizzes and educational games. Once ET started taking shape, on the advice of teacher students designed the logo of the educational site. Two of the students presented their drawings and after a short vote the logo shown in fig. 1 - a tree whose crown is the globe. Since the main theme of the educational site is the ecology and conservation of air, water, soil, ecosystems, animal and plant world, the green color and the word "green" are present everywhere in the content and layout of the web site.

A learning tool of such of kind (such projects created by students and pupils are presented and described in [10], [11] and [12]) is accessible and easy to use. Project participants hoped that it would help many students learn the learning material. With such a goal is created tab "Games of green", which included tests "Cache green" ("Who wants to be a millionaire"), "Green Thinking" ("Gibbet"), "Green conundrum" ("Crossword "- fig. 2) implemented with the applications "Who wants to be a millionaire green", "Gallows", "Crossword" by means of the web application LearningApps [5] and [6].

Evidence of the viability and sustainability [13] of ET and ELM created by students is the fact that two months after the first version of the textbook, the project's authors still used it for self-training and included new games.

The work on the Ten IT Green nuances project [14] demonstrated how ELM can easily and by accessible means be made available in the form of a website not only useful for acquiring new knowledge by pupils but also expanding their horizons simultaneously they are

improving yourself by acquiring additional knowledge and skills. Many of the teachers in the school, as well as students from other classes and profiles of the Natural-mathematical gymnasium, were involved in the project. The results of the work shown at the student conference have provoked interest and desire on the part of the teachers in the school to implement ELM in their subjects as well. Ideas have emerged for the creation of such projects in Chemistry, History and others.

Fig. 1. Home page of the web-site "Ten IT green nuances"

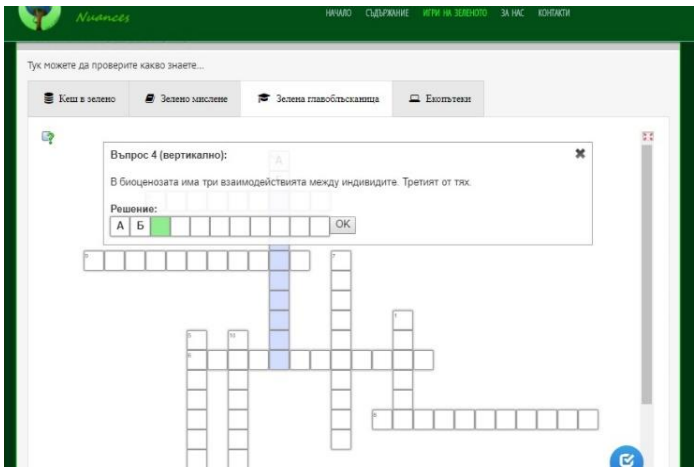

Fig. 2. The created crossword puzzle named by the pupils "Green conundrum"

A proof of the enthusiasm of the students is the fact that when they were given a task to do the project on Literature (in the works "Don Quixote," "Hamlet," "Tartuffe," "The Divine Comedy") they themselves (without thinking and without seeking foreign help) made the web site "Tartuffe" [15], and after that they included games on all of the above-mentioned books. The color scheme of the site was chosen black in relation to the fact that Tartuffe is a negative character (Figure 3 and Figure 4).

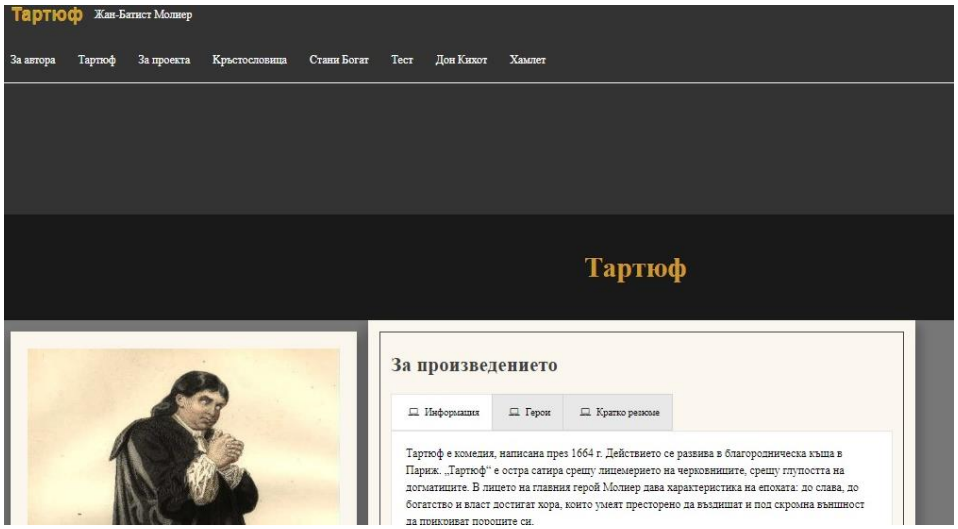

Fig. 3. Project on Literature "Tartuffe"

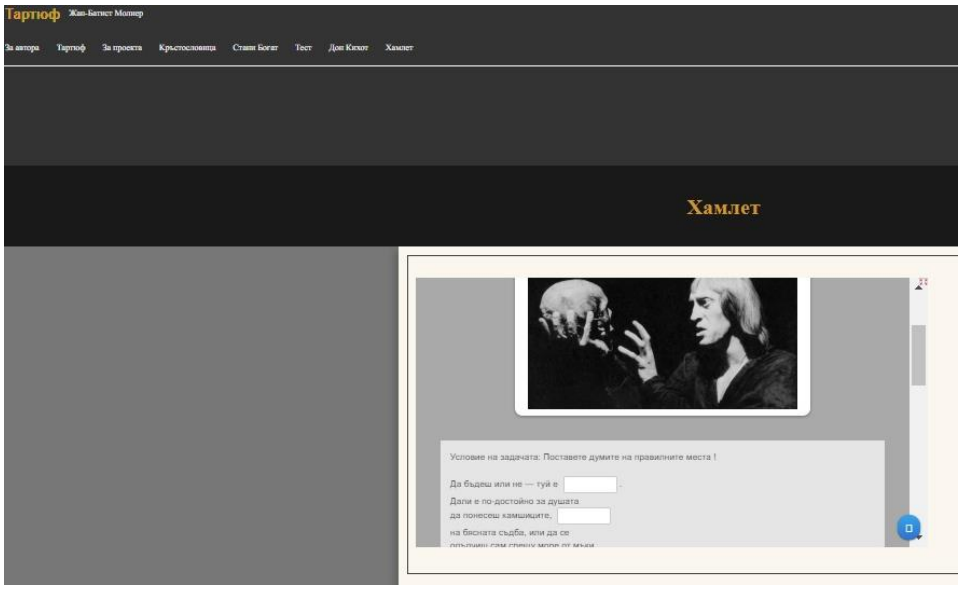

Fig. 4. Game "Fill the gaps" in the Hamlet's monologue in the project "Tartuffe"

3. Other ideas for student projects

Here are some examples of subjects that combine teaching subjects: 1) Mathematics and Information technology; 2) Informatics and Information Technology; 3) Geography and Information Technology.

Mathematics and Information technology

As an example, we consider the project in Statistics, which aims to compare and show what academic development of students in mathematics who have chosen to train in a mathematical profile.

The original idea for the project was to see what is the success of mathematics students from specialized class "Informatics". The original hypothesis [16] stated that the success of the class students was getting worse. Therefore, data were collected from the diaries of the class for four years (from 2015/2016 to 2016/2017, 2017/2018, 2018/2019). By the Microsoft Excel spreadsheets, data were classified and treated with built-in functions of this software.

The work on the project consists of solving the following tasks:

1) Making math assessments of pupils in a class for a four or five year period starting with their entry into the 8th grade;

2) Designing appropriate tables to represent numerical rows;

3) Drawing appropriate tables with the numerical rows in the Microsoft Excel spreadsheet;

4) Calculation of Student's T-criterion [16] for comparing the mean values and F-test of Fisher [16] for comparing the dispersion at an appropriate degree of reliability;

5) Performing a correlation analysis by the method of Kruger-Spearman [16];

6) Adoption or rejection of statistical hypotheses for the success of mathematics students.

For the purposes of the project and the automated performance of student success analysis, both formulas and embedded Excel functions are used (*AVERAGE*(); *STDEV*(); *TINV*(); *TTEST*()). For all the samples computed, the T-criterion was lower than the T-criterion table value (t = 2,0129), *FINV*(), *RANK*())

To calculate the T-criterion, for example the formula (1) is entered in cell D33 of the spreadsheets.

```
=(((ABS(sr_81-sr_82)))*SQRT(((((n1n2-1)*dis_81*dis_81+(n1n2-
1)*dis_82*dis_82)/ ($C$30)))*SQRT(n1n2*n1n2/n1n2+n1n2)))          (1)
```

In this way, students recall how absolute cell addressing names is used in Microsoft Excel. (In the example formula, cell names are given with the calculated mean values, dispersions, freedom degrees, etc.)

The presented experience of applying the Statistics in the development of training projects has shown its effectiveness. Students see the meaning of learning math statistics.

In addition, students feel significant that they are working on research useful for the High School. This type of project enables students to improve, acquiring additional knowledge and skills. Learn a lot about spreadsheets (especially Microsoft Excel) and when in the future they will need to form and process tabular data, they will be confident in yourself. And last but not least: This type of project is "patriotic" to the school because it refutes the unfortunate rumors that secondary education is not at today's level.

Informatics and Information technology

One such idea, which was realized last year and was highly appreciated at the annual Student Session of the Union of Mathematicians in Bulgaria, is the creation of software for testing for programming tasks. With this software was created by a student of 9th class with an interest in programming and in particular - programming in C #.

The aim of the project is to automate the verification of programming tasks.

The initial goal of the project is to integrate the software into a mathematics school in order to facilitate the work of the teachers and to offer students a self-test option during their own work.

Due to the flexibility of the core code of the developmental testing programs, they can be easily modified and Disseminate. The modification consists of compiling a test file for a particular task and modifying the master code of the test program by adding test input data, and in the future this process will be simplified to a simple level, indicating that the test programs can be created and by people without knowledge of informatics. The idea for the project comes from the fact that the principle of testing programs does not differ greatly from the programs for checking the programming tasks of the Olympiads and competitions (the so-called "checkers").

Geography and Information technology

An example of such a project that is similar to the one mentioned at the beginning "Ten IT Green Nuances" is the project "The Karst Teacher" [17]. With this project students from 11th grade speciality "Informatics" are included in the initiatives of specialized educational strategy ProKARSTerra-Edu [18] of the Experimental Laboratory on Karstology in the National Institute of Geophysics, Geodesy and Geography - BAS. The authors of the site, inspired by the idea of learning about karst systems by the karst, draw attention to the "underground" beauty of our land. Deploying in depth, students seek, find and show the science and disciplines in the karst.

On the website they can read the following lessons: "Karst Geography", "Karst Chemistry", "Karst Physics", "Biology in karst", "History in karst", "Literature for karst," "People and karst".

The aim of the project "The Karst Teacher" is not only to show these beautiful and stunning places in nature and help students understand what is the karst as a theme in Geography, but also to see the application and interconnection between "classic" science. That's why the Karst's textbook includes the following topics:

What is karst. This is the first page of the Karst textbook. It explains basic concepts of karst and karst forms (fig.5). The page is illustrated with schematic images of the karst forms from the 8th grade geography textbook [19].

Karst Geography. This page describes the importance of karst and its origin. Special attention has been paid to the karst in northeastern Bulgaria, as one of the aims of the project is to tell about the riches of the native land. The "Karst in Northeastern Bulgaria" subtopic considers its construction, its species and its economic significance for this part of Bulgaria.

Karst Chemistry. On the page of the of chemistry lesson are given the equations of chemical reactions that “create” karst forms.

Karst Physics. This page tells about the formation of stalactites and stalagmites (fig. 6). It illustrates a schematic representation their formation, as well as the process of breaking down under the force of gravity *G*.

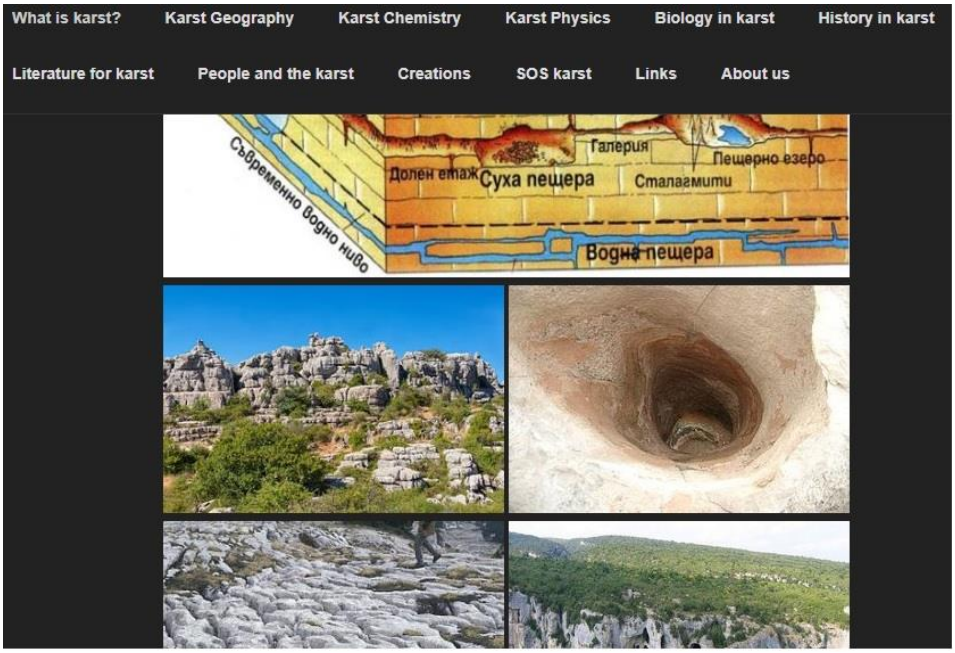

Fig 5. Page "What is Karst?"

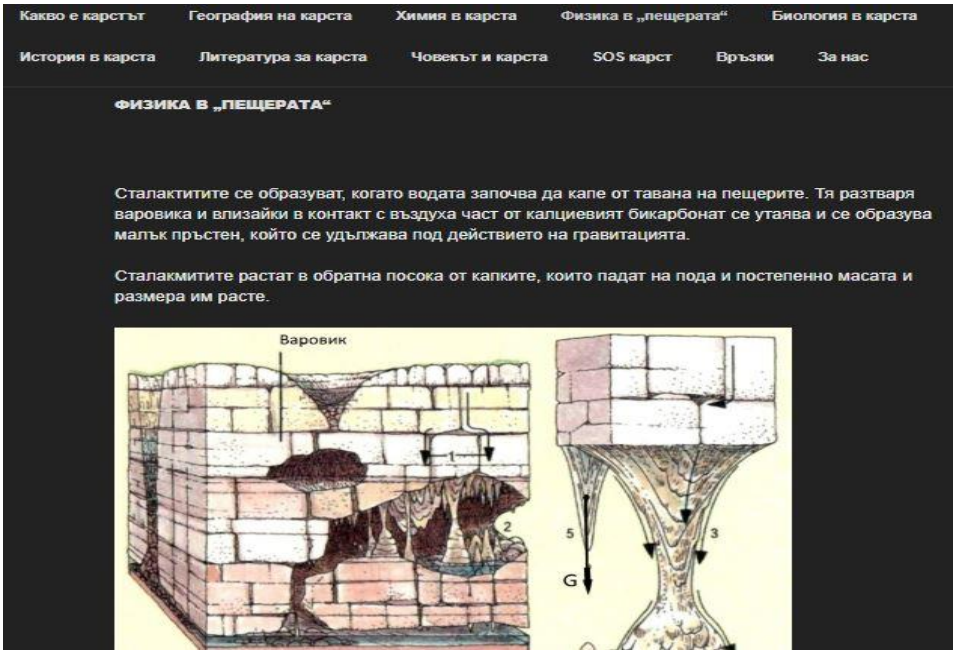

Fig. 6 Page „Physics in the cave"

Biology in karst. This page-lesson gives examples of cave fauna. The lesson is illustrated with photographs of some types of cave organisms.

History in karst. As the most typical representative of karst forms - caves, the homes of our ancestors are considered in this lesson (in the Bulgarian version of the page - History in Cave). The "lesson" is illustrated with pictures of drawings in caves describing scenes of hunting, dancing, and a wide variety of animal species (fig. 7).

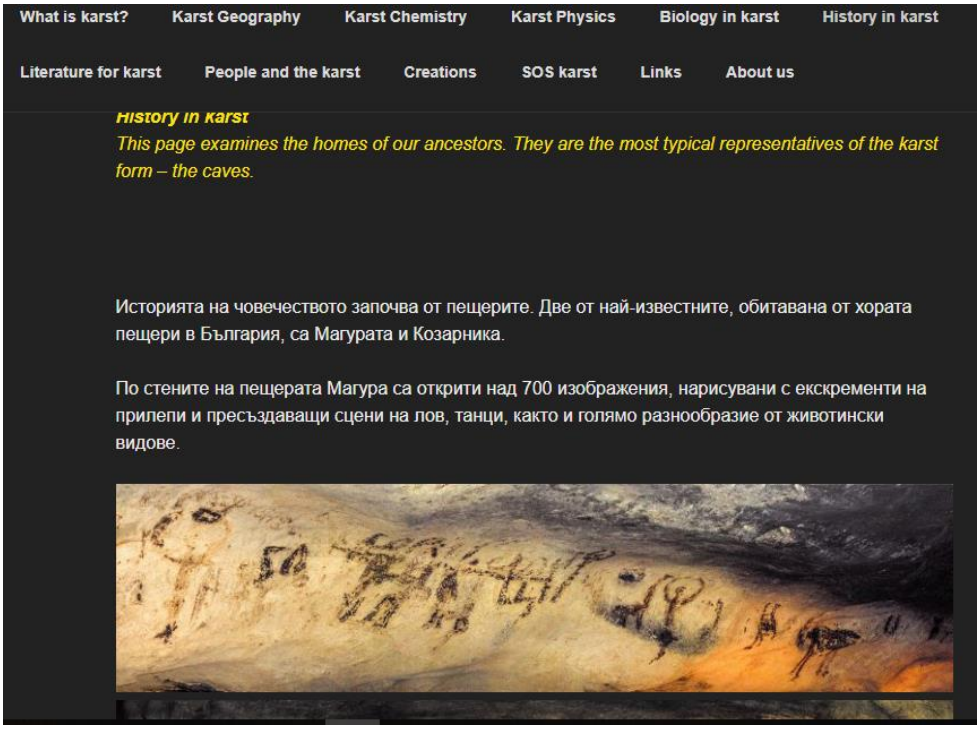

Fig. 7 Page „History in karst“

Literature for karst. There are many (beautiful and terrible) legends about caves. So in this lesson they tell the legend of the best musician in Ancient Greece, namely the singer of Thrace - Orpheus.

People and the karst. This page looks at the contamination of karst inside and outside caves, anthropogenic factors and cave pollutants. The page is illustrated with examples of malicious human activity in karst areas.

SOS karst. This page contains links to websites of the Bulgarian caveman associations, so that every "fan" of the Karst textbook to actively engage with the protection of karst in Bulgaria.

"The Karst teacher" is a learning project. Besides the "moral" aspect of karst conservation, it is also a motivation for active learning, as well as the discovery of science as a professional future for students. And with the two most important for the authors pages "People and the Karst" and "SOS karst", the authors call for study in order to preserve Karst forms and Nature as an environment of existence and an active civic position.

4. Conclusion

Training, which is implemented as illustrated allows students to develop their skills related to the information technology, and also to develop innovative thinking. In addition, lecturers teach children the so-called soft skills as creativity, self-thinking, and also team thinking and skill to discuss without quarrels, self-control, integration skills, and last but not least: a process of mutual learning between teachers and their students is going on. When teachers know how do think their students "entering into their skin" and learn with them, they are much more effective will be able to manage the learning process, improve their experience can offer and introduce more adequate training methods.

The projects shown demonstrate the capacities of the blending of interactive educational content [13] so as to educate a whole personality in the learning process, which means that not only knowledge and skills are the objectives of teaching but also the development of a "complete" personality.

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Gamification in Management Information Systems

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Abstract. The paper aims at revealing how gamification may be in use in management information systems (MIS) implementations and further management of these. Two hypothesis stand in the centre of the research. These are: Gamification may be used within MIS to stimulate user engagement and fight the user rejection in these systems' implementation and Gamification may stimulate the right and sustainable usage of MIS. The research methodology employs a focus group of MIS consultants for elicitation of some useful gamification elements, which are suitable for embedding within MIS products. The general goal of the study is for achieving stronger key users' engagement during implementation project phases and prominent MIS usage after go-live. ERP implementations only were used for limiting the scope of the study.

Keywords. Management Information Systems; Gamification; ERP; Innovation Management; Project Management;

1. Introduction

Gamification has recently gained much interest of both practitioners and academics. Normally, gamification is used as a tool for better understanding of a particular material or topic and also to illustrate a specific scenario or a case in which demonstration and empathy are required. It has been used for greater commitment to a cause (representing the topic as a game, not an obligation or responsibility). Other case studies show gamification utilization for increasing results and bringing reality closer through role play (in which situations the user would be in an artificial environment and would not be able to show his potential). Gamification is used as well to accommodate intergenerational differences in the setting of objectives and tasks (particularly between the different thinking of millenniums - born around and after 2000 and their possible leaders from previous generations). Gamification is applied for many other purposes, its main idea is the use of game elements in a non-business context in order to achieve concrete and better results. Thus, the generalized perceptions of gamification give reasons for the researchers to believe that it would be a particularly useful and applicable tool for increasing the learning outcomes and the business results as a whole. Bearing in mind the scale of the concept and the wide spectre and scope of its application, the proper usage and application of gamification is a difficult task especially for achieving particular goals. No matter of the large quantity of research during the latest years analyzing and digging the gamification, the topic is still not scoped. Even more, the concept is increasingly attracting more interest from different industries for achieving different purposes. On the other hand, the large number discussions, research and case studies give reasons for reckoning the topic as a hot one.

Currently, much research examine the application of gamification in different contexts, for different purposes, in different industries. However, a deep understanding is still missing since gamification has been studied mostly as a tool for learning purposes.

This research focuses on researching how gamification may be of use in implementation of management information systems (MIS) for handling different problems that these systems meet during their implementation and usage. This is achieved through employing a focus group from subject matter experts in MIS implementation and maintenance who formulate some game elements, which are already in use for these purposes, as well as some good practices in embedding gamification into MIS projects and products.

2. Theoretical Framework of Gamification

Play as a phenomenon is older than culture, economy, all socio-cultural and socio-economic system as we know them today prior to human society and human civilization [1]. The author makes an analogy with animal games that resemble and etymologically represent the same process, which suggests that games as a phenomenon may have existed even before the birth of mankind. Analysing the game as a concept, Huizinga concludes that it is more than just a physiological phenomenon or a psychological reflex. It goes beyond purely physical or purely biological activity. This is a significant feature – i.e. has some meaning and serves not only on its own, isolated from side factors and purposes, it is a function of human being. The importance of games as a phenomenon is also confirmed by pedagogical research, which determines games as an essential and critical element of the maturation process. After the brief preface, which puts the games at the centre of human development since its inception, the concept of gamification is brand new, yet significant and promising for its development.

Among the first to define the concept of gamification as a modern concept is Nick Pelling [2] [3], who saw it back in 2002 as a process that makes the interface of different products, in his case, electronic transactions, more fun, faster and more playful. The gamification process defined by Deterding et al. [4] is the use of game elements in non-game contexts. In depth, this definition is dealt with in another authors' study [5], where they explain that it is a matter of game elements, not a game in general. While games are usually played, play itself is a different and broader category than the game itself. Games, on the other hand, are characterized by rules and competition, or the struggle with concrete and persistent results or goals on the part of those involved. The authors make a distinction between the term "serious games" and "gaming". While serious games describe the use of incomplete games for non-entertainment purposes, the use of games and the use of gaming elements is a way of diversifying existing approaches for better performance. A link between the concept of gaming and serious games, however, is that both concepts use games for purposes other than their normal use for entertainment. In addition, gamification is also defined as a process of using gaming mechanisms and game thinking to solve problems from Deterding itself. In another study, [6] claim that gamification as a term derives from the digital media industry. Lee & Hammer [7] believe that gamification is the use of gaming mechanisms, dynamics, and frameworks to promote desired behaviour. Kapp [8] defines gamification as the use of game-based mechanics, aesthetics and playful thoughts to make people loyal, to motivate action, to encourage learning, and to solve problems. The key point of gamification is the inclusion of gaming tasks that players have to perform [9]. McGonigal [10] summarizes in a study that, since the beginning of the 21st century, a lot of research interest has been on games as a phenomenon through which can be conveyed an element of joy and excitement in serious work situations and their solution. Spakova et al. [11] defines gamification as "the process of doing activities in non-game contexts such as games." Another definition in the literature interprets gamification as an informal term for the use of video game elements in non-gaming systems to improve user experience and user engagement [12]. Huotari & Hamari [13] divide gamification into three parts: (1) implementing elements of the game in non-gaming activities, (2) making psychological changes, and (3) visible changes in user behaviour.

As a summary of the analysed definitions, it can be concluded that gamification is a concept for using game elements [14] [15] [16] in a different non-game context [17] [18] [19] for the purpose of increasing consumer engagement [20] [21] [22]. Again for the purpose of systemizing and summarizing, Jakubowski [23] concludes that he considers the following two definitions to be the most focused: 1.) Gaming is the use of game elements in non-game contexts [24]; 2.) Ignoring is the process of gaming and gaming mechanics for consumer engagement and problem solving [25].

The table below summarizes the definitions in the scientific literature.

Table 1 Definitions of gamification in the scientific literature

Authors	Definition
(Pelling, 2011, p.1)	„A process that makes the interface of different products, more fun, faster and more playful“
(Deterding et al., 2011)	„Using game elements in non-game contexts“
(Deterding et al., 2011)	“The process of using gaming mechanisms and game thinking to solve problems by yourself “
(Deterding et al., 2011)	“Term for using video game elements in non-gaming systems to improve user experience and user engagement”
Lee & Hammer (2011)	“Using gaming mechanisms, dynamics and frameworks to promote desired behavior”
Kapp (2012)	“Use of game-based mechanics, aesthetics and playful thoughts to make people faithful, to motivate action, to promote learning and to solve problems”
Spakova et al. (2017)	“The inclusion of gaming tasks that players must perform”
Huotari & Hamari (2012)	“Implementing elements of the game in non-games activities, making psychological changes and visible changes in user behavior”
(Zicherman & Cunningham, 2011)	„ A process of using thinking and mechanics to engage users“
(Burke, 2012)	“Using game mechanics and game design techniques in non-game contexts of design behavior, skills development, or engaging people in innovation”
(Werbach & Hunter, 2012)	“Using gaming elements and game design techniques in non-gaming contexts”
(Huotari & Hamari, 2012)	“A process of improving the service with the ability to play games to maintain the overall value creation of the user”
(Werbach, 2014)	“Process of turning activities into more playful situations”

For the research purposes after the performed literature analysis on the concept of gamification, the author uses the following definition:

“Gamification is using of game elements, techniques and mechanism in non-game context to achieve specific goals”.

The result of the analysis of all the definitions and understanding of gamification in the literature provides a contribution with 1.) Unifying all the mentions ingredients of game within

the concept, i.e. elements, technics and mechanism; and 2.) Clarifying that gamification concept aims at delivering results on particular topics and already set goals.

Bearing in mind the formulated concept of gamification, the study goes to its main objective, i.e. answering to the main research questions (RQ) of the study:

RQ 1: Which ones of the gamification elements, techniques and mechanism are suitable for implementation within MIS products.

RQ 2: What specific goals may be achieved and supported by gamification during MIS implementation and management.

3. Methodology

The methodology in the study employs a focus group with subject matter experts in MIS implementation. The reason for using this specific research technique is its usefulness in qualitative research for depth understanding of research questions [26]. The choice of using subject matter experts is because of the required knowledge on MIS for the research purposes and also for extracting value with providing the understanding of different stakeholders, which permits the analysis to predict the reaction of potential groups on the field [27].

Two different focus group meetings were organized. The first focus group meeting took place in September, 2018 and it was formed by fours specialists in MIS implementation. The literature analysis, performed above was provided to the specialists for bringing more knowledge and understanding on gamification as a concept even though the fourth members of the focus group had declared their awareness of gamification. The awareness of gamification and its application were both criteria for selecting the subject matter experts as the main purpose is to elicit and summarize the already used gamification in MIS implementation. For setting a scope in the discussion, the group limit their brainstorming activities to ERP implementations only. The focus group set a limitation also by defining the usually used modules in ERP. These are: Finance – general ledger; Finance – fixed assets; Accountancy – customer payments; Accountancy – vendor payments; Accountancy – bank management; supply chain management – vendor management; supply chain management – purchase order management; supply chain management – return management; Procurement – vendor offers; Procurement – master planning; sales and marketing – customer management; sales and marketing – sales order management; human resource management – employee management; human resource management – payroll management; Inventory – product management (items, BOM, services); Inventory – warehouse management; customer relationship management – lead and prospect management; customer relationship management – offering process; production – master planning; production – production management processes; Reporting – standard ERP reports; Reporting – BI extended reports. For each discussed module as part of an ERP implementation, different game elements, techniques and mechanism are assigned as well as the appropriate project phase for their usage. The focus group sat down in a meeting for 4 hours. The approach for performing the discussion was based on completely affirmation and acceptance of the game elements, techniques and mechanism in the different modules, processes and stages during MIS implementation.

The second session for an hour was arrange for a discussion on game elements, techniques and mechanism, which are more relevant and appropriate for maintaining/supporting/managing MIS after its implementation in an organization. The assignment of a gamification element to each of the ERP modules during implementation and management is made based on the gamification tools described by Boer [28] since they are wide ranged enough for achieving diverse results. These are: limitations; emotional reinforcement; storytelling; progressive relationships; challenges; opportunities for rewarding; cooperation in the field of competition; cooperation; feedback, opportunity for a victory;

achievements; leadership; avatars; levels; badges; points; fights; searches; collections; social graphics; combat the team; unlocking the content; virtual goods, gifts. During the discussion, the focus group also agreed on the appropriate project phase where the game elements, techniques and mechanism would be more suitable. For this purpose, the project phases from Project Management Institute have been used: initiation phase; planning phase; analysis phase; implementation phase, monitoring phase and closing phase [29]. The assignment is done on the bases of relevance and adequacy. During both meetings the author of the paper was taken the role of a moderator so as to keep the scope, target and the focus of the group. The moderator had also the responsibility to take notes and summarize the discussed topics.

The outcomes of both meetings are presented in the results' section of the study and aim at delivering knowledge on the already applied gamification practices within the business. The added value and the contribution from this approach is the relevancy and purposefulness of application of gamification in MIS implementation and maintenance for clarifying how exactly it is used at the moment. Main supporting reason for this is the characteristic of gamification to be extremely useful when it is applied for targeting specific and particular goals.

4. Results

The outcomes of the focus group meetings are presented in table 2 and table 3. The results from the first focus group meeting, which was supposed to elicit the game elements, techniques and mechanism in the different modules and respectively in the different phases during MIS implementation, are presented in table 2. They are organized in sections from the author for better understanding according to the ERP module for which they are the most relevant.

Table 2 Game elements, techniques and mechanism used the different ERP modules

ERP module	Game element techniques and mechanism	MIS implementation phase
Finance – general ledger	virtual goods, opportunities for rewarding, feedback, achievements, gifts, challenges	analysis; implementation; monitoring
Finance – fixed assets	fights	Planning; analysis; monitoring
Accountancy – customer payments	Collections; achievements	Planning; analysis; implementation; monitoring
Accountancy – vendor payments	progressive relationships	analysis; implementation; monitoring
Accountancy – bank management	progressive relationships; Collections	analysis; implementation; monitoring
supply chain management – vendor management	cooperation in the field of competition, progressive relationships, gifts, storytelling, challenges; storytelling	Planning; analysis; implementation; monitoring; closing
supply chain management –	Gifts; challenges; storytelling	analysis; implementation; monitoring; closing

purchase order management		
supply chain management – return management	virtual goods, levels	analysis; implementation; monitoring; closing
Procurement – vendor offers	cooperation in the field of competition, progressive relationships, storytelling	analysis; implementation; monitoring; closing
Procurement – master planning	emotional reinforcement, achievements	Planning; analysis; implementation; monitoring
sales and marketing – customer management	emotional reinforcement, opportunities for rewarding, gifts, challenges	Planning; analysis; implementation; monitoring; closing
sales and marketing – sales order management	levels, challenges	Planning; analysis; implementation; monitoring
human resource management – employee management	emotional reinforcement, progressive relationships, storytelling	analysis; implementation; monitoring; closing
human resource management – payroll management	virtual goods, cooperation in the field of competition, gifts, storytelling	Planning; analysis; implementation; monitoring; closing
Inventory – product management (items, BOM, services)	cooperation in the field of competition, progressive relationships, storytelling	Planning; analysis; implementation; monitoring; closing
Inventory – warehouse management	levels, cooperation in the field of competition	analysis; implementation; monitoring; closing
customer relationship management – lead and prospect management	emotional reinforcement, achievements	Planning; analysis; implementation; monitoring' closing
customer relationship management – offering process	virtual goods, cooperation in the field of competition	Planning; analysis; implementation; monitoring; closing
production – master planning	levels, cooperation in the field of competition, achievements	analysis; implementation; monitoring
production – production management processes	Achievements, levels	analysis; implementation; monitoring; closing
Reporting – standard ERP reports	virtual goods, cooperation in the field of competition, achievements, levels	analysis; implementation; monitoring
Reporting – BI extended reports	virtual goods, cooperation in the field of competition	Planning; analysis; implementation; monitoring; closing

The results from this first discussion provided also understanding on where exactly these gamification tools could be used from project management point of view. It seems these are most relevant and appropriate for analysis; implementation; monitoring phases of MIS implementation.

The second part of the deliverable from the research is the outcome from the discussion taken part in the second meeting of the focus group. It was also taken place in September 2019, two weeks after the first one. It was relevant for maintaining and management MIS. The results are presented with explanations from the experts on how exactly the examined gamification elements, techniques and mechanism might be in use. The approach of presenting the outcomes aims at delivering more practical knowledge on real application of gamification within MIS management. The results are presented in table 3 with the leading role of gamification elements, techniques and mechanism, identified in the previous focus group meeting.

Table 3 Game elements, techniques and mechanism used ERP management

Game elements, techniques and mechanism	Explanation for usage
virtual goods	By promising virtual good for performing tasks accurately, the overall performance of MIS is better and users follow the right process more engagingly
cooperation in the field of competition	Most of ERP processes rely on good cooperation between users and different teams. That is why cooperation is stimulated by competition and thus brings better performance and minimizing mistakes.
achievements	Since ERP users have usually been assigned to daily and routine duties and tasks, different levels of achievements bring them more engagement and passion in work.
levels	Since ERP users have usually been assigned to daily and routine duties and tasks, different levels of achievements bring them more engagement and passion in work.
opportunities for rewarding	Rewarding has been recognized in the literature and practice as one of the strongest motivators for achieving tasks and performance. The properly embedded opportunities for rewarding not directly related to payment gives other perspective of users and motivate their engagement better than extra payment on monthly basis. On the other hand, that approach stimulates each one of the performed tasks and the team work.
gifts	Gifts are almost as strong motivator for achieving performance and results as payment is. By providing gifts instead of extra payment, employers stimulate the inner employees'' engagement.
challenges	The newly generations are more and more less susceptible to extra payment. The motivational factors for stimulating their work performance is a huge topic and challenges have been recognized as a tool for handling this problem.

5. Conclusion

The research provides a general information on how gamification, i.e. game elements, techniques and mechanism may be used in MIS implantation (with the example of ERP systems) and possible these to be continually used within the ERP management after the go-live of the system. As part of the enterprise assets, MIS are usually compromised by curved processes, bad practices, single-headed in decision-making, etc. By embedding gamification within these two processes – implementing and managing a management information system, the issues might be solved or at least improved.

The research questions stated at the beginning of the paper have been answered.

RQ 1: Which ones of the gamification elements, techniques and mechanism are suitable for implementation within MIS products.

- The suitable gamification elements, techniques and mechanism according to the formed focus group and the provided both gamification literature analysis and summary of gamification tools is described in details in the research. The most appropriate gamification tools which were several time mentioned within different phases of implementation and for different ERP modules are: cooperation in the field of competition; achievements; virtual goods; levels; opportunities for rewarding, feedback.

RQ 2: What specific goals may be achieved and supported by gamification during MIS implementation and management.

- The outlined specific goals that may be achieved and supported by gamification during MIS implementation and management were: stimulating engagement; stimulating better performance; enjoying the route tasks and operations; stimulating the proper work; minimizing process curving.

The stated hypothesis are also supported by the research by providing examples and expert opinion via a focus group and a brainstorming. Gamification may be used within MIS to stimulate user engagement and fight the user rejection in these systems' implementation and Gamification may stimulate the right and sustainable usage of MIS.

Future work of the author will examine what exactly are the results of embedding of gamification in real MIS implementations.

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Management Information Systems (MIS) Boost Organizational Innovation Competencies

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Abstract. The purpose of the paper is to research empirically the interconnection between using management information systems (MIS) and boosting corporate innovation competencies of business organizations. The corporate innovation competencies in the study are framed by the Company Innovative Leadership model, which encompasses eight core business functions to create and stimulate innovation competencies. These are: (1) keep of organizational experience; (2) increasing motivation; (3) systematization of lessons learned from completed projects; (4) human capital characteristics; (5) creativity management (ability to generate ideas, critical thinking and creative problem solving); (6) Change management (situation sensitivity, status quo, intelligent risk taking, enhancing change); (7) integration of perspectives (openness to ideas, research orientation, cooperation); (8) entrepreneurship (identifying problems, seeking improvement, gathering information, independent thinking, technological consciousness, result orientation). The research methodology employs a survey across 51 middle and high level managers from business organizations, operating in Bulgaria.

Keywords. Management information systems, Innovation, Innovation management, Innovative mix, ERP, CRM, BI.

1. Introduction

Innovation is a top priority for companies, as there is a positive correlation between innovation on one side and corporate profitability and competitiveness on the [1]. This link also exists at sectoral and national levels, not only at an organizational one [2]. Innovation has been also recognized in the literature as strategical tool for overcoming both organizational and national challenges [3]. Many researchers summarize that, basically, there are two fundamental aspects that can be directly used for achieving economic viability and competitiveness on macro and micro level: to develop countries' and organizations' potential to generate innovations and to develop some mechanisms of these countries and organizations to adopt innovations [4] [5] [6]. Obviously, improving and boosting a country's innovativeness means improving these countries enterprises' innovativeness.

This research steps on the common understanding that innovation is essential for organizations and based on the statement that innovations would transform the economy up to a superior level, the issue how to manage them more effectively is still valid [7]. Some researches point out that development of radical innovations requires completely different managerial approaches compared to the ones needed for incremental innovations [8] [9] [10]. All these do support the statement that researching deeper the areas of application of managerial practices for innovation stimulation is a topic from intensive interest of both researchers and practitioners. The current study examines how Management Information Systems (MIS) boost organizational innovation competencies. Organizational innovation

competencies are an important ingredient and asset of organizations. On the other hand, MIS are a management irreplaceable element in most of enterprises all around the world and their importance for organizational management has been widely researched. However, the collaboration between use of MIS and innovation competencies is still unexplored. The research has been supported by empirical research across 51 managers in different industries, which reveals their vision on how MIS might be of use in innovation management.

2. Theoretical background

The presented theoretical background aims at scoping the currently existing research contributions of the objects of the research in the scientific literature. The objects of the research are the organizational innovation competencies and MIS, and their possible collaboration as management tools for enterprises. The collaboration and knowledge transfer between until recently separate scientific branches is now common sense. Innovation has been more and more interdisciplinary and technology is a key ingredient in it [11].

2.1. Innovation and innovative mix

Innovation represents a wide range of complex and individual aspects and most precisely would be defined according to their more detailed classification and specificity according to the object of innovation. Innovation is categorized and systematized in the scientific literature on a variety of criteria and according to many of their characteristics. For the purpose of this study, the following definition has been used, which extends the common understanding of innovations and generally summarized the definitions in the literature:

"Innovation is a purposeful activity to identify or create needs better and introducing new solutions for these needs' satisfaction that improve the current state and the satisfaction of the users and also innovators profiting from it."

Other way of setting the scope of innovation is defining it by check listing the aspects of innovation, which are: something new; leads to improvement; brings value; they are made on purpose, not accidentally; satisfy a particular need or create new necessity; they are the result from systematic experiments; well feed-backed from customers/users; suggests scalability; they are reasonably priced, respectively are produced, created or executed in an economic reasonable way; applicable for practical and commercial objectives; create wealth or social welfare; adoption of something existing [12].

Innovative mix or innovative management mix is a concept that is rare in the literature and there is no uniform definition. It follows the example of the marketing mix, which is a set of actions or tactics that a company uses to promote its brand or product on the market. 4Ps are a typical marketing mix - price, product, promotion, and [13]. The innovative mix has been used so far to summarize the variety of practices applied by organizations in their efforts to develop and manage their innovativeness and innovation without the concept to claim having a structure and interdependence [14]. In contrast to the marketing mix, which has its clear elements and represents a "set of actions or tactics," the innovation mix is currently described in the literature as a variety of elements, features or actions that apply to a particular organization without claiming for universality, sufficiency, consistency or efficiency. The innovative mix in the present study is used as a set of core actions in the organization that aim at increasing innovation in general, by action towards: (1) innovation management and (2) organizational innovativeness. Innovation management is seen as an action on the part of the organization to create and maintain a management model that stimulates and provides the full cycle of innovation activities, the creation of innovation process and innovation strategy, the use and implementation of innovative models for the development and realization of innovation, the creation and optimization of an innovative portfolio and the management of

innovative projects. The innovativeness of the organization or the organizational innovativeness is a state of the organization in which it is located, to which it seeks and which assures its ability to realize innovations. Elements of the innovation of the organization are innovative co-modality, innovation capacity and innovation performance, the business environment for innovation (internal and external).

2.2. Innovation competences

The term Organizational Innovativeness is used in literature to describe organizational innovativeness, firm-level innovativeness, team innovativeness or group innovativeness. These terms explain the capability of companies to reflect the turbulent economic environment characterized by radical changes in a short time, companies' ability to be adoptive by developing a unique strategy with high standards of innovation, proactivity, calculated risk-taking and learning through analyses of changes taking place in customers' preferences and competitors' behaviour [15]. Innovativeness reflects the tendency of companies to promote and support new ideas, experimentation and creative processes [16]. The company's innovativeness is not measured by its new products, services and processes. It is the company's ability to generate and develop innovations as a systematic process. The innovativeness of a company is part of its characteristics, competences and part of its performance [17]. Usually company's innovativeness is related also to its ability to participate in networks and partnerships so to be able to extend and improve innovations. In the context of the research, the innovation competences are part of the organizational innovativeness.

This paper emphasizes on innovation competencies of organizations as part of the innovative mix, presented in the study. They are deeply examined and defined by the Company Innovative Leadership Model [17] [18]. The model views them as a permanent pattern of behaviour resulting from a bunch of knowledge, skills, abilities and motivation as Boyd et al. [19] also do. Prahalad and Hamel [20] define it as "a harmonized combination of multiple resources and skills that distinguish the company in the marketplace." In their research, both scientists have summarized that this is an ambition and a desire to build competencies that characterize the world's winners. The concept of competence was developed by McClelland [21] first in 1973 and was later elucidated by Boyatzis [22] in 1982. The main idea behind competencies for the purpose of this study is that no one criterion is significant enough to ensures success or innovativeness of an organization. Only a set of criteria such as skills, knowledge, abilities, competences and motivation can be significant enough in a collaboration. This "set of criteria" includes organizational experience, business motivation, innovative competencies behavioral characteristics of staff and management. Some of the innovative competencies are: creativity (ability to generate ideas, critical thinking and creative problem solving), change management (situation sensitivity, status quo, intelligent risk taking, enhancing change, integration of perspectives, research orientation, cooperation), entrepreneurship (problem identification, search for improvement, information gathering, independent thinking, technological experience, results orientation, leadership), etc. All innovation competencies are complex and difficult to evaluate and use for the purposes of indexes.

2.3. Management Information Systems (MIS)

Technology and information systems, in particular, are an essential component of everyday life and work of employees and overall for organizations. Information systems are becoming increasingly integrated in the business processes of enterprises, making their divisibility and their definition as separate objects of the organization system increasingly difficult, but also increasingly important for the overall process of corporate governance and an element of the enterprise's economy. Until recently, information systems were the primary

responsibility of Information technology (IT) departments and IT specialists. Today, more and more information technology is becoming a major tool of management, of business professionals, of units that are directly responsible for organizational goals, not just technical provision. In this sense, IT knowledge is also needed to a great extent by economists in their role as financiers, marketers, accountants, logistics specialists, management, manufacturing, sales, human resources, sales, trade, entrepreneurs, etc. Businesses are highly dependent on IT infrastructure and are increasingly demanding in terms of maintaining and processing vast amounts of user data, dynamic resource sharing, rapid adaptation to changing business requirements, ease of use and automation of services and processes, measurability of technology costs, operational provision of different information services, etc. [23]. Kisimov [24] examines information systems in terms of their management flexibility, especially for the purposes of business management. Under Business Management, Kissimov (2009) understands management of any system driven by business considerations using the following business environment components as leadership tools - business strategy, business policies, business processes, business critical performance indicators, business critical business success factors. Business management is thus a form of governance in which business components are leading to how to implement the management process, in this case the management information system.

The information systems in organizations that address the management of various business processes and overall management activities meet different terms in the literature [25]: management information systems, business management information systems, business information systems [26], corporate information systems [27] [23], company information systems, management information systems. Despite the differences, the functions of all of them are to support and provide the information processes in the organization and their management. For definition in this study, Kisimov's definition [27] has been adopted, which summarizes that these systems usually serve to support the corporate business and include modules designed to support core corporate activities, which in practice outlines their broad scope. It is with this definition and within its scope that a wide range of information systems are involved in the study, which are related to different aspects of the company activities and their management. Petkov [25] concludes that MIS is a complex system for providing information about the management activity in an organization or, in more detail, it is a constantly evolving system for transforming data from various sources (internal and external to the organization) in information and presentation in an appropriate form for managers at all levels and in all functional activities of the organization to assist them in taking timely and effective decisions in the planning, management and control of activities. which they are responsible. According to Ferguson [28], the organization's performance management is sought and achieved at strategic, tactical and operational levels, namely through MIS, ERP, CRM, Supply Chain Management, and BI systems.

Information systems are also considered to be one of the strongest decision-making tools. Lucas [29] outlines the four main trends that organizations need to cope with and steadily manage: (1) to use information provision through MIS as part of their corporate strategy and to achieve their goals; (2) Technology as a highly penetrating component of the day-to-day work of the employees and the business environment; (3) The use of technology to transform the organization, continuous change according to the environment, competition, customer requirements and innovation progress; (4) The use of personal computers as the main tool of management.

All these arguments support and motivate this research in searching for a link between using MIS and innovation competences of organizations.

3. Research Methodology

The main approach in the study, which aims at identifying the use of MIS for innovation management and organizational innovativeness in Bulgarian business organizations, is conducting a survey. The survey is comprised of 61 questions covering the main areas of the study: innovation management and organizational innovativeness through MIS. The current paper focuses on organizational innovation competencies only. The share of the elements to be assessed in terms of MIS support for organizational innovation is composed of 15 questions organized in two groups - a group of innovation elements of the organization that address innovative potential and innovative capabilities and a set of elements relevant to organizational innovation competencies. The choice of relevant elements comes from the use of the Company Innovative Leadership Model [17] [18]. The questions in both categories aim to evaluate the respondents in terms of specific elements of organizational innovativeness. The rating scale used is: (1) without MIS, this function / task would not be possible; (2) MIS help to a great extent in the performance of this function / task; (3) MIS help to a low degree of performance of this function / task; (4) MIS is not relevant to the performance of this function / task.

The items surveyed in this category are:

• For the group of elements of innovative potential and innovative capabilities: (33) sales growth; customer feedback; (34) feedback from employees / offices; (35) presentation management in the media and the Internet (including website, social networks); (36) use of customers and users in the development of innovations; (37) communication with clients; (38) use of customer data and product development features; (39) product catalog maintenance; (40) sales channel management;

• For the group of organizational innovation competencies: (41) organizing organizational experience; (42) increasing motivation; (43) systematization of learned lessons from completed projects; (44) staff characteristics; (45) creativity management (ability to generate ideas, critical thinking and creative problem solving); (46) change management (situation sensitivity, status quo, smart risk taking, enhancing change); (47) integration of perspectives (openness to ideas, research orientation, cooperation); (48) entrepreneurship.

The data analyses aimed at identifying the current state of use of MIS for innovation purposes, so each of the questions is analysed as a share of the respondents' response to highlight the overall trend. For each issue, some identified dependencies between the evaluation and use of specific MIS, developed types of innovations in the organization, a tendency for a link between an evaluation of MIS for a specific activity and the overall assessment of the organization's innovativeness, etc., are also analysed.

For the whole group of questions, an average assessment was also applied (statistical mean) on issues that were studied through Pearson's correlation analysis of the interdependencies between respondent ratings, systems used, or belonging to any of the informally formed groups and types of organizations in the survey. The SPSS tool, version 23, was used for statistical analysis.

The empirical study as part of the current research included the following MIS: ERP; CRM; Business Intelligence (BI); Accountancy systems; Supply-chain management systems; Human resources programs; SaaS; Procurement systems; facility management and long-term assets management systems; Quality control systems; Mobile applications for sales representatives, etc.

4. Results

With regard to corporate competencies and how MIS helps their development, eight criteria have been addressed: (1) organizational experience storage; (2) increasing motivation; (3) systematization of learned lessons from completed projects; (4) staff characteristics; (5) creativity management (ability to generate ideas, critical thinking and creative problem solving); (6) Change management (situation sensitivity, status quo, intelligent risk taking, enhancing change); (7) integration of perspectives (openness to ideas, research orientation, cooperation); (8) entrepreneurship (identifying problems, seeking improvement, gathering information, independent thinking, technological consciousness, result orientation).

Regarding the storage of organizational experience, 61% of respondents find MIS as a tool that has a strong influence and helps to a large extent, sometimes even an irreplaceable factor. This is especially true for companies developing product and process innovation. One of the tools to store organizational experience is ERP systems, and 72% of the survey users appreciate highly MIS for the successful implementation of this task. Organizational experience has accumulated through innovative projects, and 69% of the organizations using a project management system also highly value their MIS for their performance. 72% of organizations that consider themselves innovative through the responses of their managers who have taken part in their research also highly appreciate the use of MIS for managing organizational storage.

The majority of respondents (59%) find MIS as a low or insignificant factor in increasing employee motivation as part of organizational innovation. Instead, 52% of respondents working in innovative organizations provide a positive assessment. Only 56% of organizations using a human resources management program find MIS a tool of great benefit in increasing employee motivation. This result suggests that many companies do not use MIS for the purposes of employee motivation and management.

The systematization of learned lessons from completed projects is an important component of the organization's innovativeness. 49% of respondents highly appreciate the use of MIS to accomplish this task.

Less than 50% of respondents believe management and knowledge of staffing features are essential and relevant to the use of MIS. 56% of organizations using a human resources management program highly appreciate their contribution to this task. It remains unclear whether other companies using these systems are otherwise performing this activity or whether it remains subject to unsystematic knowledge. 52% of organizations that have said they are innovative still appreciate the great role of MIS in managing staff characteristics.

The ability to generate ideas, critical thinking and creative problem solving, or generic - the management of creativity in the organization is a complex organizational issue and object of research on the theory of innovation. 75% of respondents do not appreciate the strong role of MIS in managing creativity. This is largely due to the general belief that creativity is an individual characteristic of an individual, and organizational creativity cannot be systematized and organized into a system, especially an information system.

Managing change is often seen as a response to specific circumstances and managing actions to respond to specific triggers for change. In the present research, change management is presented as part of the organization's innovativeness. 71% of survey respondents found the role of MIS in managing change processes as low or insignificant.

Prospective integration (openness to ideas, research orientation, co-operation) is considered by 76% of respondents to non-MIS activity used in the organization. Entrepreneurship has also been poorly evaluated by respondents in the survey as regards its specific links to the use of MIS. The share of positive ratings increases to 48% for organizations that consider themselves innovative.

5. Conclusion

In conclusion, the results from the research do not support the hypothesis that Management information Systems boost organizational innovation competencies. It is opposite to the previously researched links between use of MIS and innovation management [30]. Future work of the author will search for decomposition of innovative competences into smaller elements and finding their use in MIS for boosting performance.

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The Digital Transformations in the Accounting Systems of the Bulgarian Enterprises

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Abstract. The paper reviews the global trends in the organization of the accounting of the Bulgarian enterprises. The impact of information and communication technologies on accounting activity is examined. An analysis of the positive aspects and risks of the introduction of the modern digital technologies on the accounting systems of the Bulgarian enterprises was carried out. The need for changes in the accounting regulatory basis to allow for its faster adaptation to new methods and forms of creating, processing, summarizing and reporting accounting information is emphasis. The benefits for all economic subjects and the national economy of the digitization of accounting activity are presented.

Keywords. Digital transformation, accounting system, enterprise, regulations.

1. Introduction

Over the past few years, information and communication technologies (ICT) have become a vital component of the organization of the accounting of every enterprise in Bulgaria. The penetration of digital services into the daily routines of businesses triggered revolutionary changes in accounting. The digital transformation of accounting takes place at a lighting speed compared to the understanding and time required to adapt the accountants to the changing circumstances. Transformation in the organization of accounting can be described as adopting a diverse palette of ICT providing a number of services that increase the efficiency and effectiveness of accounting work and consequently a high quality of the accounting product. Adapting to the technological revolution, accounting as a science and practical activity as well as accounting entities acquire a different meaning and role in the global economic environment. The professional "rebirth" of accountants through digital technology transforms them from data loggers for past transactions and events into valuable business consultants who forecast the future and add value to businesses. Accounting systems, on their part, are increasingly transformed into "information systems" on the financial performance and business performance of real-time enterprises, providing the foundations of the predictive business models needed for strategic enterprise management.

The digital transformation of accounting as a leading direction to achieving global standardization in enterprise accounting is the subject of research in the article. The aim of the paper is to emphasize and to reveal the following aspects of digital transformation, which according to the author have the most important meaning and application in the activity of Bulgarian enterprises: "cloud accounting", "mobile accounting", blockchain technology, OCR (Optical Character Recognition) - technology, integration and decentralization of accounting software applications, cooperation and integration of accounting and tax software applications, artificial intelligence, and transformation of the role of accountants in the digital environment.

2. Cloud Technologies in the Organization of the Accounting Activities of Bulgarian Enterprises

More generally, for purposes of this article, "cloud" can be defined as a way of providing services that includes both software applications provided in the form of web services and access to the hardware and system resources of a particular Data Center that provides these services. The statistics provided by EUROSTAT [1] at the EU level for 2018 show that only 8.3% of Bulgarian companies use cloud technologies, and it is for e-mail or file storage. Bulgarian enterprises are the last in comparison with the other EU member states (EU), as well as compared to the average EU levels (27-28%).

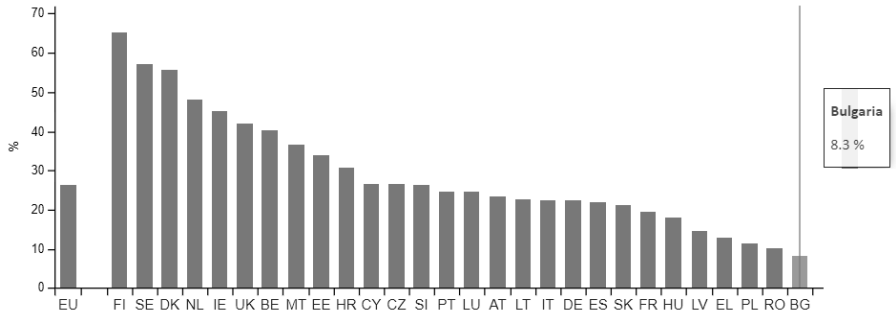

Fig. 1. Use of cloud computing services, 2018 (Source: EUROSTAT)

The EUROSTAT study summarizes that significant differences can be observed across countries. In Finland, Sweden, Denmark, the Netherlands, Ireland, the United Kingdom and Belgium at least 40 % of enterprises used cloud computing. On the other hand, in Romania and Bulgaria only 10 % or fewer enterprises did so. Of the enterprises that reported using cloud computing, some 69 % relied on a cloud solution for their e-mail. Instead of setting up a server infrastructure for their e-mail system, which would have involved inter alia capital expenditure and maintenance costs, these firms opted for a cloud solution based on per-user operating costs.

Regardless of the low levels of application of cloud computing services, managers and accountants in Bulgaria appreciate as indisputable the following benefits of their implementation in organizations and especially in accounting systems:

- reduction of the cost of purchasing and maintaining hardware devices, installing and updating software applications;
- increasing the productivity of accountants as cloud technologies provide accountants with 24-hour access to accounting software, enabling them to work from home on the principle of "remote access" and in non-working hours;
- the high level of data security, the regular back-up of information and the ability to quickly and easily recover lost archives are seen as essential functionalities in the implementation of cloud technologies in accounting.

3. Automation of Accounting Activity Through Mobile Applications - "Mobile Accounting"

"Mobile Accounting" is a new form or way of organizing accounting activity, which includes applications for creating and processing accounting information for particular groups of accounting items. Mobile applications are especially designed and installed on mobile devices. And in some cases, it is not required to download or install applications on the local device. Users can perform some or all of the functions by using their mobile devices

(smartphones and tablets), just like they are able to access the full version of the accounting software from a desktop computer. The objective is a flexible and operational performance of accounting operations related to financial transaction management (mobile banking), issuing and sending invoices, wage management, preparation and submission of VAT declarations, generation of accounting records for tracking sales revenue and the key operating costs of the enterprise. The basic purpose is that accounting operations are carried out mobile - through a device that is familiar and convenient to the user and which does not require the accountants to be physically located in the office premises.

4. Blockchain Technology

Blockchain technology has shown some promising potential for the accounting industry in Bulgaria. It will enable businesses to share a common infrastructure for storing databases. Blockchain is an evolutionary reincarnation of the fundamental accounting method of double-entry accounting, in which each business operation is reflected in at least two accounting items - of the same value but in a different direction. The Block-Chain is a high-tech accounting register jointly controlled by equal players. Instead of companies keeping records independently of each other and then reconciling the records of the same business operation in their self-managed databases or accounting books, for both sides of the transaction, business operations may be recorded simultaneously in a general ledger or register. Blockchain is a process that is less susceptible to human error and deceptive behavior, that makes the falsification or destruction of financial-accounting information virtually impossible. The innovation in the block-chain is that it is decentralized, i.e. each user has free access to it and can check the validity of each accomplished transaction. Some accountants define technology as "triple accounting" because its functional capabilities provide a high degree of accounting standardization and an increased efficiency of financial audit. It will allow auditors as "third party controllers" to automatically check big part of the most important data associated with the financial statements.

The Blockchain together with Cloud and Mobile Services enable the accounting offices to work with customers from the whole country, or even from all over the world. There is no need for the accountant to be in close proximity to his clients in order to fulfill his role of consultant.

Although the implementation of a block of accountancy may not be as advanced as in other sectors, its impact on the future of accounting is more certain as it provides competitive advantages in the following areas:

- fast money transfers (payments) in the country and abroad;
- low costs for servicing of the accomplished transactions;
- protection of personal data;
- limited oversight of public authorities on the payments made;
- verification of the accuracy and legitimacy of accounting documents;
- verification of concluded contracts for the transfer of ownership of assets, the so-called "smart contracts". Through these contracts, real estate frauds and frauds with expensive movable properties such as cars, machinery and equipment will become very difficult.

5. OCR – Technology

OCR (Optical Character Recognition) is the technology that converts scanned images, photos and PDF files into legible and editable text. This digital technology is extremely valuable and useful for the operational work of accountants, as it will finally eliminate the difficulties with the incoming in the accounting system manual invoice receipts, commodity receipts, cash receipts. With the help of OCR, an accounting nightmare ends up by uploading

all manual written primary accounting documents into an online accounting platform that recognizes and retrieves all text and numeric data. There are several major players worldwide in the field of OCR - Receipt Bank, Expensify, Hubdoc, which are unfortunately not yet widely distributed in Bulgaria.

Accountants are very well aware of one of the steps to digital transformation and the maximum limitation of "paper document turnover". Paperless processes in accounting can successfully trust OCR. The massive implementation of this digital service will result in fewer human errors, accounting records that are easy to manipulate will be limited, accounting information will be processed and stored much easier and will provide a very easy way to search for archival data. For example, embedding OCR tools in cost accounting can help prevent fraud with cost management. It will also assist in the financial control of revenue and expenditure accounts, which allows auditors to easily search for income and expenditure documents for specific transactions.

6. Integration of Accounting Information in One Place

Integrating accounting applications with other types of software applications used by enterprises provides accountants with more digital tools, restricts operational work, and frees up time to provide analytics, reporting, and counseling adding value to the company's management. The benefits of integrating accounting modules, the automated introduction and processing of routine accounting operations are related to the ability of accountants to extract accounting records and perform real-time key financial asset analyzes. A huge amount of operational accounting work and time are being saved, as the hundreds of sales invoices issued by warehouse software or invoice software do not have to be entered and processed again by the accountant in the accounting software. Integrating accounting information in one place via ERP systems allows automation not only of the accounting system but also integration with the accountability and control of other enterprise resources such as:

- human resources management - accrual, analysis and payment by bank transfer of salaries and benefits to the staff;
- managing relationships with business partners - Effectively tracking customer and supplier balances, managing raw material supplies, alerting customers about unpaid bills, etc.;
- management of the intangible assets of the enterprise;
- the financial planning and the budget process in the enterprise.

7. Decentralization of Accounting Software

Parallel to the processes of merging financial and accounting information in one place with the help of ERP systems, the decentralization of software applications is gaining popularity. It turns out that the integrated software solutions also have their disadvantages, as in the financial and accounting activity in many cases they appear to be clumsy to adapt to the constantly changing Bulgarian legislation and they are expensive as an initial investment and maintenance, which is not within the possibilities of micro and small enterprises in Bulgaria. Decentralized software applications for automation of accounting and business processes in general allow accountants and managers to tailor their software packages to meet their needs. Thus, there is no need to rely on expensive software packages that offer complete financial management solutions. Instead, if the accountant only needs some functions, then he can create personalized solutions by adding / removing different applications that meet his requirements. Subsequently, if business activity is expanded and changed, then it is possible to purchase and integrate additional non-accounting modules, for example, to manage purchases of raw materials, to manage customer relations and sales, to calculate the cost of production and services.

8. Co-operation and Integration of Accounting and Tax Software Applications

One of the most significant limitations of the digitization of accounting activities in Bulgaria is the legal framework of accounting and tax legislation. Digital technologies are progressing very fast compared to the regulatory framework. In practice, the information systems of the National Revenue Agency (NRA), the National Social Security Institute (NSSI), the Registry Agency and a number of other institutions are not very reliable, too often errors occur in their use by consumers and need to be rewritten through more advanced programming platforms and they should provide more integration opportunities with accounting software applications and ERP systems used by enterprises in Bulgaria. These steps will help reduce errors in tax and social security declarations, reduce the risks of tax breaks and penalties due to gaps in deadlines for submitting of declarations or submitting false data. The universal implementation of the principle of submitting information through an "entry point" from business to state administration will undoubtedly improve the efficiency and quality of tax control, cost savings on time and specialized work of accountants, auditors and tax advisers. The Bulgarian economy as a whole will benefit from the cooperation and integration between the accounting and public administrative information systems.

A very illustrative example of the benefits of integration and convergence between business processes, accounting systems, and regulations in the field of accounting and taxation are electronic invoices. They are the most noticeable nuance from the palette of digital changes in accounting. It has a synergy between digital technologies and national regulations. An electronic invoice is the first real step towards "paperless accounting". It is an electronic document [2], compiled in accordance with Directive 2006/112 / EC, the VAT Act and the Accountancy Act. According to Art. 114, para. 9 of the VAT Act the documentation of realized sales with electronic invoices and electronic invoice notifications shall be made, provided that such documentation is accepted by the recipient with written or silent consent. The origin, content and legibility of the electronic invoice and electronic invoice notification shall be guaranteed in two ways: (a) by signing them with a qualified electronic signature, or (b) by electronic data interchange.

Qualified electronic signature is an electronic signature within the meaning of Art. (3) (p. 12) of Regulation (EU) No 910/2014, namely: an advanced electronic signature created by a qualified electronic signature creation device and based on a qualified electronic signature certificate. The Bulgarian Communications Regulatory Commission is responsible for establishing and maintaining a Register of Certification Service Providers (Qualified Electronic Signatures). By December 2018, only 6 (six) providers of this type of service listed in Table 1 were included in the register.

Table 1. List of providers of certification services established / accredited on the territory of the Republic of Bulgaria

No	Deliver	Web site
1.	„Information Services“ JSC	http://www.stampit.org/
2.	„Borica” JSC	http://www.b-trust.org/
3.	“Infonotary” Sole JSC	http://www.infonotary.com/
4.	„Spectur” JSC	http://www.spektar.org/
5.	„SEP Bulgaria” JSC	http://e-sign.sep.bg/
6.	„Eurotrust Technologies“ JSC	http://www.evrotrust.com/

9. Artificial Intelligence in Accounting and Transforming the Role of Accountants

Accounting science and practice are once again in breakthrough times, at the threshold of a new evolutionary stage in their development. In the five-centuries-old history of double-entry accounting, many situations have been known in which accountants have always been at the "comb of the wave" in order to improve the efficiency and effectiveness of their work. But to date technology has not been able to replace the need for expert knowledge and decision-making. Indeed, previous generations of 'intelligent' systems have generally demonstrated the continuing power of human expertise and the limits of machines [3].

Artificial intelligence (AI) is a broad term that refers to technologies that make machines "smart". Organizations are investing in AI research and applications to automate, augment, or replicate human intelligence. AI is a way of making a computer, computer-controlled robot, or a software think intelligently, in the similar manner the intelligent humans think. The accounting profession must be prepared to fully participate in organizational AI initiatives. According report of Institute of Chartered Accountants in England and Wales (ICAEW) [3] accountants can use machine learning to improve accuracy and speed when entering data, through automation, better detection of fraud, and enhanced predictive analytics. This will lead to efficient utilization of capital and better management of resources.

AI on a global scale is already able to handle current accounting, corporate taxation, collection and processing of wage information, financial reporting and auditing. Although we are approaching the era of "uncoded accounting" by virtually zero input of data into software applications, AI will not replace accountants. There will be no end to accounting as scientific knowledge and professional activity. Businesses will always need the human intellect, which is at the other end of artificial intelligence technology. Actually, according to the leading US research and consulting firm Gartner, AI will create more jobs than it will replace, creating needs for accountants with new types of knowledge and competencies. Companies will always need accountants who can analyze and interpret the data generated by AI technologies, as well as provide consultancy services. Rather than replacing the accountant, AI's technology will change its obligations to the enterprise.

With each passing day, accountants are transformed from "producers" and "compilers" of financial statements of past economic transactions into analysts who make "accurate financial diagnoses" at the right time and offer reliable and long-term proposals for financial health and enterprise sustainability. Digital technologies and artificial intelligence will help the accountants' "hierarchical renaissance" in the organizational structure of the enterprise and turn them into middle management, consultants and analysts who have to abandon and get rid of technical and operational tasks related to the processing of accounting information. Their knowledge and skills should focus on activities that move them up into the corporate "value chain" such as financial analysis, forecasting and planning of key financial indicators.

With AI technology and machine training, managing many of the common, repetitive tasks, accountants will have more time to focus on other aspects of the job such as consulting and data analysis. This is good news for many accountants. Instead of spending hours on routine, operational tasks, future accountants will be able to use and analyze AI data to provide their clients with reliable business decisions.

In many ways, AI will help accountants improve the level, scope and quality of their services. AI technology will improve the accuracy of entering accounting information and reduce the risks for accountants. Also, receiving real-time data allows accountants to provide real-time financial solutions. Even more impressive is the ability of machine learning to

analyze large amounts of data immediately, to assess past successes and failures in its quest to accurately predict future results.

Like any new global technology, AI is expected to meet its adversaries among accountants. What accountants can do if they want to win in any way is to embrace this new technology and learn how to maximize the results of its use. The better the accountant is prepared, in order to help the management of the enterprise or its clients to integrate and use AI technology in their business and accounting processes, the higher will be assessed as a specialist and business partner.

Surveys of **The Big Four** [5] show that, in general, accounting departments will be reduced in 2030. It is an opportunity for left and dismissed employees to focus on more strategic initiatives and value added activities such as process improvement, cost control, and capital optimization. Steve Hill, KPMG's U.S. head of innovation and global head of innovation and investments, suggests the combination of artificial intelligence, Big Data, and cloud computing creates a new form of cognitive technology. It's a technology he called **digital labor** [6]

In order to be well prepared and adapted to "digital labor", the Bulgarian economy needs to be organized and purposefully "to plant seeds of artificial intelligence". In the field of accounting as a field of study and profession, this implies that universities in Bulgaria need to incorporate in their accounting programs courses for management of information systems and databases. In this way graduate students will enter the labor market with the necessary skills for future accounting work. Accountants already in the workforce must find ways to improve and update their qualifications and digital competences to meet the requirements of their employers and / or clients.

The Bulgarian education system should adopt and implement a realistic strategy for convergence and adaptation of accounting education to the needs and requirements of enterprises and macroeconomics by focusing in two directions:

On the one hand, higher education institutions in Bulgaria should attach great importance to the combination of theoretical knowledge and accounting practices of students, to enhance university-business cooperation and to seek to create practical opportunities for improving the skills and abilities of students and to "cultivate" accountants - practitioners

On the other hand, universities must always be responsible for maintaining and improving the level of lecturers. Academic circles must always keep up with the changes and trends in accounting theory, international accounting standardization, and the links between accounting, tax and financial control so that learning in the classrooms and practical training can follow the real processes in accounting practice.

Only by striving to improve the level of accounting teaching at Bulgarian universities can we create and grow excellent accounting talents that meet market requirements at national, European and global level.

10. Changes in the Organization of Accounting Activities in Bulgarian Enterprises

It is possible to draw conclusions and conclusions on the extent to which the digital transformation of the accounting activities of enterprises in Bulgaria has been made by conducting a sample empirical study among accountants. According to the author, it is necessary to carry out a representative statistical survey covering accounting firms and accountants working in different positions on labor and non-labor relationships in all economic sectors. To objectively evaluate the digital transformation phase in accounting, the following nine key issues need to be addressed:

Question No. 1. Do you digitize primary accounting documents issued by your enterprise (invoices, debit and credit notifications) according to the requirements of the Electronic Document and Electronic Certification Services Act?

Question No. 2. Do you receive invoices, debit and credit notifications and other primary accounting documents in the form of files from your partners (suppliers, creditors) that can be accepted and processed directly through the interface of your accounting system?

Question No. 3. Do you control the quality (accuracy and reliability) of the data that you have received and processed automati- cally? How often do you perform this type of control within the reporting year?

Question No. 4. Do you use new digital capabilities to automate your routine accounting tasks to the fullest extent?

Question No. 5 Are the software applications used in the accounting software synchronized with the software applications used by the other departments in your enterprise?

Question No. 6. Do you apply innovative real-time reporting and financial analysis technologies?

Question No. 7. Do you need and use the analysis of large databases from different sources of information?

Question No. 8. Do you use digital visualization tools to prepare the results of the data analyzes in graphical form and with varying degrees of detail depending on the goals and requirements of the relevant information users?

Question No. 9. Are your accounting software applications located on web-based (cloud) platforms?

Digitization in the organization of accounting is a long-term process, which should be carried out in stages according to the personnel potential and the financial capacity of the enterprises in Bulgaria. The implementation of digital technologies in accounting should be entrusted to the head of the enterprise accounting system (Chief Accountant, CFO). He is the figure who has to guide the whole process of transformation of accounting activity by developing a strategic plan, that should be approved by the management of the enterprise. In the digital transformation strategy, it is imperative to define:

- new digital technologies to be used in accounting;
- the new digital skills and competences that must be acquired and applied by the accounting staff in their activities;
- redistribution of duties and responsibilities between accountants as a result of digital transformation;
- the accounting officer's argument to the management regarding the need for digital changes in accounting and the provision of the necessary financial resources and IT specialists for their practical implementation.

11. Conclusion

Artificial Intelligence passes from the technological research phase to industrial application and becomes a new driving force for globalizing of the accounting [7]. Undoubtedly, we are all on the verge of a new form of organization of accounting activity called "intelligent accounting" or "digital accounting". This is the underlying trend of accounting development. In the process of integrating artificial intelligence in accounting, state institutions, businesses, universities, individuals and all other stakeholders need to participate. They should work together in a team to effectively address the problems that arise in the process of implementing and applying digital technologies in the accounting of private and public sector enterprises. Integrating accounting, artificial intelligence and automation should

be achieved through a balance between human knowledge and modern technology to derive global accounting and economic benefits.

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Data Mining Methods and Techniques Used for Data Analysis in the Telecommunications Sector

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Abstract. In order to be competitive in the telecommunications sector nowadays, companies have to predict their customers' behavior. Thus companies search for the best possible data mining techniques in order to derive maximum information from their data. This main purpose of this paper is to review data mining techniques and methods which could be used for extracting valuable knowledge from different data types collected in the systems of a telecommunication company. Classification and cluster methods are considered.

Keywords. Telecommunication, classification, customer retention, cluster analysis

1. Introduction

The volume of data generated within the telecommunications field is increasing every day. The duration of data processing and knowledge extraction are crucial processes within a telecommunication company which the competitive advantage depends on. The data itself could be structured or unstructured, depending on the systems which are derived from the company's data warehouse. The information could be related to the purchased products and signed contracts as well as to network strength and capabilities of providing the services to the clients.

Data Mining is related to extracting knowledge which is hidden in large volumes of data and it is part of the knowledge discovery process which provides a new way to observe data. This is a complex process of identifying the understandable and useful data. Looking at the process of Knowledge Discovery in the database, Data Mining is the advanced analysis step [1].

The methods and techniques of knowledge extraction from data, or also known as Data mining, are being used in many fields. They are successfully applied in marketing, customer relations, production control, warehouse management, finance and many more in order to solve different problems, and can be used to prevent customer churn or evaluate network strength when it comes to the field of telecommunications [2].

2. Data Mining

Data Mining is a term that explains the process of knowledge discovery in databases. At the beginning, this term was related only to the part of the process concerning the data analysis, but nowadays it covers the whole process shown on Figure 1.

The process of knowledge discovery in databases starts with the selection of the previously loaded data into the data warehouse. At this step only the data that is necessary for the data mining process has to be selected.

Then preprocessing of the data is needed, because the data could be noisy or inconsistent. If possible, different strategies are applied for filling the missing data, otherwise

the corrupted rows are deleted.

At the transformation step, the data volume is reduced to the necessary amount and data types could be converted in case it is needed.

When it is time to implement the data mining, a certain method is chosen, which will be applied to the selected and pre-processed data.

The final step is the interpretation and evaluation of the results. The derived information is being visualized and sometimes there is an option of changing the data in the previous steps, in order to achieve better results.

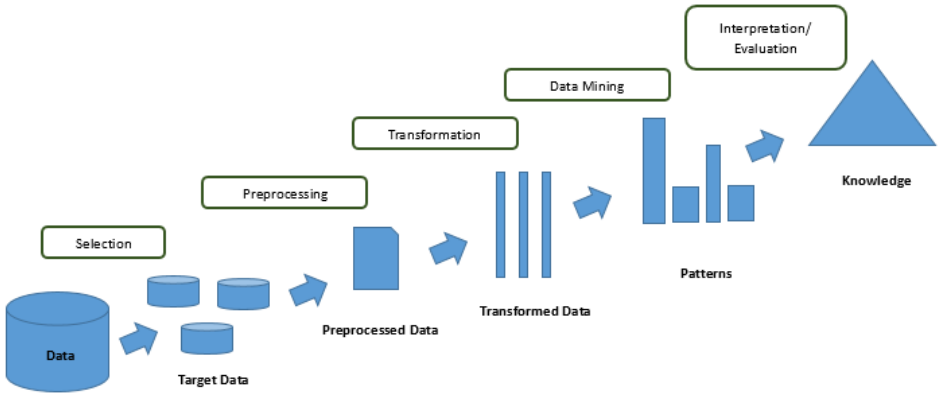

Fig. 1. Knowedge discovery in databases

The most important problems which are being discussed in the telecommunications field are:

1. Customer churn,
2. Fraud detection,
3. Network failure,
4. Product recommendation,

Customer churn and network failure are in the focus of this paper.

3. Customer Churn

The process in which a customer leaves a company is known as churn. It is necessary to understand why s/he leaves her/his present telecommunication provider and goes to another one, this is why churn analysis is performed. The analysis involves creating a pattern or model of customers' actions. The problem is associated with revenue loss and high costs spent for attracting new customers.

Customer churn is one of the biggest issues in the telecommunications industry, this is way all of the companies in this sector offer as many as possible minutes and megabytes in their plans at the lowest possible price in order to provoke customers to switch carriers [3].

The first step to be made is clients' behavior examination – to find out their needs. The clients have to be offered the most suitable service and their particular needs have to be identified by using Data Mining methods and techniques. Every company tries to keep good relations with its customers, especially with the valuable and loyal long-term clients.

The process starts with the data extraction from the source systems, e.g. including: the online shop of the company – the client's purchase history and viewed items, the website of the company – client behavior (which are the first and the next visited pages until the client

leaves the website), data concerning the client's visits in the physical stores of the company and the dealer shops is collected. The dealer shops are physical shops which are not owned by the telecommunication company but are known as partners who sell the main company's services and products (Figure 2), additional information about minutes and megabytes spent by the client is calculated and his/her payment history (e.g. any liabilities left) is taken into account.

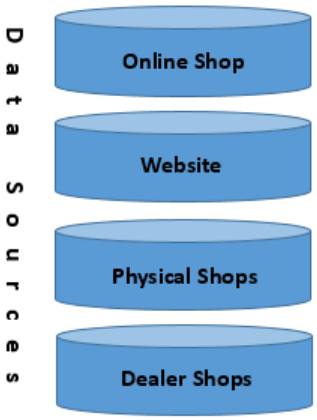

Fig. 2. Data Sources

A possible solution to the customer retention problem is applying cluster analysis on customer data. The idea of the cluster analysis is to form groups consisting of elements which are as close as possible in regards to meaning while at the same time the groups remain as distant as possible in regards to meaning. First, the initial cluster is being formed, it is being transformed several times using different criteria in order to form the final cluster (Figure 3).

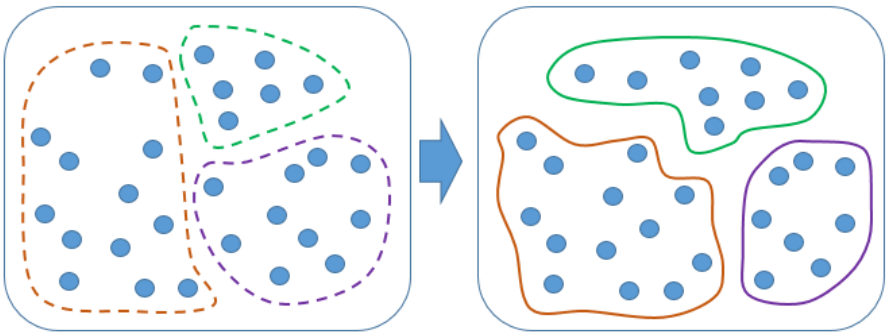

Fig. 3. Cluster transformation

The core concept of cluster analysis is data grouping according to some traits and it is very suitable for large volumes of data. By dividing the volumes of data into individual clusters, the information could be more easily understood. Cluster analysis is mostly used when customer segmentation is needed.

Data about frequently viewed services and products is retrieved. Previously purchased products and services are checked and clients are sorted into different groups according to their

online behavior. New customer-related criteria are set according to the customers' behavior in the physical stores of the company – purchased services and products at the point of sale. The next step is the formation of customer loyalty criteria – for how long the customer has had a service in the company, whether she/he has paid all her/his obligations on time, and whether there are any obligations for previous periods.

New criteria are set for the way customers spend their available minutes and megabytes.

After entering the final cluster, the data is being processed into information which is then provided to the marketing department. This information is about clients' needs and their loyalty – e.g. whether it is necessary to propose a plan with more minutes or MB and whether this can happen at preferential conditions in order to keep this client in the company.

Pattern models of the loyal and the leaving customers are received. These models are applied to the data of the present customers – the customers that possess the features of the leaving ones are sorted out. The company should respond in timely manner by contacting exactly those customers who are valuable for the company.

4. Network Quality

The second problem which is discussed in this paper is the quality of the network - predicting network problems. The following data is needed:

- Length of the calls
- Dialed/received calls
- Corrupted calls
- Decline in the number of calls from a particular cell
- The ratio of the messages sent/received through a particular cell
- "Replacement history" data of the hardware components at a particular cell

The final goal is to obtain information about those cells which may cause problems and the timely reaction of technicians to prevent future network problems.

Because the data from the 'log' files of cells is in unstructured form, unlike the structured and semi-structured data in the previous example, this problem could be solved by using the classification task. The classification Data mining task identifies what class the incoming information belongs to based on what is previously taught [4]. Classification techniques require discrete attributes. If there are any continuous attributes they must be converted before the method is applied. It is necessary to create rules in order to classify data, thus it is going to be sorted according to the certain criteria graphically presented on Figure 4:

- Mobile or fixed network calls
- Defined ranges of the calls duration

1. 0 - 1 min
2. 2 - 5 min
3. 6 - 10 min
4. 11 - 30 min
5. 31 - 60 min

- Defined ranges of possible call interruptions

1. 0-1 – not a problem
2. 2-3 – attention problem possibility
3. 4 or more – network problem

Tracking data from the cells would indicate a potential problem in a cell before its complete shutdown.

Call Type	Call Length	Calls canceled in a row	Network failure indicator
Mobile	0-1 min	0	No
Fixed	2-5 min	2	Attention
Mobile	6-10 min	4	Yes
Fixed	2-5 min	1	No
Mobile	2-5 min	3	Attention

Fig. 4. Classification

5. Conclusion

This paper presents data mining methods and techniques used in the telecommunications industry. Customer data, cell data and calls details are described as data sources. Data mining applications such as customer churn prevention and network quality are observed.

Data mining applications must always consider privacy issues. This is especially true in the telecommunications industry, since telecommunications companies maintain highly private information, such as whom each customer calls. [5]

Data Mining is a must for the companies in the telecommunications sector in order to be competitive and to expand their market share. Analyzing customer data in order to fulfil customers' needs and discovering patterns of churn customers are part of the key processes of the customer retention policy of a company.

The timely spotting of potential problems in a telecommunication company network would increase the quality of the telecom services which would results in cost reduction and also in decrease of the number of customers churn.

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Step by Step Consideration's Method for Equations Describing Linear Systems and Its Applications

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Abstract. The present paper introduces some examples of using the step by step consideration's method in the case of processes which can be described by linear differential equations. The examples have different character: a mathematical pendulum driven by a force of a dry friction and a singular mathematical pendulum's equation on which some dissipative forces are acting. In some cases the small parameter's method plays an essential role.

Keywords. Differential equations, Asymptotic methods, Nonlinear dynamics.

1. Introduction

The step by step consideration's method is often used for the equations' solutions which can describe specific dynamic systems [1, 2]. The continuous functions' principle which characterises the whole process and also the first derivatives of these functions stays on the basis of this method. In the case of nonlinear systems the use of this method leads to analyse a specific problem in different intervals of the given definition set. Each interval is chosen so that the analysed problem to have an accessible analytic solution and after that the separate solutions are united into one continuous solution. In the case of linear equations often we can meet events for which if we give different values of the current variable then the equations will have different mathematical structure. If we assume that the model is describing a continuous process then it is inevitably to use the step by step consideration's method. This method plays an essential role in the investigation of the singular equations.

In the examples below the small parameter's method is used jointly with the step by step consideration's method. Even though we are searching for analytic solutions of some linear problems the obtained solutions have the accuracy of the corresponding chosen small parameter's power [3, 4].

2. An investigation of the linear oscillator's movement which is moved from a short term impulse

Let us consider the following mathematical pendulum's model:

(1) $\ddot{q}+\omega^2 q=a$, where

$$a=\begin{cases}-\alpha, & t\in\left[0,\dfrac{\varepsilon}{\omega}\right], \quad \left|\dfrac{\varepsilon}{\omega}\right|<<\dfrac{1}{\omega}\\ 0, & t>\dfrac{\varepsilon}{\omega},\end{cases}$$

with initial conditions:

$$\begin{cases} q(0) = 0, \\ \dot{q}(0) = 0. \end{cases}$$

The process is introduced step by step. For the interval $t \in \left[0, \frac{\varepsilon}{\omega}\right]$ we are searching the solution of the equation **(1)** in the following way:

$$q_1 = A_1 \cos \omega t + B_1 \sin \omega t - \frac{\alpha}{\omega^2}.$$

As we report the initial conditions for the first stage of the result we get the following equation:

(2) $$q_1 = \frac{\alpha}{\omega^2} \cos \omega t.$$

For $t > \frac{\varepsilon}{\omega}$ we search the equation **(1)** in the way:

$$q_2 = A_2 \cos \omega t + B_2 \sin \omega t.$$

Obviously for the second derivative of the given variable is valid the following equation:

$$\dot{q}_2 = -\omega A_2 \sin \omega t + \omega B_2 \cos \omega t.$$

The equations below follow from the continuity's condition of the solution at the moment $t = \frac{\varepsilon}{\omega}$:

$$q_1\left(\frac{\varepsilon}{\omega}\right) = q_2\left(\frac{\varepsilon}{\omega}\right) \quad \text{and} \quad \dot{q}_1\left(\frac{\varepsilon}{\omega}\right) = \dot{q}_2\left(\frac{\varepsilon}{\omega}\right).$$

After solving the obtained equations in front of the trigonometric functions which describe the solution in the second stage we get the following:

$$A_2 = \frac{\alpha}{\omega^2} - \frac{\alpha}{\omega^2} \cos \varepsilon \quad \text{and} \quad B_2 = -\frac{\alpha}{\omega^2} \sin \varepsilon.$$

As we take into account that the acting impulse has a little duration give us the opportunity to decompose the trigonometric functions to the second power of ε.

Finally the equation that describes the second stage of the problem is the following:

(3) $$q_2 = \frac{\alpha}{2\omega^2} \varepsilon^2 \cos \omega t - \frac{\alpha}{\omega^2} \varepsilon \sin \omega t.$$

3. An investigation of poorly connected linear oscillators under the influence of a dry friction

Let us consider the following system of two ordinary differential equations:

(4) $$\ddot{q}_1 + \nu_1^2 q_1 - \varepsilon \lambda_1^2 q_2 = \begin{cases} -a, & \dot{q}_1 > 0; \\ a, & \dot{q}_1 < 0; \end{cases}$$

(5) $$\ddot{q}_2 + \nu_2{}^2 q_2 - \varepsilon\lambda_2{}^2 q_1 = \begin{cases} -a, & \dot{q}_2 > 0; \\ a, & \dot{q}_2 < 0; \end{cases}$$

where $|\varepsilon| << 1$. In this case ε is a small parameter.

For this system we use the following initial conditions:

$$\begin{vmatrix} q_1(0) = A, \\ q_2(0) = B, \end{vmatrix} \quad \text{and} \quad \begin{vmatrix} \dot{q}_1(0) = 0, \\ \dot{q}_2(0) = 0. \end{vmatrix}$$

We are searching the system's solutions of the following form:

(6) $$q_1 = a_1^1 \cos\Omega_1 t + \varepsilon\xi + (\pm)\frac{a}{\omega_1},$$

(7) $$q_2 = b_1^1 \cos\Omega_2 t + \varepsilon\eta + (\pm)\frac{a}{\omega_2}.$$

Substituting in the system and equalizing the coefficients before the equal powers of the small parameter we obtain the following:

(8) $$\Omega_1 = \omega_1, \quad \Omega_2 = \omega_2 \ ,$$

(9) $$\ddot{\xi} + \omega_1{}^2\xi - \lambda_1{}^2 b\cos\omega_2 t = 0,$$

(10) $$\ddot{\eta} + \omega_2{}^2\eta - \lambda_2{}^2 a\cos\omega_1 t = 0.$$

We are searching the solutions of the form:

(11) $$\xi = a_1^2 \cos\omega_2 t,$$

(12) $$\eta = b_1^2 \cos\omega_1 t.$$

Substituting the solutions in **(9)** and **(10)** we obtain:

$$a_1^2 = \frac{\lambda_1{}^2 b_1^1}{\omega_1{}^2 - \omega_2{}^2} \quad \text{and} \quad b_1^2 = -\frac{\lambda_2{}^2 a_1^1}{\omega_1{}^2 - \omega_2{}^2}.$$

Respectively we write the solutions:

(13) $$q_1 = a_1^1 \cos\omega_1 t + \varepsilon\frac{\lambda_1{}^2 b_1^1}{\omega_1{}^2 - \omega_2{}^2}\cos\omega_2 t + \frac{a}{\omega_1{}^2}, \quad \text{for} \quad t \in \left[0, \frac{\pi}{\omega_1}\right];$$

(14) $$q_2 = b_1^1 \cos\omega_2 t - \varepsilon\frac{\lambda_2{}^2 a_1^1}{\omega_1{}^2 - \omega_2{}^2}\cos\omega_1 t + \frac{a}{\omega_2{}^2}, \quad \text{for} \quad t \in \left[0, \frac{\pi}{\omega_2}\right].$$

As we get the initial conditions finally we obtain:

(15) $$q_1^1 = \left(A - \varepsilon\frac{\lambda_1{}^2 B}{\omega_1{}^2 - \omega_2{}^2} - \frac{a}{\omega_1{}^2}\right)\cos\omega_1 t + \varepsilon\frac{\lambda_1{}^2 B}{\omega_1{}^2 - \omega_2{}^2}\cos\omega_2 t + \frac{a}{\omega_1{}^2},$$

for $t \in \left[0, \frac{\pi}{\omega_1}\right]$;

(16) $$q_2^1 = \left(B + \varepsilon \frac{{\lambda_2}^2 A}{{\omega_1}^2 - {\omega_2}^2} - \frac{a}{{\omega_2}^2} \right) \cos \omega_2 t - \varepsilon \frac{{\lambda_2}^2 A}{{\omega_1}^2 - {\omega_2}^2} \cos \omega_1 t + \frac{a}{{\omega_2}^2},$$

for $t \in \left[0, \frac{\pi}{\omega_2} \right]$.

Respectively we are searching the solutions in the next intervals as follows:

(17) $$q_1^2 = a_1^2 \cos \omega_1 t + \varepsilon \frac{{\lambda_1}^2 b_1^2}{{\omega_1}^2 - {\omega_2}^2} \cos \omega_2 t - \frac{a}{{\omega_1}^2}, \quad \text{for} \quad t \in \left[\frac{\pi}{\omega_1}, \frac{2\pi}{\omega_1} \right];$$

(18) $$q_2^2 = b_1^2 \cos \omega_2 t - \varepsilon \frac{{\lambda_2}^2 a_1^2}{{\omega_1}^2 - {\omega_2}^2} \cos \omega_1 t - \frac{a}{{\omega_2}^2}, \quad \text{for} \quad t \in \left[\frac{\pi}{\omega_2}, \frac{2\pi}{\omega_2} \right].$$

For the solution's sewing we use the following dependence:

$$q_1^1\left(\frac{\pi}{\omega_1} \right) = q_1^2\left(\frac{\pi}{\omega_1} \right) \quad \text{and} \quad q_2^1\left(\frac{\pi}{\omega_2} \right) = q_2^2\left(\frac{\pi}{\omega_2} \right).$$

The expressions are as follows:

$$q_1^2 = \left(A - \varepsilon \frac{{\lambda_1}^2 B}{{\omega_1}^2 - {\omega_2}^2} - \frac{2a}{{\omega_1}^2} + \varepsilon \frac{{\lambda_1}^2 b_1^2}{{\omega_1}^2 - {\omega_2}^2} \cos \frac{\omega_2}{\omega_1} \pi \left(B - \frac{2a}{{\omega_2}^2} \right) \right) \cos \omega_1 t + \varepsilon \frac{{\lambda_1}^2 \left(B - \frac{2a}{{\omega_2}^2} \right)}{{\omega_1}^2 - {\omega_2}^2} \cos \omega_2 t - \frac{a}{{\omega_1}^2}$$

(19) for $t \in \left[\frac{\pi}{\omega_1}, \frac{2\pi}{\omega_1} \right]$;

$$q_2^2 = \left(B + \varepsilon \frac{{\lambda_2}^2 A}{{\omega_1}^2 - {\omega_2}^2} - \frac{2a}{{\omega_2}^2} - \varepsilon \frac{{\lambda_2}^2 a_1^2}{{\omega_1}^2 - {\omega_2}^2} \cos \frac{\omega_1}{\omega_2} \pi \left(A - \frac{2a}{{\omega_1}^2} \right) \right) \cos \omega_2 t - \varepsilon \frac{{\lambda_2}^2 \left(A - \frac{2a}{{\omega_1}^2} \right)}{{\omega_1}^2 - {\omega_2}^2} \cos \omega_1 t - \frac{a}{{\omega_2}^2}$$

(20) for $t \in \left[\frac{\pi}{\omega_2}, \frac{2\pi}{\omega_2} \right]$.

In a similar way we can also find solutions for other following arbitrary intervals of time.

4. Equations with singular disturbances

Let us consider the Cauchy's problem:

(21) $\varepsilon \ddot{x} + \dot{x} + \varepsilon x = 0$, with the following conditions:

$$\begin{vmatrix} x(0) = \alpha, \\ x(1) = \beta, \end{vmatrix} \quad \text{for} \quad 0 < \varepsilon << 1.$$

We are searching the solution of the equation **(21)** in power series of the small parameter ε :

$$x = x_0 + \varepsilon x_1 + \ldots .$$

Then for the zero and the first approximation we obtain the expressions:

(22) $\dot{x}_0 = 0$, $x_0(0) = \alpha$, $x_0(1) = \beta$;

(23) $\dot{x}_1 = -\ddot{x}_0 - \dot{x}_0$, $x_1(0) = 0$, $x_1(1) = 0$.

The solution in the zero approximation is $x_0 = C$. It's seen that it's not possible the two boundary conditions to be satisfied at one and the same time unless the case $\alpha = \beta$. We will assume that the problem is satisfied for the first boundary condition $x_0(1) = \beta$. Therefore

(24) $x_0 = \beta$.

We substitute **(24)** in the equation **(23)** and we solve it. We obtain that $x_1 = a_1 - \beta t$ Again this solution can't satisfy at one and the same time the two boundary conditions.

That's why we assume that the problem is satisfied only for the second boundary condition $x_1(1) = 0$. In result we obtain

(25) $x_1 = \beta(1-t)$.

The final result can be written as a sum of the two approximations:

(26) $x = \beta + \varepsilon\beta(1-t) + \ldots$

We will name the obtained decomposition external and we will mark it as x_e . Near to the point $x = 0$ arises the so called *boundary layer*. In this area we will use another solution's decomposition which is called *internal* and we will denote it by x_i . We substitute $t = \varepsilon^{\nu}\xi$, where ν is defined by the so called sewing's principle: $(x_e)^i = (x_i)^e$.

The symbol $(x_e)^i$ shows the decomposition of x_e in the specific approximation which is obtained by the substitution $t = \varepsilon^{\nu}\xi$ and the decomposition on fixed ξ .

After this stage we start with the internal solution's decomposition. Of course we will not make a complete investigation.

We will just show that on fixed $\nu = 1$ is possible to have a solution's sewing. We make the substitution $t = \varepsilon\xi$ and after that the equation **(21)** obtains the form:

(27) $$\varepsilon^{-1}\frac{d^2x}{d\xi^2} + \varepsilon^{-1}\frac{dx}{d\xi} + \varepsilon x = 0 .$$

Or in the zero approximation we obtain:

(28) $$\frac{d^2x}{d\xi^2} + \frac{dx}{d\xi} = 0 .$$

Then the solution of **(28)** is $x_i = a_2 + a_3 e^{-\xi}$.

For $\xi = 0$ it follows that $x_i = \alpha$ or $\alpha = a_2 + a_3$.

Hense for the internal solution we obtain the expression:

(29) $$x_i = \alpha - a_3 + a_3 e^{-\xi}.$$

We substitute $\xi = \dfrac{t}{\varepsilon}$ in the equation **(26)** and decompose at fixed ξ as in the zero approximation we know that $\left(x_e\right)^i = \beta$. We use the solution's sewing principle and obtain: $\beta = \alpha - a_3$. Then for the internal decomposition we obtain the equation:

(30) $$x_i = \beta + (\alpha - \beta).\mathrm{e}^{-\frac{t}{\varepsilon}}.$$

Finally in the zero approximation we can write the complex decomposition in the following way:

(31) $x_c = x_e + x_i - \left(x_i\right)^e$, which in the specific case have the expression:

(32) $$x_c = \beta + (\alpha - \beta).\mathrm{e}^{-\frac{t}{\varepsilon}}$$

In the analyzed problem we properly suppose that the boundary layer is in the zero. If we want to check if there is not a boundary layer in the equation **(21)** we make an external decomposition which satisfy the left boundary condition. In neighborhood of the digit one we make an internal decomposition as we go to a new variable by using the substitution:

$$\frac{1-t}{\varepsilon^{\nu}} = \xi.$$

Again we have the same procedure.

5. Concluding remarks

In this paper, we introduce three interesting examples for finding of an analytic solution by using the step by step process's introduction which is described by linear differential equations. Although the analytic solution has the accuracy to the first or second power of the small parameter, it gives the real idea of the system's behaviour [7]. In this example and in the solution of many other problems in technical and physical fields the step by step consideration method can't be replaced by another method which can be so clear and effective [8].

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Opportunities of Measuring the Efficiency of Administrative Processes

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Abstract. This paper addresses the issues of measuring the effectiveness of administrative processes. In the field of administrative services, this is a very important problem, because it determines the work of the whole administration. The study provides a methodology for measuring performance, which is accompanied by relevant examples. At the end, the possibilities for applying the methodology and the main conclusions are formulated.

Keywords. Administrative service, Work processes, Efficiency

1. Administrative processes and capabilities to measure their effectiveness

Public organizations and the public sector have several peculiarities. The processes taking place in these organizations have a direct connection with the administrative service provided by these institutions. These are municipalities, ministries, agencies and others. The main challenges to administrative service can be summarized as:

- Reviewing and modeling administrative processes;
- Detailed analysis of the functions performed by participants in the processes;
- Reengineering and optimization as needed;
- Digitization of the provided administrative services based on research effectiveness of administrative processes;
- Project management in public sector organizations. Some researchers in this area, such as Kirilov, emphasize the possibilities for applying modern information solutions in this direction [1].

Performance testing is an important prerequisite for overcoming these challenges. This is a complex action that should be constantly held. In this sense, the question of the possible application methodology is essential. In practice, it is often necessary to develop specific methodologies for the essential features of the studied processes, which is also done in the present study. The goal pursued is to search for opportunities for digitization of phases or whole processes, as well as the transition of existing services to electronic ones.

From a technological point of view, the search for higher efficiency and the redefinition of the nature of the services provided is also related to the trends in the development of information solutions. An emphasis in this direction should be placed on the increasing use of data centers and search algorithms in large data volumes. In this respect, the development of this methodology is based on results achieved in some recent studies [2]. These researchers, as well as other researchers, put emphasis on building data structures that allow better search and therefore higher efficiency for complex administrative services that use multiple data sources at the same time. Fig. 1 presents basic stages in the assessment and measurement of

the efficiency of administrative processes. The presented concept expresses the understanding that the assessment is carried out in two phases - preliminary and final. The preliminary phase aims at defining the parameters and the scope for modeling and optimizing processes.

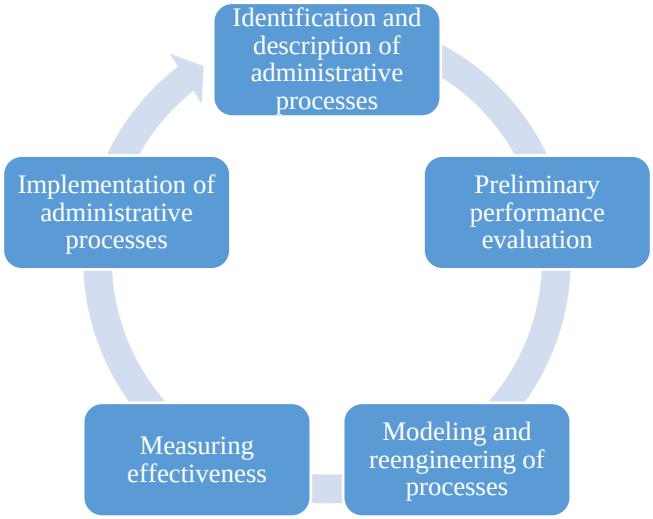

Fig. 1 Stages in measurement of the efficiency

The main stages in assessing and measuring the effectiveness of administrative processes are:

- Identification and description of administrative processes;
- Preliminary performance evaluation;
- Modeling and reengineering of processes;
- Measuring effectiveness;
- Implementation of administrative processes.

These milestones are conditional and can be varied and adapted in every single application case. The underlying idea is to prioritize and assess the impact of any process change or reengineering. It is also possible to distinguish as a separate stage the assessment of the risk of introducing changes in a particular administrative process in a specific adaptation of the methodology. The subject area implies many opportunities for constant improvement and improvement.

2. Methodology for measuring and evaluating effectiveness

Creating a unified methodology to measure the effectiveness of administrative processes is a complex and difficult task. However, contemporary theory and practice requires and requires efforts to develop and implement modern approaches in this field. They can allow for the modernization of the administration, based on the development of new, efficient and e-services for citizens and business. Fig. 2 presents in a graphical form the proposal for groups of indicators, which will consist of the methodology for assessment of the administrative processes.

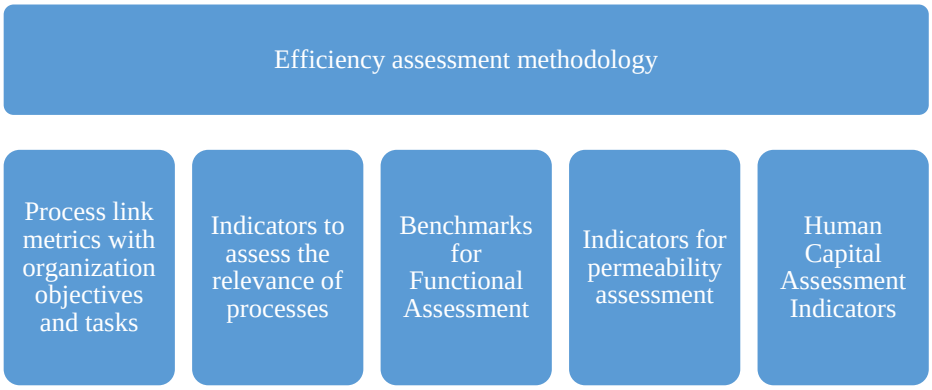

Fig. 2 Structure of the proposed efficiency assessment methodology

It is proposed to include in the structure of the methodology for assessing the effectiveness of administrative processes five groups of indicators for:

- Linking processes to the goals and tasks of the organization. This set of indicators includes options for assessing the relevance of the goals and tasks of the organization and the ongoing administrative processes. It is important for each objective and tasks to be secured with appropriate administrative processes and services. In a number of cases of similar matching, key evaluation indicators have to be defined. It is also important to properly identify the relevant information sources for calculating the values of key indicators;
- Assess the connectivity of processes. It is of utmost importance that the processes of the administrative service are connected and that their overall effectiveness allows the normal performance of the public organization's activity;
- Functional evaluation. This set of indicators aims at verifying the correspondence between actions, documents and process actors. This is achieved by checking for duplication of actions or roles of the individual participants;
- Assessment of permeability. Bandwidth is an important metric for assessing the effectiveness of each administrative process. The presence of bottlenecks in processes indicates the need for modeling and reengineering processes. From the point of view of administrative service, bottlenecks create difficulties and lead to loss of time by the participants;
- Assessment of human capital. This set of indicators aims at identifying the training needs and further qualification of the employees involved in the individual processes.

In each specific application of this methodology new groups of indicators can be added as well as their individual components can be parameterized.

3. Opportunities to improve the methodology

The main possibilities for improvement of the proposed methodology can be summarized in the following several ways:

- Extension of metric groups. In this direction, opportunities for risk assessment can be consistently integrated in introducing changes in administrative processes, linking each process with specific administrative services, measuring and evaluating digitized services, etc.;

- Setting and changing the system by weighting factors that apply to each of the pointer groups. Here the emphasis should be on the complexity of applying the weighted average approach and the risks involved;
- Extend the metrics in each of the defined groups. This approach should be applied on the basis of an analysis of the application of each of the predefined criteria and its redefinition if necessary.

The extension of the proposed methodology can not be an end in itself. It must be properly justified on the basis of the search for tools for more accurate assessment of efficiency and improvement of administrative services and the introduction of digital services.

4. Conclusion

Because of the research we can draw the following conclusions:

- In each measurement of the effectiveness of administrative processes, a certain sequence of activities and tasks must be respected;
- Preliminary efficiency assessment may offer opportunities for specific parameterization of process modeling activities;
- Assessing the effectiveness of administrative processes is a starting point for maintaining a high level of administrative capacity for the administration.

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Modern Trends of E-government in Bulgaria

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Abstract. The paper presents the methodological foundations for measuring the extent of e-government development worldwide. Data from leading UN studies has been used. On this basis, analyzes of the values for Bulgaria in the period 2003 - 2018 are made, as well as the respective trends. The study attempted suggestions for changes that would increase the value of the overall index. At the end, the main conclusions are formulated.

Keywords. E-government, Electronic services, Public policies

1. Methodology for assessing the development of e-government

The research of e-government and electronic services on a national and global scale is a difficult and responsible task. In a large part of the theoretical research, authors such as Kirilov highlight the risk factors in the public sector [1]. Other authors note the importance of data analysis in public organizations [2]. These and other researches are based largely on wide-ranging methodologies, including the UN tripartite assessment [3]. A common composite index for assessing the level of e-government development (EGDI) is being developed. Analytical results can be used to:

- Identifying the main trends in the values of the common indices and their constituent parts. In this way, charts can be formed and the movements of the individual organizations in them can be tracked;
- Areas for improvement by the individual indicators from the introduced assessment systems. This way an impact assessment can be made of the implementation of the various public policies in the field of digitization;
- The major challenges facing organizations in the area of digitization of services and administrative services for citizens and business;
- Assessing the effectiveness of investments in information and communication technologies. This can be achieved through the application of leading financial methods and traditional approaches used in the theory (example: cost-benefit comparison);
- Assessing the effectiveness of the e-services provided by public organizations, etc.;
- Forming a comprehensive state policy in the area of data center building, introduction of universal digital identification, digital content creation, associated administration and registers.

All these measures can improve the e-government's e-services and sectoral e-government policies. UN methodology consists of a composite index and three main components, which are:

- Telecommunication infrastructure development index (TTI);
- E-services development index (OSI);
- Human capital development index (HCI).

Fig. 1 shows the ratio of the three components and the value of the general index for Bulgaria by data for 2018 [3].

Fig. 1 EGDI values for Bulgaria for 2018

The graphical representation of the rectangles shows the ratio of the three major components from which the general index is formed. As this details the results in the next part, the outline of the main trends is based only on the value of the overall index.

2. Modern Trends for Bulgaria

To show today's trends in e-government development, data for the period 2003-2018 are analyzed. They are a total of 9 UN studies [3]. The presented analysis does not show the sub-components of the general index EGDI, but only the aggregated data (Table I).

Table I EGDI values for the period 2003-2018

	2003	**2004**	**2005**	**2008**	**2010**	**2012**	**2014**	**2016**	**2018**
E-Government Development Index	0,548	0,541	0,56	0,571	0,559	0,613	0,542	0,637	0,717
World Rank	35	41	45	43	44	60	73	52	47

The data in 2003 shows, that Bulgaria has ranked 35th in the world and in 478 it is 47th. This is generally a negative trend. At the same time, the EGDI values increased from 0.548 to 0.717 (see Fig. 2) for the paradigm and the overall trend was positive.

Fig. 3 shows the negative tendency to change the world ranking of Bulgaria - from 35th in 2003 to 47th place in 2018. These results show that investing in the development of the e-government subsystems is a problem of all the economies and the efforts in this direction only lead to success.

The graphical representation of the data shows that there are fluctuations in the figures by years. This is most likely due to a complex of internal and external causes.

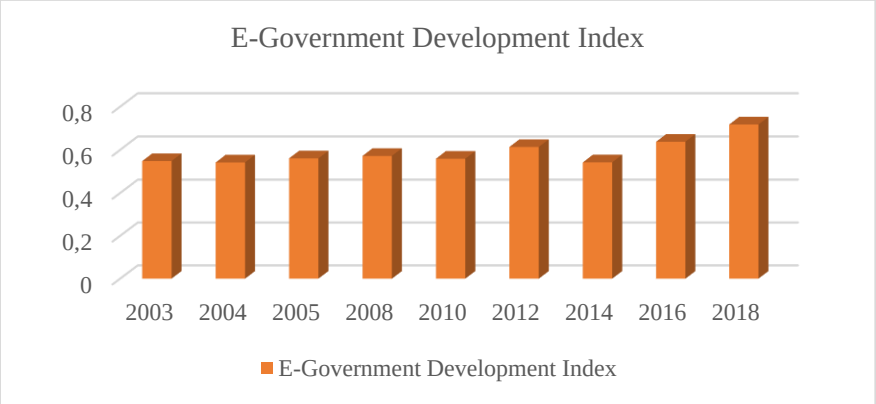

Fig. 2 EGDI for the period 2003 - 2018

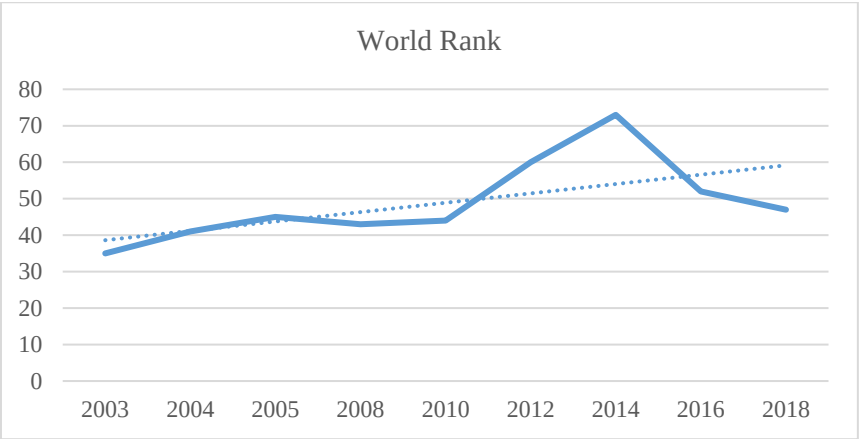

Fig. 3 World Rank for the period 2003 - 2018

3. Development Guidelines

The performance of periodic analyzes of the level of development of e-government gives grounds for formulating development guidelines. With regard to Bulgaria, the following can be mentioned:

- Introducing a comprehensive communication policy to promote the use of digital services by citizens and businesses;
- Studying the relationship between citizens' and business attitudes towards digital identity;
- Investing in new digital administrative services from central and local administrations;
- Improving work and increasing the efficiency of national data registers;
- Expanding the use of digital portfolios and mailings over the Internet;
- Introducing new mobile apps to pay for new administrative services;
- Periodic assessment of the impact of broadband expansion and new telecom infrastructure;

- Conducting permanent training of employees on the introduction of new digital services, etc.

We believe that this set of measures can bring very positive results to the core components of the general index and allow Bulgaria to move forward in the world e-government ranking.

4. Conclusion

Because of the research we can draw the following conclusions:

- The accumulation of historical data on the level of e-government development at national and international level allows comparative analysis and highlighting areas for improvement in the field of service digitization;
- Bulgaria has made a lot of effort in the last few years in the field of eGovernment subsystems. There is still a lag in comparative terms, with the greatest impact on e-services;
- Efforts should be made to develop new electronic administrative services from central and local administrations and to enhance the use of digital identity by citizens.

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An approach for Improvement Network Planning in Defining Optimal Routes for Urban Passenger Transport in Sofia

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Abstract. An approach for improvement network planning in defining optimal routes for urban passenger transport using SPSS program is represented in this report. A method of determining event reserves and reserves of operations through event reserves in model network patterns for planning the travel destination for urban passenger transport in Sofia is illustrated with the program SPSS. A formula for determining the full reserve of operations is obtained through the reservation of events and the deadlines for their implementation. An SPSS analysis of the event reserves and operations of the network models under consideration is performed.

Keywords. Network model, Optimal routes for urban passenger transport, Event reserves and reserves of network models operations, SPSS.

1. Introduction

Network planning is designed to describe a complex of interconnected operations and enables mathematically accurate and cost-effective addressing of complex organizational, planning and management issues.

Basic concepts of network planning are network model, event, operation (work), and route. Network models are information-dynamic models for a logical-mathematical description [1] of a planned process and algorithm for determining its parameters (duration, labor intensity, value, etc.). An event is the fact that the outcome of one or more operations, necessary and sufficient for the commencement of subsequent operations. Operation (work) - this is a process that is done to achieve a certain result and connects one event to another. Route - this is a sequence of operations in the network model in which the final event of an operation coincides with the initial event of the next post operation. [2]

From a mathematical point of view, the network model is oriented graph [3], the vertices of which depict events, and the ribs elementary operations (works). In the network models, each rib is matched to the time required to perform the respective operations. [2]

This report presents an approach using the SPSS program to improve network planning in defining optimal travel routes for Sofia city passenger transport.

The policy in the sphere of mass urban transport and transport services in Sofia is an important factor in determining the optimal routes for public transport in Sofia. The main basic factor determining the choice of travel routes for city passenger transport in Sofia is the Urban Mobility Center. It is who realizes the policy of Sofia Municipality in the sphere of mass public transport in Sofia.

The main function of the Urban Mobility Center is to organize and control public transport in Sofia. The Urban Mobility Center via travel schedules and vehicle routes sets the basic parameters for searching a public transport route.

2. SPSS program for determination of event reserves and operations of network models for travel by urban passenger transport in Sofia

Event and operation (works) reserves are basic parameters of network models and their determination allows to analyze network models.

Reserve of an event i in the network model shows how long it can hold its performance without changing the timing of the ending event [2]. The difference between late and early times for the event i is a time deposit for this event and is determined by [2, 4] of formula (1):

$$R(i) = t_k(i) - t_r(i) \quad (1)$$

Each operation (work) (i, j) in the network model has four types of reserve: full reserve $R_p(i, j)$, free reserve $R_s(i, j)$, independent reserve $R_n(i, j)$, and guaranteed reserve $R_g(i, j)$. [4]

The full reserve of each operation (work) (i, j) in the network model is essentially a reserve of the time of the longest route through this operation, and is the same for all of its operations [2,4]. The full time reserve of each operation (work) (i, j) is defined [2,4] by the time frame for its execution by formula (2):

$$R_p(i, j) = t_k(j) - t_r(i) - t(i, j) \quad (2)$$

By expressing $t_r(i) = t_k(i) - R(i)$ and $t_k(j) = R(j) + t_r(j)$, and substitution in the formula (2), the following formula for determining the full reserve of network model operations is obtained, through the reserve of events and their execution deadlines:

$$R_p(i, j) = R(i) + R(j) + t_r(j) - t_k(i) - t(i, j) \quad (3)$$

The free reserve of each operation (work) (i, j) in the network model is part of its full reserve and is indicative of its maximum delay (deferment), not affecting the following operations and is determined [4] by formula (4):

$$R_s(i, j) = R_p(i, j) - R(j) \quad (4)$$

The independent reserve of each operation (work) (i, j) in the network model is part of its full reserve of time when its initial event runs in its latest possible time, and its ultimate event runs at its earliest time and is determined [4] by formula (5):

$$R_n(i, j) = R_p(i, j) - R(i) - R(j) \quad (5)$$

Guaranteed reserve of each operation (work) (i, j) in the network model is part of its full reserve of time and may increase the operation duration without altering the late event of its initial occurrence and is determined [4] by formula (6):

$$R_g(i, j) = R_p(i, j) - R(i) \quad (6)$$

A method using the SPSS program for determining the reserves of events and operations of network models for travelling by Sofia city passenger transport is presented in this part of the report. In order to illustrate the developed approach with application of the

SPSS program we will consider an exemplary transport destination for the urban passenger transport in Sofia, generated by the new electronic platform [5] for urban transport route planning of the Urban Mobility Center.

For this purpose, we will plan a transport destination along a route of the public transport in Sofia (08.21.2018): From point A: *20, Tsarigradsko shosse Blvd.* To point B: *10, 8th March Str.* (fig.1) and From point B: *10, 8th March Str.* To point A: *20, Tsarigradsko shosse Blvd.* by selecting the time of arrival 4 pm. Three routes are generated: the fastest route, the least walking route, and the route with least transfers with start and end times for traversing each section of each route. The travelling and starting time travel instructions, for each section of each route, and the time in minutes for each section of each route in the AB and BA directions are given in Table 1 and Table 2 respectively.

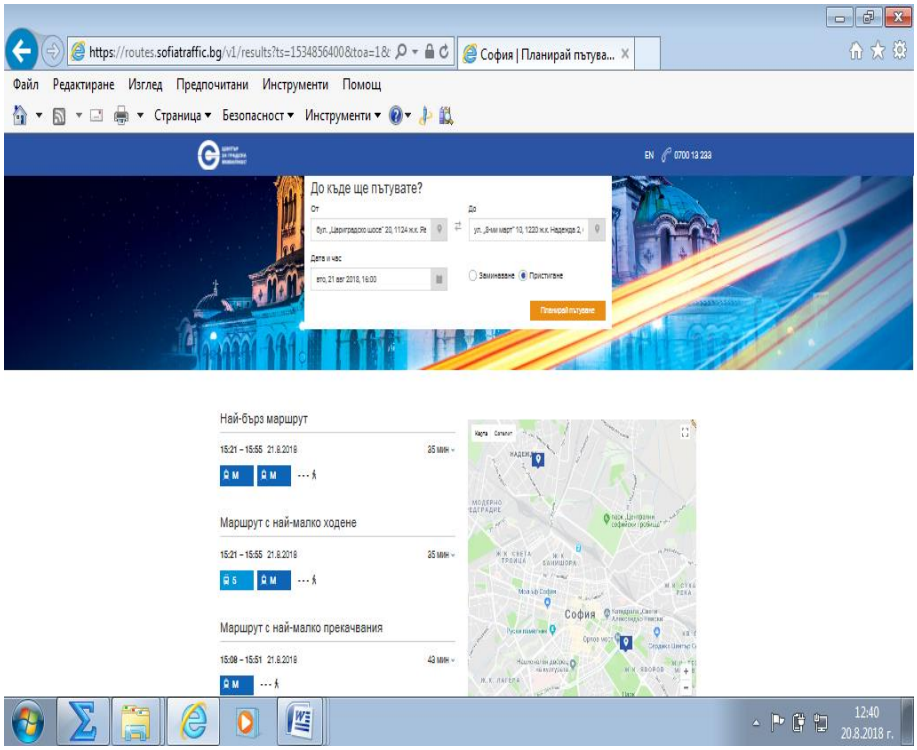

Fig. 1. Route for urban passenger transport in Sofia
from 20, Tsarigradsko Shosse Blvd. to 10, 8th March Str.

Using the start and end time for travelling the separate section of each route and the time in minutes for each section of each route in the *AB* и *BA* directions (Table 1 and Table 2) we can complete lists of sections to reflect the sequence and timing of their passage. From Table 1 and Table 2 we can define the operations that correspond to the sections of the lists and codify these lists for both directions.

The two-dimensional frequency distribution of the AB and BA operations is generated by the SPSS program respectively in Table 3 and Table 4. Table 3 is generated by program SPSS through functions *Analyze* ⇒ *Deskriptive Statistics* ⇒ *Crosstabs* ⇒ *Row(s):* ***kode.AB*** ⇒ *Column(s):* ***operation.AB*** ⇒ *Layer 1 of 1:* ***t.i.j.AB*** , when

kode.AB is the list of operation codes in the direction *AB*, ***operation.AB*** are the operations for the respective codes in the direction *AB*, and ***t.i.j.AB*** is the time corresponding to each operation in the direction *AB*. Similarly, Table 4 is generated by SPSS program.

Table 1.Instructions for travelling by urban passenger transport in Sofia in the direction AB: from 20, Tsarigradsko Shosse Blvd. to 10, 8th March Str.

Route		Duration in minutes
Fastest route: Metro Line 1 и Metro Line 2		
15:21-15:32	Walking from *20, Tsarigradsko Shosse Blvd.* to *SU St. Klimet Ohridski* metro station	11
15:32-15:34	Going down to *SU St. Klimet Ohridski* metro station	2
15:34-15:37	Travel by metro line 1 (1 stop) to *Serdica* metro station	3
15:37-15:41	Walking to *Serdica II* metro station	4
15:41-15:49	Travel by metro line 2 (5 stops) to *Nadezhda* metro station	8
15:49-15:50	Going out of *Nadezhda* metro station	1
15:50-15:55	Walking from *Nadezhda* metro station to *10, 8th March Str*.	5
Least walking route: Trolleybus 5 and Metro		
15:21-15:27	Walking from *20, Tsarigradsko Shosse Blvd.* to st. *BTA* (1395)	6
15:27-15:37	Travel by trolleybus 5 (4 stops) to st. *NDK square* (1136)	10
15:37-15:39	Walking to *NDK* metro station	2
15:39-15:49	Travel by metro (6 stops) *Nadezhda* metro station	10
15:49-15:50	Going out of *Nadezhda* metro station	1
15:50-15:55	Walking from *Nadezhda* metro station to *10, 8th March Str.*	5
Least transfers route: Metro		
15:08-15:19	Walking from *20, Tsarigradsko Shosse Blvd.* to *SU St. Klimet Ohridski* metro station	11
15:19-15:21	Going down to *SU St. Klimet Ohridski* metro station	2
15:21-15:45	Travel by metro (11 stops) to *Nadezhda* metro station	24
15:45-15:46	Going out of *Nadezhda* metro station	1
15:46-15:51	Walking from *Nadezhda* metro station to *10, 8th March Str*.	5

Table 2.Instructions for travelling by urban passenger transport in Sofia in the direction BA: from 10, 8th March Str. to 20, Tsarigradsko Shosse Blvd.

Route		Duration in minutes
Fastest route: Metro and Bus 213		
15:20-15:25	Walking from *10, 8th March Str*. to *Nadezhda* metro station	5
15:25-15:27	Going down to *Nadezhda* metro station	2
15:27-15:34	Travel by metro (4 stops) to *Lavov most* metro station	7
15:34-15:37	Walking to st. *Lavov most square* (1278)	3
15:37-15:48	Travel by bus 213 (4 stops) to st. *Voenna akademiya* (0442)	11
15:48-15:56	Walking to *20, Tsarigradsko Shosse Blvd.*	8
Least walking route: Bus 86 and Trolleybus 5		
15:10-15:15	Walking from *10, 8th March Str*. to st. *Targovski kompleks Nadezhda* (2299)	5
15:15-15-20	Travel by bus 213 (3 stops) to st. *Knyaginya Maria Louisa Blvd.* (2299)	5
15:20-15:27	Waiting for trolleybus 5	7
15:27-15:52	Travel by trolleybus 5 (12 stops) to st. *Orlov most* (1287)	25
15:52-15:55	Walking to *20, Tsarigradsko Shosse Blvd.*	3
Least transfers route: Metro		
15:15-15:20	Walking from *10, 8th March Str*. to *Nadezhda* metro station	5
15:20-15:22	Going down to *Nadezhda* metro station	2
15:22-15:47	Travel by metro (11 stops) to *SU St. Klimet Ohridski* metro station	25
15:47-15:48	Going out of *SU St. Klimet Ohridski* metro station	1
15:48-15:59	Walking to *20, Tsarigradsko Shosse Blvd.*	11

Table 3.

kode.AB * operation.AB * t.i.j.AB Crosstabulation

Count

t.i.j.AB			operation.AB walking	metro	trolley bus	Total
1	kode.AB	10-11	1			1
		12-13	1			1
	Total		2			2
2	kode.AB	2-3	1			1
		5-6	1			1
		7-8	1			1
	Total		3			3
3	kode.AB	6-7		1		1
	Total			1		1
4	kode.AB	7-9	1			1
	Total		1			1
5	kode.AB	11-14	1			1
		13-15	1			1
	Total		2			2
6	kode.AB	3-4	1			1
	Total		1			1
8	kode.AB	9-12		1		1
	Total			1		1
10	kode.AB	4-7		0	1	1
		8-12		1	0	1
	Total			1	1	2
11	kode.AB	1-2	1			1
		3-5	1			1
	Total		2			2
24	kode.AB	3-10		1		1
	Total			1		1

Table 4.

kode.BA * operation.BA * t.i.j.BA Crosstabulation

Count

t.i.j.BA			operation.BA walking	bus	waiting	metro	trolley bus	Total
1	kode.BA	10-11	1					1
	Total		1					1
2	kode.BA	4-5	1					1
		6-7	1					1
	Total		2					2
3	kode.BA	12-13	1					1
		8-9	1					1
	Total		2					2
5	kode.BA	1-2	1	0				1
		2-3	0	1				1
		2-4	1	0				1
		3-6	1	0				1
	Total		3	1				4
7	kode.BA	3-7			1	0		1
		7-8			0	1		1
	Total				1	1		2
8	kode.BA	11-14	1					1
	Total		1					1
11	kode.BA	11-15	1	0				1
		9-11	0	1				1
	Total		1	1				2
25	kode.BA	5-10				1	0	1
		7-12				0	1	1
	Total					1	1	2

In the left column of Table 3 and Table 4, the time and codes of the respective operations are generated in the directions, and in the ***operation.AB*** and ***operation.BA*** columns are generated operations in both directions and their frequencies.

With the data from Table 3, there is a network model *AB* for public transport travelling in Sofia on the route *20, Tsarigradsko Shosse Blvd. to 10, 8th March Str.*, when with the data from Table 4, a network model *BA,* for public transport in Sofia on the route *10, 8th March Str. to 20, Tsarigradsko Shosse Blvd.* is generated.

We will illustrate an approach using the SPSS program to determine the event reserves and operations of the AB and BA network models. To determine the reserves of events and operations of the network AB model five quantitative variables are defined: *t.i.j.model.AB*, $t.r.i.model.AB$, $t.r.j.model.AB$, $t.k.i.model.AB$ and $t.k.j.model.AB$ on page *Variable View* of the SPSS program, and after that on page *Data View* values for these variables are entered. In the column *t.i.j.model.AB* the values for the duration in minutes of each operation are entered (i, j) in network model *AB*, when in the column $t.r.i.model.AB$ the early start terms of the initial event i are entered for the operation (i, j), in the column $t.r.j.model.AB$ the early terms of the final event j are entered for the operation (i, j), in the column $t.k.i.model.AB$ the late terms of the start event i for the operation (i, j), and in the column $t.k.j.model.AB$ the late terms of the final event j are entered for the operation (i, j). Similarly, the variables $t.i.j.model.BA$, $t.r.i.model.BA$, $t.r.j.model.BA$, $t.k.i.model.BA$ and $t.k.j.model.BA$ are defined for the network model *BA*.

The event reserves of each operation (i, j) in the network model AB marked with the variables $R.i.model.AB$ and $R.j.model.AB$ can be calculated by SPSS program by selecting the functions *Transform* $\Rightarrow$ *Compute Variable*. The event reserve i is determined by its deadlines $t.k.i.model.AB$ and $t.r.i.model.AB$ by SPSS program, as in the field *Target Variable* is entered $R.i.model.AB$, and in the field *Numeric Expression* is entered $t.k.i.model.AB - t.r.i.model.AB$. The result of the given formula is generated in the column of the variable $R.i.model.AB$ on the page *Data View*. Similarly, the event reserve j is generated by the SPSS program by its terms $t.k.j.model.AB$ and $t.r.j.model.AB$ with the functions *Target Variable*: $R.j.model.AB$ $\Rightarrow$ *Numeric Expression:* $t.k.j.model.AB - t.r.j.model.AB$.

The full reserve of each operation (i, j), marked with a variable $R.p.i.j.model.AB$ in the network model *AB* , can be defined by the SPSS program (Fig. 2) by the event reserve generated by the SPSS program with the variables $R.i.model.AB$ and $R.j.model.AB$, and the terms $t.r.j.model.AB$, $t.k.i.model.AB$, $t.i.j.model.AB$ for its implementation by choosing functions *Transform* $\Rightarrow$ *Compute Variable* $\Rightarrow$ *Target Variable*: $R.p.i.j.model.AB$ $\Rightarrow$ *Numeric Expression:*

$$R.i.model.AB + R.j.model.AB + t.r.j.model.AB - t.k.i.model.AB - t.i.j.model.AB.$$

After determining the event reserve and the full reserve of operations in the *AB* network model with the SPSS program, the free, independent and guaranteed reserve of operations are generated through their full reserve generated by the SPSS program with the variable $R.p.i.j.model.AB$ and the event reserve generated by the SPSS program with the variables $R.i.model.AB$ and $R.j.model.AB$.

The free reserve of operations marked by variable $R.s.i.j.model.AB$ is determined by the SPSS program through the full reserve $R.p.i.j.model.AB$ and the event reserve j generated through the variable $R.j.model.AB$ by selecting functions *Transform* $\Rightarrow$ *Compute Variable*, through entering $R.s.i.j.model.AB$ in the field *Target Variable*, and entering $R.p.i.j.model.AB - R.j.model.AB$ in the field *Numeric Expression.* The result of the given formula is generated in the column of the variable $R.s.i.j.model.AB$ on the page *Data View*.

The independent reserve of operations marked with the variable $R.n.i.j.model.AB$ is determined by the SPSS program through their full reserve $R.p.i.j.model.AB$ and the event reserve $R.i.model.AB$ and $R.j.model.AB$ with the functions *Transform* $\Rightarrow$ *Compute Variable* $\Rightarrow$ *Target Variable*: $R.n.i.j.model.AB$ $\Rightarrow$ *Numeric Expression:* $R.p.i.j.model.AB - R.i.model.AB - R.j.model.AB$.

Using the SPSS program, the guaranteed reserve of operations marked with the variable $R.g.i.j.model.AB$ is determined through their full reserve $R.p.i.j.model.AB$ and the event reserve i generated by the variables $R.i.model.AB$ choosing functions *Transform*

$\Rightarrow$ *Compute Variable* $\Rightarrow$ *Target Variable*: $R.g.i.j.model.AB$ $\Rightarrow$ *Numeric Expression:* $R.p.i.j.model.AB - R.i.model.AB$.

Similarly, using SPSS program the event reserves $R.i.model.BA$ and $R.j.model.BA$ and reserves of operations $R.p.i.j.model.BA$, $R.s.i.j.model.BA$, $R.n.i.j.model.BA$ and $R.g.i.j.model.BA$ are determined by the event reserves for the network model *BA*.

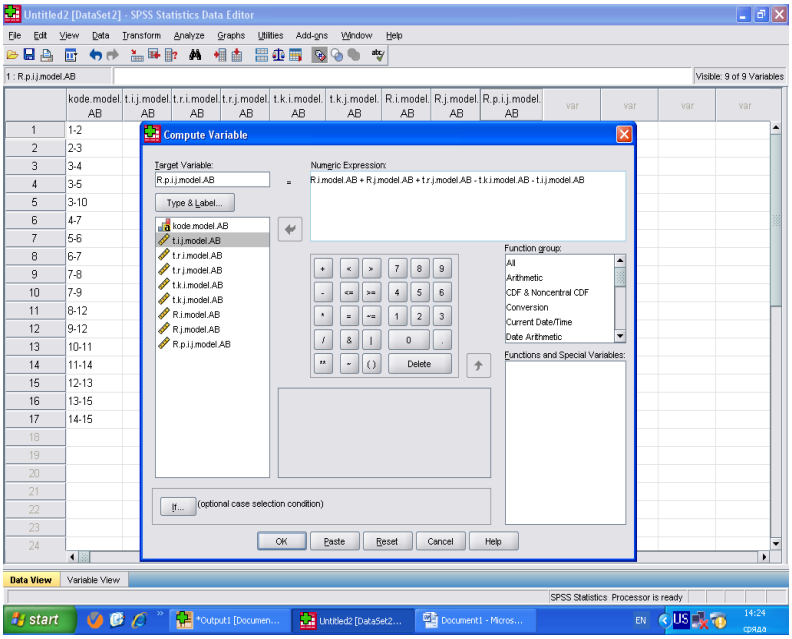

Fig. 2. Calculation of the full reserve of operations in the AB network model by through the event reserve and deadlines for their execution with the SPSS program

3. Analysis of events and operations reserves of network models with SPSS program

After determining the event reserves and the reserves of operations through the event reserves of the AB and BA network models, we will illustrate an SPSS analysis approach of the event reserves and the reserves of operations of the network models under review. For that purpose by selecting the functions *Analyze* $\Rightarrow$ *Classify* $\Rightarrow$ *K-Means Cluster Analysis* $\Rightarrow$ *Options: Initial cluster centers, cluster information for each case*, with which the SPSS cluster analysis of the K-averages [6] is performed, an analyses of the event reserves and the reserves of th operations of AB and BA network models is made.

The cluster analysis result for the purpose of distribution in 10 clusters is generated with the SPSS program for the network model AB in Table 5, and for the network model BA is generated in Table 6. In the K-Means cluster procedure, the SPSS program also generates a table of cluster centers for each of the network models *AB* и *BA* (Table 7 and Table 8), from which the duration of the operations and the reserves of events and operations included in the clusters can be determined.

Table 5. Clustering of the network model AB

Cluster Membership

Case Number	kode.model. AB	Cluster	Distance
1	1-2	1	,500
2	2-3	2	,250
3	3-4	3	,500
4	3-5	1	,500
5	3-10	5	,000
6	4-7	1	,500
7	5-6	2	,250
8	6-7	8	,000
9	7-8	2	,250
10	7-9	10	,000
11	8-12	1	,500
12	9-12	4	,000
13	10-11	7	,000
14	11-14	9	,000
15	12-13	2	,750
16	13-15	3	,500
17	14-15	6	,000

Table 6. Clustering of the network model BA

Cluster Membership

Case Number	kode.model. BA	Cluster	Distance
1	1-2	1	,000
2	2-3	1	,000
3	2-4	1	,000
4	3-4	7	1,600
5	3-6	1	,000
6	3-7	6	,000
7	4-5	7	,400
8	5-10	8	,000
9	6-7	7	,400
10	7-8	6	,000
11	7-12	2	,000
12	8-9	7	1,400
13	9-11	5	,000
14	10-11	7	,600
15	11-14	10	,000
16	11-15	5	,000
17	12-13	3	,000
18	13-15	4	,000
19	14-15	9	,000

Analyzing the non-zero reserves of the events and operations of the network models examined (Table 9 and Table 10) we can draw the following conclusions:

The non-zero reserves $R(j) = R_p(i,j) = R_g(i,j) = 4$ have the operations that are included in the ***5*** *cluster* of the network model *AB* (Table 9) and in ***2*** *cluster* of the network model *BA* (Table 10). From Table 7 and Table 8 it can be determined that these are operation *3-10* of the network model *AB* and operation *7-12* of the network model *BA*.

Non-zero reserves $R(i) = R_p(i,j) = R_s(i,j) = 4$ are available with the operations, which are included in ***6*** *cluster* of the network model *AB* and in ***4*** *cluster* of the network model BA. These are operations *14-15* of the network model *AB* and operations *13-15* of the network model *BA*.

Non-zero reserves $R(i) = R(j) = R_p(i,j) = 4$, $R_n(i,j) = -4$ are available with the operations, which are included in ***7*** и ***9*** *cluster* of the network model *AB* and ***3*** *cluster* of the network model *BA*. These are operations *10-11* and *11-14* of the network model *AB* and operations *12-13* of the network model *BA*.

Non-zero reserves $R(i) = R_p(i,j) = R_s(i,j) = 3$ are available only with the operations, which are included in ***9*** *cluster* of the network model *BA* (Table 8). This is operation *14-15* of the network model *BA* (Table 8).

Non-zero reserves $R(j) = R_p(i,j) = R_g(i,j) = 3$ are available only with operations, included in ***10*** *cluster* на of the network model *BA*. This is operation *11-14* of the network model *BA*.

Another conclusion we can make is that only one operation of the two network models of the travelling operations by metro, bus and trolleybus has non-zero reservations. This is the operation (*3-10*) for metro journey of the network model *AB* (Table 3) and operation (*7-12*)

for trolleybus journey of the network model *BA* (Table 4).

Table 7. Cluster centers of network model AB

Initial Cluster Centers

	Cluster									
	1	2	3	4	5	6	7	8	9	10
t.i.j.model.AB	11	1	6	8	24	0	1	3	5	4
R.i.model.AB	0	0	0	0	0	4	4	0	4	0
R.j.model.AB	0	0	0	0	4	0	4	0	4	0
R.p.i.j.model.AB	0	0	0	0	4	4	4	0	4	0
R.s.i.j.model.AB	0	0	0	0	0	4	0	0	0	0
R.n.i.j.model.AB	0	0	0	0	0	0	-4	0	-4	0
R.g.i.j.model.AB	0	0	0	0	4	0	0	0	0	0

Table 8. Cluster centers of network model BA

Initial Cluster Centers

	Cluster									
	1	2	3	4	5	6	7	8	9	10
t.i.j.model.BA	5	25	3	0	11	7	2	25	0	8
R.i.model.BA	0	0	4	4	0	0	0	0	3	0
R.j.model.BA	0	4	4	0	0	0	0	0	0	3
R.p.i.j.model.BA	0	4	4	4	0	0	0	0	3	3
R.s.i.j.model.BA	0	0	0	4	0	0	0	0	3	0
R.n.i.j.model.BA	0	0	-4	0	0	0	0	0	0	0
R.g.i.j.model.BA	0	4	0	0	0	0	0	0	0	3

4. Conclusion

Four main results are received in the report.

First of all, with the original SPSS program method illustrated in the report, the network planning is improved in determining the optimal routes for travelling by urban passenger transport in Sofia.

Secondly, the presented SPSS program method is used to determine the event reserves and the reserves of operations through event reserves of the network model.

Third is the illustrated approach to analyzing reserves of events and operations of the network models with SPSS program.

Fourthly, the formula for expressing the full reserve of network model operations is obtained through the event reserve and deadlines for their execution.

An advantage of the described original approach for determining and analyzing the reserves of events and operations of the network models with the SPSS program is that it can be applied to all network models.

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Featuring Service Design Paradigm in Small-Sized Service Organisations in Bulgaria

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Abstract. The paper reviews an attempt to delineate a typical service design paradigm followed by small-sized service organizations in Bulgaria. A theoretical model of the Köln International School of Design is represented as a point of reference to conduct further marketing research. In this respect, in-depth interviews with service managers in consultancy-and-training services, meal-kit services, construction and repairs businesses, educational services are carried out. The majority of service managers acknowledge they are weakly familiar with the service design pattern. They agree they do not implement service design paradigm neither formally, nor intuitively, but are concerned to carry out design actions.

Keywords. Service design, KISD model, In-depth interviews, Small-sized service enterprises, Bulgaria.

1. Introduction

Defining the interconnection between the service design and the business model that a service organization utilizes, requires that we elaborate on the context of an investigation of a given service and on its prospects. In the following text, the examination of the investigative context is carried out with the help of research focused on different branches of services in Bulgaria while the prospects of the investigation are derived from the interaction model "client-service" and the service process. The relation "design-business model" is defined as a part of the wider research of the problem, namely as an attempt to establish the possible effects of the service design on the business model, and, respectively, on the market results of a service organization.

The purpose of this paper is to clarify the framework of the construction and components of a service design; the scheme "design-business model" of the service suppliers is also expounded. From this viewpoint, the research results of an investigation of the theoretical knowledge about design of service organizations in Bulgaria and the practical application of this knowledge are summarized, while some of the specific features of the design context in Bulgaria are developed.

2. A Service Design Paradigm

Service design concerns innovations in services. In the service organization the design serves as a strategic process of innovating and as a tactical model for improving the supplied services. The direction of innovation in design is: (1) from the perspective of the client, better utility and more desirability, and (2) from the perspective of the organizations – unlocking business value. The value of design comes from top management rigor, company-wide teamwork, rapid iteration, and relentless user-centricity [6]. Service design is a relatively new, holistic, multidisciplinary and inclusive field of knowledge [5].

Service design is a realm in which complex and interactive experiences, processes and systems are developed, all of which have to do with the realization of the "client-service" interaction. The design process is multidisciplinary as it involves the competencies of experts in related fields and the competencies of the participating clients. Special procedures, instruments and methods are applied in the process [4].

Service design involves the management from the functional fields of marketing, research and design as well. It acts in a holistic way as an interface, which connects clients and service suppliers in a new way. In particular, it has a different approach to the relationship between organizations and clients. The role of design here is to "nurture" relationships by creating meaningful and innovative experiences for service clients [5]. This role of design is increasingly becoming an object of inquiry by the academic community. Research expands in the direction of how strong companies are at design and how that links up with their financial performance [6].

In the process of designing the service, the role of the consumer changes the most. Designers no longer make him into an object of observation, nor do they examine him from the viewpoint of his desires and needs. The approach in the actual contact with the consumer also changes – designers try to encourage his participation in the service. Through the concept of participation in the service, they develop ways to allow the consumer to represent (serve) himself or to experience the service [1]. Such an interface of the service is precisely what confirms the inclusion of the consumer in the process of design. This is why service design today conforms to the client-oriented paradigm, while designers accept the client as a part of the project and collaborate with him [4].

As a multidisciplinary platform for expert evaluation, service design is becoming a constant process of renewing the interaction "client-service". It is an activity of working out the components needed to include organizations to new practices of services. In other words, service design adjusts itself to organizations and their needs, and turns itself into a process of planning, while the design becomes a formal part of business structure.

The *Köln International School of Design* (KISD) advances a general model for service design [5]. According to this model, service design is a "mediator" between organizations and clients. Design increases the output of organizations by working on the efficiency of their services and by increasing the level of satisfaction of their clients, while enhancing the usefulness, utility and desirability of the services. The KISD model demonstrates how service design could study the organization, look into its resource security, and uncover its limitations and the context in which it is competing. The context of the organization consists in its workers, possible suppliers, key partners, competition and a corresponding technology. By following the model, service designers penetrate the needs of the clients and of the market, and develop prognoses and insights based on the information they have attained. The service design also explores the client context, namely: the market wherein the service provider is working, the community, society, politics, economics and development tendencies.

The model is based on the idea that the design helps managers in business organizations develop marketing strategies and the service in general. It advices them how to develop technological solutions, to shape the service process and to compile the necessary leadership. Design changes the culture an organisation– it derives its meaningfulness from the service, focuses on the client and orients itself towards innovation. Design nurtures talent in its employees as a permanent component of the service enhancement. The service enhancement only becomes possible when the design shapes all interaction phases between the service and the client in order to improve the overall service experience. By boosting the relationship between customer and organization, design makes the affinity to the brand increase. Using the model, service designers control the feedback and encourage the integration of people – from

the organization and the clientele – into the process of designing. The model shows how design acts as an interface. It works both with the prospects of the organization and with the perspective of the client – from studying the needs and behaviour of clients to developing projects and realizing the service they require.

3. The Contextual Service Design Paradigm in Bulgaria

The necessity of clarifying whether service design is an active paradigm in Bulgaria, as well as the need to explore the context of service design, presupposes the exploration of business from different service branches.

Formulative program of research: Companies, which have accepted to partake in preliminary questionnaire to the study concerning the particularities of service design in Bulgaria, embrace the areas: a) professional and consultant services, b) retail services in the food sector, food deliveries, c) restaurants and hotels, d) construction – repairs, interior design e) education and professional training [6]. The particulars of the marketing study have necessitated the preparation and conduction of in-depth interviews with service managers in Bulgaria. The study provides guidelines for the interview, including a general questionnaire with the main conversation topics presented as open questions. They are based on the topics of: 1) theoretical knowledge and practical usage of the service design paradigm; 2) process and ways of application; and (3) specifications and problem areas in service design or model application in service management. Seven managers were interviewed in personal meetings, while three of them expand on the factual activity of marketing service management with the help of a design. In the interviews, specific questions were posed regarding the purposes of service design in Bulgaria.

Summarizing the results of in-depth interviews: Knowledge and application of the service design paradigm in Bulgaria is relatively small in scope. From a formal, theoretical point of view, the topic is unrecognizable and unknown to the respondent service managers. The prevalent opinion is that, on the one hand, the topic is not exclusive to the academia; that is, according to the service managers, the service design paradigm has been practised and disseminated from companies with a consultant profile, which conduct practical training of their clients in the field of service design. On the other hand, according to the interviewees, the working paradigm in Bulgaria is defined either by the adapted market models of service management, or by those, which have been shaped by the scale of a particular business.

According to all interviewed respondents, very often, the accommodation of the service design is not understood in light of the service process as an element of its marketing mix and it is not strictly defined or observed as an integrated marketing management activity from the service organisation. In essence, the service process is a component of design and its function is to illustrate the interaction "client-service", respectively, "client-employee". In this respect the respondents recognize the idea of service process in some of its contemporary treatments with regard to modelling client experience: as "customer experience journey mapping" and "employee experience journey mapping". While commenting on the paradigm of service design, service managers – especially in micro-enterprises or small companies – said that they rarely use specialized studies and rely mostly on "experience" and data from particular clients. Thus, design paradigm would seem discredited, as there is often a lack of adequate studies and data for the market and consumer behaviour. Service managers, however, demonstrate optimism that the weight of opinions and signals from active or previous clients could be used for the purposes of a design and even show conviction that this is the case. After service design was conceptually explained to the respondents, they found out that they intuitively use some techniques and aspects of the service design paradigm. According to them, their "interface" is commonly based on "experience" or "common sense".

Accepting the specifications and problem areas of service design, respectively in the application of a management model for services, the respondents are unanimous that there is *very often* a lack in effective communicateon between departments and between specialists in the service organization. Two of the respondents state that "true" multidisciplinary approaches are also rare in applying the service design paradigm.

Managers identify the so-called "following" of market behaviour as a typical problem in design paradigm in Bulgaria. The respondents acknowledge that the competition is crucial for the marketing service management but in place of an attempt to "outplay" the competition, a common practice is the "reproduction" of business practices, product categories and effectiveness, comparable to those of the close competitors and the competition leader. The competitor is being followed without detailed market research or a clearly defined marketing strategy. In order for the client to be won over, a situation from the type "everyone does everything" emerges, in which this *everything-doing* can include subcontractors or suppliers.

The specific character of the service design paradigm in Bulgaria consists in the policy according to which every possible redesign or change in the service is actualized in the course of its provision, with frequent feedback from the client or feedback based on indicators for effectiveness (i.e. number of services). Another particularity of the design is that service managers attach great importance to market trends, such as automation of services, increase in the participation of the client in the service, self-service, "all-in-one" service, integration of services, "door-to-door" delivery, the idea of "green" services, inclusion of bio or organic products, bringing services up-to-date with the help of modern technologies for communication, video-surveillance and tracking.

4. Discussion

Considering the above leads us to the possibility of developing models of corporate sustainability. Firstly, it would be more appropriate to consider the company as an autonomous system. This means not paying attention to management impacts. In this case, the conditions of the organization (stable or unstable) are considered as a set of possible conditions. The main task is to assess the effects that lead to a certain condition. Choosing two relevant indicators to characterize the organization's activity, their impact on the corporate sustainability can be addressed through a system of two ordinary differential equations. These variables can be investments and amount of dividends paid, costs of attracting new customers and costs of retaining existing customers, and more. They allow us to build a model for corporate sustainability and the organization is considered an autonomous system. After summarizing the results of the in-depth interviews with service managers, the study attempts to grasp the overall picture of service design in Bulgaria along with its most pertinent features. As a rule, managers have a vague knowledge of the design paradigm. They have not really integrated it into their work and have not perceived its format as a basis for service management. On their part, they tried to understand the paradigm and to compare it to their own work methods, commonly pointing out that they are applying its normative and procedurally substantiated equivalent. On the other hand, the representatives of small businesses in the service sector build and manage the service interface intuitively, based on their "experience" as participants in the market – even if this is a result of a trial and error-based approach or imitation. Regardless of their previous knowledge of the paradigm, and regardless of whether they work with an analogous market approach, all respondents show vivid interest in service design and the solutions to key challenges, the profitableness of the activity and the improvement of results. Managers are interested in whether the goals of service design are related to the business model of the service organisation.

As we conclude the exploratory stage of the academic study, which concerns the

particularities of the service design paradigm in Bulgaria as perceived by service managers and in the specifically Bulgarian context of its application, there is another important topic to be discussed. We can convincingly say that there are three groups of persons concerned by the problems of service design in Bulgaria: the service managers of a high or middle level of management, managers of consultant companies in the field of service design, and the academic staff of a higher education institution, that is, "service suppliers – consultant business – academy". After conducting the in-depth interviews with service managers, managerial consultants in service design have also been interviewed in an open conversation. General questions have been discussed, concerning the place of the consultant business as service designer in Bulgaria and its role in the educational service in general. Similarly to the unfolding of digital marketing and its following endorsement as an academic discipline in Bulgaria, business is crucial to service design, as it succeeds in building the necessary infrastructure and ecosystem for the practical execution of design paradigm.

It turns out that, on the one hand, business in the service sector in Bulgaria – whether driven by successful adaptions of models for service management, or compelled by the influence of market context, or simply due to inertial movement – is contained outside of the service design paradigm. On the other hand, consultant business is acquiring market power in nurturing and applying the design paradigm. Meanwhile, higher education is studying the capabilities and problems of the design paradigm, but without a lucid academic research profile and without a clearly defined role in the exercise of the paradigm.

5. Conclusion

Service design paradigm is still not sufficiently acknowledged by the business in Bulgaria, in order to be widely used or integrated – especially in micro-enterprises, small or start-up companies. Currently, managers rely on expert opinions and partial analyses for service modelling. Given the stable market trend in the transition from "product" to "service" in all sectors of the economy, there is a growing need for better knowledge and application of the paradigm – this holds especially for traditional services such as education and tourism. Parallel to that, the service organisations attach great importance to the market trends and to feedback from interested parties, and try to adapt the offered services to the needs and the dynamics of the market in a more intuitive, but also flexible way.

Regarding education, we can draw the conclusion that it is necessary to introduce and use the methods of service design *adaptively* (i.e. towards a particular micro-group or a particular consumer – trainee or student) and *dynamically* (with constant feedback) in using the contemporary technical means and information. The redesign of the educational service in higher education must be based on approved methods and adequate research concerning the possibilities, needs and goals of the participants (including those of the students, or of the business). In addition, ways must be found to stimulate the wider training in service design through working on projects or internships.

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Smart Cities in Japan

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Abstract. This publication is part of the material of science project "Economical aspects of security in smart settlements", a University of National and World Economy №15/2018. It concerns the smart cities in Japan. The goal of this study is to observe and gain knowledge about best practices in this country. In addition, there are examples of smart cities in Japan, their role and purposes. There are also explained the problem and the reasons for implementation of the smart technologies.

Keywords - Japan, Smart city, Smart society

1. Introduction

The future of the market in the European Union (EU) and especially in Japan is connected to the smart technologies and in private to the smart cities.

The problem in this article is the lack of knowledge about some of the future generation projects in the world. Our EU and United States of America(USA) centric approach often ignore one of the most technically developed countries in the world Japan. According to the problem the goal is to study and to be described the good practices in implementing the smart technologies in everyday life of Japanese citizens. Also, this technology (smart cities) in Japan, is also called "Next-Generation Energy and Social Systems Project"[1] Also they are directly connected to the problem that concern the energy security. Overall the one thing is for sure. Cyber technologies require a huge amount of energy. This energy according to the current technology can come only from nuclear power plants.[2] Even that the Japan approach is to implement renewable energy sources. Only the time will show the effectiveness of this approach. For example, Bulgaria has very bad experience concerning this kind of energy sources.

The problem is current because of the growing economic importance of smart cities. This address the necessity of coverage of environmental issues that require developing of local solutions for energy management especially in Japan. One of the reasons for the fast developing of this issue is the accident at the Fukushima nuclear power plant so "Japan has to adjust"[3] its energy policy. There is a prediction that the investments in smart-cities will rise up to 4 quadrillions JP¥[4] (around 3 trillion EUR). For comparison, we can use the investments in Bulgaria, where more than 1 billion euro was invested in the renovation of residential buildings with a not very clear result.

The object of the article is the smart cities in Japan and the subject is the good practices and economical aspects.

The methodology is documentary analysis and data mining. The scope is limited just to the description of this process.

Japanese smart cities are a work in progress. Among the factors that distinguish Japanese smart cities from their counterparts overseas are:

- A focus on smart energy systems and disaster resilience;

- A "whole of government," integrated approach;
- An emphasis on building up from the micro as opposed to bolstering the macro-grid;
- An accelerating deployment due to the March 11, 2011 (3/11) Fukushima disaster.

2. Smart cities in Japan (the approach)

Public-private partnership

The smart cities in Japan rely on public-private partnership. Municipal governments in Japan rely on the private sector's business savvy and technology expertise to fill knowledge gaps for "smart" city initiatives. For each of the projects, consortiums were created to match local governments with companies. The emphasis is on retrofitting existing infrastructure rather than building new cities.[5] Public-private partnerships between a government agency and private-sector company can be used to finance, build and operate projects, such as public transportation networks, parks and convention centres. Financing a project through a public-private partnership can allow a project to be completed sooner or make it a possibility in the first place.[6]

Cities are hubs of economic activity. They attract most of the national businesses and services and concentrate the densest infrastructures. The larger they are, the more investments they draw. For example, the urban population keeps on increasing, and in 2012 accounted for respectively 74% and 92% of the total European and Japanese population.

Definition

Establishing what a Smart City is can be challenging: the definition differs depending on the sources and on the projects, and have changed over time. Indeed the branding of projects ranges from "Smart City", "Smart Community", "Smart Grid", "Sustainable Smart Town", "Eco-city", "Active Aging City" to "Green Community" among others.[3] Overall as it said in the project concept the expression "Smart Community" is more common than "Smart City" in Japan.

There are different definitions in Japan according to the project type.[7] The definition that is given by Japan Smart Community Alliance (JSCA) "A smart community is a community where various next-generation technologies and advanced social systems are effectively integrated and utilized, including the efficient use of energy, utilization of heat and unused energy sources, improvement of local transportation systems and transformation of the everyday lives of citizens."[8] This approach is focused on specific energy, infrastructure, ICT and lifestyle projects.

There is a different approach in Europe. European Parliament on Smart City projects in Europe proposes this definition "A smart city is a city seeking to address public issues via Information and Communication Technology (ICT)-based solutions on the basis of a multistakeholder, municipality based partnership."[9] This report also states that all projects aimed at the optimization of management in at least one of the six following areas: economy, environment, government, living, mobility and people[10].

The most important resource

The massive spread of smart technology combined with the increasing concentration of urban activity leads to an increase in energy consumption as it made it the most important resource. The cities are not only the centre of production but also the centre of consumption of electricity. In order to meet this energy demand, energy supply has expanded too. However, the most productive and cost-effective source of energy production is not the cleanest (coal, nuclear, est.). Globally, cities consume up to 80% of energy supplies and produce about 75% of CO2 emissions.[11] [12]Cities in the EU and Japan are among the largest consumers, as urban hubs where infrastructure and technology are highly developed. They face the challenge

of maintaining energy security and economic competitivity while promoting sustainable development and preservation of the resources. For Japan, this issue has led the central and local governments from the EU and Japan to support an innovative model of urban growth: the Smart City.[3] In reality, the electricity grid in Japan is pretty stable. The average interruption on is the lowest in the major countries.

Energy consumption in urban areas is made up of residential and commercial demand, but also of transportation use. In cities, the maintenance and operation of existing infrastructures are more costly energy-wise than industry consumption. For instance, in 2003 it was estimated that Tokyo's residential and commercial consumption makes up 53% of the total, while transport represents a 38% share, against 9% of industrial energy use.[13] However, industrial consumption in a number of Japanese cities can be a more important source of consumption, in the case of cities built around the local industry and still dependent on them, such as Kitakyushu for example.[3]

The accident in Fukushima Daiichi nuclear plant showed how unstable the energy supply was in Japan. Firstly, it put into light the lack of safety, linked to insufficient risk prevention in the construction of nuclear power plant sites and the radioactive threat to local citizens. Considering that there are 50 plants throughout Japan, the risk could not be disregarded and all plants were stopped until security checks were conducted and new safety regulations were applied. Secondly, the sudden shortage of power and the inadequate electricity grid resulted into blackouts and undesired lumps in electricity consumption, showing how constant energy supply cannot be ensured, even for key services in emergency situations, such as communication networks.[3]

3. The most popular projects

The first wave of subsidized projects: from 2010 onwards

The first wave focused on the Test Projects for Next Generation Energy and Social Systems. The four key pilots for smart solutions are located in the following cities[14]:

- Keihanna (Kyoto, Ohara and Nara prefectures)
- Kitakyushu (Fukuoka prefecture)
- Toyota City (Aichi Prefecture)
- Yokohama (Kanagawa prefecture)

3.1. Keihanna (Kyoto, Ohara and Nara prefectures)

The Keihanna Science City (officially known as the Kansai Science City) is nestled in the green Keihanna hills stretching over Kyoto, Osaka, and Nara prefectures in western Japan. The city, which has been constructed and maintained under the Kansai Science City Construction Act, is one of the Japan's national projects - much like the Tsukuba Science City in the east of Japan. Twelve cultural and scientific research districts (about 3,600 ha) scatter the 15,000 ha of land that makes up the Keihanna Science City. The city is about 30 km from the centre of both Kyoto and Osaka cities, and about 10 km from the centre of Nara city. More than 130 research facilities, including universities and cultural facilities, the city has accomplished remarkable success in the fields of cultural and scientific research.[15]

Regarding to" Tsukuba; the East" clustering and placing national organizations and academia, our city called"Keihanna; the West"has 3 characteristics; 1) Development of the cooperative frameworks among industries, academia, government and citizens 2) Cluster-type development along with the current affairs and business matureness 3) Complex city development between cultural and scientific facilities and local residents 30 years later enactment of Keihanna Science City Construction Promotion Act in 1987, the city has advanced step by step with the number of facilities counting over 130, and city population is

reaching to about 250 thousands as the result of our urban plan activating these characteristics. The time has come, the city thrives as creating frontier value with these facilities and citizens residing and blessing the benefit in the same city.[16]

The Plan for Creating New City. The aspect Keihanna Science City aims

Keihanna Science City lying across 3 prefectures is about going up to the next stage enhancing city's presence in the world on featuring the powerful characteristic with lots of integrated parties and their diversity, proceeding construction of new facilities and city development, deepening networks with the relevant districts and parties, and playing the role as the cultural and scientific research town.

Based on this recognition and the purpose of creating a new city, this plan shows basic ideas about their vision for creating this smart city.

1) Creating city under sustainable high-levelled urban management to activate and to interact our characteristics with various clusters

2) Realizing an inexperienced new urban plan[16]

3.2. Kitakyushu (Fukuoka prefecture)

Kitakyushu lay in the northern part of Kyushu, the westernmost of the four main islands in the Japanese archipelago. Historically, Kitakyushu area served as Japan's western gateway and played a major role in the intercourse between Japan and Asia.

Today, the concerted effort of the citizens, universities, enterprises and city government to surmount pollution has proved successful. Of all the large cities of Japan, Kitakyushu City, with its clean skies and blue sea, enjoys one of the most comfortable environments. Kitakyushu City is rich in a variety of environmental technologies as well as human resources and has a tremendous amount of expertise gained through these 30-40 years' struggle.[17]

Kitakyushu Eco-Town is the first Eco-Town in Japan that was approved by the government in 1997. The project is a practice to build a resource recycling-oriented society that reduces waste to zero by utilizing all waste products of one industry as the raw material of another. The Eco-Town Center, Hibiki Recycling Complex and Comprehensive Environmental Complex were at first the only targeted areas of the Eco-Town Project. Kitakyushu City then applied for a change in their Eco-Town plan so that the area could be expanded into the whole Hibikinada area in 2002, and then into the whole Kitakyushu City in 2004. The expansion intended to invite new recycling business and incorporate the existing industries. Kitakyushu Eco-Town aims to be"Asia's International Resource-Recycling and Environmental Industry Base City." The "vein industry" had been clustered as a unique regional development measure to integrate environmental conservation with industrial promotion in the first phase of the plan (1997~2002). Kitakyushu City formulated the second phase of the Eco-Town Plan in 2002. Kitakyushu developed EcoTown, Japan's largest research base for the recycling industry, leading the effort in Japan to create a recycling-oriented society, and is now promoting a Cleaner Production project, which combines increased productivity in the course of implementing environmental measures. Kitakyushu invested 120 billion yen in its recycling industry, which created jobs for 1,300 citizens. Presently, the Eco-Town Project has accomplished 17 facilities on the practical research and 23 industrial plants under operation, leading to the reduction of waste and minimizing CO2 emission together with the efficient utilization of resources and energy, which are beneficial to the environmental conservation and economic development in recent years.[17]

Including the hydrogen town project, Kitakyushu also started the Smart Community Creation Project. The government invested 16.3 billion yen over the five-year period from 2010 to 2014. The project was developed beyond the Hydrogen project in the same area. It had four scenarios, smart life, smart office, smart mobility and smart factories. Higashida district

is the demonstration area of the green village, Higashida district has already cut 30% of the CO2 emission compared with the other place in the city. However, the target for the smart community was to cut 50% of the existing emission, still, 20% need to get.[17]

The urban structure has been changed in the past few years under the concept of "Environmentally Growing Town" and "Creation of a Shared Community." Commerce, entertainment, museum and residential buildings were introduced into this area, which made a "compact district" with mixed function. The district energy supply and generation also suggested an indication with regional cooperation. One of the characteristics of the project is the participation of citizens in the use of energy. It optimized the demand and supply of regional electricity by utilizing IT technology that revolves around the energy-saving station. The energy saving stations are the control centres responsible for operating the smart grid. On one side, the energy-saving stations will send the energy-saving guidance according to the demand-supply situation and the customer can pick up the information by the smart meters. On the other side, the timely energy consumption information and the solar power generation is sending back to the energy-saving stations. The advice from the smart meters can help the customers to smooth out the energy fluctuation and improve the efficiency of energy using in the district. At the same time, the consumers can also benefit themselves, including reduced electricity rates by using power in a "smart" manner by introducing the dynamical pricing system.[17]

3.3. Toyota City (Aichi Prefecture)

Project Description

The population is 422,784 (as of Sep. 1, 2015). It transparent over an area of 918.32 km2 as the land use is 68% forest, 8% agricultural land, 7% of residential land. The main industries are automotive and agriculture.

The Verification Project is being conducted as a Next-Generation Energy and Social System Demonstration project (a five-year project running from 2010 to 2014) of the Japanese Ministry of Economy, Trade and Industry (METI). Toyota City was selected as a demonstration area for the Verification Project in April 2010 to support the development of testing equipment and information systems. The key feature of the project is the pursuit of optimal energy use in living spaces at the community level.

1) Optimization of Household Energy Use

Household energy consumption is increasing. The Verification Project seeks to coordinate supply and demand within communities in conjunction with the use of both grid and renewable natural energy to achieve local production of energy for local consumption. Verification of distributed power supply from storage batteries and reduced carbon emissions from homes will be carried out, with the overall aim to reduce household carbon dioxide emissions by 20% (70% or more for smart houses).

2) Achieving Compatibility between Environmental Preservation and Resident Satisfaction

The Verification Project will predict and control energy consumption and support activities using an original Energy data management system (EDMS) and home energy management system (HEMS). The aim is to maximize the use of renewable energy while achieving energy savings and conservation that maintains community quality-of-life levels and comfort.

3) Creation of Low-Carbon Traffic Systems

The traffic system plan is created in addition to reducing the carbon dioxide emissions from road traffic through the introduction of plug-in hybrid vehicles (PHVs), electric vehicles (EVs), and fuel cell vehicles (FCVs). The Verification Project will use IT and ITS technologies

to efficiently integrate motor vehicles and public transportation for commuting and other travel with the aim of reducing carbon dioxide emissions in the transport sector by 40%.[18]

Under the motto of "The Standards of Tomorrow, Today", Toyota City has developed a series of broad initiatives aimed at combining the strengths of its citizens, local regions, and industry to create an environmentally conscious city that is putting practical measures in place to achieve a low-carbon emission lifestyle that is comfortable, affordable and waste-free.

To this end, Toyota Ecoful Town was created in an effort to bring the Toyota City initiatives alive in fun and easy to understand ways. Not only as a place where visitors can experience cutting-edge environmental technology in such various fields as low-carbon lifestyles, transportation, and industry, Toyota Ecoful Town also plays a role as a centre for new industrial development.[19]

Roles and responsibilities Corporations and organizations: Development of advanced eco-technology Government: Communication and development/familiarization support Citizens: Promotion of eco-activities Toyota Ecoful Town has been developed to exhibit Toyota City's low-carbon efforts in cooperation with the private sector. It reproduces the city's regional characteristics on a small scale. Through the experience of the latest eco-technologies, it aims for the lateral expansion of eco-activities. The facility has been visited by about 150,000 people from 80 countries worldwide.[20]

Promoting local production for local consumption of renewable energy with tax reduction and various subsidy programs.[20]

Toyota City Eco-tax reduction

(1) Smart house tax reduction (first in Japan) Partial exemption of property tax, etc.;

(2) Renewable energy plant tax reduction (first in Japan) Partial exemption of property tax for power plants with an output of 10 to 2,000 kW;

(3) Electric light vehicle tax reduction (first in Aichi) Full tax exemption for the light EV and ultra-compact EV.

Toyota City Eco-Family Subsidy

(1) Solar power system;

(2) Fuel cell system;

(3) Next-generation vehicle (including charging facility and external power supply system);

(4) Home Energy Management System (HEMS);

(5) Li-ion battery system for home use.

3.4. Yokohama (Kanagawa prefecture)

In 2010, Yokohama was selected by the Ministry of Economy, Trade and Industry (METI) as one of four "Next-Generation Energy and Social System Demonstration Areas." Through its Yokohama Smart City Project (YSCP), the city works to provide a system optimizing energy supply and demand at individual homes, commercial buildings and in urban areas, in cooperation with 34 companies. Those include Japan's leading energy company, an electrical manufacturer, and construction companies.[21]

In 2015, a new public-private body, the Yokohama Smart Business Association (YSBA), was established to advance the project from demonstration to implementation. Yokohama's aim is to be an energy-recycling city that is environmentally robust, resistant to disasters, and economically strong.[22] This is going to happen in three stages.

1) Yokohama Smart Business Association

The Yokohama Smart Business Association (YSBA) was established to realize the energy-recycling promise of the YSCP demonstration; to promote new activities related to the operation of energy management systems and energy interchanges; and to further develop,

domestically and internationally, the energy technology and systems created to this point.[23]
2) Yokohama Smart City Project Demonstration Tests

Chosen in 2010 by METI as a Next-Generation Energy and Social System Demonstration Area, Yokohama carried out its Yokohama Smart City Project (YSCP) at the demonstration stage. The demonstration's goals involved the introduction of home energy management systems (HEMS), solar panels and electric vehicles (EVs). Those were achieved by fiscal 2013.

Results: HEMS - 4,200 systems (4,000); solar panels - 37 MW (27 MW); EVs - 2,300 vehicles (2,000 vehicles).[23]

3) Virtual Power Plant Project[23]

On July 6, 2016, Yokohama City, TEPCO Energy Partner, Incorporated (TEPCO EP), and Toshiba Corporation concluded a basic agreement on a Smart Resilience Virtual Power Plant (VPP) Project to construct VPPs in Yokohama.

At two schools in each of the 18 wards (elementary or junior-high schools) already designated as regional disaster prevention bases, TEPCO EP installed a 10-kWh or a 15-kWh storage battery. In normal periods, TEPCO EP uses them as demand response (DR) power sources using a control system developed by Toshiba. In emergencies, Yokohama will use them as emergency power sources.

For Yokohama, it is the first model case, carried out with national subsidies, and the results are shared externally. TEPCO EP automatically effects charging and discharging every 30 minutes using Toshiba's control system, maintaining levels of 70 to 80% of each storage battery's capacity. In emergencies, Yokohama will have that level of charge available as emergency power.

Hereinafter, as use of renewable energies increases along with cooperative efforts such cogeneration system (CGS) and Building Energy Management System (BEMS), the project to construct virtual power plants will be expanded. The city will promote the more efficient use of energy and the entire region will promote energy management. In this way, the city will achieve an efficient balance of energy supply and demand in normal times and have disaster-prevention bases protected from power disruptions and available in emergencies.[24]

4. The social role of smart cities in Japan

Smart technologies allow people to be replaced by less educated people. Also, they provide the way for the total elimination of the human factor. In Japan, there is a big problem with the ageing of the population.

Initially, Smart City projects have been promoted because they serve the double purpose of environment preservation and economic growth. The projects are developed by consortiums of enterprises, which aim first at showcasing their products and second to massively commercialize them. A large panel of companies are involved, from ICT firms (like Fujitsu) and real estate agencies (for example Mitsui Fudosan) to the car industry (such as Toyota) and Electric Power Companies (for instance Kansai EPCO). Every feature of the Smart City plan calls in companies providing services relating to transport infrastructure, sensors, construction material or data security. Most often, the projects take place in a previously disused area of the selected city, thus boosting the local economy around a massive project and revitalizing a piece of land, making it attractive for new inhabitants. The Smart Community becomes a new symbol of social standing where Quality of Life (QoL) is advertised as enhanced and improved in all possible ways. At the individual level, daily life is supposed to be more comfortable thanks to high tech use, and at the community level, the district is to be safer and more convenient in regards to mobility. Moreover, care for the elderly is often included in Japanese Smart City plans: in a country where the elderly population could

reach 40% by 206031, it has become essential for municipalities to plan for their welfare, even as they live on their own. Many project plans have a section dedicated to elderly care; it is the case for instance with the sanatorium in Higashi Matsushima's master plan where the Smart Community involves the Kitahara Nursery Institute, a major medical treatment centre in Japan.[25]

QoL upgrading is not just a marketing tool for all Smart Cities in Japan. In the case of Tohoku cities in the reconstruction phase, Smart Community projects help to mobilize key actors from the private and public spheres with the support of government subsidies for urban and economic revitalization. The reconstruction is also the opportunity to improve the infrastructure and to promote a new resilience based on the ICT of the Smart City.[3]

5. Conclusions

In this part of the research the researcher study one of the best and proactive best practices in the world. It defers allot from the practice in EU for example. Actually, after a closer look, there are some similarities between the problems in Japan and the Bulgarian society. Smart cities (communities) are a decision for a lot of local and global problems. Japan choose the way of smart technologies to solve their biggest problems.

- In Japan, the smart communities are connected mostly with the word eco-town.
- Actually, the smart cities concern the security;
- They are a solution for abandoned settlements, industrial sites;
- They are the solution to the problem of the ageing population;
- They are a solution for some energy problems;
- They eliminate some of the flops of the human factor.

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Future Digital Society 5.0: Adversaries & Opportunities

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Abstract: The future digital Society 5.0 transformation, targeting a new smart cyber-physical reality establishment with embodied IoTs, will give a more creative and innovative role, senses, knowledge & skills for the humans and intelligent technologies (real robots & softbot services with relevant AI, aiming singularity) in the new mixed hyperreality. The paper gives and exploration framework to this future digital society transformational adversaries & opportunities, combining crowdsourcing landscape definition, followed by analytical effectiveness modelling of future human-machine advanced interactions. The obtained discoveries are finally experimentally assessed via both short- and long-term experiments. A concluding discussion on the progressive future outlook of the upcoming Society 5.0 is also provided.

Keywords: Society 5.0, Digital transformation, Adversaries & opportunities identification, Crowdsourcing landscape definition, Analytical modelling, Experimental assessment

1. Introduction

The present epoch of social evolution is characterized by many rapid changes and it is often said, that we live in revolutionary times fostered by the information technologies – ITs of the Third Wave [1]. The last (the ITs), we mostly use in the everyday life (also reckoned as "digital technologies") being small, efficient, fast and suitable for everything in our work, free time, planning of the day, hobbies, education, etc. So, it is obvious that day, after day we are experiencing the digital transformation, led by more and more use of computers (now sized in our pockets, under the name "smartphone" but in the future probably integrated with our bodies as implants), mobile connectivity (both Intra & Internet) and any kind of digital services related to them. Things are getting also smart by the hour – not only smartphones but we all have now smart TVs, smart watches, smart cars, smart homes. The list goes on, though not quite smart being limited artificial intelligence and still far away from the singularity idea [2].

A new societal experience of a transition towards full integration between digital technologies and people in a joint cyber-physical reality is under development. We are using (and will keep this trend growing) plenty of digital devices to facilitate, substitute or advance many of our human activities and skills. And it is suitable to note here: models and activities of work at our office, living at home, or spending our free time, at the city, during travel or being outside.

Terms like "smart industry", "smart agriculture", "smart healthcare" or "smart transportation" are no longer considered as futuristic ones, but seen around us day after day. People have more time for creative look at new models and concepts, developing innovative approaches and skills towards our future society transformation.

Here comes and the vision for "Society 5.0". This initiative was actually recently introduced in Japan and is presented as: "A human-centered society that balances economic

advancement with the resolution of social problems by a system that highly integrates cyberspace and physical space" [3]. The main goal is to overcome the difficult (so far) cross-sectional sharing of knowledge and information. There are so many digital devices, networks and communication means but the society is still not fully networked. The country aims to achieve that objective with both governmental and business efforts using its well-developed IT sector and having one of the highest penetration rates of mobile broadband [4]. The world economy grows, life of the majority of people in developed countries becomes more prosperous and convenient, while the lifespan becomes longer and the society is aging. Within this context the paper is trying to make an advancement of the "Society 5.0" concept towards an extended, global view to the digital society transformation, following the experience from mostly a decade of time (marked formally with [5], and going in more details via [6] & [7]).

The idea of the present study tries to give an exploration framework, aiming outlook towards the future (within the next 10-15 years now) of the new digital Society 5.0, outlining both adversaries and opportunities. A three-fold approach of: (2.1) Landscape Definition, (2.2) Analytical Modelling & (2.3) Experimental Assessment is further accomplished and described with more details.

2. Exploration Framework & Implementation

Understanding the future of Society 5.0 from both adversaries & opportunities perspectives is a quite fascinated and challenging task. Successful handling of it could be approached using both user/expert data survey, suitable modelling approach and findings reasonable assessment. In this sense, the present solution is based on the ideas from [8] & [9], but tries to go deeper in the problem. Thus, a more aggregated solution of crowdsourcing data survey for landscape definition is followed by suitable risk/utility effectiveness representation for analytical modelling, using the system-of-system interpretation [10]. Finally, experimental user multiple feedback assessments on the presented results is also performed.

2.1. Landscape Definition

Successfully accomplishing this task was achieved using two types of crowdsourcing data surveys from: 50 participants (in the age of 16 -18.5 years) of six countries (Bulgaria, Germany, USA, UK, India and New Zealand) during the week-long training course "Towards Future Society 5.0: Modelling, Exploration & Understanding" during Summer Research School on Mathematics & Informatics – SRS' 2018 [11] for young researchers and another group of 100 students (in the age of 19-23 years) from the University of National & World Economy. Being somewhat noisy, the participants were asked to define both certain and uncertain attitude towards the importance of a particular asset of interest. Generalized results with 10 assets ("Biohacking & Hybrid Threats", "Biodiversity & Migration", "Malware & Mixed Attacks", "Society Adaptation & Resilience", "Species & Climate Dynamics", "Space Travels Acceleration", "Political & Value Transcends", "New Realities Parallelism", "Mass Surveillance & Privacy", "AI Singularity & Robots") towards year 2033 is presented in Fig.1.

As it is clear from the survey aggregated results, the tech implants, gene modifications, together with human-machine hybrid threats (concerning singularity and transhumanization issues), climate influence to biodiversity, migrations and social aspects of political/values transcends are expected to be mostly dominating for the near future. Being somewhat fascinating, these findings produce an ambiguous role for the technological aspects (AI, IoTs, robots, new realities establishment, mixed cyber-physical attacks & malware) of the future society transformation, addressing parallelism, privacy, mass surveillance & space travels (fostered from the dual ambitions of innovations and colonization) assets. So, next, a more detailed system study of problem, adding also causality for better representing &

understanding towards the future society adaptation and resilience achievement (coping with both future adversaries and opportunities due to H-M advanced interaction) is performed.

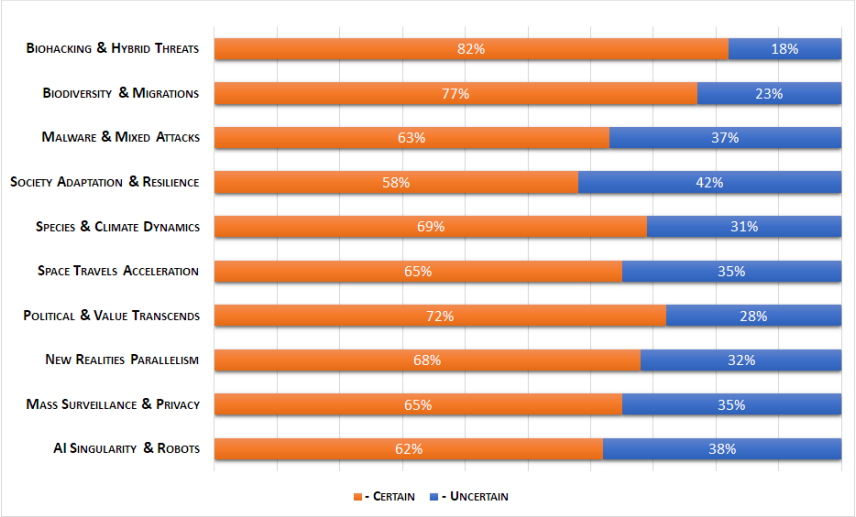


Fig. 1. Future Society 5.0 selected assets landscape towards year 2033.

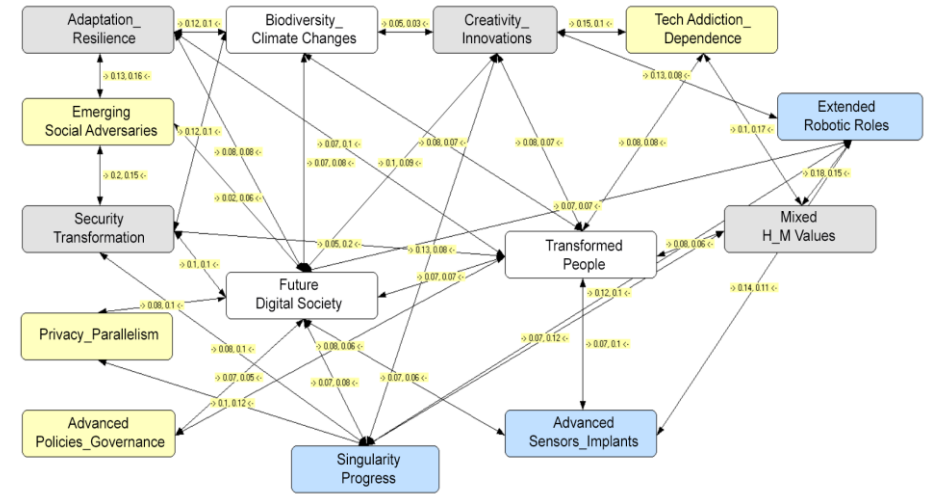
2.2. Analytical Modelling

The ideas behind the proposed model are following the system-of-systems representation [12], implementing causality over a weighted graph and the Entity-Relationship paradigm [13]. A Bayesian probabilistic approach was accomplished for generalized results visualization in a "System Effectiveness Diagram" – "SE Diagrams", providing nodes 3D visualization (noting Perpetual vs Intermittent behavior dynamics classes, graphically divided by the NW/SE diagonal plane) and defining both Active (white) and Passive (grey) ones in each of the two subclasses), after the relations' probabilistic weights as follows: E_f – forward entities' relationship effectiveness, E_b – backward entities' relationship effectiveness, E_s – resulting, generalized system effectiveness. What is important to note here is the effectiveness assessment in itself, being dependent from both risk and utility [10]. The presented concept has been successfully realized in I–SCIP–EA software environment and further used here after. The model creation was supported with some young researchers and expert data gathered from the working discussions amongst around 150 participants from 12 nations throughout the world (Brazil, Bulgaria, Germany, Macedonia, Serbia, Slovenia, Turkey, USA, UK, Ukraine, India and New Zealand) during: experimental training course within SRS' 2018 [11], Joint Research & Industrial Expert Forum "Future Digital Society Resilience in the New Digital Age" [14] & BISEC 2018 [15].

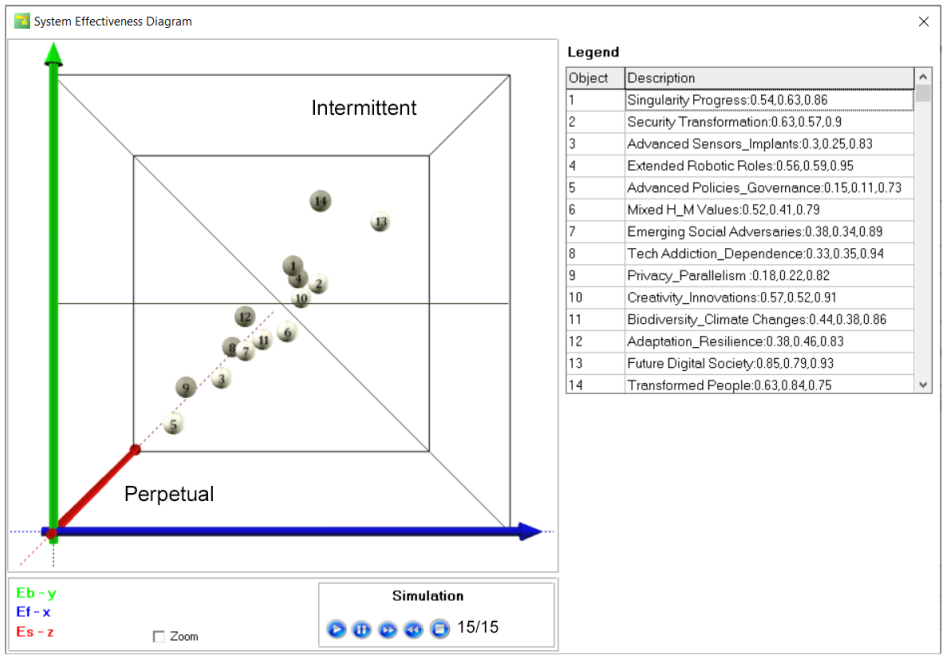
Being obvious from the aggregated results presented in Figure 2b, some model effectiveness analytical findings could be made towards year 2033 on the future digital society transformation:

Perpetual: 3 – "Advanced Sensors-Implants", 5 – "Advanced Policies_Governance", 6 – "Mixed H-M Values", 7 – "Emerging Social Adversaries", 11 – "Biodiversity_Climate Changes" (active), 8 – "Tech Addiction_Dependence, 9 – "Privacy_Parallelism", 12 - "Adaptation_Resilience" (passive).

Intermittent: 2 – "Security Transformation", 10 – "Creativity_Innovations", 13 – "Future Digital Society" (active), 1 – "Singularity Progress", 4 – "Extended Robotic Roles", 14 – "Transformed People" (passive).



(a)



(b)

Fig. 2. Future digital Society 5.0 model (a) and effectiveness assessments (b), exploring near future adversaries & opportunities for H-M interaction progressive development towards year 2033.

The outlined future expectations could be summed up around several key concerns on the future Society 5.0 digital transformation for both humans and technologies, keeping in mind the already defined exploration landscape (see Section 2.1):

(i) The progressive H-M interaction development of the digital Society 5.0 will be obviously visible for the near future though not quite stable, due to multiple social, technological and mixed bilateral influences, springing from transformations in technologies,

climate, biotope and social assets, aiming also space colonization as a future society alternative;

(ii) The upcoming singularity progress is naturally expected to establish a concurrent environment for both natural and artificial creativity and innovations in many fields of our everyday life and work where digital twining models and areas of interested are possible to be described sufficiently detailed with finite states machines and thus – implemented with advanced robots (both in the simulated and natural realities, as well as their overlaid mix);

(iii) The near future people and security transformation is going to be significantly affected by the overall comprehensive changes with technologies close integration with the living world, requiring new concepts for privacy, governance and values handling. These processes will also be strongly influenced by the speed and scale of social transformation affected by technologies, achieving successful adaptation & resilience;

(iv) The necessity of advanced skills in the future digital society definitely creates a strong demand of technological closer integration with people and biotope, towards future digital transformation and transhumanization. This from one hand opens a vast opportunity for hyper connectivity and huge information processing far beyond the human natural capabilities, and from another – creates an unhealthy addiction and also dependence to this new level of knowledge and information H-M interaction dynamics. Apart of the positive benefits of the new social transformation, this could however also limit the creativity and innovations horizon of the future people and artificial intelligence solutions due to the bounded and skewed reality landscape;

(v) Finally, except being positive the new level of human-machine interconnectivity creates also numerous advanced threats from technological perspective (malware, targeted attacks, mixed cyber-physical attacks, APTs, etc. [5]) that can break the new digital senses of future society and at the same time – produce mutated social results of rather democratic or authoritarian organization.

Having quite futuristic character, the outlined concerns for the future Society 5.0 were next experimentally assessed, using a hybrid approach of both technological and human perspectives.

2.3. Experimental Assessment

As the presented findings (see Section 2.1 & Section 2.2) are somewhat subjective and prognostic by nature, they have been experimentally further explored in a mixed cyber-physical smart environment. A combination of both short and relatively long, experimental terms has been accomplished. In this way, focus to different aspects of the future digital Society 5.0 possible adversaries and opportunities is expected to be achieved. Some aggregated results' key assessments, concerning both experiments are finally presented.

2.3.1. Short-Term Experiment

The short-term experiment has been performed in the framework of CYREX 2018 [16], implementing a fictitious scenario events script, played (for about 180 minutes) in seven multirole teams of about thirty participants. The scenario architecture included most of the already outlined adversaries & opportunities to the future Society 5.0, giving additional accent to cyber space asset (APTs: social engineering, industrial espionage; malware & targeted attacks).

A distributed organization (spread among about thirty participants from: Bulgaria, Turkey & Macedonia jointly with IFIP & Secure Digital Future 21 initiatives, combining representatives of universities, academy and ICT professional societies) has been

accomplished as follows: a start-up company – "Digital Creativity", developing a payment solution, based on human capabilities digital copying.

The innovative results are bought from a larger corporation – "Moon Digital Solutions", which has some invading plans on the "New Life" planet colony. A hacker group "Stellar Ghost" is also involved, modifying the "Digital Creativity" work, swapping the data with aggressive dictatorship and fighting skills for the robots at "New Life".

Other exercise participants were: "Galactic World" – an intergalactic association responsible for digital techs regulation, using another small company – "QHR Selection" to interfere in the situation and stop the hackers' terrorist plans, giving the "New Life" colony robots fast food skills instead of aggressive ones. Finally, a PR body – "Stellar Media" is involved for assuring public announcements of the situational dynamics.

The participants used several device types: phablets, tablets, desktop and mobile computers, numerous open cloud services (data storage and sharing, encryption, chats, social media, multimedia messaging, e-mail accounting and participants DLP multi asset configurable monitoring) some accessed directly or with encrypted QR codes.

The exercise was mainly organized in a closed Facebook social network group, partially implementing also WhatsApp & Viber, while participants' network access to the used cloud services was organized via a VPN. The players' behaviour was explored and archived remotely, using response time monitoring, video recording and COTS DLP solution [10].

Fig. 3. Moments and architecture of CYREX 2018 short-term experiment, after [10].

2.3.2. Long-Term Experiment

The long-term experiment has been organized during a week-long training course "Towards Future Society 5.0: Modelling, Exploration & Understanding" during Summer Research School on Mathematics & Informatics – SRS' 2018 [11]. An international team of young researchers was tasked to develop applied projects, concerning different technological, social & mixed assets of future digital Society 5.0. An address was given to virtual reality travel to Mars, including labyrinth orientation, adding Earth mixed reality experiments with humanoid robot, flying quadrocopter, mobile phone sensors (IoTs for environment parameters watching: temperature, humidity, atmospheric pressure) integration. Additionally, some AI

scene analysis, smart interfacing, path planning and navigation programs have been also developed and integrated jointly with sensors information processing.

During the experiment the participants were video recorded and additional psychophysiological monitoring (combining personality and cognitive capacity assessments), together with selected biometric responses (brain and heart dynamics monitoring of arousal, galvanic skin response and face analytical emotions evaluation) have been combined with working tasks questionnaires filling-up & interviews, achieving multiaspect results assessment [17].

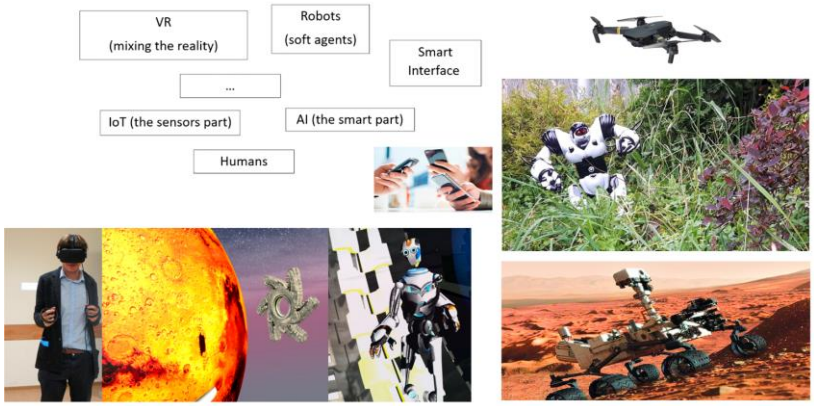
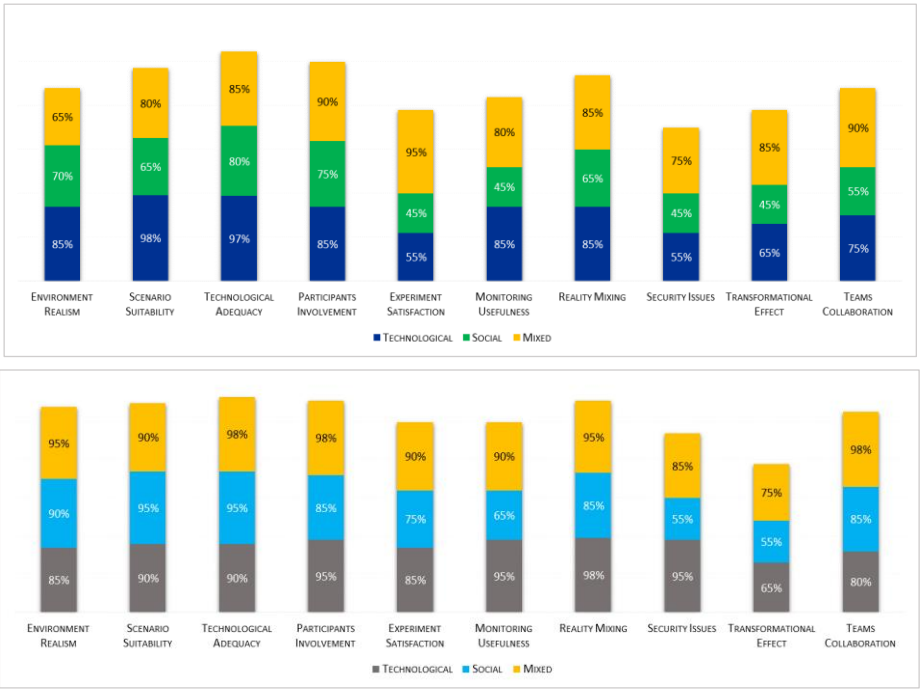


Fig. 4. Moments & concept for future digital Society 5.0 exploration long-term experiment, after [11] & [17].

An aggregated participants assessment, following some ideas from [17] & [18] of both experiments (short- & long-term) on ten criteria ("Environment Realism", "Scenario Suitability", "Technological Adequacy", "Participants Involvement", "Experiment Satisfaction", "Monitoring Usefulness", "Reality Mixing", "Security Issues", "Transformational Effect", "Teams Collaboration") multiaspect ("Technological", "Social", "Mixed" – cyber-physical, including technologies, social aspects, and the necessary knowledge for successful integration, use and control) assessment is presented in Figure 5. The overall results on a certain criterion are greater than hundred, as every aspect is evaluated separately.

Evidently, there are some clear differences between both experiments, mainly related to the participants expectations and time for work (hours vs days for the short- and long-term ones respectively). They are mostly visible in the social aspect with 10-30% difference, while the technological ones have only about 10 %. The overall satisfaction also grows significantly with more creative work engagement (especially from social perspective), while environment realism when actually designed in advanced (for the short-term experiment) is more difficult

to be handled in comparison with own created. Another interesting finding is also related to the experiments transformational effect that within the mixed (cyber-physical) case is more satisfactory and influential, regarding the short-term experiment in comparison with the long one. Being somewhat generalized results do not go too deep in the peculiar details of evaluation (as far as the presented approaches aim only to create a suitable environment for experimenting, where the idea is mostly to get the participants major beliefs for the future instead of bounding their creativity and imagination), as the approach will become rather clumsy and unsuitable for key trends finding from future digital Society 5.0 transformational perspective.



(a)

(b)

Fig. 5. Short (a) & long-term (b) aggregated experimental assessments.

3. Discussion

Future digital Society 5.0 transformation is on the way and in the next 10-15 years the role of technologies is going to become more visible in the new mixed cyber-physical reality jointly with people more creative and inventive role. The AI progressive development in this sense is in fact the most significant technological factor together with IoTs miniaturization and mobile broadband web access.

However, the expected technological immersive transformation (including IoTs implantations and integrations) of living matter to both humans and biotope is actually going to be mostly significant in the near future. This change is expected to provide both advanced opportunities (of extended skills, senses, capacity of work, results, shape, role) and adversaries (of technological and social aspects dual compromising, different types of cyberattacks, malware, behaviour transformation, parallelism uncertainties, privacy breaking, cognition & knowledge overloading in the future hyperreality). Luckily the digitalization of the future society is also dependent on policies and regulations that is expected to be adequately developed for successful changing the rights and freedoms of future people, keeping the nature

clean and supportive. Apart of this, the climate changes and species dynamics are inevitably going to foster the society transformation processes and in particular space colonization and life engineering.

Successful exploring the upcoming digital Society 5.0 requires both expert and analytical efforts together with relevant technological support. What however stays uncertain is whether the future beliefs will be accepted and kept sustainably developed or used as a reason for future digital transformation devolution assumed as dangerous or non-ethical.

Finally, the creativity and innovations springing from humans future generations and advanced technologies intellect are hopefully going to regulate and solve this uncertain problem for the future cyber-physical reality progress in a suitable and progressive manner, providing necessary resources of living and evolving jointly with the emerging security challenges towards establishing a resilient & adaptable new digital world.

Acknowledgements

The results in this study are supported by the technological and expert knowledge, obtained in the framework of the web forum "Secure Digital Future 21", http://securedfuture21.org. Additional gratitude is also provided to the organizers of Summer Research School on Mathematics & Informatics – SRS' 2018.

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Assimilating the Skills of People with Specific Needs for the IT Labor Market by Utilizing the Information Technologies for the Workplace

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Abstract. The skills which the people with the specific needs have, can be aligned with the skills of the other job seekers in the labor market, using the latest information technologies that can be lay at the work place. The idea of this report is to propose the set of the technologies, which the employers must have got, so they can hire the person with the specific needs.

Keywords. People with specific needs, Technological gadgets at the work place.

1. Introduction

The skills which the people with the specific needs have, can be aligned with the skills of the other job seekers in the labor market, using the latest information technologies that can be used at the work place. The idea of this report is to propose the set of the technologies, which the employers must have got, so they can hire the person with the specific needs (Fig.1)

Fig. 1. Aligning the skills of the people with the specific needs

2. Work place – set of information technologies and resources

If we consider a workplace as a set of information technologies and resources – hardware and software, the workplace should provide opportunities for self-fulfillment just then the person with the specific needs can be equivalent with the others. We will be giving some specific resources – software and hardware, which if the employer provides, he may hire someone with specific needs to deal with his daily tasks, just as any other person.

The software's which are available for people with the specific needs are:

- Browsers to access Internet resources - WebbIE, connected with a screen reader such as JAWS, WindowEyes, Thunder, NVDA, Narrator. As an example there is a reader which interprets the Bulgarian language SpeechLab 2.0;
- Programs for optical character recognition, which can translate printed text to digital text, and then be reproduced by a screen reader;
- Software for translating the Bulgarian texts into Braille;
- Software to convert electronic texts into Braille code;
- Programs for screen readers and to increase the screen images;

- Screen reader software combined with synthetic speech;
- Programs synthesizing human speech, the most popular and used in Bulgaria program is Gergana, which synthesizes a Bulgarian speech, i.e. It has built-in Cyrillic speech;
- Specialized software for optical character recognition - software uses Braille code is a system for decoding and encoding of information to assist the visually impaired;
- Applications for mobile phones, with which can capture and recognize printed text that translates and speaks in the appropriate language if necessary;
- Mobile applications developed specifically for job search of people with special needs;
- Software magnifier for people with residual vision, it is possible for it to be combined with a braille display;
- Braille assistant: Braille Assistant is installed with software for reading the screen.
- Braille translation software for text documents - allows conversion of documents into a format HTML, XML, RTF, TEXT and Microsoft Word in Braille and synthetic speech.
- Braille reader, Braille reader is designed for visually impaired people who can not read Braille tactile system.
- Concept of natural user interface or a physical interface - a system of interaction between man and computer as intuitive user performs actions related to natural behavior and thereby control the computer.
- Talking software tools that improve reading skills and pronunciation of words and phrases;
- Web based environments for e-learning for people with hearing impairment.

The hardware resources that are available for people with special needs are:

- Braille mouse that enables people with various visual impairments to read texts on a computer screen;
- Scanners and programs for optical character recognition, which can translate printed text to digital;
- Braille phone that is available in the market from 2014. The body of the phone is made using a 3D printer.
- Text telephones with visual and Braille display for deaf and deaf-blind persons;
- Braille display and Braille printer for deaf-blind with complete deafness and significant visual impairment, and completely deaf-blind;
- Screen reader - is a software application that integrates and identifies what is displayed.
- Laptop SIAFU, which is designed specifically for people with visual disabilities and it's intended to make working with computers more intuitive.
- Tablet for people with visual disabilities – use cylinders from special material that will dynamically show and hide, and on the reader will appear the letter with the embossed Braille.
- Braille Assistant is a modern device that has advantages in terms of availability of affordable touch screen, the Braille display and a notebook. Braille assistant includes 12-cell refreshable Braille display with touch sensor technology and automated routing the cursor; 6 Braille input, 3 function keys for writing; joystick and 2 navigation keys
- Tactile hardware devices - eyeglasses to manage the glance with tactile transducer.

3. Configuration of an exemplary workplace

There will be a configuration for an exemplary workplace for a specialist in a call center maintaining of a software which has a section for work by people with special needs. Increasingly the banks, government institutions, National Insurance Institutes offer a chance

for people with impaired vision or hearing to work with their software online, so increasingly the need for trained professionals to assist non-expert users to work with these software products is growing. This specialists should accept a phone call about a problem to register the problem and give adequate consultation.

The configuration will be made to satisfy the needs of physically healthy people who have partial or full vision problems. The workplace may include computer equipped with Braille display, Braille keyboard and mouse. Another necessary hardware is a text phone with Braille display for blind or partially blind people. As the software requires a text-oriented operating system that is more convenient for blind users than graphics. For this reason they are widely used in DOS systems. For them there are a lot of free programs for reading text and enough free speech synthesizers. This is a specialized software that translates text so that sighted and blind people can learn about the messages displayed on the screen, once they hear the text.

The technology of work can be described in several steps:

1. The specialist gets a call in a CALL center with the help of a software application. Also the call can be recorded on the screen of the braille phone, so it can be converted into a digital file for documentation and further processing the order.
2. The specialist can start the software application using the Braille keyboard or the BDS rule or just to use a regular keyboard. Then follows simulation of the inquiry, the software for speech synthesis converts messages on the screen into words. The specialist solves the problem.
3. They can answer to the queries again by the braille phone by sending a sequence of commands to the user or he clarifies them through ordinary phone.

Also the specialist can provide consultations to people on place, not only on the phone, and to train people with special needs to work with the software.

4. Conclusion

The people with special needs can be successfully included in the IT labor market, and align their skills with the skills of the other job seekers using specialized equipment at the workplace. The labor market needs these people, because there are specific actions that only they can perform. A trained blind or partially sighted IT professional can help a lot to the other people with specific problems to overcome obstacles by using the systems and software, to advise and train these people as they best know their problems.

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Goals and Benefits of Implementing Business Process Management Systems

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Abstract. The benefits of using a Business Process Management System in the organizations are well-known and an increasing number of institutions consider using such platforms. The paper reviews current trends in the application of Business Process Management Systems. It traces the development of the concept of process automation. Exposes the basic idea of designing, developing, executing, monitoring and optimizing business processes. Provides research analysis to the application of BPM systems in the real business environment and actual implementations. It summarizes that the automation of optimization methods will be a key benefit for using BPM systems.

Keywords: Business process, Business process management, Business process management systems, Process automation

1. Introduction

Nowadays many organizations, business, and nonprofit institutions need higher productivity, better quality and speed, which push the managers to look for the techniques and methods to make improvements. Every organization wants to improve the way it does business – to improve its ability to respond rapidly and dynamically to market forces and to competition, and to produce goods and services more efficiently, while increasing profits. The main problem come from the concept "How this should be done?". The underlying problem relates to the disconnect between the execution of their strategy and the day-to-day processes that produce value for customers. The primary reason for this disconnect is that these organizations fail to look at their interconnected processes as a whole.

The strategy of an organization provides it with *what* it should be doing. The processes of the organization provide it *how* it should be done, in other words the tactical day-to-day operations of the organization. The solution to the problem of improvement can be found in creating a framework for the business processes. Business Process Management Systems (BPMS) are systems that help organizations to improve their performance and make them capable for the organizational change and continuous management of business processes. Apart from the system benefits, organizations are complaining that it has its own problems. Thus, this paper is to describe the impacts of Business Process Management Systems.
It highlights the wide opportunities such as flexibility, integration and speeding up of business processes.

2. BPM Fundamentals

2.1. Business Process

Business processes are the centerpiece of the business strategy. Companies can no longer define themselves in terms of their products. They must instead define themselves in terms of their key business processes. A company's processes are among its most

precious assets and when managed and maintained, they will deliver exponential return generating value.

Before discussing business processes in general it will be good to talk a little bit about what exactly a process mean. Actually, different scholars give various definitions at different times, but the most common definition is: "A process is a specific group of activities and subordinate tasks which result in the performance of a service that is of value." [1].

Business process also can be defined as "a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer", or "a specific ordering of activities across time and place, with a beginning and an end with clearly defined inputs and outputs".

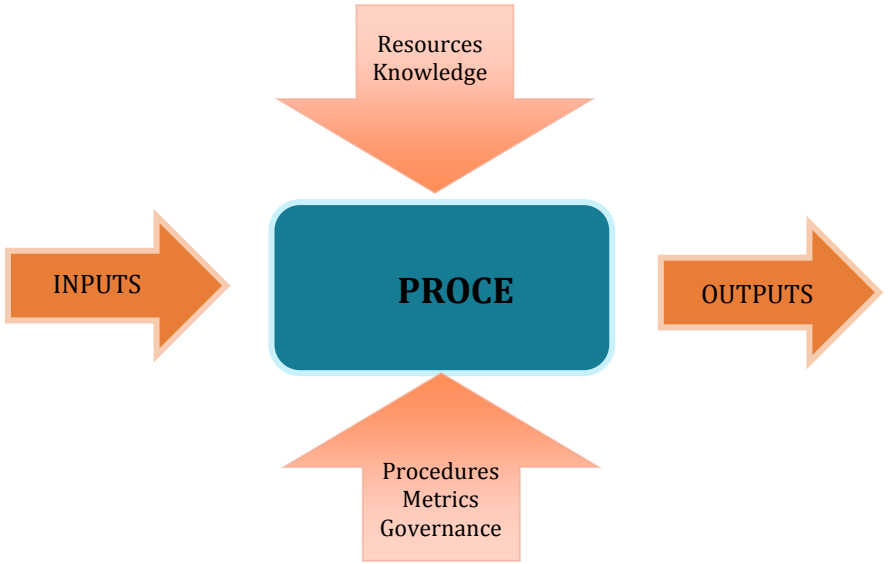

Fig. 1. Basic process model

A process might consist of more than one activity which can be handled with and depends on each other. Authors further explain "processes must be able to be tracked as well, using cost, quality and satisfaction measurement" [1]. On other hand business is an activity which has value for the society. This will let the business organizations to become competent and in general help them to achieve their organizational goals.

In a company, there could be more than one business process involved to accomplish its tasks. The processes are different to one another in many aspects. Those business processes that are carried out many times at different intervals and determined the overall output of the business activity of the organization are considered as major business processes. In order to achieve the organization goal and make the company well competent in the business environment the different sub parts of the organization need to work together. It means that a company can achieve its both short term and long term goals if it is able to integrate and allow the different resources to work together, which can be coordinated by the business processes. All business organizations have business processes regardless of the type, scope, and area of business. Business Process Management is a way, that gives the ability to those organizations to improve their activities.

2.2. The importance of business processes

Processes play an important role in the coordination of activities between individual contributors and functional departments. Business processes operate horizontally and vertically along the lines of organization. Therefore, the output of one process becomes an input for another.

- *Determine costs of the products or services*

It is cheaper to handle repetitive activities by using standard practices. Work can be explained and delegated to people easily and individual cases can be processed more quickly at a lower unit cost when processes are documented and maintained. There is less need for supervision, and administration becomes a simplified task.

- *Well-documented business processes ensure consistency of decisions*

Information used for making decisions and plans, and for taking guiding actions, must be reliable. Documented processes are needed for collecting, recording, storing, and transmitting information. If the processes are well designed, documented, measured, and maintained, the information will be reliable. These processes can provide adequate assurance to the top management that the activities that are to be done will be executed at the proper time in a proper way.

2.3. Business Process Management

To understand why Business Process Management (BPM) is important to any business, we first have to understand what it is. Every participant in a business has a different perspective and definition of BPM, that is influenced by his or her role. For some, BPM is all about technology. For others is about optimization. For many, BPM is a way to communicate how they want work. And for yet other, BPM is a method to gain visibility to how things are actually working. None of these definitions are truly wrong. Each component is only a contributing subpart of BPM as a whole. If these components are undertaken in isolation, the companies applying them will not achieve the full range of potential benefits.

BPM should be viewed as a discipline, a comprehensive methodology which is driven by business results. There is not a single official definition of the term Business Process Management (BPM). P. Antunes state that BPM is "a collection of technologies capable of translating business process models into computer-supported activities, relinquishing routine management and control tasks from the organizational agents." [3]. In another work Business Process Management is defined as "System which supports business process using methods, techniques and software to design, enact, control and analyze operational process involving humans, organization, applications, documents and other sources of information" [4]. A formal definition is presented by Ramesh Chandra Sharma and Namrata Sharma in [5]: "The modelling execution (including automation) and evaluation of processes is known as business process management".

Actually, before BPM there were other business improvement tools and programs like TQM (Total Quality Management) and BPR (Business Process Reengineering) which were widely used by different companies. According to [2] those tools failed and faced different challenges especially towards improving business processes. The BPM concepts are focusing in the modern business to overcome the problems and helping organizations to resist the changes. Organizations can analyze their processes through the techniques of BPM so that they can improve the processes according to their needs and also have a continuous access to control all the activities of the business.

BPM differs from other management methodologies in its mental model of what needs to be managed – that is, the understanding of how these processes interact in the system. BPM is based upon concept that the process of an organization is a strategic asset that needs to be managed and supported. This support comes from the fact that the processes must be customer centric, business driven and data driven, and the foundation for them is continuously improvement.

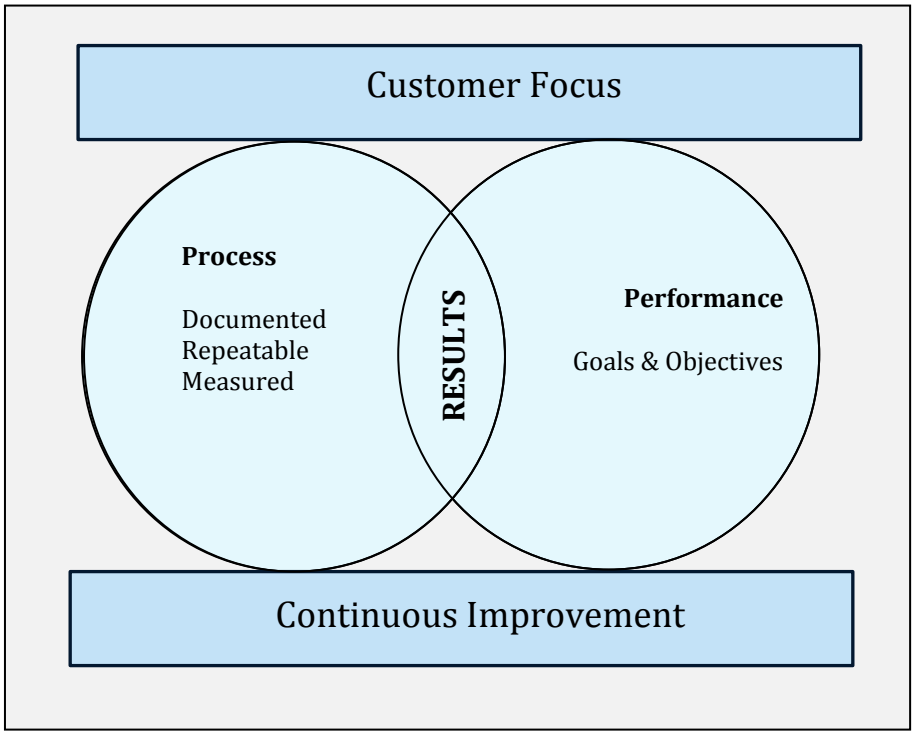

Fig.2 Business Process Management Concept

2.4. Business Process Management Systems

Organizations have interests to change the way they do business and manage their business processes according to the changes in the business environment. To manage these changes and to become competent they have been using different tools and techniques and tried to achieve their goals.

Organizations can have different reasons for their need to use BPM systems but all require the system to assist in their business activities.

"The ability of organizations to successfully deploy appropriate business processes relies heavily upon the effectiveness of systems that support the management of constantly evolving business processes that support the current set of business needs, and the ability of process participants to understand and reason about the constantly evolving business processes." [6]

As a result, unlike the business process management, organizations are intended to have a system that helps them to be more flexible, and gives a continuous and effective managerial support over the business processes. This becomes possible through the introduction of

business process management systems. BPM systems actually not only let the organization to have a continuous control access over business processes but also can give a possibility to redesign business processes according to the business needs.

As we know every company has different needs, so it should choose software that can be customized for the size of its business. The good point is that modern BPM products are not industry-specific and to be versatile. Every company has the chance to take one of them and customize it to its own business. We also mentioned that BPM enables users to design, model, implement, automate and analyze the business processes of an organization. But what are the examples that can implement that technology. Here is a list of basic process examples that could be designed and analyzed using BPM software:

- Account management
- Compliance management
- Customer requests
- Employee onboarding
- Expense reporting
- Invoice management
- Loan origination
- Project management.

These processes are only a small piece of the functionalities that a BPM system can offer. In general, we can summarize the usage of these systems in several directions:

- *Business Process Modeling* - BPM systems offer a visual process design tool, used for creating and testing multiple processes within the organizations.
- *Workflow Management* – BPM helps organizations by integrating robust communication between team members, systems and data.
- *Collaboration* – It supports communication-enabled activities as decision management, idea management, discussions and this helps the effective communication within the company.
- *Integrations* – Most BPM systems have very high level of integrity. They could be integrated with ERP systems, Document management systems, E-Commerce platforms and etc.
- *Form Generator* – BPM systems allow companies to create their own user interfaces by creating beautiful web forms without generating a single piece of code.
- *Analytics* – One of the most powerful component of the BPM systems is the ability to define metrics, get insights in real time and run reports with ease.

All of these functionalities are parts of the whole picture when it comes to BPM systems. Every organization has different needs and different point of view about this kind of software. That is why we cannot make a conclusion that BPM systems are being used only in certain cases. Every component, every aspect of BPMS is used according to the company needs. Some of them apply those systems as integration layers between already implemented systems, some use it as a tool for creating user interface, some other for data validation and collection tool. And may be one of the most interesting idea is using a BPM system as a workflow software, but not between people, but different systems.

For example, Figure 1 illustrates the process layer, positioned between business users and back-end systems. One of the back-end systems at the bottom is the core application that was the subject of the assessment (for example, CRM or Billing). The BPM solution makes use of these core business applications and legacy systems, and provides an extra value-add layer between these systems and the business users.

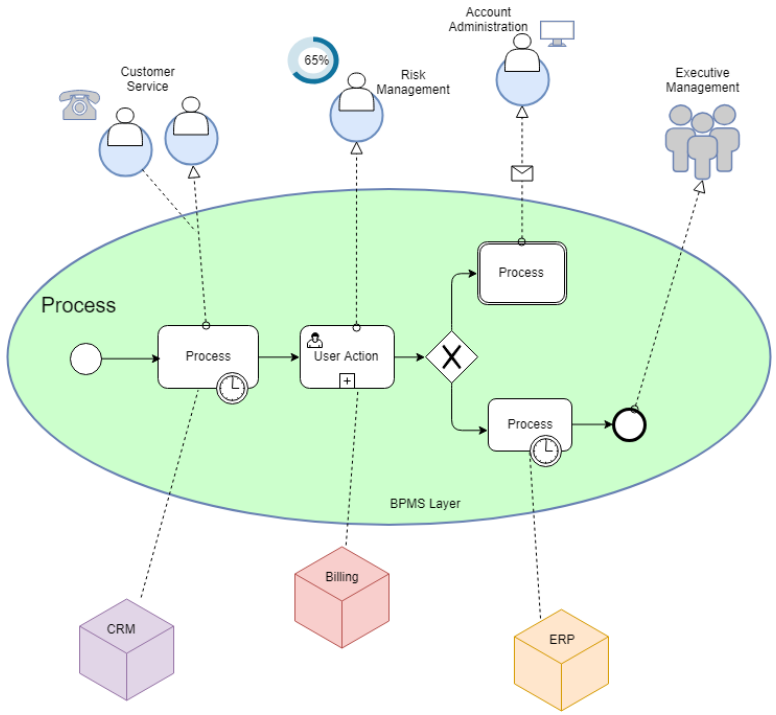

Fig. 3. BPMS as Integration Layer

As a conclusion we can say that BPM systems are extremely flexible, include many different components, they are not either business specific or organization size specific. That is why these systems are gaining larger scope and usability. There is no wrong way of using BPM system, even if it does not cover the entire business of a company.

3. BPM life cycle phases

In order to express the BPM functionality benefits, it is essential to take a look at its life cycle phases. Business Process Management is a systematic approach to understanding, improving and managing an organization. It is generally accepted to have four phases: process modeling, analysis and measurement, improvement and management.

Fig. 4. BPM Methodology life cycle

The first phase focuses on several things:

- Identifying the value chain processes
- Creating a process inventory
- Classifying processes as either core, support or management.

It is essential in this phase to keep the view of the processes at a high level. The goal of this phase is to document, review, and allow for detailed analysis of the way a given business process is currently performed in order to determine whether improvement is required or key process indicators (KPIs) to determine whether the organization's performance can or does meet its strategy and goals. Once the processes have been documented, its needed to develop a set of measurements. The main idea is "If you can't measure it, you can't manage it".

In the improve phase, the goal is to evaluate how an organization's resources can be used most efficiently. Typical objectives are reducing costs, shortening cycle time, and improving product or service quality. Implementing a redesigned process can have adverse effects in other parts of the business, so care must be taken to make the improvements with an understanding of the entire value chain. There are many choices when it comes to selecting the process improvement tools like Six Sigma, Lean principles, Lean Six Sigma, Process simulation, which improve the business process optimization.

The manage phase of BPM journey encompasses the tracking of the core processes, so that their performance can be easily monitored. The key process indicators are tracked and monitored periodically to ensure that the processes are performing as required.

Process improvement activities are intended to reduce waste and improve the processes used to create a business's products or services. That is why this phase is extremely vital for the organizations. Here also should be mentioned that process improvement activities come with a price. Organizations have to expend resources to make an improvement. These resources include human – people, who would otherwise be performing their day-to-day job functions, specialists trained in process improvement, or even external consultants. This can be expensive, but the playback from a well-executed process improvement can save many times the costs of the efforts.

4. The Strategic Value of BPM

BPM's value is to enable organizations to accomplish more with less effort. Higher quality services and products can be delivered at reduced costs. The most valuable key benefits of BPM are:

- *Improved Business Agility*

Agility is not just about an organization's ability to change. When circumstances change outside of their control, agile organizations are able to respond quickly. BPM offers the ability to monitor and discover vital data, stored by the BPM systems and provide to the organization the visibility into the performance of their processes.

- *Continuously Process Improvement & Performance*

Every organization has it is 3 P's – Policies, Procedures and Processes and these P's are constantly evolving, especially when it comes to processes. Business professionals need to examine their processes continually in order to eliminate problems. Continuous process improvement is a formal, ongoing approach to refining processes that can ultimately increase productivity, enhance service offerings and improves products. BPM establishes a system of evaluated metrics, leading to increase process efficiency, through automation, improve product/service quality, reduce time and costs and most importantly customer satisfaction.

- *Improve Risk Management*

Good risk management is an integral part of any process. BPM ensures that organizations stay in compliance through periodic reviews of documented processes. Successful BPM initiatives globally implement reliable checks and balances at every process level through the use of standardized tools, procedures and policies. This helps organizations to ensure they are compliant.

- *Saves Time and Money*

Implementing BPM systems can help organizations uncover potential cost and cycle-time saving by identifying redundant processes and eliminating duplicated work. Additionally, BPM will help organizations standardize their business processes, creating repeatable processes that produce consistent results. Those automated standardized processes can further reduce cycle time, eliminate waste and boost profits.

5. Conclusion

After having introduced the foundations of business process management and its key benefits we can conclude that the most valuable asset of the BPM systems is the process improvement. Business Process Optimization (BPO) is one of the final steps for BPM, a methodology that advocates for constant process re-evaluation and improvement. Despite the importance of process optimization, it is still often for the organizations to miss this stage of systems evolution. Typically, when designing or analyzing a process, analysts try to get as much data about the process as possible. They try to find deficiencies as well as implement appropriate optimizations. There are number of challenges associated with this approach that are at least partially linked to missing capabilities of current tools. This is partially due to the fact that BPM tools offer no guidance as to how actually change the process to achieve optimal results. Since analyst have to find all the improvement areas themselves, they require significant time and resources. This reflects to the organizations as more costs and delays in the implementation of the optimized process. To address those challenges we should think about an approach to substitute the existing manual process optimization techniques.

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Business Process Model Optimization as Important Step of Business Evolution

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Abstract. In today competitive business world, organizations and enterprises need to manipulate their business processes. The real key to be successful in these organizations lies in proper business process design and management. Concentrating on business process optimization and improvement, enterprises can achieve reduced costs, increased quality of products, raised efficiency of products and adapting with requirement changes. The main contribution of the paper is that it emphasizes the importance of proper modeling and why it is important for the organizations. It also highlights the lack of importance to this key step when implementing BPM systems. It concludes that the future trend would be techniques that would support performance analysis and enable automated process optimization.

Keywords. Business process (BP), BP analysis, BP optimization, Process efficiency, Performance analysis.

1. Introduction

In today competitive business world, organizations and enterprises need to manipulate their business processes. The real key to be successful in these organizations lies in proper business process design and management. Concentrating on business process optimization and improvement, enterprises can achieve reduced costs, increased quality of products, raised efficiency and they will adapt to the competitive environment. Definitely, business processes play an important role in the enterprise progress. Therefore, process modeling is one of the most essential steps in advanced enterprises. In addition, generating application and information systems are strongly dependable on the business process modeling. Many attempts have been made on creating variety of process modeling techniques, different notations, methods and tools, each of which views process modeling in particular way and contains its specific semantic concepts. Today, most organizations are actively trying to create their own models of business processes. A great number of business modeling endeavors aim to create representations of business processes which can be translated to computer software by IT stakeholders, while remaining understandable to business stakeholders.

The main target of this paper is to describe the basic ingredients of business process modeling, gives an overview of process modeling methods and techniques. The report highlights the importance of creating the right process model that fully reflects the real business environment and gives the point that business process optimization is the key of continuously improvement.

2. BPM Overview

Business process management (BPM) is a systematic approach, which covers the definition, execution, management and improvement of business processes. A business

process is a collection of activities or tasks that produce a specific service or product, generally involving both human interaction and computer applications. All BPM activities can be attributed to one of the five phases of the BPM lifecycle:

1. *Discover*

During this phase, existing business processes are identified and future business processes are designed. Typical information required for the identification of business processes are tasks, documents, responsibilities, computer systems and required resources.

2. *Design*

At this phase, the information gathered during the design phase is made explicit in a business process model. These models are usually created with elaborate modeling tools, using a standard for business process modeling, such as the Business Process Modeling Notation (BPMN).

3. *Execute*

During this phase, computer applications are deployed to support the automation of the business process. In traditional organizations, there are many computer applications that each perform a specific task. The more recent developments of BPM technology aim to use the business process model itself as a basis for automation. By formalizing the business process model, it can be interpreted and subsequently executed by a so-called business process engine. This approach allows computers to be aware of the actual business process as it is executed, which in turn enables a variety of advantages to the business.

4. *Monitor*

Monitoring phase is the phase in which the performance of the implemented business processes is measured. The depth of the analysis depends on what BPM technologies were implemented during the execution phase. When a feature rich BPMS is used, one can measure process performance both at the global level and at the instance level. This information can subsequently be aggregated and displayed in comprehensive monitoring dashboards, which give managers quantifiable real-life data of the performance of their business.

5. *Optimization*

Optimization is the phase, during which business processes are optimized based on the findings of the monitoring phase. These optimizations may lead to the redesign of existing business processes or the design of additional business processes. As a result, the optimization phase can be the initiator of a new design phase, thus completing the BPM life-cycle.

These five phases of the BPM life-cycle shown in Fig.1, form a never-ending loop, known as the continuous process improvement cycle.

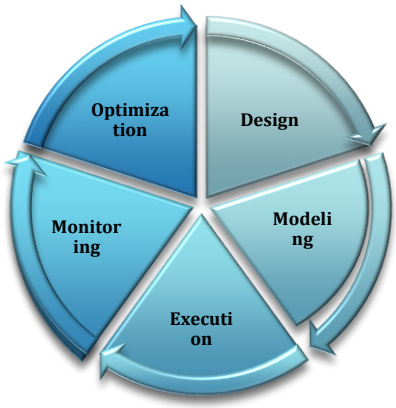

Fig. 1. BPM life cycle

3. Business Process Modeling

3.1. Business model

Before starting to explain the business process modeling in general, we have to understand what stands behind the term business model. Business model is a compact simplified view of the business, designed for the overview and analysis of interconnected business processes in the entire system. It expresses the essence of the business system, so it can only be developed by the management team of the organization. The business model should answer to the key questions about the business system, such as: ”What?”, ”How?”, ”For whom?”, “With whom?” and etc. [1]

3.2. Business Process Modeling

According to the theory, business process modeling refers to describing business processes at a high abstraction level, by means of formal notation to represent activities and their causal and temporal relationships, as well as specific business rules that process executions have to comply with. The focus of business process modeling is the representation of the execution order of activities, which is described through constructs for sequence, choice, parallelism or synchronization.

In the practice, modeling of the business processes in a company is the first step for applying the Business Process Management methodology. It allows making a comprehensive analysis, to have a look on all the processes from all angles, to identify weaknesses that other employees could not see, including management. The idea of business process modeling is a signal to the fact that the modern manager and all employees need a clear vision of all activities and, most importantly, its final result. Having a business model with its all business processes which are tailored for a specific purpose, we can open up the possibility to improve it. Analysis of a company by modeling its business processes is a convenient way to answer the question of what is necessary and sufficient to achieve a specific goal [1].

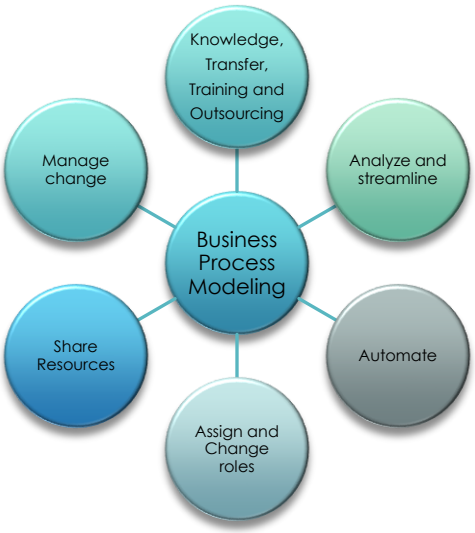

Fig. 2. Business Process Modeling

According to Volkner and Walrners in [3], since business process modeling organizes a process and analyzes current and alternative activities comprehensively and systematically,

business process modeling is necessary. Zhou and Chen in [5], proposed that business process optimization leads to reduces process completeness time and running costs, as well as increasing quality of products and customer satisfaction. With this perspective, quite literally organization can acquire the competitiveness advantage which it was looking for.

3.3. Goal of modeling business process

The ultimate goal of modeling business processes is to achieve improvement. Proper modeling of business processes has several objectives:

- The first goal is the description of the processes. Due to modeling it is possible to trace what happens in the process from start to finish. Modeling allows to "external" view of the processes and identifies improvements that will enhance their effectiveness.
- Secondly, a valuation process. Business Process Modeling sets rules for the implementation of processes. It means in which manner they should be performed. With following the rules, guidelines or requirements due to setting out the models, it is possible to achieve the desired process performance.
- Third, the establishment of relationships in the process. Modeling of business processes establishes a clear link between the different processes and requirements that they must fulfill [6].

3.4. Business Process Modeling Maturity Level

Process maturity is an indication of how close a developing process is to being complete and capable of continual improvement through qualitative measures and feedback. Thus, for a process to be mature, it has to be complete in its usefulness, automated, reliable in information and continuously improving. The maturity of the processes or activities in organization can be defined to be at one of five levels. According to Craig Hoggett [7], business process modeling is part of an enterprise wide transformation and has huge impact on the way a business operates. Fig.3 shows his maturity model, based on BPM life-cycle, and it gives a view of the process modeling development according to the organizational structure.

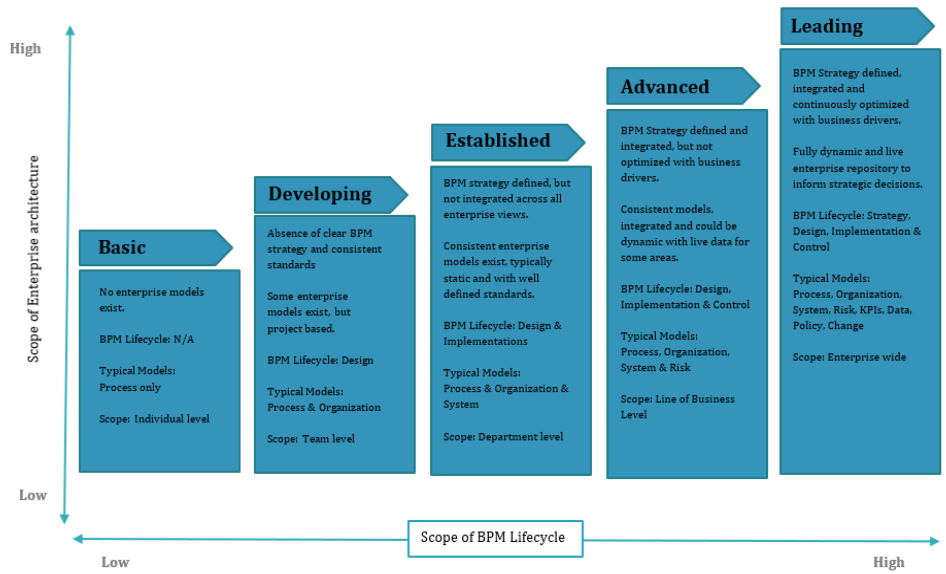

Fig. 3. Business Process Maturity Model

4. Business Process Modeling with BPMN

Over the years, various business modeling methodologies, such as the flow chart, data flow diagram, control flow diagram, Gantt chart and Unified Modeling Language (UML), have been employed to model and analyze different aspects of business processes. In recent years, Business Process Modeling Notation (BPMN) came out as a standard for modeling organizations and business processes. Based on latest publications BPMN standard has wide acceptance and usability.

BPMN is a graphical notation that provides organizations with the capability to document, analyze and communicate their business procedures in a simple and standard manner. The graphical notation of BPMN is chosen to resemble the flow-chart format. One of the objectives in the development of BPMN has been to create a simple and understandable mechanism for creating business process models, while at the same time being able to handle the complexity inherent in business processes. For this reason, the graphical notation is organized into a small set of specific notation categories.

One of the key requirements of the BPM is the ability to collaborate with other business functions within and across the organization. This increased the need to develop a language, which is capable of describing complex business processes. The language had to allow various systems and applications to share information within and across the organization and at the same time to support rich semantic for expressing business logic. Many vendors came up with such common languages and the BPMN is the result of an agreement among those vendors, that agreed on the standardization of a single notation. For this reason, now it is used in many real cases and many tools adopt it daily. BPMN provides a graphical notation to describe business processes, which is, at the same time, intuitive and powerful. It is able to represent complex process structure.

The primary goal of the BPMN effort was to provide a notation that is readily understandable by all business users, from the business analysts that create the initial drafts of processes, to the technical developers responsible for implementing the technology that will perform those processes, and finally, to the business people who will manage and monitor those processes. Thus, BPMN creates a standardized bridge for the gap between business process design and process implementation.

5. Business Process Management Systems (BPMS)

From the standard definition point of view, Business Process Management focuses on improving corporate performance by managing and optimizing a company's business processes and in summary that can be described as "process optimization". Based on the previous section 3.3, we can conclude that business process modeling is a key step in business improvement, but it does not add much value without further inspection and analysis of the business process model. The actual value of the BPM concept comes from the process optimization. It includes retrieving process performance information from modeling or monitoring phase, identifying the potential or actual bottlenecks and the potential opportunities for cost saving or other improvements and then applying those enhancements in the design of the process.

Since BPMN standard build the bridge between business process modeling and their actual implementation, many software tools have been developed to incorporate the modelling language. Business Process Management Systems (BPMS) are sets of tools that support the Business Process Management (BPM) life-cycle. Smith [9] sees a list of key advantages in using a modern BPMS:

- it bridges heterogeneous application environments,

- includes human activity by incorporating workflow,
- allows web service orchestration,
- provides the opportunity to customize the whole process for specific customers and partners,
- offers an integrated user interface through a single portal and back-end integration,
- and monitors process instances.

Rather than introducing new technology or replacing existing business applications, BPMS integrate existing technologies and existing applications in a process-oriented fashion. Based on this notion of BPMS, Smith and Fingar [9] describe requirements for a BPMS as follows: "A BPMS should be able to support modeling, deploying, and monitoring business processes, as well as to support integration of heterogeneous processes, automation, and collaboration.". Business process design includes process documentation with a process notation, such as Business Process Modeling Notation (BPMN).

5.1. BPMS Benefits

The newest BPM systems use information technology and BPMN notation as a technique of managerial problem solving. When a system is developed in a process centric way, it helps the organization to easily integrate the system with the people and also with the data which are used in the business processes.

According to Reijers "A BPMS is typically described as a piece of generic software that supports activities such as the modelling, analysis and enactment of business processes." [10]

Literatures say that since its development, BPMS is intended to upgrade the performance of business organizations and designed to make them more capable in operating business process. On top of that the system has been used to overcome problems in relation to managing business processes. Chang [11] has specifically identified the following five points as organizational capabilities due to the usage of BPMS:

- Closer business involvement in designing IT- enabled business process solutions.
- Ability to integrate people and systems that participate in business processes.
- Ability to stimulate business processes to design the most optimal processes for implementation.
- Ability to monitor, to control, and improve business processes in real time.
- Ability to effect change on existing business processes in real time without an elaborate process conversion effort.

The above points tell us business process management systems are efficient software tools to improve the overall performance of business organizations. But as it was said earlier the value of the BPM methodology and accordingly to the Business Process Management Systems is the continuous improvement.

5.2. BPMS in the organizations

Organizations can have different reasons for their need to use BPM systems, but all require this system to assist in their business activities. "The ability of organizations to successfully deploy appropriate business processes relies heavily upon the effectiveness of systems that support the management of constantly evolving business processes that support the current set of business needs, and the ability of process participants to understand and reason about the constantly evolving business processes." [12]

As a result, organizations are intended to have a system that helps them to be more flexible and gives a continuous and effective managerial support over the business processes.

This becomes possible through the implementation of business process management systems. Actually, BPM systems not only let the organization to have a continuous control access over business processes, but also can give a possibility to redesign business processes according to the business needs. [11]

BPMS helps organizations by providing real benefits such as Automations of Standard Procedures and Processes, Ability to Visualize, Simulate and Trouble-Shoot Business Processes, Change Business Rules and Processes without Impacting Underlying Applications, Manage and Monitor the Performance of Operations. It is clear, that BPM implementation is a complex and difficult process that can potentially bring enormous benefits for successful companies. The questions that arise here are "What are the critical Success factors for BPM Implementation?", "How to measure the success of the BPM initiative?" The figure below shows the most important aspects of a BPMS implementation framework. This framework distinguishes three different areas, (1) the ongoing domain of the business organization itself. (2) the measurement and control function and (3) the BPMS implementation project area. It should be mentioned that BPMS implementation is a continuous process consisting of many different projects.

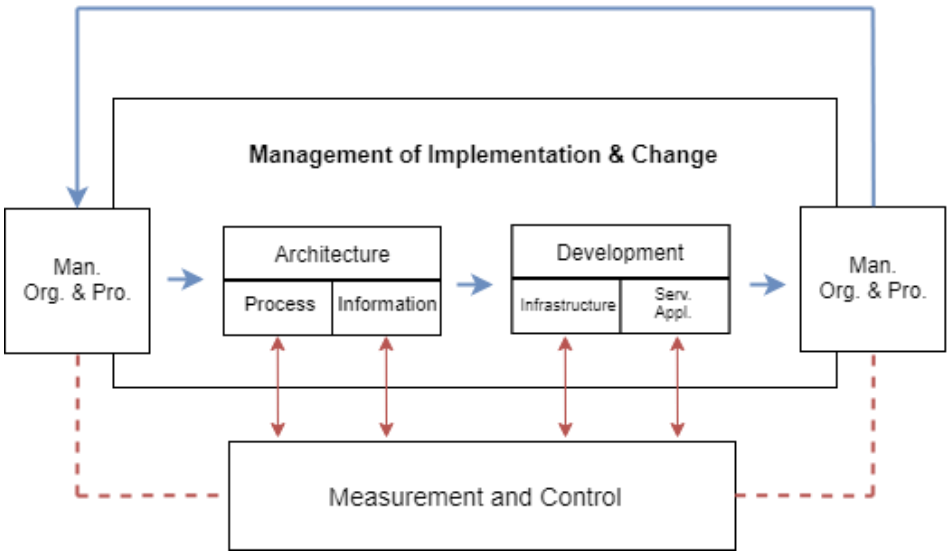

Fig. 4. BPMS implementation framework

As it is shown on Fig.4, Measurement and Control is a never-ending process. To measure the success of implementing BPMS framework in organization, it is important to have a correct and complete set of measurement dimensions. In terms of success, we can highlight three dimensions: Process efficiency, Process quality and Process agility. Process efficiency attributed to the application of the lean process improvement methodology and to the automation of the process on the technology platform. Process Quality comments are consistent with the view that BPM can reduce processing errors as well as improve process consistency. Process agility comments are consistent with the statement that BPM architecture allows processes to be changed more easily than with hard-coded applications.

Using BPMS systems companies also got some advantage towards data storage. The information is managed and stored properly, companies can easily observe and evaluate their

performance and even use the information as a base for future business design. Many authors find BPM systems as a very good tool for data or informational handling. They highlight that in order to make the right decisions, every manager need the right information. As those systems collect the data about process performance in the monitoring phase of the BPM lifecycle, they store the fundamental information that allows them to complete their continuous optimization. There is a solid number of researches and reports about this topic – techniques for business process optimization. Here is a structured list of the most valuable:

- *Task Elimination* – Elimination of the unnecessary activities from the business processes, when they add no value from a customer's point of view.
- *Task composition* - Combine small activities into composite activities and divide large activities into workable smaller activities. (Merge or Split)
- *Triage* – Consider the division of a general activity into two or more alternative activities.
- *Resequencing* – Move activities to more appropriate places. Sometimes it is better to postpone an activity, if it is not required for its immediate follow-up activities.
- *Parallelism* – Consider whether activities may be executed in parallel. The obvious effect of placing activities in parallel is that throughput time may be considerably reduced.
- *Process standardization* – All cases should be treated equally as much as possible.
- *Resource optimization* – Those techniques can be expressed in many different ways. Some examples are: (a) To let the workers perform as many steps as possible for single cases, or (b) Assign work in such a way to maximum flexibility is preserved for near future, or (c) To give the workers most of the decision-making authority, instead of relying on middle management and etc.
- *Communication optimization* – Reduce the number of messages to be exchanged with customers and business partners, try to automate the handling of messages.
- *Automation* – Avoid duplicate data entry, replace paper document flow with information flow, enable self-service.

These are only some of the techniques that can be used to support the processes optimization. As we can see some of the techniques cannot be implemented in a BPM System, but what about the rest. The present optimization processes usually involve a lot of analyst and manual work to use the above techniques and find the best way for optimization. Could we think about a way to combine the collected data from the different life cycle phases in the BPM systems and the above said techniques. Can we automate the application of those techniques? Will that lead to actual measurement of the three success factors - Process efficiency, Process quality and Process agility?

6. Challenges for BPM Systems

So far, we have seen the various benefits of BPMS to business organizations from different angles. During the research work was found that there are some challenges which organizations are facing in association with the system. The ability of a business to achieve superior process performance is nowadays one of the main sources of competitive advantage. Change is accelerated in today's business dynamic, but how should BPM systems adapt to such transformation? At the organization level and its value channels, all processes should be observed, controlled and optimized as a whole, not separated. Real time performance dashboard KPIs data could be analyzed for the future re-model of the entire business processes chain. To achieve this, nearly all companies have dedicated or hired staff to execute the

business process optimization projects. Most of the companies even find that as a disadvantage, because it cost them a solid amount of resources.

7. Conclusions

This research is conducted to answer our research question "What are the impacts of Business Process Modeling in organizations?" After studying the theoretical concepts and background, we can conclude that business process modeling is the foundation of improving business operations in the organizations. BPM systems became really valuable for the organizations. Their implementation has got both - opportunities and challenges. The research findings, in general, imply BPMS provide a lot of perceived impacts to organizations. The opportunities are either from the technological, business or management points of view. The system is highly required due to the frequent changes of business environment so that organizations become competent and cope with the changes.

BPM systems are important in today's business and they benefit organizations by speeding up the business processes, so they can give the appropriate services to customers and manage the business processes in time. Integration is another interesting advantage of BPMS where the system unites the business components to one another then all work towards to achieve the organizational goal. Among the many positive impacts of BPMS, we found that the systems have not yet present automation of the technologies for continuous process optimization. Process analysis are still considered as manually tasks, which delays the constant optimization and requires solid resources.

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Technological Issues of Analyzing Unstructured Data

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Abstract. This paper looks at the current issues in analyzing unstructured data. It presents an overview of the ways of organization and management of the data over the years of the technological progress, as well as popular approaches to analyzing of unstructured data. Finally, the findings of the study are outlined.

Keywords. Information, Internet, Unstructured data, Data mining, Natural language processing

1. Introduction

Today most of the information stored in the companies is in an unstructured form. Obtaining and retrieving information is a key activity that is of utmost importance in semantic web. More than 80% of potentially useful business information is unstructured data [3]. The Web is a bright example for a storage of huge collections of unstructured data. Text mining and natural language processing are two techniques for extracting knowledge from text in documents.

2. Issues of analyzing unstructured data

Prior to the widespread use of computers, data for various activities (e.g. population census, scientific experiments, sample surveys) was recorded on paper. The data collection was done by pre-defining the questions to be answered and the collected data was presented in the form of tables with arranged rows and columns so that the data is susceptible to traditional statistical methods of analysis. In the middle of 20th century, part of the research data was stored electronically, helping to ease the process of data collection and data processing. With the launch of the World Wide Web in 1989 and its subsequent rapid development, it has become more and more feasible to generate, collect, store and analyze data electronically. This process of technological progress generates inevitable problems related to the processing of ever larger and more diverse data sets and their transformation into meaningful information [5].

Due to tremendous advances in hardware and software technologies a rapid development has occurred in the area of data mining [1]. This progress has led to availability of different types of data. This is especially true for text data where the development of hardware and software platforms for web and social networking has enabled the rapid creation of large storages of different types of data. In particular, the network is a technological factor that encourages the creation of a large amount of text content by different users in a form that is easy to store and process. Increasing amounts of textual data from different applications give rise to a need for further development of the algorithmic design. This need encourages the creation of new and interesting data models.

While the structured data is typically managed with a database, the text data is usually managed by a search engine due to the lack of structures. The search engine allows the user to

find useful information from the data collection by using a keyword query. Improving the efficiency and effectiveness of the search engine is a central research topic in the field of information retrieval [2, 7], as many search-related issues such as text clustering, text categorization, summarization, and recommender systems are also a subject of research [4, 13]. Many authors note in their researches, that public organizations also use different types of data for implementation of their services [8, 9]. Fig. 1 illustrates the two common types of unstructured data.

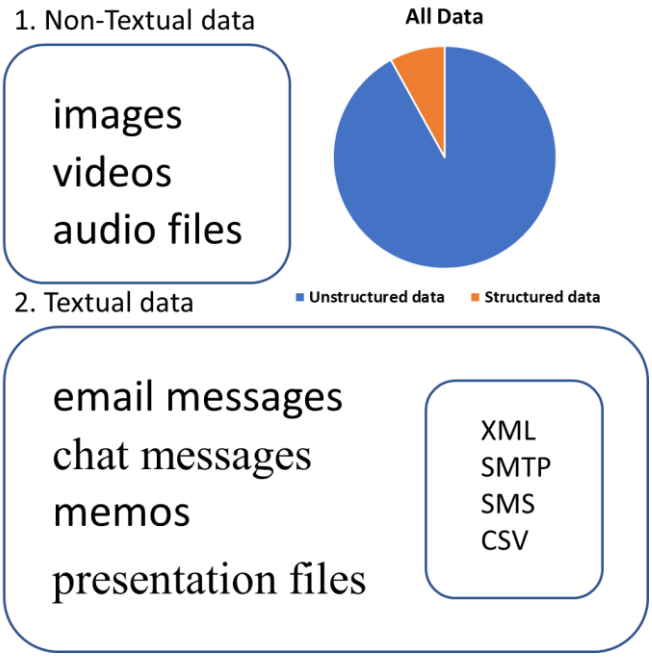

Fig. 1 Types of unstructured data

3. Data analysis approaches

The problem of text analysis has attracted increasing attention in recent years due to the large amount of textual data produced in the variety of social networks, web and other information applications. Unstructured data is the final form of data that can be created in each application scenario. That is why there is a tremendous need to design methods and algorithms that can efficiently process a wide variety of textual data [1]. The two most common techniques for analyzing and retrieving information from text cited by many authors are text mining and natural language processing (NLP). Many authors also research the opportunities for assessment of information systems in this area [11].

Natural Language Processing (NLP) is a set of techniques which allow computers to analyze, understand, and generate languages which are used naturally [6]. It is a challenging field of Artificial Intelligence which is aimed at addressing the issue of automatically processing human language, called natural language, in written form. This is to be achieved by way of the automatic analysis, understanding and generation of language [12]. Fig. 2 shows a schema of application of NLP in Web.

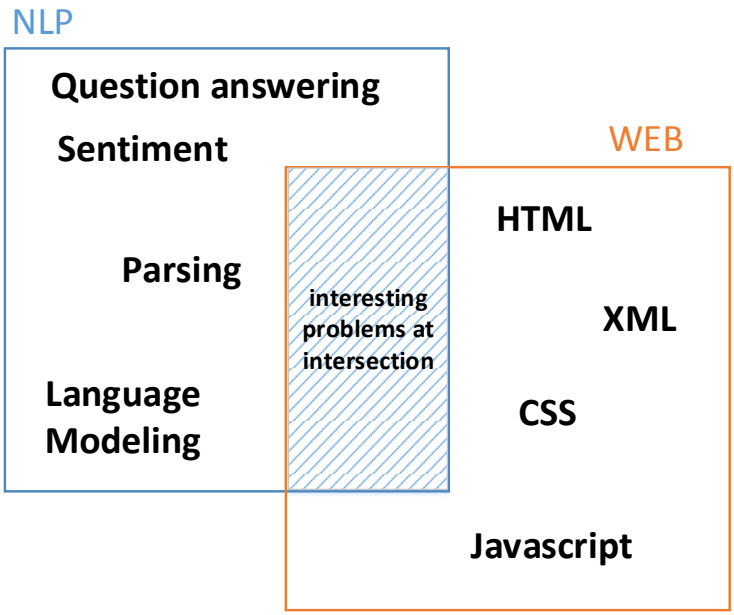

Fig. 2 NLP in Web

Various activities are included in the text mining, namely:

- Automatic classification of text according to a set of categories;
- Grouping of texts based on common features;
- Automatic summarization;
- Retrieving topics from texts and analyzing thematic trends in text streams.

Text mining is used in practice by business intelligence solutions for different purposes and takes a key place in the architecture of this kind of systems [13].

The problem of text analysis has gained increasing attention in recent years due to the large amount of textual data created in the variety of social networks, web and other information applications. Unstructured data is the last form of data that can be created in each application scenario. As a result, there is a tremendous need to design methods and algorithms that can efficiently handle a wide variety of textual data.

4. Conclusion

The problems in analyzing unstructured data are associated with their sharp increase and diversity as a result of the development of hardware and software technologies and the creation of the Web. Most of the data on the Internet is stored in textual form. Text data management is carried out with a tool called a search engine. The analysis of this type of data is related to the two most popular text analysis techniques – text mining and natural language processing.

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Modern Trends of Retrieving Information from Internet

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Abstract. This paper looks at current trends towards application and organization of information retrieval from the Internet. The paper presents the application of this process in the field of business intelligence. It illustrates the basic architecture of the core components of the process, as well as their place in the architecture of business intelligence systems. Finally, some conclusions are presented.

Keywords. Information retrieval, Internet, Unstructured data, Business intelligence, Architecture, Business intelligence systems

1. Introduction

As a result of the rapid growth of the Web, search engines have become an integral part of people's everyday lives, and users' behavior in search process is much better understood. Search based on bag-of-word representation of documents cannot give satisfactory results. Addressing more complex search issues, such as entity search, structured search, and question answering can provide users with better results [1].

2. Information retrieval and business intelligence

Information retrieval (IR) can be described as finding materials (usually documents) of an unstructured character (usually text) from large collections (usually stored on computers) according to defined criteria [6]. This notion is associated with Information Retrieval Systems, which have been applied for finding documents on the Web since 1996 [10]. Information retrieval system is a system that can store, deliver and maintain information. The information in this context can be composed of text (including numeric values and dates), images, audio, video and other multimedia objects. Although the form of the objects in these systems is varied, the text data type is the only one that can be fully processed [5].

In order to improve their performance, the organizations are forced to collect, interpret and use data to ensure optimal management [1]. Aiming at solutions supporting decision-making process leads to development of different business technologies and tools for business analysis known as Business Intelligence. The systems designed to support decision-making using various analytical tools are associated to the notion of "Business Intelligence Systems" (BIS).

The creation and implementation of BIS is one of the newest and most rapidly developing directions in the field of information technology building [12]. There is no specific definition of BIS. Different authors offer various definitions depending on the chosen focus of definition - objectives and purpose, building components, technologies used, etc. According to one definition BIS is a type of systems that performs data collection and storage and knowledge management with the support of analytical tools with the purpose of providing complex and business-critical information needed for planning and management decision-making. Another definition is that BIS is an architecture and a set of integrated applications

for servicing operations and supporting decision-making processes. Regardless of the specific definitions, BIS are linked to two important matters: data integration (combining data from different sources and in different formats) and providing of techniques for analysis and visualization of information [11]. The research in this paper covers the topics of the first matter, namely the loading of BIS with data (mostly unstructured) from different sources and in different formats or, in other words, the extraction of unstructured data (from different sources) and their bringing into a unified and structured type, consistent with the requirements of a specified BIS. Data sources for a system can be internal (within the organization) and external. We perceive all sources of the World Wide Web (considered as a huge multitude of sources of unstructured data) which do not belong to an organization as external. That is why we can generally accept sources of the Web as external sources. Since the external data for BIS is particularly valuable for analyzing at senior management level [11], we believe the problem of extracting information from unstructured data is of crucial importance for this type of systems. In future, as a result of the rapid growth of data around the world, the challenges of solving this problem will increase rather than decrease.

3. Information retrieval architecture

Architecture is the fundamental organization of a system, its components, relations between them and the environment and the principles of management and development [8]. The architecture is used to describe a given system at a certain level of abstraction [2]. The description of a system architecture consists of defining its basic components, the connections between them and the environment, as well as indicating the objectives and tasks that each component performs. The descriptions of an architecture are presented in graphical, verbal or mixed form and are called architectural models [8]. Different types of architectures are defined: hardware architecture, software architecture, corporate architecture, manufacturing system architecture, and so on. These architectures are also applicable in the public sector [3, 4]. The software architecture consists mainly of software components, interfaces provided by these components and relations between them.

In this paper we will look at the basic software architecture of search engine for information retrieval. Similar approach is presented by Milev in his research with focus on the issues of development of web scrapping applications [7].

A search engine architecture should be designed to ensure that the system meets the requirements or purposes of the application. The two main goals of a search engine to be achieved are:

- Effectiveness (quality) - the ability to derive the most appropriate set of possible documents upon query;
- Efficiency (speed) - the ability to process users' queries as quickly as possible.

The defined goals of a search engine typically fall within the categories of effectiveness or efficiency (or both). For example, a set of documents to search in may change. In this case, the search engine's immediate response to the changes in the documents is a matter of both, effectiveness and efficiency. The architecture of search engine is determined by these two criteria. To achieve efficiency search engines, use specialized data structures optimized for fast retrieval. To obtain high-quality results search engines carefully process the text and store textual statistics that help improve the relevance of results.

Search engine components support two main functions, which are called indexing process and query process. The indexing process builds the structures to search in, and the query process uses these structures to produce a ranked list of results based on defined criteria. Fig. 1 shows the basic building blocks of indexing process - text extraction, text conversion and index creation [2].

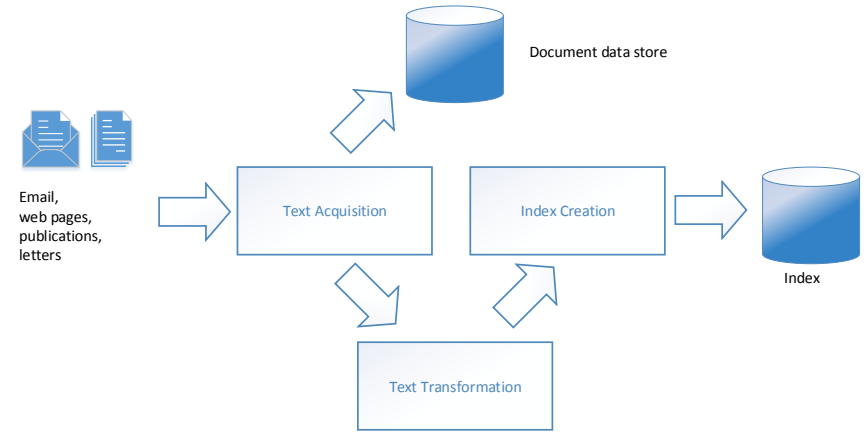

Fig. 1 Information retrieval – indexing process

Fig. 2 illustrates the basic building blocks of the query process – user interaction, ranking and evaluation.

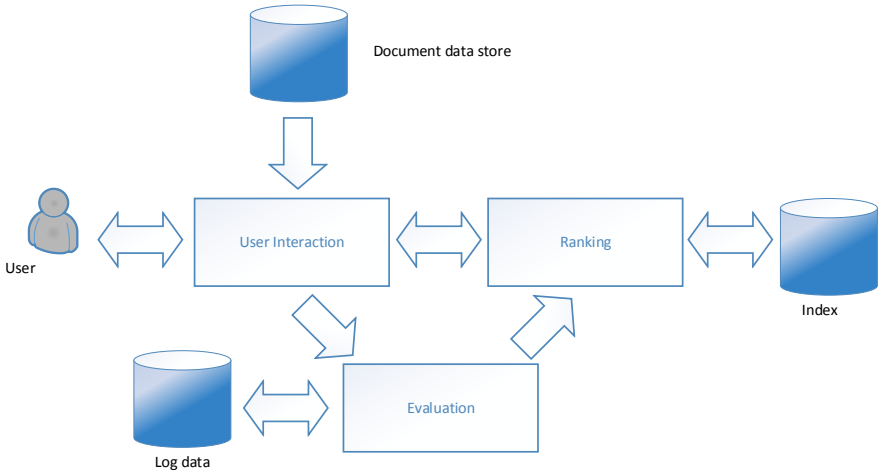

Fig. 2 Information retrieval – query process

4. Information retrieval in business intelligence systems

Architecture of a business intelligence system consists of two environments - a data environment and an analytical environment. The data environment includes data sources (internal and external), ETL process (which includes retrieving of data from sources, transforming this data into a suitable form, and loading it into system data warehouse), and a data warehouse [11]. Fig. 3 shows a basic BIS architecture that uses data from external sources from the World Wide Web.

The ETL (Extract, Load, Transform) is one of the main components of a business intelligence system, on which it depends in highly measure, the data accuracy the organization will analyze [9]. The extraction process (as part of the ETL process) of these sources passes through an intermediate layer, called a web service in this case. This web service includes retrieving and indexing data (from web sources) and providing them (by specified criteria)

using standard communication protocols (TCP, HTTP, etc.) and data formats (HTML, XML, JSON, etc.). There is also a scenario in which the ETL process is performed by direct extraction from the sources (without an intermediate layer). Regardless of whether a BIS uses or does not use an intermediate layer for network sources, the Web retrieval process is present and can be done with search engine model.

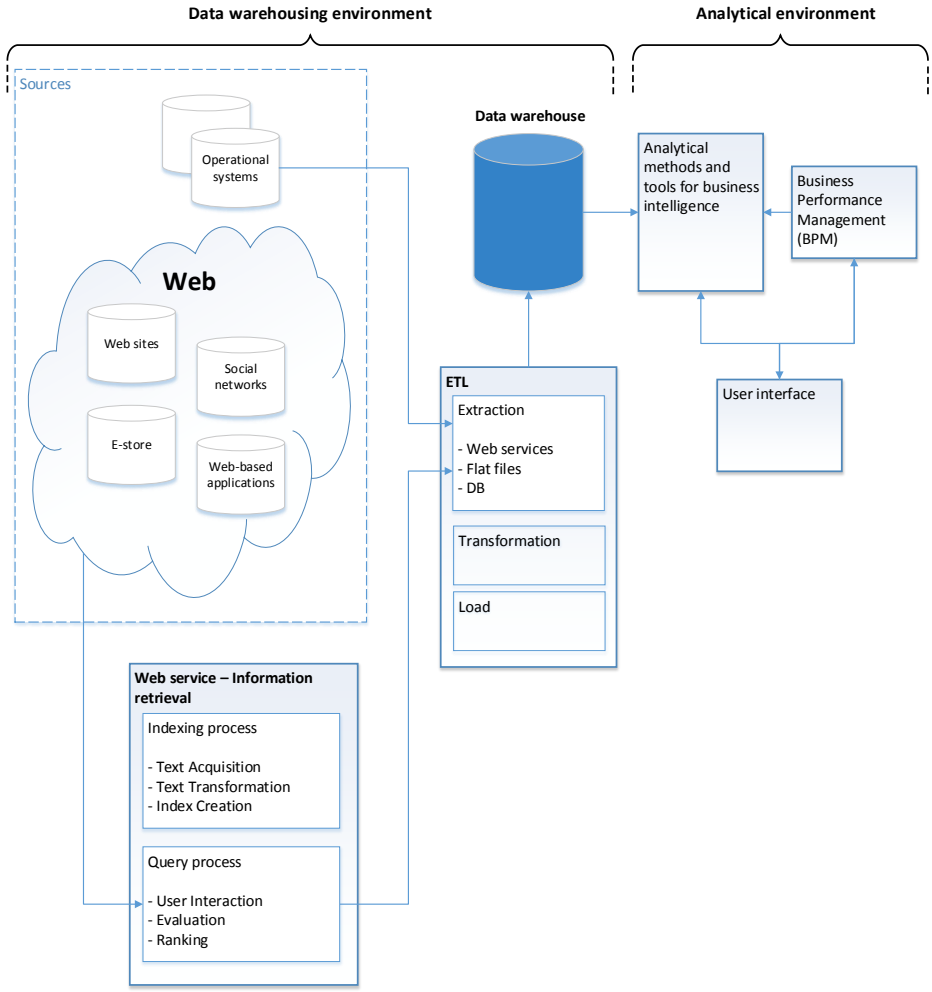

Fig. 3 BIS architecture with external web sources

5. Conclusion

In conclusion, from the presented study of the modern trends of retrieving information from unstructured data, it can be said that the extraction of information is important for organizations and businesses. This process takes a key role in business intelligence and in providing data to business intelligence systems from sources that are external to an organization. The main processes in the retrieval of information are index process and query process. The process of data loading into BIS from external sources can be accomplished with search engine model.

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Modern major CMS Classifications and Combined Classification

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Abstract. The paper reviews some of the modern Content Management Systems (CMS) classifications. It traces their development and give brief review of most used CMS systems. Several major classifications are combined with the vision of the author. Main goal of the paper is to present new classification merging several classifications in a new way. Promising directions for future research are outlined.

Keywords. CMS Classification, Content Management Systems Classification, Major type of CMS, CMS Brief Descriptions

1. Introduction

In the last 10 years, Content Management Systems (CMS) have quickly entered into the practice and have become widely available to a wide range of users. CMS importance has increased due to their use for different type of activities. As technology advances, various CMS have emerged, based on different platforms and technologies, some of them paid, another part free. Both closed-source and open-source content management systems have emerged. Whole ecosystems have been created around some of the open source CMS, allowing for their rapid development and building on a number of new features.

A large number of different CMS have emerged, and this sometimes makes it difficult for users to choose which CMS will be appropriate for them. This raises the need for the detailed description and systematization of the CMS. The purpose of this paper is to list and classify the most significant CMS systems by several criteria: license of the code (open source or proprietary), programming language and platform (Java, ASP.NET, PHP, etc.), payment terms (free or paid), and infrastructure (hosted on own server or SaaS / Cloud Service). The author's point of view for systematization of different CMS systems also will be presented according to their most common use and purpose (for building of personal web blogs, small web sites, corporate web sites, web portals, online shops, etc.).

2. Definition of Content Management System

Content Management System (CMS) is a type of application software that allows publishing and editing a website as well as main interface support. The goal is to facilitate the development of a dynamic website with the ability to easily and quickly change its content. These systems greatly facilitate teamwork and offer many options for delegating different administrative rights and roles to the content creation and editing process.

Content management systems are often used on a variety of websites:

- business and corporate websites and blogs
- government and non-government organizations websites and blogs
- personal websites and blogs
- news portals and information portals

- online catalogues
- online shops
- online communities platforms
- other types of online media platforms

This technology aims to avoid or at least minimize the need for manual code writing. This greatly reduces the need for specialists to maintain the program code. This division allows system users to focus on creating and editing content itself rather than on technology used to make it accessible to the target audience.

There are different types of systems that differ mainly in the level of functionality. Some contain extremely powerful process management tools but in return require more in-depth knowledge on the part of the users. Such systems are suitable for large organizations that have sufficient resources to support them. Other systems rely on the most simplified and intuitive user interface and even allow people with minimal computer skills and knowledge to share content.

3. Main features of CMS

The main purpose of content management systems is to manage information on websites and corporate systems. Whether it's a personal blog or a corporate website, the content management system allows users with no HTML and CSS knowledge to add content. There is an extraordinary choice of such systems and each one is different, but the overall is that they have an intuitive interface and can also be used by people without programming skills. Some of these systems only provide functions that are user-friendly in an easy and accessible way, and others - an extremely complex data manipulation feature. Most management systems include publishing, formatting, reviewing, indexing, searching and retrieving texts. The system can be used as a central repository containing documents, movies, photos, phone numbers, scientific data, and more. It can be used for storing, controlling, reviewing, semantically enriching, and publishing the documentation. Users can easily add and delete pictures and photos and edit the text on their own websites. The system automatically generates hyperlinks and takes care of user access rights.

4. Dissemination and usage of CMS

About 50% of all websites on the web use some kind of content management system. The highest share is **WordPress**, which drives more than half of websites with such systems.

Other very popular CMS are:

- Joomla
- Drupal
- ModX
- TextPattern
- Refinery CMS
- Concrete5
- DotNetNuke
- Umbraco
- ExpressionEngine
- Radiant
- SilverStripe
- Alfresco
- Contao (TYPOlight)

5. Web Content Management System (WCMS)

The Web Content Management System is a package or self-contained application for creating, managing, storing and using content on web pages. Web content includes text and embedded graphics, photos, videos, audio files, and programming code. The web system can collect and index content, select and assemble content at work, or deliver content to specific users in a particular way, such as another language. This type of systems typically allow the client to control HTML-based content, document files and web hosting plans based on the system and the depth of the niche it serves.

6. Classification of remarkable Open source CMSs based on different platforms

The list below classifies only **free open-source** CMS intended for **installation and managing on own web server**.

6.1. List of Open source CMS based on Java

Name	Platform	Supported databases	Licenses	Latest release date
Apache Roller	Java	HSQL, MySQL, Oracle, SQL Server, DB2, PostgreSQL, Apache Derby	Apache 2.0 License	06.11.2017
Ametys CMS	Java	MySQL, Oracle, SQL Server, JCR, Apache Derby	Apache 2.0 License	27.04.2015
Crafter CMS	Java	Git, Solr, CMIS	GNU GPL v3	01.08.2017
dotCMS	Java	MySQL, Oracle, MSSQL, PostgreSQL	GNU GPL v3	28.09.2018
DSpace	Java	Oracle, PostgreSQL	BSD License	16.01.2015
Enonic XP	Java	Embedded NoSQL	GPL v3	17.07.2018
Fedora Commons	Java	MySQL, Oracle, PostgreSQL, Mulgara (MPTSTore RDF Semantic Triplestore)	Apache License	04.02.2015
LogicalDOC Community Edition	Java	MySQL, Oracle, SQL Server, PostgreSQL	LGPL	24.03.2016
Nuxeo EP	Java	MySQL, Oracle, SQL Server, Ingres, PostgreSQL, MongoDB	Apache 2.0 License	26.07.2018
OpenCms	Java	HSQL, MySQL, Oracle, SQL Server, DB2, PostgreSQL	LGPL	17.05.2018
Alfresco Community Edition	Java	MySQL, Oracle, SQL Server, PostgreSQL, DB2,	LGPL	17.05.2016
Hippo CMS	Java	MySQL, Oracle, SQL Server, Ingres, PostgreSQL, JCR	Apache 2.0 License	01.08.2018
OpenWGA	Java	MySQL, PostgreSQL, IBM DB2, HSQLDB, Oracle, SQL Server, IBM Lotus Domino, CMIS	GPL & proprietary	25.02.2015
Jahia Community Distribution	Java	Apache Derby, JCR, MySQL, PostgreSQL	GPL	01.03.2018
Magnolia	Java	H2, Derby, MySQL, PostgreSQL, Oracle, MSSQL	GPL & proprietary	15.11.2017
OpenKM	Java	MySQL, PostgreSQL, Oracle, SQL Server, HSQLDB	GPL	24.10.2016
XWiki	Java	MySQL, PostgreSQL, Oracle, SQL Server, HSQLDB	LGPL	26.03.2018

6.2. List of Open source CMS based on Microsoft ASP.NET

Name	Platform	Supported databases	Licenses	Latest release date
C1 CMS	ASP.NET (Web Forms, MVC)	XML, SQL Server	Mozilla Public License	07.03.2018
DNN	ASP.NET (Web Forms, MVC)	SQL Server, SQL Server Express, SQL Azure	MIT License	05.07.2017
Kentico CMS	ASP.NET	SQL Server	Proprietary, Free	30.11.2016
mojoPortal	ASP.NET	SQL Server, MySQL, PostgreSQL, SQLite, Firebird, SQL CE	CPL	10.04.2016
Orchard Project	ASP.NET (Web Forms, MVC)	SQL Server, MySQL, PostgreSQL, SQLite	New BSD License	11.05.2016
Umbraco	ASP.NET (Web Forms, MVC)	SQL Server, SQL CE, SQL Azure, MySQL	MIT License	09.02.2018
BetterCMS	ASP.NET (Web Forms, MVC)	SQL Server, SQL Azure	LGPL	14.06.2016

6.3. List of Open source CMS based on Python

Name	Platform	Supported databases	Licenses	Latest release date
django CMS	Python/ Django	PostgreSQL, MySQL, SQLite 3 and Oracle	BSD	18.04.2018
Mezzanine	Python/ Django	PostgreSQL, MySQL, SQLite 3 and Oracle	BSD	25.11.2016
MoinMoin	Python	Flat-file database	GPL	09.09.2018
Plone	Python/ Zope	MySQL, PostgreSQL, SQLite, Oracle, ZODB, via Zope	GPL	15.03.2017
Wagtail	Python/ Django	PostgreSQL, MySQL, SQLite 3 and Oracle	BSD	18.09.2017

6.4. List of Open source CMS based on Perl

Name	Platform	Supported databases	Licenses	Latest release date
blosxom	Perl	Flat-file database	MIT	02.10.2008
Bricolage	Perl on mod perl	MySQL, PostgreSQL, Oracle	BSD	09.02.2011
EPrints	Perl on mod perl	MySQL, PostgreSQL	GPL	22.12.2015
Foswiki	Perl	Flat-file database	GPL	02.03.2018
Ikiwiki	Perl	Git (software), Apache Subversion, Mercurial	GPL	11.01.2017
Movable Type Open Source	Perl, mod perl, FastCGI, w/PHP	MySQL	GPL	14.04.2015
TWiki	Perl	Plain files (under version control)	GPL	29.11.2015
Sellerdeck eCommerce	Perl	Flat-file database, Flat-file database	GPL	20.02.2017
SPINE	Perl, mod perl	MySQL, PostgreSQL	GPL	27.12.2006
WebGUI	Perl on mod perl	MySQL	GPL	06.01.2016

6.5. List of Open source CMS based on Ruby on Rails

Name	Platform	Supported data	Licenses	Latest release date
Alchemy CMS	Ruby on Rails	PostgreSQL, MySQL, SQLite	BSD	22.12.2016
BrowserCMS	Ruby on Rails	MySQL, SQLite	LGPL	05.07.2013
Radiant	Ruby on Rails	MySQL, PostgreSQL, SQLite, DB 2	MIT	24.09.2013
Refinery CMS	Ruby on Rails	MySQL, PostgreSQL, SQLite	MIT	23.11.2016
Typo	Ruby on Rails	MySQL, PostgreSQL, SQLite	MIT	03.11.2016

6.6. List of Open source CMS based on JavaScript

Name	Platform	Supported data	Licenses	Latest release date
Ghost	Node.js	SQLite, MySQL	MIT	10.12.2018
TiddlyWiki	Node.js & client-side JavaScript	Flat-file database	BSD license	06.12.2018
Wiki.js	Node.js	MongoDB	GNU Affero General Public License	12.08.2018

6.7. List of Open source CMS based on ColdFusion Markup Language (CFML)

Name	Platform	Supported databases	Licenses	Latest release date
ContentBox Modular CMS	Lucee / Railo / Adobe ColdFusion	MySQL/Microsoft SQL Server/PostgreSQL/HSQLD	Apache License or proprietary	05.05.2015
Mura CMS	Lucee / Railo / OpenBD / Adobe ColdFusion	MySQL/Microsoft SQL Server/Oracle	GPL or proprietary	03.01.2017
FarCry CMS	Lucee / Railo / OpenBD / Adobe ColdFusion	MySQL/Microsoft SQL Server/Oracle/Postgres	GPL or proprietary	14.01.2015

6.8. List of Open source CMS based on other platforms

Name	Platform	Supported databases	Licenses	Latest release date
OpenACS	Tcl AOLserver	PostgreSQL/Oracle	GPL	01.12.2015

6.9. List of Open source CMS based on PHP

Name	Platform	Supported databases	Licenses	Latest release date
ATutor	PHP	MySQL	GPL	01.07.2016
b2evolution	PHP	MySQL, MariaDB	GPLv2	20.06.2018
CMSimple	PHP	Flat-file database	GPLv3	07.05.2017
CMS Made Simple	PHP	MySQL	GPL	10.03.2018
Coderity	PHP	MySQL	MIT	27.02.2015
Composr CMS	PHP	MySQL	CPAL	22.01.2018
concrete5	PHP	MySQL	MIT	13.07.2018
Contao	PHP	MySQL	LGPL	23.01.2018
DokuWiki	PHP	Flat-file database	GPL	19.02.2017
Dotclear	PHP	MySQL, PostgreSQL, SQLite	GPL	27.07.2017
Drupal	PHP	MariaDB, Microsoft SQL Server, MySQL, Oracle, Percona Server, PostgreSQL, SQLite	GPLv2+	05.09.2018
Exponent CMS	PHP	MySQL	GPL	01.01.2018
eZ Publish	PHP	MySQL, PostgreSQL, Oracle, Microsoft SQL Server	GPL	02.12.2014
eZ Platform	PHP	MySQL, MariaDB, PostgreSQL	GPL	15.12.2016
Geeklog	PHP	MySQL, PostgreSQL, Microsoft SQL Server	GPL	22.06.2017
GetSimple CMS	PHP	Flat-file database	GPL	11.10.2016
Habari	PHP	MySQL, PostgreSQL, SQLite	Apache License	16.09.2014
ImpressCMS	PHP	MySQL	GPL	28.12.2016
ImpressPages	PHP	MySQL	GPL MIT	30.10.2016
Jamroom	PHP	MySQL, MariaDB, Percona	MPL	30.08.2017
Joomla!	PHP	MySQL, PostgreSQL, MSSQL, SQLite	GPL	28.08.2018
Kajona	PHP	MySQL, PostgreSQL, SQLite, MariaDB, Oracle	LGPL	08.06.2017
Known	PHP	MySQL, MongoDB	Apache License	16.05.2017
Magento	PHP	MySQL	OSL Ver. 3 / AFL Ver. 3	27.06.2018
Mambo	PHP	MySQL	GPL	01.06.2008
MediaWiki	PHP	MySQL, MariaDB, PostgreSQL, SQLite, MSSQL	GPL	20.09.2018
MiaCMS	PHP	MySQL	GPL	29.07.2009
Microweber	PHP	MySQL, PostgreSQL, SQLite	Apache License	10.04.2018
Midgard CMS	PHP (Midgard framework)	MySQL	LGPL	26.09.2012
MODX	PHP	MySQL	GPL	11.07.2018

Name	Platform	Supported databases	Licenses	Latest release date
Novius OS	PHP	MySQL	AGPLv3	08.07.2014
Nucleus CMS	PHP	MySQL	GPL	14.03.2011
OctoberCMS	PHP	MySQL, PostgreSQL, SQLite	MIT	25.09.2018
OpenCart	PHP	MySQL	GNU	18.07.2017
Omeka	PHP	MySQL	GPL	31.01.2017
papaya CMS	PHP	MySQL, PostgreSQL, SQLite	GPL v2	12.02.2013
pH7CMS	PHP	MySQL, MariaDB	GPL 3.0	25.05.2018
Phire CMS	PHP	MySQL	New BSD License	07.07.2016
PHP-Nuke	PHP	MySQL	GPL	30.01.2014
phpWebLog	PHP	MySQL	GPL	31.10.2001
phpWiki	PHP	MySQL	GPL	11.12.2015
Pimcore	PHP	MySQL	GPL	02.01.2018
PivotX	PHP	MySQL, Flat-file database	GPL	21.06.2015
Pixie (CMS)	PHP	MySQL	GPL	21.03.2010
PmWiki	PHP	Flat-file database SQLite	GPL	09.07.2018
Prestashop	PHP	MySQL	Open Software License 3.0	26.10.2016
ProcessWire	PHP	MySQL	Mozilla Public License 2.0	06.04.2018
SMW+	PHP - Media Wiki	MySQL	GPL	24.04.2012
Serendipity	PHP + Smarty	MySQL, PostgreSQL, MySQLi, SQLite	BSD	26.09.2016
SilverStripe	PHP	MySQL, Microsoft SQL Server, PostgreSQL, SQLite, Oracle	BSD	31.07.2018
SPIP	PHP	MySQL, PostgreSQL, SQLite	LGPL	16.03.2018
Textpattern	PHP	MySQL	GPL	21.10.2016
Tiki Wiki CMS Groupware	PHP	MySQL	LGPL	29.01.2018
TYPO3	PHP	MySQL, Oracle, PostgreSQL	GPL	02.10.2018
WordPress	PHP	MySQL, MariaDB	GPL	02.08.2018
Xaraya	PHP	MySQL, PostgreSQL	GPL	23.02.2013
XOOPS	PHP	MySQL	GPL	01.08.2018

7. Classification of remarkable Software as a service (SaaS) CMS

The list below classifies **free** but **proprietary** CMS offered as a complex SaaS solution with included cms software package, web hosting and technical support.

Name	Licensed version available	Last stable version	Web content management	Group content management	Enterprise content management
Adobe Business Catalyst		26.03.2021 V4 End Of Life	Yes	Yes	Yes
Alfresco Cloud	(Alfresco Community &	01.05.2012	No	Yes	Yes
Cloud CMS	Yes	03.02.2003	Yes	Yes	Yes
Crafter CMS Cloud	(Crafter CMS Enterprise)	01.08.2017	Yes	Yes	No
censhare	Yes	01.02.2017	Yes	Yes	Yes
Clickability (Limelight Networks)	No		Yes	No	No
Content SORT	Yes	01.11.2013	Yes	Yes	Yes
dotCMS Cloud[92]	Yes	5.0.2	Yes	Yes	Yes
Frontis Archive Publishing System	Yes	V3.12.01.11	Yes	Yes	Yes
Huddle	Yes	2012	Yes	Yes	Yes
Microsoft Office 365	SharePoint, MS Lync, MS	2013	Yes	Yes	Yes
nuBuilder	No	01.12.2017	Yes	Yes	Yes
O3Spaces	Yes	03.02.2001	Yes	Yes	No
OU Campus	Yes	10.02.2004	Yes	Yes	
Polopoly Web CMS		10.2	Yes	Yes	No
Quintype	Yes	1	Yes	Yes	Yes
uCoz			Yes	Yes	No
Windows Live	No	2011	No	Yes	No
XaitPorter	Yes	04.09.2006	No	No	Yes
Zesty.io	Yes (Multi-Tenant SaaS)	Versionless	Yes	Yes	Yes

8. Classification of remarkable proprietary CMS

The list below classifies **freeware** but **proprietary** CMS intended for **installation and managing on own web server**.

Name	Platform	Supported databases	Licenses	Latest release date	Web content management	Group web content management	Enterprise content management
Adobe Experience Manager (formerly Day CQ5)	Java	JCR (Apache Jackrabbit Oak), MongoDB	Proprietary software	01.01.2018	**Yes**	**Yes**	**Yes**
Altitude3.Net	ASP.NET	SQL Server	Proprietary software	14.07.2015	**Yes**	**Yes**	**Yes**
censhare	Java	Oracle	Proprietary software	12.05.2017	**Yes**	**Yes**	**Yes**
Contentverse	Java	Oracle, SQL Server	Proprietary software	2014	**Yes**	**Yes**	**Yes**
Contegro	ASP.NET	SQL Server	Proprietary software	17.11.2010	**Yes**	**Yes**	**No**
CoreMedia WCM	Java	JDBC-compliant databases		19.03.2015	**Yes**	**No**	**Yes**
DocLogix	ASP.NET	SQL Server	Proprietary software	15.12.2015	**No**	**No**	**Yes**
dotCMS	Java	Oracle, SQL Server, MySQL, PostgreSQL	Proprietary software	09.11.2018	**Yes**	**Yes**	**Yes**
Ektron CMS	ASP.NET	SQL Server	Proprietary software	09.12.2016	**Yes**	**Yes**	**Yes**
Elcom CMS	ASP.NET	SQL Server	Proprietary software	15.02.2011	**Yes**	**Yes**	**Yes**
OpenText Documentum	Java	Oracle, SQL Server, DB2	Proprietary software	01.05.2018	**No**	**No**	**Yes**
Episerver CMS	ASP.NET	SQL Server	Proprietary software	16.01.2017	**Yes**	**Yes**	**Yes**
ExpressionEngine	PHP	MySQL	Proprietary software	02.10.2018	**Yes**	**No**	**Yes**

Name	Platform	Supported databases	Licenses	Latest release date	Web content management	Group web content management	Enterprise content management
Hyland OnBase ECM	.NET	SQL Server, Oracle			**Yes**	**Yes**	**Yes**
IBM Enterprise Content Management	Java	Oracle, DB 2	Proprietary software	2013	**Yes**	**Yes**	**Yes**
OpenText Teamsite	Java, .Net, XML, XSLT	Oracle, SQL Server, DB2, MySQL	Proprietary software	01.04.2017	**Yes**	**Yes**	**Yes**
Jadu	PHP	MySQL, SQL Server	Proprietary software		**Yes**	**Yes**	**No**
Jahia Enterprise Distribution	Java	MySQL, Oracle, PostgreSQL, Microsoft SQL Server	Proprietary software	20.12.2013	**Yes**	**Yes**	**Yes**
Kentico CMS	ASP.NET	SQL Server	Proprietary software	30.10.2016	**Yes**	**Yes**	**Yes**
Movable Type	Perl	MySQL, Oracle, SQL Server	Proprietary	29.05.2018	**Yes**	**Yes**	**Yes**
XaitPorter (local license)	PHP	Oracle	Proprietary software	01.04.2013	**No**	**No**	**Yes**
Oracle WebCenter Content	Java	Oracle			**Yes**	**Yes**	**Yes**
(formerly Universal Content Management)							
OU Campus	Java	MySQL, Microsoft SQL Server, SAP Sybase ASE	Proprietary software	24.06.2015	**Yes**	**Yes**	**Yes**
Pulse CMS	PHP	Flat-file database		11.04.2018	**Yes**	**No**	**No**
Microsoft SharePoint	ASP.NET	SQL Server (2005, 2008 or 2012), SQL Express	Proprietary, Open API	04.05.2016	**Yes**	**Yes**	**Yes**
Sitecore	ASP.NET (Webforms or MVC)	SQL Server (2005, 2008, 2012), Oracle	Proprietary software	01.08.2017	**Yes**	**Yes**	**Yes**
Telligent Community	ASP.NET	SQL Server		26.06.2009	**Yes**	**Yes**	**No**
TerminalFour (SiteManager)	Java	MySQL, Oracle, SQL Server	Proprietary	24.06.2017	**Yes**	**Yes**	**Yes**

9. Classification of most popular free open-source CMS according to their primary usage – author view

The list below classifies only popular **free open-source** CMS according to their most common application for providing different type of services.

Blogs	Serendipity	WordPress	eggBlog
	open Blog	Nucleus CMS	Pixie
	b2evolution	Dotclear	PivotX
	LifeType	Textpattern	Chyrp
Micro Blogs	StatusNet	Sharetronix	
	PageCookery	Storytlr	
Portals/CMS	Zikula	Concrete5	Mahara
	Xoops	phpwcms	Tribiq
	ocPortal	CMS Made Simple	ImpressCMS
	Joomla 2.5/Joomla 3.1	Contao	Typo3
	Website Baker	SilverStripe	Quick.cms
	sNews	PyroCMS	ImpressPages
	Geeklog	Redaxscript	Pluck
	Drupal 7/Drupal 8	PHP-fusion	BIGACE
	Mambo	Silex	Subrion
	PHP-nuke	Saurus	Monstra
	Pligg	jCore	Tiki Wiki CMS GroupWare
	MODx	Fork	
	e107		
Forums	phpBB	Phorum	bbPress
	AEF	PunBB	Vanilla
	XMB	SMF	FUDforum
	MyBB	FluxBB	miniBB
Image Galleries	Gallery	Piwigo	phpAlbum
	Coppermine	Pixelpost	4images
	TinyWebGallery	ZenPhoto	Plogger

Wikis	DokuWiki	PmWiki	
	MediaWiki	WikkaWiki	
Social Networking	Dolphin	Beatz	
	Elgg	Etano	
	Jcow	PeoplePods	
	Oxwall		

Ad Management	Noahs Classifieds	GPixPixel	
	OpenX	OSClass	
	OpenClassifieds		
Calenders	WebCalendar	phpScheduleIt	
	phpicalendar	ExtCalendar	
Gaming	BlackNova Traders	Word Search Puzzle	
	Shadows Rising	MultiPlayer Checkers	
Mails	phplist		Webmail Lite
	Websinsta maillist		OpenNewsletter
	SquirrelMail		
	ccMail		
	RoundCube		
Polls and Surveys	LimeSurvey	LittlePoll	Piwik
	phpESP	Simple PHP Poll	Open Web Analytics
	CJ Dynamic Poll	Aardvark Topsites	Logaholic
	EasyPoll	Advanced Poll	

Project Management	dotProject	Feng Office	Traq
	phpCollab	eyeOSh	Collabtive
	PHProjekt	The Bug Genie	Eventum
	ProjectPier	TaskFreak	FlySpray
	Mantis Bug tracker	Mound	

E-commerce	Zen Cart	WHMCS	Quick.cart
	Magento	Open Source Point of SaleTheHostingTool	Axis
	osCommerce	TomatoCart	Zuescart
	OpenCart	Avactis	AlegroCart
	Prestashop	phpCOIN	BoxBilling
	CubeCart		AbanteCart
ERP	SugarCRM	Dolibarr	Tine
	OrangeHRM	Vtiger	EGroupware
	FrontAccounting	SimpleInvoices	EPESI

Guest Books	phpBook	Lazarus	PHPkode Guestbook
	BellaBook	RicarGBook	
	VX Guestbook	Advanced Guestbook	
Customer Support	Crafty Syntax	ExoPHPDesk	iQDesk
	Help Center Live	Open Web Messenger	Trellis Desk
	HESK	phpOnline	Maian Support
	osTicket	phpMyFAQ	Support Incident Tracker
Frameworks	CodeIgniter	CakePHP	WideImage
	PHPDevShell	Kohana	HTML Purifier
	PRADO	Smarty	
	DIY	Symfony	

Educational	Moodle	TCExam	Chamilo
	Claroline	DoceboLMS	eFront
	ATutor	Omeka	
DB Tools	PhpMyAdmin	Vty	Chive
	Adminer	MyWebSQL	RockMongo
	SQLiteManager	SIDU	
RSS	Gregarius	Feed On Feeds	
	SimplePie	selfoss	
File Management	PHPfileNavigator	LetoDMS	ownCloud
	OpenDocMan	Arfooo	eSyndiCat
	ProjectSend	eXtplorer	
Others	phpLD	Hablator	Question2Answer
	WeBid	PHPWeby	JoobsBox
	PhpGedView	PASTE	Codiad

	phpFormGenerator	Open journal Systems	ArticleSetup
	YOURLS	OpenBiblio	GLPI
	phpFreeChat	Seo Panel	SVNManager
	PHP QR Code	SPIP	
	Form Tools	jobberBase	Open Conference Systems
	phpDocumentor		

10. Conclusion

The paper clearly shows several different classifications of all remarkable CMS based on different criteria: on what platform and programming language are they based, are they open source or proprietary, are they paid or free, whether they can be installed on own web server of the client or are available as SaaS / Cloud service. An author's classification of the CMS is presented according to their main and most common application in practice. These classifications can be very useful for a much faster and easier orientation when choosing CMS by users, and can also serve as a quick reference in the field of research related to appliance of CMS. CMS have a large distribution and application in modern Internet. CMS can be used for building various kinds of dynamic websites, online stores, web portals, web catalogs, web applications and more. Also, CMS can be used for performing of wide range of tasks within different type of organizations. For these reasons, CMS application is a promising area for future research.

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Methods of Providing Self-service Opportunities in Business Intelligence Systems

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Abstract. The paper reviews three methods of providing self-service opportunities in business intelligence systems. Corporate users can make dashboards using describing data (dimensions) that are discovered before they need them to solve problem or looking for new opportunities about expanding. These three methods use structural, data and combined profiling and show easy way to see needed information for analysis.

Keywords. self-service BI, Business intelligence systems, Structural profiling, Data profiling

1. Introduction

Over the last few years, business has paid great attention to the opportunities that business intelligence systems provide it with. They allowed to solve problems, to seek competitive advantages, or simply to monitor business processes that are being implemented.

Business intelligence systems are a powerful tool that requires robust technical training, as it combines both knowledge of the data and knowledge of their visualization. Initially, this activity was carried out by IT analysts. Ove time, it has been found that there are two main disadvantages:

- **time lag** – to provide the necessary data for analysis, it takes technological time, as it follows a requesting process -> processing data (adding new if missing in the warehouse) -> providing the result. Often the result does not coincide with the expectations of the end users, so a requirement is born – that the user of the result should also be his creator;
- Accumulation with many tasks – since the creation of data for analysis is a time-consuming process, this means that is it is performed by an IT department in the organization, employees ate lagging behind in other operational tasks. From this point of view, IT professionals ask the issue of getting rid of this type of task, so they can concentrate on their more pressing obligations.

This has resulted in ан intersection point between IT professionals and end users – a new technology is needed to give more power to create the necessary data for analysis. The goal is to optimize processes and maximize efficiency. This new concept is called "self-service business intelligence".

After years of attempts to fully implement technology in a real environment, it has been determined that enormous knowledge and preparation is required to cover the data processing and visualization processes. Therefore, emphasis was placed on the data visualization itself, not its preparation. In addition, it is much easier to visualize data with pre-released tools when there are already clean and ready-to-analyze data.

The understanding of self-service business intelligence is divided into traditional and advanced i.e. the visualization of the data and the overall scope of the business intelligence

process. Still, it can be said that traditional understanding is by no means a rejection, because by means of pre-created and provided methods, data processing would not be complicated, and so familiar end users can not cope with the so-called "complex task of analysis". Thus, the subject of this work is to examine three methods that would bring users to build their analysis of analysis data into more advanced self-service business intelligence.

2. Main components of self-service business intelligence systems

Self-service business intelligence systems have several key components that distinguish them from operating information systems. They are:

- **data processing (ETL – extract, transform, load)** – self-service business intelligence systems, like business intelligence systems, use operational data that daily serve the processes in the organization. However, the data is not always suitable for visualization and almost always requires processing that is known as an ETL process i.e. data is retrieved from operating sources, processed, and loaded int a pre-created data warehouse structure.
- **data warehouse** – the data store they are the other main component in the architecture of self-service business intelligence systems. It stores quantitive (fact) and qualitive values (dimensions) i.e. numerical and descriptive data. Mathematical and logical processing at the visualization level can be applied to the former, while the latter translate the resulting result into understandable language.
- **data visualization** – this is an essential element in the traditional understanding of self-service business intelligence systems. With available tools, existing data should be presented in the appropriate form.

Numeric values in the data warehouse are not difficult to recognize, but quality values can not always be recognized and used. Often, the latter are represented as different types of data, i.e. text value is not always used. Therefore, end users who do not have the technical knowledge of working with data would have difficulty in preparing them.

3. Methods of providing self-service opportunities in business intelligence systems

Methods that would help processing data for self-service business intelligence systems can be considered from the point of view of data profiling, which can be by analysis:

- the structure of the data;
- the data itself;
- combined profiling.

Before moving on the essence of the methods, it is worthwhile to note that each of them is dealt with in a predetermined sequence:

- definition;
- algorithm;
- example realization.

a. Method for identifying dimensions by analyzing the data structure

i. Definition

It is most often possible to determine whether there are descriptive data when considering the data structure and whether there is any link between two or more tables at the operational level. When there is a connection between two tables and one contains nomenclature data, it is certainly a sign of the existence of quality measures.

Another is the time when there is a connection between more than two tables and several of them contain nomenclature data i.e. potential data warehouse level dimension. These links in most cases represent a sign of an existing hierarchical sequence.

Naturally, in order to establish these relationships, it is necessary to store quantitive values in one of the tables, numerical values. In this way, dependencies can be transformed at the data warehouse level after not very complicated processing.

In this description, it can be said that the method for identifying dimensions by analyzing the data structure is *"Analysis of the existing relations and dependencies between two or more tables, one of which must contain numerical values and in the other, there are nomenclature values."*

ii. Algorithm

To determine if quality data is available, it is necessary to proceed through the following basic steps:

- selecting the table of numeric values (facts);
- Does it contain a primary key? If yes, it can continue to look at the attribute and can also be directly used in the data store, if not – it can continue to review the attributes of the table with the condition that at the data warehouse level, one must be generated;
- containing at least one external key to a table in which different non-numeric values are stored, nomenclature data.

iii. Example realization

The algorithm can be presented using a sequence of SQL queries that have the following appearance:

```
SELECT * FROM [Name of the table with fact values]
```

This syntax allows to the end user choosing table with numeric values.

```
USE [Name of the database]
SELECT COLUMN_NAME
FROM INFORMATION_SCHEMA.KEY_COLUMN_USAGE
WHERE    OBJECTPROPERTY(OBJECT_ID(CONSTRAINT_SCHEMA    +    '.'    +
CONSTRAINT_NAME), 'IsPrimaryKey') = 1
AND TABLE_NAME = 'Name of the table with fact values'
```

This syntax selects primary key name if the table contains one.

```
USE [Name of the database]
SELECT
o2.name AS from_table,
c2.name AS PK_column,
c1.name AS FK_column,
fk.name AS FK_name
FROM sys.objects o1
INNER JOIN sys.foreign_keys fk
ON o1.object_id = fk.parent_object_id
INNER JOIN sys.foreign_key_columns fkc
ON fk.object_id = fkc.constraint_object_id
INNER JOIN sys.columns c1
ON fkc.parent_object_id = c1.object_id
AND fkc.parent_column_id = c1.column_id
INNER JOIN sys.columns c2
```

```
ON fkc.referenced_object_id = c2.object_id
AND fkc.referenced_column_id = c2.column_id
INNER JOIN sys.objects o2
ON fk.referenced_object_id = o2.object_id
INNER JOIN sys.key_constraints pk
ON fk.referenced_object_id = pk.parent_object_id
AND fk.key_index_id = pk.unique_index_id
where o1.name = 'Name of the table with fact values'
ORDER BY o2.name,o1.name, fkc.constraint_column_id
```

This syntax shows names of foreign keys if the tables contains them.

All these results can be organized in an application, for example developed using C# language. To the combination of the received results can be added message that indicate which table is selected, which is its primary key, which are the foreign keys in it and in which tables they are primary keys.

An example preview of all these queries can be as follows (Fig.1.).

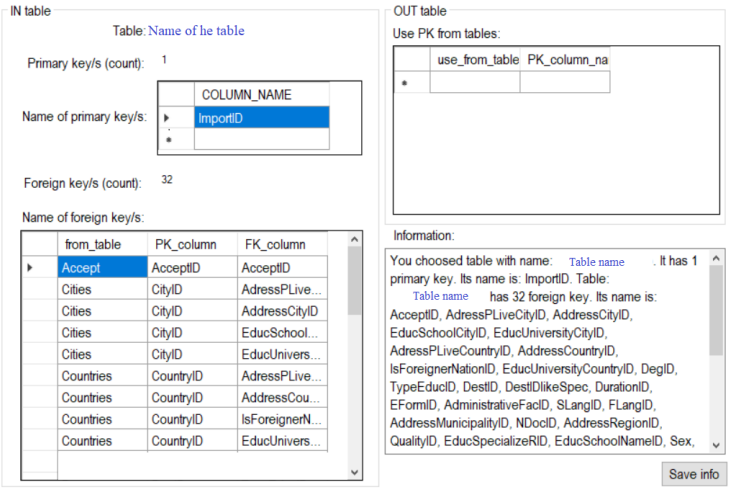

Fig. 1. Example programming realization method one

As can be seen from the figure, a table can be created in the data store to store the whole process by filtering and locating primary and foreign keys for a table in the form of the generated message. This type of functionality can help at a later stage i.e. do not always go through a review of the same table. When it is determined that a review has been taken, another data able must be addressed.

In addition to the number of external keys, their name can be displayed on the screen and in which table they are used. Anything else that can be added is a feature that displays on the screen how many times the primary key of the current table is used in other tables. It may be that the selected numeral table is a table in which descriptive data (dimensions) are stored.

Such a review of the data structure helps in reviewing them if there is deeper knowledge in the field. It can be used by end users without being familiar with the SQL and C# languages. It is possible to add functionality that automatically creates dimensions without requiring preliminary business intelligence experience and thus to generate data to be used for visualization and analysis.

b. **Method for identifying dimensions by analyzing the data**

i. Definition

Data analysis includes a review of the values contained in each table at the operational information system level. Like the index selectivity principle, a metric called "selectivity" is created here. It is a combination of three components:

- whether the selected attribute is a primary key;
- what degree of fill exist in the attribute;
- a selective index that is calculated by matching the number of unique records from a selected attribute to all records in the current table. The smaller the value obtained, the more selective the current attribute is.

Three levels for a selective index are determined, which are as follows:

- highly selective attribute – can be offered for dimension (0-35% fill);
- medium selective attribute – can be offered for interval spacing (36-64% fill);
- low selective attribute – not available for dimension (over 65% fill).

The following text can be used as a definition of the current method:

"Analyzing data that is done by using an indicator called "selectivity" and is a combination of fill rate, is there a primary key in the current table and what is the value of selective index."

ii. Algorithm

It goes through the following sequence of steps:

- Selects an attribute from a table;
- Features are displayed as follows:
  - the type of data stored in the selected column;
  - if they are text or character sequences – how many symbols they contain;
  - what language is stored (collation);
  - total number of records;
  - zero values – total number;
  - percentage of zero values for all;
  - number of null values;
  - percentage of empty values for all stored in the attribute;
  - number of unique values for the attribute;
  - in tabular form – which are and what their percentage is relative to all the values in the table;
- Determining the selectivity of the attribute by identifying:
  - is the primary key in the selected table;
  - degree of filling;
  - selective index – percentage value.

iii. Example realization

First, it is necessary to select a specific attribute, which is possible by request:

```
USE [Name of the database]
SELECT COLUMN_NAME, COLUMN_NAME as ID FROM [Name of the database].INFORMATION_SCHEMA.COLUMNS
WHERE TABLE_NAME = 'Name of the table'
ORDER by COLUMN_NAME
```

Retrieving the features listed in the algorithm:

```
USE [Name of the database]
```

```
SELECT DATA_TYPE, CHARACTER_MAXIMUM_LENGTH, COLLATION_NAME
FROM INFORMATION_SCHEMA.COLUMNS
WHERE TABLE_NAME = '[Name of the table]' AND
COLUMN_NAME = '[Name of the column]'
select count(*) as TotalV from [Name of the table]
select count(*) as NullV from [Name of the table] where [Name of
the column] is null
select count(*) as EmptyV from [Name of the column] where [Name of
the column] like '' or [Name of the column] like ' '
select count(distinct([Name of the column])) as DistinctV from [Name
of the table]
select distinct([Name of the column]), count(*) as values_count from
[Name of the table] group by [Name of the column]  order by
values_count desc
```

Determining the selectivity of an attribute:

```
USE [Name of the database]
select cast (count(distinct([Name of the column])) * 100.0 / (Select
Count(*) From [Name of the table]) as decimal(5,2)) as Selectivity
from [Name of the table] where [Name of the column]  is not null
select cast (count([Name of the column])*100.0 / (Select Count(*)
From [Name of the table]) as decimal(5,2)) as DegreeOfFilling
from [Name of the table] where [Name of the column] is not null
select s.name as schemaname, t.name as tablename, c.name as
columnname, ic.index_column_id as keycolumnnumber
from sys.index_columns ic
inner join sys.columns c on ic.object_id = c.object_id and
ic.column_id = c.column_id
inner join sys.indexes i on ic.object_id = i.object_id and
ic.index_id = i.index_id
inner join sys.tables t on i.object_id = t.object_id
inner join sys.schemas s on t.schema_id = s.schema_id
where c.name = '[Name of the column]' and i.is_primary_key = 1 and
t.name like '[Name of the table]'
```

An example preview of all these queries can be as follows (Fig. 2).

Like the previous method, it may have created a message to inform the end user about the result that is achieved by the chosen attribute selection.

In the "Column selectivity text" field, the final suggestion is given if a dimension attribute can be offered or not. The specific here is that the result as a message is a combination of the three main elements of selectivity indicator, not just the selectivity index.

Additionally, for convenience – a able can be created in which to store the result of the "Information field. The goal is – if an attribute has already been reviewed, attention should not be drawn to it, but rather to continue with other attributes that have not been seen so far.

c. **Method for identifying dimension through data analysis and their structure (combined)**

This method is a combination of the previous two. It serves to establish dimensions when, for example, it is not possible to give a clear idea in the analysis of the data structure. Then the data itself is considered. Conversely, when the data are not very spoken, it examines what relationships and dependencies exist between the structures in which they are stored (if

such structures exist). Because the same SQL queries are used, the method will not be described in sequence: definition, algorithm and example realization.

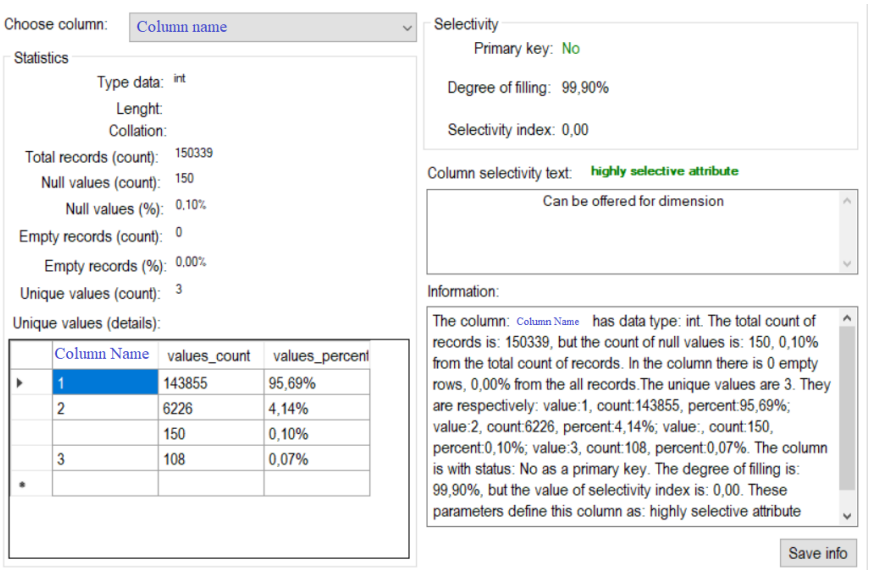

Fig. 2. Example programming realization method two

4. Limits

As we have seen from the presented methods, they apply to structured data i.e. to be stored in relational data sources. Data in the form of images, files, videos etc. are not processed by these methods because they do not have the same structure as relational databases. If they are structured / described in a database, then these methods can fit into an application.

It should be noted that at this stage there is another limitation – the personal judgment of the creator of the methods. But this is no way means that they can not develop in terms of the features they contain.

5. Conclusion

It is important to note that often end users of the self-service business intelligence systems are limited in terms of data handling. However, it is a positive fact that in the presence of performed methods, working with data does not seem so complicated. On the contrary, through such "tools", they can reach the expanded understanding of self-service business intelligence.

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