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Backgrounds of Aggregated Assessment of SMEs Competitive Advantage Determinants

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Abstract **- The study deals with the aggregated assessment of SMEs competitive advantage determinants in selected countries based on multiple criteria assessment methodology, in particular, Simple Additive Weighting (SAW), Complex Proportional Assessment (COPRAS) methods (applied on the basis of constructed models). At the first stage, it includes the identification and expert examination, also quantifiable assessment of essential primary determinants and their significance parameters. At second stage, the establishment of the global SMEs competitive advantage index was performed; the integrated evaluation system may include several scenarios by formation of determinant complex. Some evaluation results in 2011/2012 for Baltic countries (Lithuania as typical case) in transition stage are presented in the paper. The global index estimation was performed on basis of composed determinant complex using the SAW method; the parameters of determinant significance were defined by expert way.**

Keywords **- entrepreneurship competitive advantage, competitiveness indicators, multiple criteria evaluation, expert examination, Simple Additive Weighting method.**

1. Introduction

The development of entrepreneurship in the newly EU countries, also state economic competitiveness, is an important priority of economic growth in general. The entrepreneurship strategy must be taken into account the expected new competitive advantage-oriented changes and effective determinants of growing competitiveness. Simultaneously the investigation of interconnections of country's economic development and entrepreneurship competitive advantage is relevant; especially important is to consider their impact on the strategic decisions. The approach to above processes may be defined as an important object of scientific research.

The entrepreneurship has been recognized as a major transferring channel for sustainable products and processes, and new ventures are being held up as a mean for solving of many social and environmental troubles. The so-called pillars of global country's competitiveness index according to the World Economic Forum (WEF) [7] include significant primary and integral economic competitiveness indicators determining in particular the level of entrepreneurship development. It is insufficient to propose the comparison of these indicators; therefore a part of them reflects the entrepreneurship advantage/disadvantage.

The separate significant factors (goods or services, competitiveness, marketing strategy, diversification, innovations, production and export of high-tech goods, corporate social responsibility, etc.) mostly influencing the firm working effectiveness are analyzed. Therefore, it is important to identify and evaluate the influence of clusterization level on the competitiveness in the modern service-based economies. It must be emphasized that clusters, depending on the phase of their growth and development, exercise the increasing influence over the business organizations, as well as their competitive abilities. In recent years, the considerable debates on the role of marketing in competitive strategy were continuing. The researches contribute to strategic marketing theory and practice by developing, refining and validating the measures of entrepreneurship, marketing capabilities, organizational innovation and sustainable competitive advantage (SCA) constructs. Some papers were oriented to a study of the marketing capabilities role in innovation-based competitive strategy, also to the establishment and accumulation of dominant advantages, appliance of their totality [1], [3], [4], [8], [12], [13], [14], [18].

The purpose of the article below is to motivate the understanding both of competitive advantage and strategic marketing, to define their applicability for theory building and testing in the process of strategic management with account of the value priorities. The effective marketing strategy have to increase the efficiency of business value added creation, its downstream and upstream sources and, coherently, determine a wide spectrum of the factors to be analyzed and adequate methodological potential. Besides, there are only few researches dedicated to the complex evaluation of those essential advantages of entrepreneurship especially in the newly EU countries and to their assessment

revealing the priority aspects of the functioning of state institutions, business entities, also associative structures. It is importantly to integrate the small business group formation and concept of SCA as implementing the value-creating and resource-based management strategy not simultaneously duplicating its benefits [11].

This study deals with the comparative analysis of economic competitiveness indicators in Baltic States on basis of the WEF data and with the examination as well as complex (aggregated) evaluation of the SMEs competitive advantages in Lithuania applying the multiple criteria evaluation methods.

The research results consist in the constructing of complex assessment concept for the entrepreneurship competitive advantages by applying the multiple criteria assessment methods, their application for decision making also in the case evaluation. It is applicable first of all for countries - newly EU members in various possible conditions and solutions. The viability of the presented evaluation system is determined by the fact that this quantitative evaluation technique may be applied for determining the acceptance of main parameters of country entrepreneurship development strategy.

2. Selected Economic Competitiveness Indicators: Analysis of the Baltic Countries

The comparative ranking of selected economic competitiveness indicators for Baltic countries with different economic development level (Tables 1 and 2) shown both specific differences in their development and socioeconomic orientation. The so-called pillars of global country's competitiveness index according to the WEF were analyzed and those including the most significant primary and integral economic competitiveness indicators reflecting the entrepreneurship advantages were revealed in detail. The specific differences may be seen if to compare about all competitive indicators of Baltic countries selected by WEF experts, esp. some productivity factors (such as firm level technology absorption). The distance between some indicators specific for Baltic countries and Scandinavian countries amounts even 97 places for state of cluster development (between Sweden and Lithuania), 87 – for firm level technology absorption and intensity of local competition, 79 - for value chain breath (all between Sweden and Latvia), 69 – for extent of market dominance & sophistication (between Norway and Lithuania). The differences between countries are much less in the case of capacity for innovation (54 places) and reverse in case of pay and productivity in behaviour of Baltic States (75 places between Estonia and Sweden). All the mentioned differences are much narrow if to compare the expert evaluations expressed in weighed average indices.

Selected primary macro indicators included into the global country's competitiveness index pillars*	Lithuania		Latvia		Estonia	
	Rank	Score	Rank	Score	Rank	Score
Government debt	46	29.3	63	36.1	5	7.2
Government budget balance	124	-8.9	125	-8.9	29	-1.7
Burden of government regulation	115	22.7	88	3.1	7	4.4
Prevalence of trade barriers	64	4.7	29	5.2	14	5.6
National savings rate	93	15.9	25	30.2	47	24.1
Country credit rating	64	52.7	80	45.1	56	57.1
Interest rate spread	13	1.9	101	8.2	51	4,6
Ease of access to loans	112	2.2	125	2	50	3
Total tax rate	75	42.7	44	33	98	49.4
Extent and effect of taxation	126	2.7	117	2.9	18	4.3
Availability of financial services /	74	4.5	86	4.3	43	5.1

financial market sophistication						
Soundness of banks	87	4.8	127	3.9	72	5.2
FDI and technology transfer	105	2.9	103	2.9	92	3.1
Prevalence of foreign ownership	99	4.5	63	4.9	48	5.1
Extent of market dominance	45	4.5	69	4.1	61	4.3

Composed by the authors using WEF data [7]. *Rank between 134 states, score for non-dimensional indicators determined by WEF experts: 1- the worst; 7 points – the best possible. Other indicators are taken by their dimension or as % of GDP.

Table 1. The comparative ranking data of economic competitiveness of Baltic States in 2010/11 by selected macroeconomic indicators

The comparison of competitiveness indicators shows some substantial differences of competitiveness indicators: for government debt adequately Lithuania - 46, Latvia 63 and Estonia - 5 places. Extent and effect of taxation also differs Estonia from other comparative states as having benevolent liberal influence on economic competitiveness: its distance from the Scandinavian countries ranks under review amounts up to 100 and more places.

Determinants of competitiveness indicators	Lithuania	Estonia	Latvia
Capacity for innovation	48/3.3	34/3.6	57/3.1
Extent of market dominance & sophistication	97/3.3	38/4.2	70/3.7
Value chain breath	34/4.2	58/3.7	82/3.3
Firm level technology absorption	56/5	42/5.3	89/4.5
Production process sophistication	51/4	41/4.3	72/3.5
Intensity of local competition	78/4.7	31/5.4	92/4.6
State of cluster development	105/2.9	92/3.1	103/2.9
Pay and productivity	18/4.7	8/5.0	42/4.3

* Place in the world and weighed average. Selected by the authors from: WEF, [7], tables 6.01, 6.02, 7.06, 9.02, 11.03, 11.05, 11.07, 12.01 a/o. Weighted average is indexed from 1(lower evaluation) to 7 (highest evaluation).

Table 2. The comparative ranking by WEF entrepreneurship competitiveness indicators: Baltic Countries in 2010/2011*

The main differences between comparable indicators of all Baltic States are clearly interconnected with differences in their macroeconomic situation especially last years and specific of previous development, but not directly with their ability to innovations (the differences in last case amount only 23 places). So, the differences between levels of local competition intensity amounts 61 place (between Estonia and Latvia), the value chain breath evaluations (between Lithuania and Latvia) differ at 48 places and 47 places – in firm level technology absorption (difference between Estonia and Latvia). Between all selected countries, Estonia overruns all sample states by pay and productivity what shows mostly the backlog between growth of the productivity and remuneration specific for newly EU countries.

It is most important to formulate the complex assessment backgrounds by approach to evaluation of the comparable indicators totality and their differences as an indivisible system.

3. The complex assessment of competitive advantages: Main principles

The entrepreneurship of in the knowledge-oriented economy may be characterized by such essential features as its social responsibility, progressiveness, value added creation, formation & using of intellectual capital, competitiveness, ecologic sustainability and social responsibility. The principal approach to the complex evaluation of the country's entrepreneurship competitive advantages lies in formalization of the system of multitude of primary determinants determining the combined quantitative and qualitative dimensions.

The knowledge economy principles influence the modernization of entrepreneurship and its characteristics, such as progressiveness, knowledge generation and usage, innovativeness, competitiveness, dynamism and business benefits creating social value [10] a/o. The development of intellectual capital becomes especially important factor of the innovativeness of enterprises: such factors as applied innovations and investments into patents, new management solutions and similar have to be taken into account. Enterprises in Lithuania with innovative activity and the results showing their innovative actions are about at medium level between the EU countries; sometimes their significances are above the average. Besides, the corporate social responsibility (CSR) in the entrepreneurship strategy is revealed as a benefit of high priority. The globalization of the markets, as we concluded, requires of the management systems development quickly reacting to the changing situation in Lithuania.

The formation of the integrated enterprise competitive strategy, first of all under the conditions of oligopoly market, is determining its strategic position and influencing performance, as it was stressed by R. Ginevicius a/o [5], [6]. Those, the complex assessment of estimated impact of partial competitive strategies on the integrated enterprise performance criterion is suggested when applying the multiple criteria evaluation methods. The results of empirical application of the model are proposed to be employed to set up the long-term goals and the main directions of business strategy of an enterprise, to distribute the financial, human and other resources for strategic actions to be designed and implemented.

The authors provided a theoretical framework, first-of-all, for the solving of the problem to be defined on basis of the complex evaluation criteria and determined by a totality of primary competitive advantage determinants to be adapted for newly EU countries. The application of this principal concept required of choosing the evaluation method with account of the different significance of those particular determinants in general dimension. For describing the investigated approach, it is necessary to evaluate the direct and indirect influence of primary determinants. Therefore, an all-round (general matrix) expression of the total competitive advantages' vector $\{A^{(M)}\}$ can like as follows:

$$\{A^{(M)}\} = \begin{bmatrix} g_{11} & g_{12} & \cdots & g_{1n} \\ g_{21} & g_{22} & \cdots & g_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ g_{n1} & g_{n2} & \cdots & g_{nn} \end{bmatrix} \begin{bmatrix} \{A_1\} \\ \{A_2\} \\ \cdots \\ \{A_n\} \end{bmatrix}, \qquad (1)$$

where g_{11}, g_{12}, ..., g_{nn} - the weights of the direct and indirect influence of identified determinants (vectors $\{A_1\}$, $\{A_2\}$, ..., $\{A_n\}$) (constituted matrix of the significance parameters) determining a descriptive vector $\{A^{(M)}\}$; n- number of identified primary determinants.

Undoubtedly, the applicability of this model is linked with transformation according to the applicable evaluation method taking into account the identified determinants in a specific situation.

The main assessment principles we developed based on an integral approach to country's business competitive advantages as well as to entrepreneurship development level depending from many parameters and characteristics, and determined by multitude of determinants assigned to assessment of analogous social processes [19], [20]. Moreover, the provided quantitative assessment methodology (by applying the reasoned multiple criteria evaluation methods on the basis of adopted models) is oriented on the different influence of primary determinants (compatible with qualitative – SWOT - analysis also scenario method) as useful methodical tool is concerned by the theoretical background adaptation.

On the basis of conceptual solutions for the quantitative assessment of analogous integral development dimensions that are widely developed by the authors, as were indicated, it is purposeful to tackle a problem. First and foremost multiple criteria evaluation methods are suitable in essence by nature of raised tasks, actually SAW (Simple Additive Weighting), COPRAS (Complex Proportional Assessment) and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) methods [2], [6], [15]. The application of the multiple criteria

evaluation methods requests to formulate the adequate valuation criteria system.

The COPRAS method may be employed in the case when research is oriented both towards maximising and minimising criteria within a systemic approach. The method presumes a direct and proportional dependence of the weight and utility degree of the investigated versions on a system of attributes adequately describing alternatives with the help of values and weights of the attributes. The method is primarily applicable when determining the complex criterion describing the object of evaluation and integrating several partial criteria.

Absolute and relative indices and criteria with different dimensions (both: maximized or minimized) may be integrated by these methods and recalculated as normalized or comparisons, p. ex., using such formula:

$$\lfloor R_{ij} \rfloor = \frac{R_{ij}}{\sum_{i=1}^{n} \sum_{j=1}^{m} R_{ij}}, \qquad (2)$$

where $\lfloor R_{ij} \rfloor$ –normalized significance of j index from i- group.

The inversion of minimized indices ($min_{\ j}\ R_{ij}$) usually is done such way that they achieve highest significance:

$$\lceil R_{ij} \rceil = \frac{\min_{j} R_{ij}}{R_{ij}}. \qquad (3)$$

The SAW method is especially applicable for the compound evaluation of substantially different primary criteria (both having quantitative and qualitative parameters to be measured) and determining the integral measure (the last one can be used also as measure on different level). The choice is determined by the moment that this method is suitable in case of all factors being independent in the system and when their interaction with the integral measure is not important (as observed in the case study). By using the SAW method, the significance of every factor is measured, because the system must finally involve only these factors (criteria) that meet the essential level of significance [5], [16]. The choice of SAW method is grounded by the certitude that this method is suitable in case whereas both maximizing criteria are included. Besides, the significance parameters of primary criteria are taken into account; also they may be differentiated according to potency of the influence to generalized measure. The sum of significance parameters of the essential factors, determining generalized criterion, must be equal to 1 (or 100%).

The prolonged perspective of the complex evaluation and application for strategic business development program validation suppose integrated application of mentioned *Multiple Criteria Decision Making* (*MCDM*) methods for alternative decisions a/o with account of multiple tasks and multiple criteria.

The SAW method was applied in this study for determining the value of the global SMEs competitive advantage index *A(I)*, which is determined in this case by summing the products of identified determinants values and their significances for each of them.

The suggested examination technique supposes the expert evaluation of primary determinants in 10 points system (5 point - medium evaluation, 7 point and more - good or very good, and 3 point or less – as satisfactory or poor). Their significance parameters could be established by experts determining the concordance coefficient and the Pearson's chi-square test - the concordance coefficient significance parameter χ^2 [9]. The multiple criteria evaluation process includes the following essential procedures (computer-generated process algorithm schematically is shown in Fig. 1):

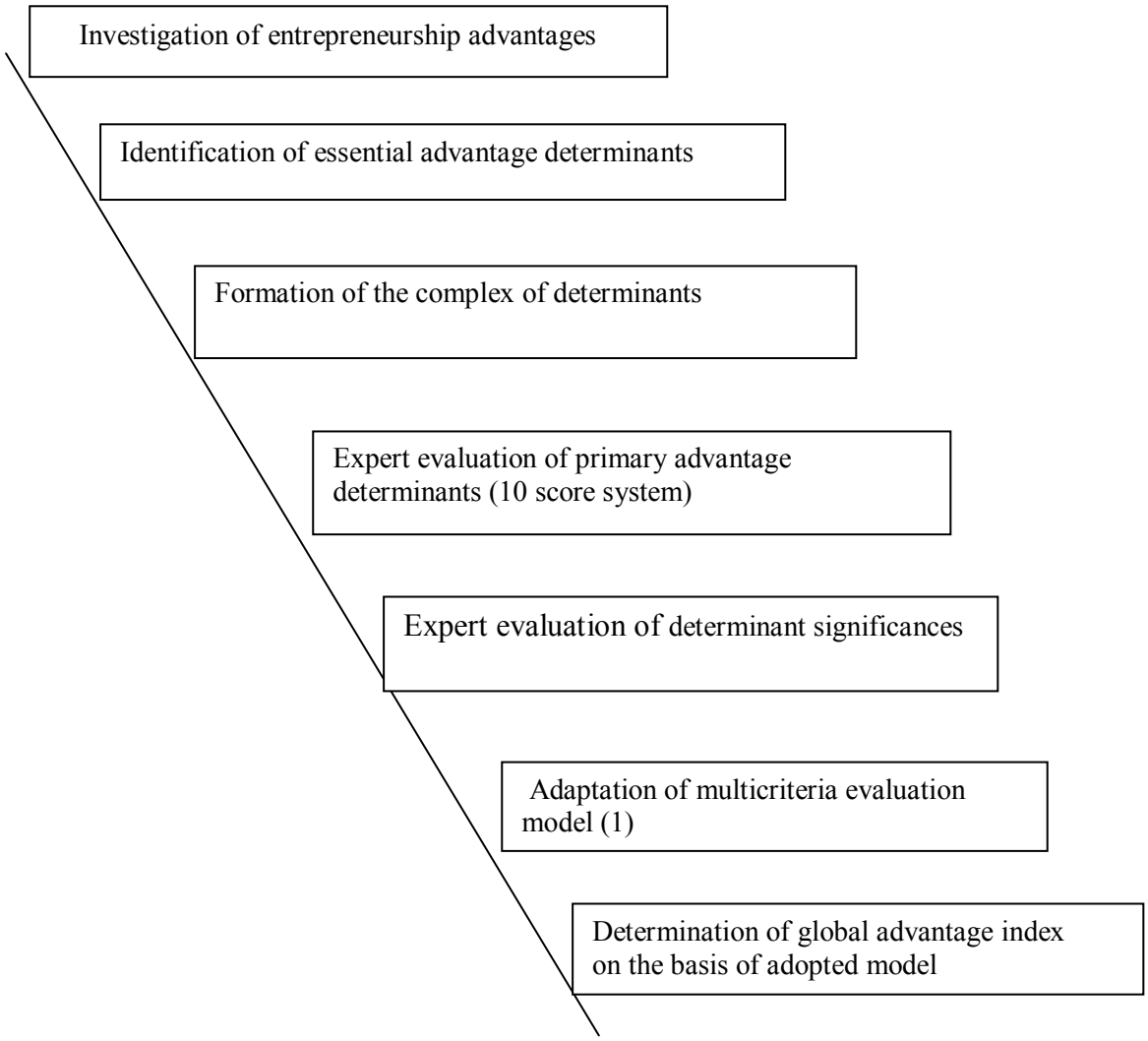
a) formation of the determinant complex;

b) expert examination and determination values of determinants;

c) establishment of significance parameters of determinants;

d) estimation of general dimension (global index) of SMEs competitive advantages;

The modeling of alternative development variants can be fulfilled with account of composed scenarios [17].



Source: composed by the authors.
Figure1. Essential procedures of multiple criteria assessment process

4. Examination of SMEs competitive advantages in Lithuania

The complex examination was performed adequately to the Lithuania's situation in 2011/2012. At first stage the idiosyncratic advantage determinants (according to 10 points score) and their significance coefficients (non-dimensional) were estimated by the expert group. According to the expert method application methodology, the satisfactory accuracy of estimations of main factors was achieved by a research team consisting of 7 professional experts. The necessary reliability of expert examination is characterized by the main reliability parameters: the values of the concordance coefficient W and the significance parameter for concordance coefficient χ^2 (Pearson's chi-square test). They are also acceptable at the pre-selected level $\alpha = 0.05$ and at the pre-selected level $\alpha = 0.01$ so as they are better than minimal permitted significances [9]. As a result, the assessed essential primary determinants, describing country's entrepreneurship advantage (adopted for newly EU countries) were identified and their significance coefficients were examined (Table 3).

On this basis (the complex of identified determinants is presented in table 3) and according to principles mentioned above the basic equation was obtained:

$$A(I) = a_1 A_1 + a_2 A_2 + ... + aiAi; \sum_{i=1}^{9} a_i = 1. \qquad (4)$$

At the second stage, the global index of the SMEs competitive advantages was determined for Lithuania (4.7 point, i.e. comparatively unfavorable evaluation) according to the proposed equation (4).

Some primary indicators such as creating of value chain and breath, state of cluster development were evaluated poor (<4.0 point).

It was observed that an assessment process may integrate the scenarios interpreting the government policy for national entrepreneurship development and strategic perspectives (entrepreneurship development trends) in newly EU countries. This process is important when modeling the changes with account of the perspective of the national entrepreneurship advantages. At the same time, it is important theoretical tool when revealing the reserves of enlarging the country's entrepreneurship potential and evaluating its perspective entrepreneurship development programs in most of newly EU countries. These results may be useful as well for the associated entrepreneurship structures.

Primary advantage determinants	Symbol	Assessment (in points)	Significance coefficients
Extent of marketing sophistication	A_1	4.7	a=0.14
Production process sophistication	A_2	4.5	a=0.13
Pay and productivity	A_3	4.4	a=0.11
Capacity for production/services export	A_4	5.3	a= 0.11
Capacity for innovation	A_5	4.9	a=0.11
Firm level technology absorption	A_6	4.7	a=0.1
Creating of value chain and breath	A_7	3.9	a=0.1
Corporate social responsibility	A_8	4.2	a=0.1
State of cluster development	A_9	3.9	a=0.1
Global index	***A(I)***	4.7	

Table composed by the authors with account of expert group evaluations.

Table 3. The expert examination of primary advantage determinants and estimation of global index by SAW method

5. Conclusion

It is not enough of studies dedicated to the complex assessment of national entrepreneurship advantages. The adequate quantitative evaluation methodology is still not adapted and not integrated with adequate expert evaluations. This may be seen if to compare the rankings of economic competitiveness indicators of Baltic countries (esp. some productivity factors - such as firm level technology absorption), by the WEF. All the differences are much narrow if to compare the expert evaluations expressed in weighed average indices. Between the countries selected in the paper, Estonia overruns other sample states by pay and productivity shows mostly the backlog between the growth of productivity and remuneration specific for newly EU countries.

The application of sophisticated multiple criteria system for the estimation of the SMEs competitive advantage level in the newly EU countries supposes two stage approach. The quantifiable expert evaluation of primary determinants and parameters of their comparative significance procedures are performed at the first stage. At the second stage, the global index of the country's SMEs competitive advantages may be determined by using adequate multiple criteria methods, including the Simple Additive Weighting. This algorithm allows to evaluate the significances of various constitutive advantage determinants in the common system and to model their changes. The determined global index of the Lithuania's SMEs competitive advantages at 4.7 point (in 10-grade evaluations) shows the comparatively unfavorable situation.

References

[1]. Avlonitis, G. J.; Salavou, H. E. (2007). Entrepreneurial orientation of SMEs, product innovativeness, and performance. *Journal of Business Research,* 60 (5), pp. 566-575.

[2]. Dombi, J.; Zsiros, A. (2005). Learning multicriteria classification models from examples: Decision rules in continuous space. *European Journal of Operational Research,*160 (3), pp. 663-675.

[3]. Fleisher, C. S. (2003). *Strategic and competitive analysis: methods and techniques for analyzing business competition*, New Jersey, Prentice Hall.

[4]. Geoff, S.; Brychan, C. T.; Gary. P. (2009). Opportunity and innovation: Synergy within an entrepreneurial approach to marketing**.** *The International Journal of Entrepreneurship and Innovation*, 10 (1), pp. 63- 72.

[5]. Ginevicius, R.; Podvezko, V., (2009). Evaluating the changes in economic and social development of Lithuanian counties by multiple criteria methods. *Technological and Economic Development of Economy,* 15 (3), pp. 418- 436.

[6]. Ginevicius, R.; Podvezko, V.; Bruzge, Sh. (2008). Evaluating the effect of state aid to business by multi-criteria methods. *Journal of Business Economics and Management*, 9 (3), pp. 167- 180.

[7]. *The Global Competitiveness Report 2010/2011*. World Economic Forum, 2011. http://www.weforum.org/en/media/publications/CompetitivenessReports/index.htm.

[8]. Gries, T., Naude, W. (2010). Entrepreneurship and structural economic transformation. *Small Business Economics,* 34(1), pp. 13-29.

[9]. Kendall, M. (1979). *Rank correlation methods*. Griffin and Co, London.

[10]. Krisciunas, K.; Greblikaite, J. (2007). Entrepreneurship in sustainable development: SMEs Innovativeness in Lithuania. *Engineering Economics*, 4 (54, pp. 20-26.

[11]. Lechner, Ch.; Leyronas, Ch. (2009). Small-business group formation as an entrepreneurial development model. *Entrepreneurship: Theory and Practice*, 33 (3), pp. 645-667.

[12]. Ma, H. (2000a). Of competitive advantage: kinetic and positional. *Business Horizons,* vol. 43(1), pp. 53-64.

[13]. Ma, H. (2000b). Competitive advantage and firm performance. *Competitiveness Review*, vol. 10 (2),

[14]. Man, T.; Lan, T.; Snape, E. (2008). Entrepreneurial Competencies and the Performance of Small and Medium Enterprises: An Investigation through a Framework of Competitiveness. *Journal of Small Business and Entrepreneurship,* 21(3), pp. 690-708.

[15]. Peldschus, F. (2007). The effectiveness of assessment in multiple criteria decisions. *International Journal of Management and Decision Making,* 8(5 – 6), pp. 519-526.

[16]. Podvezko, V. (2008). Comprehensive evaluation of complex quantities. *Business: Theory and Practice,* 9(3), pp. 160-168.

[17]. Ratcliffe, J. (2002). Scenario planning: strategic interviews and conversations. *Foresight*, vol. 4(1), pp.19–30.

[18]. Weerawardena, J. (2003). The role of marketing capability in innovation-based competitive strategy. *Journal of Strategic Marketing,* 11(1), pp. 15-35.

[19]. Zvirblis, A., Buracas, A. (2009). Multiple criteria assessment of socioeconomic indicators influencing the company's marketing decisions. *Management of Organizations: Systematic Research,* 49, pp. 137-153.

[20]. Zvirblis, A., Buracas, A. **(**2010). The consolidated measurement of the financial markets development: the case of transitional economies. *Technological and economic development of economy*, 16 (2), pp. 266-279.

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Neural Network Method for Person's Personality Recognition on the Face Image

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***Abstract*. This article examines the neural network methods to identify a person's identity on the face image used in biometric identification systems.**

Keywords – **Neural networks, personality recognition, biometric systems**

1. Introduction

Nowadays more widespread biometric person identification. These systems are based on the unique biological characteristics of a person that uniquely define the personality and are difficult to forge. The main biometric characteristics include fingerprints, hand shape, the pattern of the iris, the image of the retina. Recognition of human face image is most common in biometric systems, which is associated with the following factors [1]:

• No special or expensive equipment (for most applications, a PC and an ordinary video camera);
• Does not need physical contact with any input devices.

The disadvantages of this method include the fact that in itself is a biometric system does not provide the reliability of identification. If you need high reliability, it is necessary to apply the system using a variety of biometrics (the so-called multimodal system).

At the moment, the problem of recognition of human faces in the image has been widely discussed, but overall, it is still far from being resolved. The main difficulty is to recognize human faces in the image, regardless of changes in the angle and lighting conditions when shooting, as well as with various changes associated with age, hair, etc. [1,2]
One promising area of constructing similar biometric systems is the use of neural network methods of recognition of facial images. A neural network (NN) consists of elements called formal neurons, which themselves are very simple and are connected to other neurons. Each neuron transforms the set of signals that it receives the input to the output signal. That connection between neurons encoded weights, play a key role. One major advantage is the ability of the National Assembly of the parallel operation of the network elements, thereby significantly increases the efficiency of the solution. Education NA eliminates the need to choose the key features, their relevance and the relationship between them. The choice of the initial representation of input data affects the quality. Consider the application of the National Assembly for recognition of different types of the human person in the image of the face.

2. Multilayer neural networks

Multi-layer neural network (MNN) consists of series-connected layers, where each layer neuron its inputs connected to all the neurons of the previous layer, and outputs - the next (Figure 1). Transfer functions for these types of neurons are linear, threshold and sigmoid functions [3].

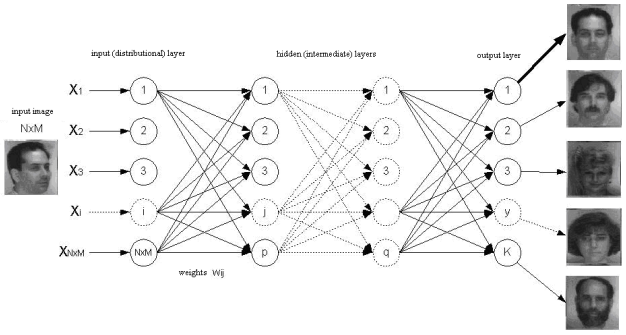

Figure. 1. Multilayer neural network architecture and its application for image recognition. Neuron with the maximum activity (here first) points belonging to a recognized class.

NA with one casting layer capable of forming a linear separating surfaces, which greatly narrows the range of problems they can solve, in particular, the network will not be able to solve the problem of the "exclusive or". Speaker with the nonlinear activation function and two decisive layers allows you to create any convex region in the solution space, but three crucial layers - of any complexity, including nonconvex. In this case, the MNN does not lose its generalization capability. Also using a two-layer NA possible with any precision approximate any multi-dimensional function in the interval [0, 1]. MNN

trained with back propagation algorithm is a kind of gradient descent in the space of weights in order to minimize the total network error:

$$\Delta W = -\alpha \frac{dE}{dW},\ E = \frac{1}{2}\sum_j (y_j - t_j)^2,$$

where t_j - reference value of the network output. In this case, the adjusted (based on the minimization of the error) values of weights applies in the opposite direction from inputs to outputs, through the weight connecting the neurons. Backpropagation is NP-hard, so the training network increases exponentially with the dimension of the data.

For the standard output values are known, it is a supervised learning. But when applied to the extraction of the key features when recirculating network is trained to reconstruct applied to the input image, and the hidden neurons formed by its succinct representation, it can be called a self-learning.
MNN prior to training initialized with random weights. Therefore two different NN training that have the same error rate, often are quite different dividing surfaces, can not be reduced to each other. Based on this method groups (groups) of neural networks that are often used in the recognition of human face images. Its essence lies in the fact that there is a set (group) networks trained to solve the same problem, but in different ways (different initialization of weights, the architecture, the order of the examples in the training, etc.). A generalized solution of the group, usually more accurate (and safer) than the only solution of the neural network.

3. High-order neural networks

High-order neural networks (HONN) differ from MNN that they have only one layer, but the inputs of neurons do the same high-order terms, which are the product of two or more components of the input vector, such as networks of second order [4]:

$$S = \sum_{i=1}^{n} w_i x_i + \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij} x_i x_j - T \ .$$

Such networks can also form complex separating surfaces. Separating surface of the second order is called hyperquadric. Adding the components of the input vector in the works, which share class of polynomial surfaces. Such networks also can be trained by back-propagation. MNN generally effective, but there are some applications in which high-order network is better than the MNN.

A feature of such networks lies in the fact that for a certain class of learning enough to show his image without variations, scale and rotate - after learning network will recognize the known classes is invariant to scale and rotate the image. Such a network is not a full mesh, quick to learn and work. A significant improvement of the classification accuracy of such a network rotated and scaled images in comparison with the MNN [5,6].

4. Radial basis neural network

Radial basis neural network (RBNS) consist of two layers (Figure 2). The first layer has a radial-basic transfer functions: $y = \exp(\frac{-S^2}{2\sigma^2})$

where σ - the standard deviation characterizing the width of the function (cluster size), S is defined as the distance between the input and the weight vector:

$$S^2 = |X - W|^2 = \sum_i (x_i - w_i)^2$$

is essentially the distance to the center of the cluster is determined by specific neurons [7]. A hidden layer is a set of clusters in space and implement the first phase of clustering input pattern - the value of the activation function of each neuron decreases rapidly with distance from the cluster center.

The second layer neuron has a linear activation function, and a second step of clustering - distributes clusters of classes.

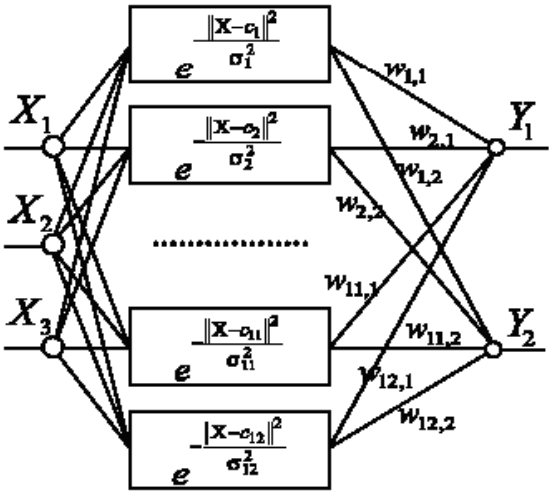

Figure 2. The structure of radial basis neural networks

RBNS also able to construct complex and approximate share of multivariate functions. Compared with the multilayer neural network, radial-basis network is trained much faster, but has a much worse extrapolated power, ie can not work on images that lie far away from the image-examples. Dimensions RBSN more than MNN for similar

problems, and RBNS become ineffective with the dimension of the input data [1,7].

Such network trained in two stages. The first stage is carried out without a teacher, it selects the first layer of a compact arrangement of the clusters. Thus adjusted the cluster center. In the second phase of training, the second layer learns to distribute the input images, passed through the first layer, the classes. Information relating to the reference values of the outputs is known, the training run, or matrix methods or back propagation algorithm. Described below types of neural networks allow to take into account the topology of the image. The principles of these networks is based on dividing the image into small areas and the hierarchical relation as their relative location, and content. These networks are the most promising for image recognition.

5. Kognitron

The operation principle of kognitron (Figure 3) is based on the anatomy and physiology of the brain and its architecture is similar to the structure of the visual cortex [4]. Each layer of the brain implements various levels of generalization - the input layer is sensitive to simple images, such as lines and their orientation in certain areas of the visual field, while the reaction of the other layers is more complex, abstract and independent of the position of the image. Similar functions are implemented in kognitron by modeling the organization of the visual cortex.

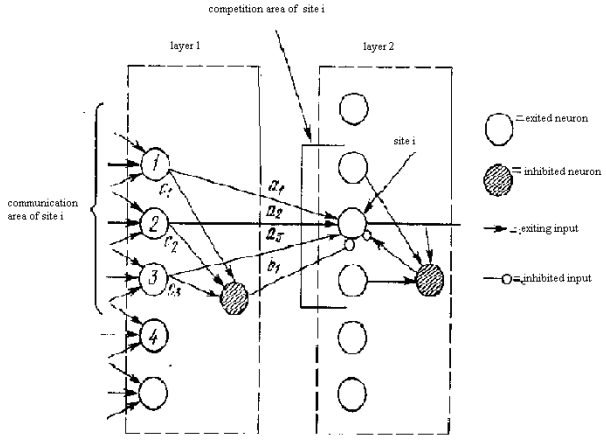

Figure 3. Kognitron's structure

Kognitron's main architectural differences lie in the fact that each neuron is connected only to a small local area of the previous layer, and the areas of overlap with each other. Layers in kognitron usually greater than in other types of networks. Thus achieving a hierarchical organization where the higher layers kognitron responds to more abstract images, less responsive to their displacement and distortion. Trains kognitron competitive learning (unsupervised).

6. Neocognitron

In the visual cortex were found nodes that respond to elements such as lines and angles of a specific orientation. At higher levels, units respond to more complex and abstract patterns such as circles, triangles and rectangles. At even higher levels, the degree of abstraction increases as long until you find the nodes that respond to faces and complex shapes. In general, the nodes at higher levels receive input from a group of low-level nodes and, therefore, to respond to a wider area of the visual field. Reaction units higher than depend on the position and are more resistant to distortion.

Neocognitron is a further development of the idea kognitrona and more accurately reflects the structure of the visual system can recognize the images, regardless of their transformations: offset, rotation, zoom, and distortion [4]. Neocognitron can both educate themselves, and to learn from the teacher. Neocognitron takes as input two-dimensional image, similar images on the retina, and processes them in subsequent layers is similar to that found in the visual cortex of man.

The main difference between the Neocognitron kognitrona - two-dimensional organization of local areas and flat hierarchical structure (Figure 4).

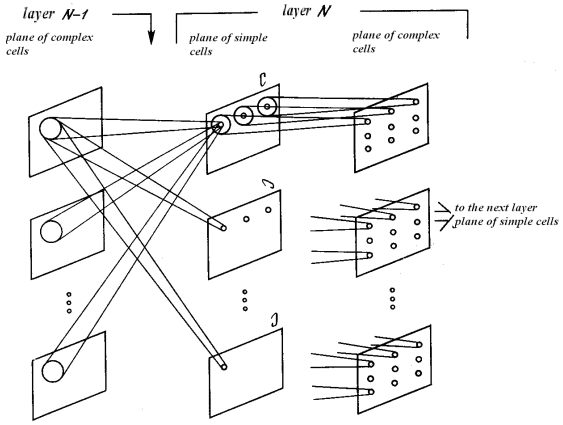

Figure 4. Neokognitron's structure

Each layer consists of planes of simple and complex cells. Each neuron is a simple plane relative to the local portion of the two-dimensional planes of the previous layer, the weights of all the neurons in a single plane of the same, and thus the plane reacts to a certain image that is in the image (the example in the figure - the plane respond to the letter "C" rotated at different angles). The position of the activated neuron in such a simple plane marks the site where the image was found, regardless of the distortion of the image. Neuron complex plane associated with the site of its simple plane, and finds the activity of neurons in this area, thus reducing the sensitivity of

the position of the image. Thus achieving a hierarchical image processing, when the subsequent layers neocognitron responds to more general features of the image without losing the distortion, shift etc.

Classic neocognitron is a powerful image recognition, but requires high computational cost, which is unattainable today [4,8].

However, there are a lot of work to improve the neocognitron [9]. One of the most promising approaches for the recognition of human faces in the image - this is a convolutional neural network.

7. Convolutional Neural Networks

In classical multilayer neural network interlayer neural connections are fully connected and the image presented in the form of n-dimensional vector, is not taken into account either the two-dimensional local organization of pixels or possibility of deformation. Architecture of convolutional neural network (CNN) (Figure 5) aims to overcome these problems and is based on principles Neocognitron architecture, simplified and augmented learning back propagation algorithm [8].

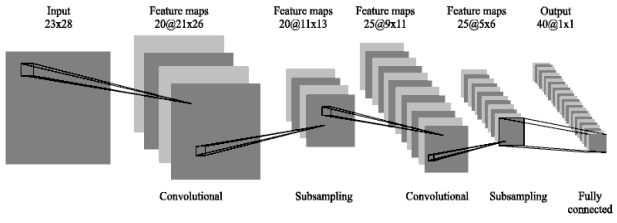

Figure 5. Convolutional neural network architecture

It used local receptive field (providing local two-dimensional connectivity of neurons), total weight (ensure detection of certain features anywhere in the image) and the hierarchical organization of spatial subsample.

CNN provides partial resistance to change scale, offset, rotation, change the angle, and other distortions.

CNN architecture consists of many layers. The layers are of two types: Convolutional and Subsampling, convolution and subsampling layers alternate with each other. Each layer has a set of several planes, with one plane neurons have the same weight, leading to all local areas of the previous layer (as in the visual cortex of man), the image of the previous layer as it is scanned a small window and passed through a set of weights, and the result is displayed on corresponding neuron of the current layer. Thus, the set of planes is the card features (feature maps) and each plane is "their" parts of the image in any place of the previous layer for the next layer convolutional Subsampling layer reduces the scale of the planes by local averaging the outputs of neurons. In this way, a hierarchical organization. Overlays extract more common characteristics, less dependent on image distortion [8].

Trains CNN standard Backpropagation. Comparison of MNN and CNN showed significant advantage of the last both the speed and the reliability of classification. A useful feature of the SNA is the fact that the characteristics that are generated at the outputs of the upper layers of the hierarchy can be applied for the classification of the nearest neighbor method (for example, calculating the Euclidean distance), and CNN can successfully retrieve such data and images that are not in the training set. For CNN characterized by a high rate of learning and working.

8. Disadvantages of neural network pattern recognition methods

The considered neural network methods provide rapid and reliable detection of images. However, applying these methods to the images of three-dimensional objects were difficulties with spatial rotations and lighting conditions change. Images for different angles of rotation of the object vary widely, with some of the information in the image is lost and there is new information that is specific to a given angle. For example, a person who rotated through a certain angle, in terms of classifying the system more similar to another person's face, turned to the same angle than on the face of the same man, shown from the front (Figure 6).

а б в

Figure 6. From the point of view of (в) is more similar to (б) than (а)

A similar problem occurs when the brightness of light changes (Figure 7).

Figure 7. Images of the same person varies significantly lighting conditions change.

Such limitation is usually overcome by bringing all sorts of variations of the image (various turns and

light) in the training, but the construction of the training set - a difficult task, and often these kits are not available. As international experience shows, these problems can not be solved completely the choice of data source. Therefore, classifying systems are required - based on the existing final representative set of images of certain classes of variations, summarize the existing experience at all the other classes, are not included in the training set. So. system must extract features that are invariant to changes in the intra-and the most representative in relation to the cross-class changes. Such a problem in general for face recognition systems have not yet been solved, but there are methods to ensure the solution of some of its aspects (invariance to lighting, synthesis rotated in the space of face images based on the study).

In addition, there are difficulties associated with the intraclass variations. For face images are different emotions, closed / open eyes, the presence of glasses and beards, changes in hairstyle. Such cases, the system must also be able to generalize.

In general, with the recognition of a person uses information from various sources and also attracts a wealth of contextual knowledge that pattern recognition system is not yet available.

9. Conclusion

The main advantage of neural networks is the ability to solve various problems formalized. It is possible simply to simulate different situations, giving the input of a variety of data networks and evaluating the result issued by the network.

In the application of neural networks is marked by a significant drawback: the difficulty of understanding the process of obtaining a network effect. The first step to resolve this problem is to develop a new technology that allows you to generate a description of the process of solving the problem of neural network. Using a table of experimental data describing the subject matter, it will be possible to get a formal algorithm for solving the problem. This calls for further experiments on the learning algorithms, the choice of the initial presentation and adaptation algorithm of the National Assembly with the image properties.

References

[1] W Pankanti, RM Bolle, Jane E. Biometrics: The Future of the identification / / Open Systems, № 03, 2000. http://www.osp.ru/os/2000/03/

[2] Foltyniewicz R. Efficient High Order Neural Network for Rotation, Translation and Distance Invariant Recognition of Gray Scale Images. Lecture Notes in Computer Science - Computer Analysis of Images and Patterns, 1995, pp. 424-431.

[3] Golovko V.A. Neyrointellekt: Theory and application. Book 1. Organization and training of neural networks with forward and backward linkages - Brest: BPI, 1999.

[4] Daughman J. Face and Gesture Recognition: Overview. IEEE Transactions on Pattern Analysis and Machine Intelligence 1997, Vol. 19, pp. 675-676.

[5] Galushkin AI, Tomasevic, D., S., Tomasevic, N. Methods of implementation invariant to affine transformations of two-dimensional images / / Annex to the magazine "Information Technology", 2001, № 1, pp. 1-19.

[6] Giacinto G., Roli F. Automatic Design of Multiple Classifier Systems by Unsupervised Learning. Lecture Notes in Artificial Intelligence - Machine Learning and Data Mining in Pattern Recognition, 1999, pp. 131-143.

[7] Golovko V.A. Neyrointellekt: Theory and application. Book 2. Self-organization, fault tolerance, and application of neural networks - Brest: BPI, 1999.

[8] Lawrence S., Giles C. L., Tsoi A. C., Back A. D. Face Recognition: A Convolutional Neural Network Approach / / IEEE Transactions on Neural Networks, Special Issue on Neural Networks and Pattern Recognition, 1997. pp. 1-24.

[9] Ranganath S. and Arun K. Face recognition using transform features and neural networks / / Pattern Recognition 1997. Vol. 30. pp. 1615-1622.

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SCORM Player WP7: a Software Solution for Review and Presentation of the Learning Content on Mobile Devices

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Abstract **– The purpose of this paper is to present a software solution we have developed in order to enable download, review and presentation of the learning content on mobile devices. This Windows Phone 7 solution, named SCORM Player WP7, uses SCORM reference model because of its ability to provide the transfer of learning content from one system to another, storing, sharing and reuse of the learning content. Application development is based on the usage of Microsoft .NET C # programming language and modern technologies such as the Silverlight.**

Keywords **– e-learning, m-learning, software, SCORM.**

1. Introduction

E-learning, distance learning, e-education and other related concepts are now widely used both in formal education (primary, secondary, tertiary), and in non-formal education (learning while working, retraining for new jobs, etc.). These terms are used to refer to "a particular form of learning with the use of information and communication technology, especially computers and the Internet, where users access content independently without spatial and/or temporal constraints" [1]. In order to improve the e-learning process, computer network, as well as different types of satellite and mobile networks, interactive TV etc., can be used for user interaction and information delivery. Communication technologies thus enable the use of electronic mail, discussion groups and systems for collaborative learning.

Ongoing progress in the development of communication technology such as Wi-Fi, Bluetooth, wireless LAN and global wireless technologies (GPS, GSM, GPRS, 3G) is providing new capabilities to users. Once combined with mobile devices, these technologies have led towards the creation of mobile learning or m-learning as one of the e-learning sub-areas. This type of learning is present in cases when knowledge is distributed using mobile devices such as smart mobile phones, portable pocket PCs, MP3 players, etc. [1]. M-learning is characterized by spatial independence. Also, this type of learning is adapted to the way of life in urban areas where the number of mobile device users increases on daily bases. Thus, the benefits of m-learning lie in taking advantage of user capabilities including user mobility (user can access data anytime, anywhere), content exchange and collaborating with other users.

The development of new methodologies in learning leads to emerging of new questions and problems which need to be solved. Although learning management systems (LMS) offer various possibilities, the most commonly used functionality of these systems is a static visualization of the learning content. Future development should provide an answer to the question of how to increase the efficiency of learning e.g. how to deploy interactive and intelligent features that will make the learning process more advanced in achieving knowledge? Moreover, there are still major problems in the form of merging and linking learning content from different sources, methods of creating content that can be reused and separated from each other, methods of creating vendor-independent and technology-independent content.

In order to make the learning process, such as m-learning, successful, it is necessary to introduce appropriate standards to ensure the quality of the management, transmission, organization and control of information and knowledge, as an end product of the learning process. In this paper we will present a short analysis of Sharable Content Object Reference Model (SCORM) standard that answers the question of how to create and structure educational content, how to develop software solutions in which these activities occur and how they can be managed in the learning process. The reason for this analysis and the main contribution which will be presented in this paper is the development of mobile phone application which enables users to download, store and visualize SCORM packages.

2. E-Learning Standards

Standards play an integral role in the development of software applications. They ensure interoperability and integration of systems and indicate a certain level of software maturity. This is the case with the development of learning materials and learning management systems also. Until the emergence of standards, learning materials were often tightly coupled to the LMS. Because of this, generated materials could not be reused on other systems so e-learning systems had to be acquired from a single vendor in entirety. In this type of development environment, learning materials were developed separately which resulted in lack of possibility to integrate materials from different sources or move materials from one system to another.

The main goal of the standardization of e-learning process is to develop standardized data model and standardized educational content structure which will enable the usage of the generated materials regardless of the tools used for their creation and the environments in which they are used. It is necessary to ensure that the e-learning content is easy to find, reuse and transfer between different systems. This necessity raises a question - how to ensure the creation of learning content according to the specifications which ensure the reusability of the learning content and its exchangeability between different learning management systems? In this context, the usage of standards in the field of e-learning is essential in preventing the situation where learning content becomes unusable for a number of reasons: a software company has left the market, incompatibilities between tools used to create learning content and LMS used to manage it etc.

There are currently few standards used for the exchange of educational content between platforms which manage the process of learning and appropriate software tools used for content creation. These standards are developed by different international organizations and institutions.

- *Advance Distributed Learning (ADL) Initiative, www.adlnet.org* – an organization founded in 1997 by the U.S. government with the support of the Ministry of Defense with the aim of providing high-quality educational materials adapted to individual user needs and available anytime, anywhere.
- *IMS Global Learning Consortium (IMS GLC), www.imsproject.org* – international institution whose members are government members, financial and educational institutions; this institution emphasizes two goals:
  - defining technical standards for the interoperability of applications and services in distributed learning environments, and
  - providing support for the usage of IMS specifications within different products and services worldwide
- *Aviation Industry CBT (Computer Based Training) Committee (AICC), www.aicc.org* – founded in 1988, this committee represents one of the earliest attempts at introducing e-learning standards. Although primarily focused on the needs of the aviation industry, AICC has led to the development of a particular learning specification named Computer Managed Instruction (CMI), which is widely used.

Often, some of these organizations collaborate with other companies to promote standards for electronic learning technologies. All proposals generated as an output of the efforts of these organizations is submitted to the designated standards body IEEE Learning Technology Standards Committee (IEEE LTSC). Based on the received proposals, the IEEE LTSC tries to develop specifications and industry standards, which are then submitted to ISO for formal internationalization. Eventually, some of these proposals become accredited standards [2].

Prominent researches in the area of e-learning content standardization indicate that the work of various standards organizations has resulted in two prominent e-learning standards [3]: SCORM Content Hierarchy and AICC Content Hierarchy [4]. The SCORM Content Hierarchy consists of content aggregations, shareable content objects (SCO) and assets, whereas the AICC Content Hierarchy consists of courses, instructional blocks and assignable units (AU) [3]. Therefore, SCOs and AUs can be observed as the digital learning objects in these standards [3].

3. SCORM

SCORM can be generically described as a set of technical standards for e-learning software [5]. Since SCORM stands for Sharable Content Object Reference Model, it can be observed as a reference model for shared content objects. Shared content objects indicate that SCORM deals with creating and manipulating shared units of online training materials that can be recycled and used in different systems and contexts. A reference model is something that

indicates what kinds of services are necessary for a problem to be solved e.g. how should these services be combined, which standards are applicable and how should they be used. Reference model essentially reflects the fact that SCORM is not a standard developed from scratch. Members of the ADL organization ADL have noticed that the industry already has many standards that partly solve the problem they were addressing. SCORM is simply a collection of the existing standards which directs developers how to use them properly.

SCORM determines a framework for sharable content objects which meets the following criteria, called the RAID principles [6]:

- Durability – content should last and be used long enough to amortize its cost i.e. to be useful as long as it is relevant.
- Portability – the transfer of learning content from one environment to another should be possible. The same content should work without modification in various environments until as long as this environment includes a Web browser.
- Reusability – the content should be created in the form of small, reusable modules which can be combined in different ways.
- Accessibility – users should have the possibility to store and retrieve the learning content to/from repositories. This implies that the information considering the storing and cataloging of data should be directly related to the learning content.

Three basic criteria that describe a reference model followed by SCORM can be distinguished. According to these criteria, SCORM should:

- Provide guidelines that can be understood and implemented by learning content authors.
- Be adopted, understood and used by the wide range of possible economic actors, especially by the learning content authors.
- Enable mapping of any user's specific model for instructional systems design and development into itself.

SCORM model consists of digital units, assets, sharable content objects (SCO), activities, organization content and aggregations content (Figure 1). This standard specifies exactly how to package the learning objects and SCOs so that they can be stored, copied, moved, archived, uploaded or delivered using SCORM compliant management system. A single packaging can contain one or more SCOs.

IMS Global Learning Consortium has developed a specification used for packaging learning content. This specification is named IMS Content Packaging Specification provides a useful template for generating content organization in the form of a manifesto which should included into the packaging. Manifest is used to list the contents of the package, but also to describe the package using metadata. Manifest can also be used as way to visualize the internal content organization.

Manifest is a XML document which consists of several parts:

- Metadata contains descriptive and administrative information considering the package, but also enables querying and locating the package contents.
- Organizations describe the way content is organized within a package. They may consist of one or more organizational components, each of which describes a particular structure of the content in the package. Organizations define the sequence of delivery of resources to the end user.
- Classifications are attributes which describe the package. They can be used for querying and catalog the package content.
- Submanifests describe package content subsets. Submanifests may have their own metadata, organization and resources.

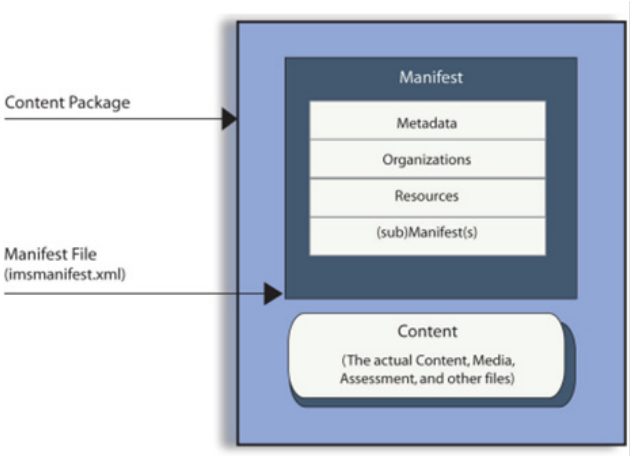

Figure 1. SCORM content package [7]

4. SCORM Player WP7

SCORM Player WP7 is a Windows Phone 7 application which implements basic operations used for manipulating a SCORM package. Specifically, SCORM Player WP7 implements download, store, display and view functions. Application development was preceded by a survey of existing applications that have similar capabilities. As a result of this research, the application SCORM Player for Google Android and the paper which describes this application [8] have provided a starting point for the development of SCORM Player WP7 application. Also, the basic idea of how should SCORM Player function and appear was given by the SCORM Cloud [9], which is part of a complex LMS system.

The final results of the functional requirements analysis are implemented in the first version of the application:

- Implementation of the SCORM package download mechanism.
- Storing of the downloaded packages in the local phone memory with the ability to delete them.
- Presentation of course (lesson) content with additional user functions:
    - Navigation within the content of a course (with options to view the previous and following lessons and also with option to choose between lessons).
    - Marking previously visited lessons.
- Implementation of undo/redo options
- Creating, storing and deleting records on the application level.

SCORM Player WP7 is a client application which communicates with a server application named SCORM Server. SCORM Server is an application developed for the testing and simulation of SCORM Player WP7. Both applications were developed using Microsoft .NET C # language. Manifest.cs, Storage.cs and MainPage.cs implement the core application logic. These classes take advantage of the events mechanism for the communication. Along with other classes, these classes are shown on the SCORM Player WP7 class diagram (Figure 2).

Manifest.cs class is an auxiliary class which contains the properties of SCORM package manifest file. Thus, the structure of this class coincides with the structure imsmanifest.xml file and its main purpose is to store data temporarily. Various classes, such as Storage.cs, use Manifest.cs class instance to easily and efficiently manage the contents of the manifest file.

Storage.cs class uses Manifest.cs object as helper objects. These helper objects are created during the instantiation of the Storage.cs class instances and their purpose is to reserve memory space needed for storing the SCORM package content, primarily the manifest file. This class implements the following functionalities:

- Retrieving SCORM packages from the server.
- Storing of SCORM packages.
- Acquiring and opening of the local SCORM packages.
- parsing of the SCORM package structure
- deleting SCORM packages

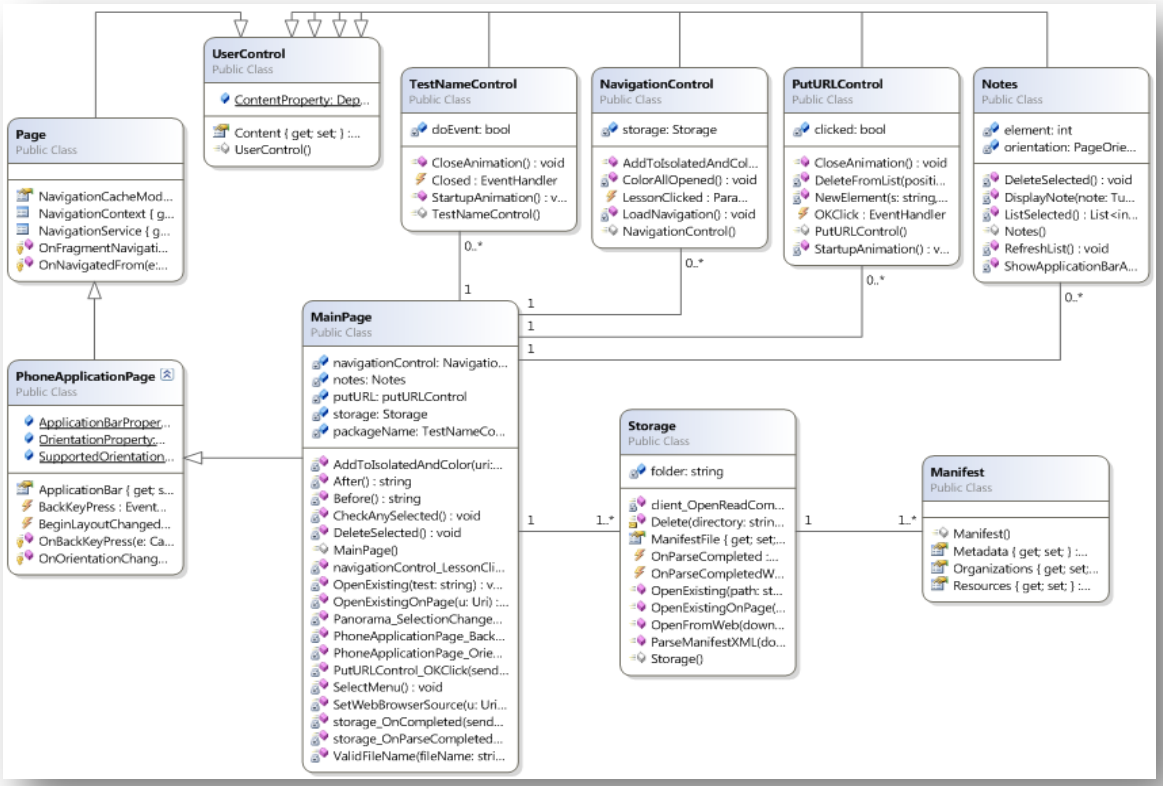

Figure 2. SCORM Player WP7 class diagram

MainPage.xaml.cs class manages event processing. It contains the user interface, created via XAML code, "listens" for the user interaction with the application and processes the resulting events. In this way, the application design is separate from the application logic which conforms to the rules of the Silverlight application development. Also, this class determines the controls which will be displayed on the screen depending on the current user activity.

Server application side is a console application named SCORM Server. The server uses Representational State Transfer (REST) style of software architecture for distributed systems. Requests and responses are created with the transfer of resources representations. A resource can be any meaningful coherent concept that can be addressed. Representation of resources is typically a document that captures the current state of the resource [10]. The main classes of SCORM Server application are shown on Figure 3.

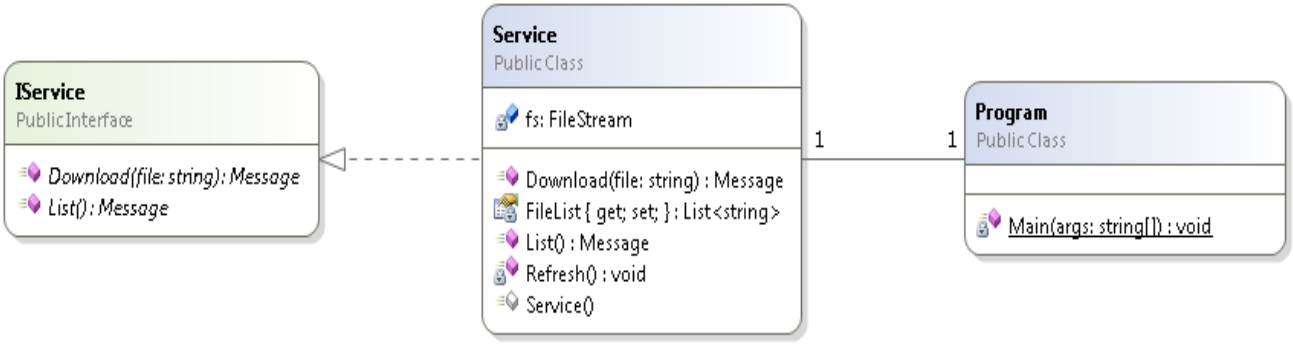

Figure 3. SCORM Server class diagram

5. SCORM Player WP7 application interface

SCORM Player WP7 application interface is based on the usage of Panorama Controls. These controls represent the basic application layout for Windows Phone Panorama Application. SCORM Player application panorama consists of three basic sections which can be accessed by scrolling the screen horizontally (Figure 4). Each section has a menu at the bottom of the screen, which can be increased by pressing the menu surface. Menu elements (buttons and items) will change depending on the currently active panorama section.

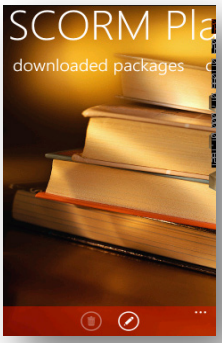

Figure 4. SCORM Player WP7 startup layout

SCORM package can be downloaded by selecting the appropriate section and then pressing a "URL path" button. On the screen, a dialog box which is used to enter a SCORM package address appears. After entering the package address, the application establishes communication with the server. If a valid package exists on the server, application displays an unopened packages identified by the package name and address (Figure 5).

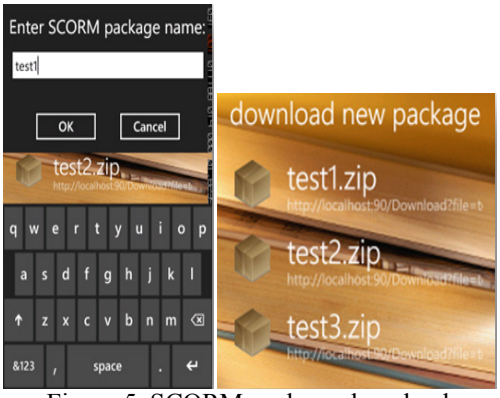

Figure 5. SCORM package download

Users have the possibility to enter notes. Creation date and note content is stored for each note (Figure 6).

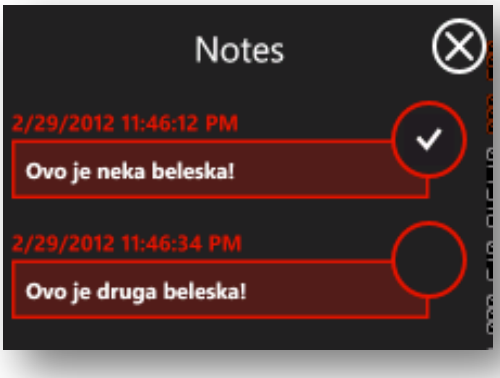

Figure 6. SCORM Player note layout

Notes are global objects and do not correspond to a particular SCORM package. Each user can:

- Add a new note.
- Edit an existing note.
- Delete an existing note.

Application section were users will probably spend most of their time while using SCORM Player application is one which displays the contents of downloaded packages. Full package content is displayed within the integrated Web control which, aside from the notes menu options, contains the navigation functions. These functions allow users to efficiently navigate through the package content. Application menu contains "previous" and "back" buttons used to navigate to the previous/next content page, "navigation" button which activates the navigation control and other menu items such as "back", "forward" and "refresh" (Figure 7). Also, SCORM Player WP7 implements undo/redo operations so that the user can always return to the lessons that are not in the order propagated by the package (course) content.

Figure 7. SCORM package contents visualization

The "navigate" button activates controls which enable navigation through the contents of the currently opened packages. This control visually presents available lessons which are distinguished by the name of the chapter (Figure 7). Here the user can choose any of the lessons by scrolling the content vertically choosing the appropriate lesson. After the appropriate lesson is selected, navigation control is disabled and the integrated Web control which displayed the lesson content is displayed again. Navigation control implements the logic which allows the monitoring of all previously selected lessons and uses this capability to highlight previously selected lessons so users are always aware of the content they have read.

6. Conclusion

Currently a majority of universities defines strategies for the development and usage of e-learning systems. Along with these trends, software community is developing different software solutions and tools which enable the knowledge transfer process using information and communication technologies. In order to preserve the quality of e-learning systems, it was necessary to introduce the standards which ensure the compatibility of different solutions applicable in this field.

Although certain standards already existed, it was important to recognize the importance of integration of the different models and specifications of a uniform standard and a recommended practice. A consensus which was reached among several international organizations for the development of standards in the field of e-learning resulted in the development of SCORM reference model – a standard used for the creation and delivery of learning content between different distance learning management systems. SCORM standard provides transfer of learning content from one system to another, storing, sharing and reuse of the learning content. Due to these characteristics, SCORM has been selected as the standard to be used for the development of Windows Phone 7 applications presented in this paper. This application, called SCORM Player WP7, enables download, review and presentation of the learning content. Application development is based on the usage of Microsoft .NET C # programming language and modern technologies such as the Silverlight.

The first version of the application is experimental and allows users to download courses to their smartphones using wireless network, and afterwards display and preview the downloaded material which was developed according to the SCORM standard. Through means of contemporary software development technologies, SCORM Player WP7 has been successfully developed as an application which represents the first step towards the development of more advanced and more functional applications. In the near future, this application is expected to be able to interact with a LMS like Moodle, which would enable the active participation of students in the education program via mobile phone as well as the monitoring of student's work. Further, this application is expected to implemente a Run-Time Environment (RTE) model [11] which would allow students to follow the learning materials anywhere, anytime. Thus portability, portability and accessibility, as the basic e-learning and m-learning requirements, will be met which should contribute to e-learning and m-learning become ever more popular.

ACKNOWLEDGEMENT

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References

[1]. Kljakić D., Online učenje, in serbian, available from: http://issuu.com/kljakic/docs/online_ucenje, last visited November 9, 2012

[2]. Sonwalkar N, *Demystifying Learning Technology Standards Part I: Development and Evolution.* 2002. http://campustechnology.com/articles/2002/03/demystifying-learning-technology-standards-part-i-development-and-evolution.aspx.

[3]. Kerstner M, *E-Learning Standards – Critical and Practical Perspectives*, Master's Thesis at Graz University of Technology, pp. 199, 2011 http://www.kerstner.at/wp-content/uploads/2011/05/E-Learning-Standards-Critical-and-Practical-Perspectives.pdf

[4]. Fallon C, Dams JM, Brown S, *E-Learning Standards: A Guide to Purchasing, Developing, and Deploying Standards-Conformant E-Learning*, CRC Press, ISBN: 978-1-57444-345-5, 2002

[5]. Rustici M, *SCORM Versions – An eLearning Standards Roadmap*, 2009a, http://scorm.com/scorm-explained/business-of-scorm/scorm-versions/.

[6]. *ADL Guidelines for Creating Reusable Content with SCORM 2004*, 2008, available from: http://www.adlnet.gov/wpcontent/uploads/2011/07/ADL_Guidelines_Creating_Reusable_Content.pdf, last visited November 9, 2012

[7]. Jesukiewicz P, *SCORM 2004, 4th Edition, Content Aggregation Model [CAM]*, Version 1.1, Advanced Distributed Learning Initiative Office of the Deputy UnderSecretary of Defense for Readiness and

Training, Policy and Programs, 2009, available from: http://www.moschorus.com/centre/MosPub/documents/contenu/pages/SCORM_2004_4ED_CAM.pdf, last visited November 9, 2012

[8]. Padiadpu R, *Towards Mobile Learning: A SCORM Player for the Google Android Platform*, available from: http://users.informatik.haw-hamburg.de/~schmidt/thesis/Rashmi.pdf, last visited November 9, 2012

[9]. Rustici Software, SCORM Cloud, available from: http://scorm.com/scorm-solved/scorm-cloud/, last visited November 9, 2012

[10]. Rodriguez A, *RESTful Webservices: The basics*, available from: http://www.ibm.com/developerworks/webservices/library/ws-restful/, last visited November 9, 2012

[11]. Jesukiewicz P, *SCORM 2004, 4th Edition, Run-Time Environment (RTE)*, Version 1.1, Advanced Distributed Learning Initiative Office of the Deputy Under Secretary of Defense for Readiness and Training, Policy and Programs, available from: http://www.moschorus.com/centre/MosPub/documents/contenu/pages/SCORM_2004_4ED_RTE.pdf, last visited November 9, 2012

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Usage of Service-Oriented Architecture for Developing Prototype of Intelligence Information System

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***Abstract* – The level of technological development in society has influence on implementing contemporary technologies because benefits of using ICT make pressure on increasing level of development in society.**

In this paper we propose key points of usage of Service-Oriented Architecture for Developing Prototype of Intelligence Information System.

***Keywords* – Service-oriented architecture, Model of Intelligence Information System, Security standards, Metrics for service availability, service reliability and service response time, Intelligence.**

1. Introduction

Intelligence, as a public service, has a great significance for a country [1], [2]. Frequently used information systems, which support intelligence activities, have high influence in the decision making process. Contemporary information technology considerably contributes to the processes' (activities) improvement by supporting intelligence cycles (planning, collecting data, analyzing data and dissemination). Although, there is constant improvement in the field of information technology, significant advancement in the quality of work in the field of intelligence has not taken place in the last ten years [3], [4], [5].

According to NATO Glossary of Terms and Definitions (AAP-6) [6], processes or phases that are going in Intelligence are shown on Figure 1:

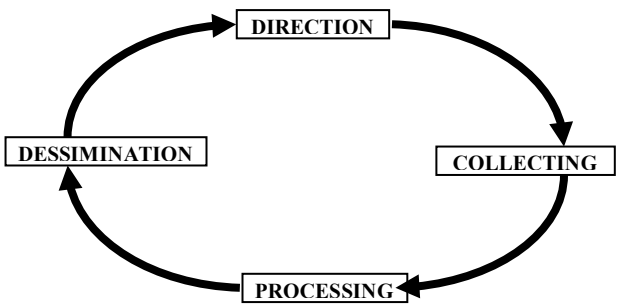


Figure 1. Intelligence cycle

Implementation of Service Oriented Architecture – SOA, [7] i.e. the usage of SOA provides possibilities for making new opportunities in the form of expanded solutions for designing intelligence [8], [9], [10], [11], [12] information systems, regarding the more efficient management of information, as well as their use by the end users for whom hum they are intended. In order to keep up with the pace with contemporary development, planning on short, medium and long term is needed for development of information systems for supporting intelligence [13], [14], [15], in relation to IT development.

Nowadays, as a response of challenges and better coordination, contemporary intelligence agencies have established teams for monitoring and responding on events to different locations with usage of modern IT solutions.

After the changing of the traditional hierarchical model in the target-centric model of intelligence, intelligence analysts as a part of the intelligence community are facing the need of new IT solutions, with one goal – achieving better intelligence products.

This contribution is divided on several sections. In the section 2 is presented concept for Intelligence Information System development using SOA. The section 3 and 4 explain our approach for developing metrics to evaluate services and information in information system. Also, we propose metrics for service availability and service reliability. In the section 5 are given concluding remarks.

2. Service-oriented architecture concept for Intelligence Information System development

Every modern intelligence system is based on some type of information system [18]. Usage of contemporary technology, especially Information Communication Technology (ICT), is giving more efficient execution of all phases of the intelligence service.

Such IIS achieves minimum requirements for designing services that are needed to be implemented in intelligence process with internal functions which can be processed from external IIS peer [19].

As result of system complexity solution is realized as a layer architecture model [20].

Web services are a possible solution to integration problems [7]. Information systems can be integrated, depending on the aim and function, with different web services they create. Web services are presented

with WSDL that firmly define communication interface [12], [21]. Web services are anticipated to be used in information systems integration on the method of peer-to-peer connecting.

The enterprise application integration usually means the sum of technologies that support the interoperability of separate information systems. The principal use of this concept is based on the integration of different enterprise applications and process automation. Because of that, the service oriented architecture represents the main platform for the existing application integration solutions [5], [22]. Application integration means building a system which consists of different software components which communicate among each other via standardized messages. Certain components of that system are called adapters and use the external components, which need to be integrated in the system.

The key difference between the broker architecture, which uses hub-and -spoke topology, and the bus topology is that the integration component, which performs the message transformation and their delivery, is distributed into the application adapters; also the bus architecture requires the application adapters to use the same platform as the original applications [3].

The figure (Figure 5) bellow shows one possible solution for Information Systems integration with the Intelligence Information System (IIS) [16].

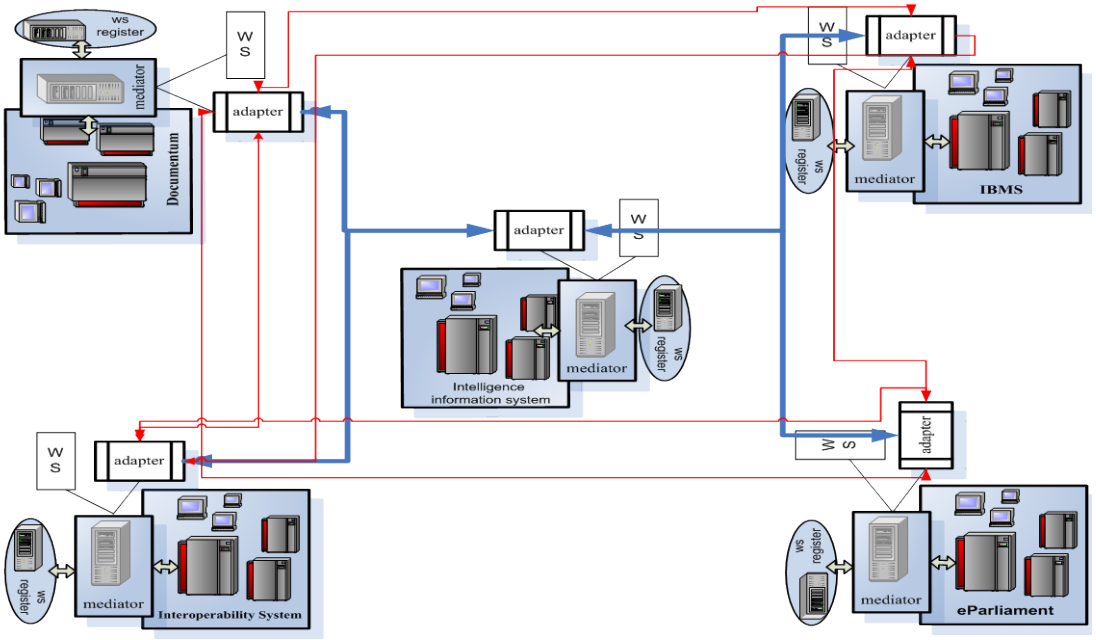


Figure 5. Information systems integration according to the peer-to-peer model

2.1 Model of Security Solution for Intelligence Information System-Based on SOA

Our model of security solution for intelligence information system-based on SOA [23], [24] is proposed on Figure 6. Figure 6 also presents: control flow (blue direction) and data flow (red direction)of the data in our model. XML Signature standard is used in control flow to validate security policies. XML Encryption is used in data flow to validate security policies.

In both cases information flow through three phases:

1. Request phase – identifying information requester and registering request with the purpose of establishing security mechanism;
2. Verification phase – identifying requester and its security mechanisms are appropriate for gaining response according to security policies related to information;
3. Notification phase – according to security mechanisms and policies, requester for information is notified for access to use information form services or requester is notified that access is denied sending forward cause in terms of security policy.

Requested information flows form source to the information requesters, going to mediation component which serves for connecting and formatting security systems in institutions. Mediation component is important for IIS, because it can be connected to more information systems which are embedded in heterogonous environment. Requested information is encrypted and it has unique security policy. Although IIS Center and System registry are not involved, they play important roles in control flow.

Control flow establishes three functions:

1. Recording information requester in terms of date and time, location and type of user who requests for information;

2. Validation to security policy of user type called requester of information and security policies attached to the information;
3. Recording each request which is not followed with information at moment of request. This third function is interested for information system designers on future services.

Highly structured suggested model of Security Solution for Intelligence Information System not only interpolates security a mechanism also provides by following:

- Effective data transmission endorsing data encryption and data formatting on appropriate level;
- Recording each request whether it is inserted in database or not, furthermore it has appropriate security policy or not. This supports recording possible disruption of security policy.
- Flexible scalable mechanisms and mechanisms for extending services which are located in IIS Registries.

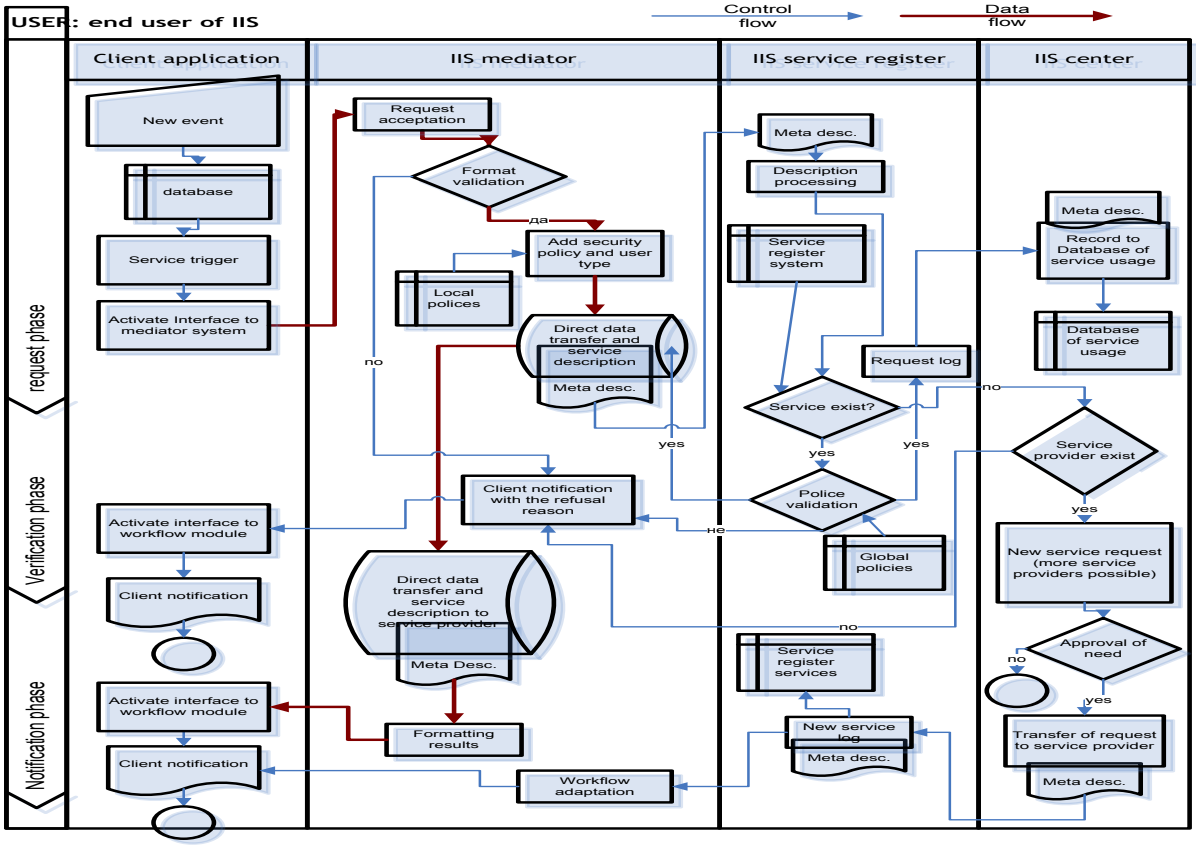


Figure 6. Model of Security Solution for Intelligence Information System

3. Metrics for intelligence information system model based on SOA

In order to conduct a proper service evaluation, appropriate methods for measuring should be used [25],[26]. The value that is obtained as a result of the measuring should be used as a referent parameter, indicating the size of the measured quantity.

Based on [25],[26], we define unifying metrics that will allow evaluation of some selected principles in SOA, such as unique categorization, discoverability, loose coupling and autonomy. These principles are typical for developing services in SOA. In the same context we introduce separate metrics for evaluating accessibility to certain intelligence information, assessment of intelligence information reliability and assessment of cost of information acquisition.

3.1 Metrics for Evaluating Services in SOA

A. Unique categorization is analyzed through four service indicators: business-oriented or technical functionality BT(s), agnostic and non-agnostic functionality AN(s), data superiority DS(s) and common business entity usage CB(s) [25]. Taking into consideration the desirable values of the given indicators, we introduce a unifying metric for services (or in a phase of service design, for service candidates), also called unique categorization K(s). The equations refer to each of the following four cases of functionality preferences:

A.1.Business-oriented BT(s), agnostic functionality AN(s):

$$K(s) = \frac{BT(s) + AN(s) + DS(s) + CB(s)}{4} \qquad (1)$$

A.2.Technical-oriented functionality BT(s), agnostic functionality AN(s):

$$K(s)=\frac{1-BT(s)+AN(s)+DS(s)+CB(s)}{4} \quad (2)$$

A.3.Business-oriented BT(s), non-agnostic functionality AN(s):

$$K(s)=\frac{1+BT(s)-AN(s)+DS(s)+CB(s)}{4} \quad (3)$$

A.4. Technical-oriented functionality BT(s), non-agnostic functionality AN(s):

$$K(s)=\frac{2-BT(s)-AN(s)+DS(s)+CB(s)}{4} \quad (4)$$

In each of these cases, the value of K(s) will be interpreted in the interval [0,1]. Furthermore, the desirable value for K(s), according to the preferred functionality, is the maximal value of 1.

B. *Discoverability*, in addition to being related to unique categorization, is described by the following indicators: *functional naming FN(sc)*, *functional naming compatibility CFN(sc)* and *information content IC(sc)*. These indicators are relevant for the process of service design, so they can only apply to service candidates. In order to define a discoverability metric **D(sc)** that will unify all of the mentioned indicators, we will firstly define the middle values for FN(sc) and CFN(sc) taking into account the appropriate values in relation to the *roles (R), operations (O), parameters (P), data types (T)* and *interfaces (I)*. We have:

$$FN(sc)=\frac{1}{5}[FN_R(sc)+FN_O(sc)+FN_P(sc)+FN_T(sc)+FN_I(sc)] \quad (5)$$

The discoverability metric for D(sc) can now be defined by:

$$D(sc)=\frac{FN(sc)+CFN(sc)+IC(sc)}{3} \quad (6)$$

The values of service candidate discoverability D(sc) will be interpreted in the interval [0,1]. A values of indicates that maximal service candidates discoverability D(s) has been achieved. On the other hand, a value of 0 indicates that discoverability is nonexistent.

C. *Loose coupling* is another principle in service oriented architecture. It contributes to increased scalability, flexibility, fault tolerance and maintainability of the architecture. Indicators that are relevant in this context are: *asynchronity of long-runing operations AS(s), common data types complexity CCT(s), abstraction of knowledge related to operations and parameters implementation AN(s)* and *(non)compensation of operations NC(s)*. Using these indicators, we define the unifying loose-coupling metric LC(s) in SOA by:

$$LC(s)=\frac{AS(s)+CCT(s)+AN(s)+NC(s)}{4} \quad (7)$$

We should note that here, is the middle value of the abstraction metrics, as calculated separately for the operations and the parameters.

The quality of loose coupling is maximal when the value of the given metric LC(s) is 1.

D. The quality of autonomy of services can be described by the indicators of direct service dependency SD(s) and functionality overlap FO(s). Since the degree of autonomy is reversely proportional to the values of service dependencies SD(s) and functionality overlap FO(s) metrics, we define the autonomy metric AU(s) in the following manner:

$$AU(s)=\frac{SD(s)+FO(s)}{SD(s)\cdot FO(s)} \quad (8)$$

The values for AU(s) that we obtain in this manner will be in the interval $[1,\infty]$. A value of 1 for AU(s) indicates lowest level autonomy. The greater the value of AU(s), the greater is the autonomy of the service. We should stress here that the value of AU(s) is unbounded from above.

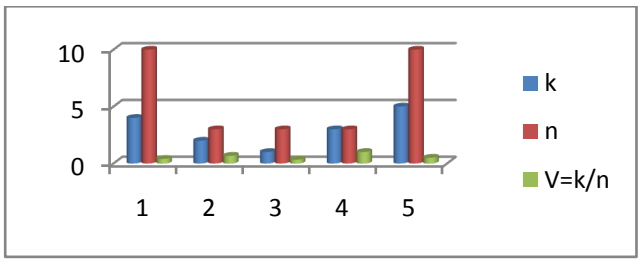
3.2 Metrics for Evaluating Services in Intelligence Information System

The reliability V of information collected by a certain service can be defined as the probability of accuracy for the particular information. It can be determined empirically according to:

$$V=\frac{k}{n} \quad (9)$$

Table 1. Reliability V of information collected by a certain service

k	n	V=k/n
4	10	0.40
2	3	0.67
1	3	0.33
3	3	1.00
5	10	0.50



where **n** presents the total number of information collected by designated service during some past period of time (consisting of one or more intelligence cycles) and **k** is the number of accurate (proven) information among them. It is clear that the possible values of **V** lie in the interval [0,1]. Given as such, V can be also considered as reliability of the service in question.

We are considering a SOA based information system that consists of **m** services with mutually independent functionality. The reliability of information in this system depends on the reliability of each of the services that information is collected from. If particular information is obtained from at least one of the previously activated services in the intelligence cycle, its *maximal reliability* V_{max} can be expressed as:

$$V_{max} = \max_{\substack{\chi(i)=1 \\ i=1,m}} \left\{ \chi_A(i) \cdot \frac{k_i}{n_i} \right\} \tag{10}$$

Here, the action of the authorities is presented by $\chi(i)$, the characteristic function of service activation,

$$\chi(i) = \begin{cases} 1 & \text{if the service is activated} \\ 0 & \text{if the service is not activated} \end{cases}$$

and $\chi_A(i)$ is the binary characterization function of the particular information

$$\chi_A(i) = \begin{cases} 1 & \text{if the information is obtatned by service "i"} \\ 0 & \text{if the information is not obtained by service "i"} \end{cases}$$

In order to optimize reliability analysis of collected data, the summary information should be broken down to elementary pieces of information. As previously, we express the emergence of elementary information by the binary characterization function. Thus, we evaluate *average reliability* V_E of each elementary information by the following equation:

$$V_E = \frac{\sum_{i=1}^{m} \chi(i) \chi_A(i) \cdot p_i}{\sum_{i=1}^{m} \chi(i)} \tag{11}$$

It can easily be noticed that values obtained in (10) and (11) depend on the set of activated services. This points that the reliability of collected information is significantly influenced by the decision process that precedes the activation of services. Namely, in order to increase the expected accuracy of the information, it is desirable to introduce criteria that will be applied in the process of decision making related to this issue.

A part of these criteria is the *information accessibility* of a service, which we will denote by **d.** The value of **d,** which belongs to the interval $[0,1]$, is estimated empirically using previous observations, assessments and known facts. A value of 0 for d indicates that the information in question is estimated to be unavailable for the service, and if $d = 1$ then information is estimated to be fully available for that service. Using this estimation, we can evaluate the a priori reliability AV_i for receiving accurate information from service **i**, according to the following formula:

$$(AV)_i = d_i \cdot p_i = \frac{d_i \cdot k_i}{n_i} \tag{12}$$

The maximal reliability for collecting accurate information by service **i** can be expressed as:

$$(AV)_{i\_max} = \max_{\substack{\chi(i)=1 \\ i=1,m}} \left\{ \frac{d_i k_i}{n_i} \right\} \tag{13}$$

while the expectation of getting accurate information from active services is given by:

$$V_E = \frac{\sum_{i=1}^{m} \chi(i)\, d_i\, p_i}{\sum_{i=1}^{m} \chi(i)} \tag{14}$$

The problem of maximal accuracy and accessibility of information by activating **s** out of **m** services is formalized by the following optimization problem:

$$\max_{\substack{S \in 2^m \\ |S|=s}} \left\{ \frac{1}{s} \cdot \sum_{i \in S} \frac{d_i k_i}{n_i} \right\} \tag{15}$$

where 2^m is the power set of $\{1,2,\ldots,m\}$.

The comparisons of the results from (1) and (3), and respectively from (2) and (4), can give a useful indication about the correctness of the decisions that have been made.

Another element that should be taken into consideration during the development phase is the *cost of information acquisition*. Its assessment should include not only the resource requirements, but also risks that can emerge during the process. For service **i,** it can be nominally expressed by a number U_i. For more convenience these numbers can be normalized to u_i, thus having their values in [0,1]. Now we formulate $k_i = d_i / u_i$ as a *coefficient of acquisition* and apply it the following maximization program:

$$\max_{\substack{S\in 2^m \\ |S|=s}} \left\{ \frac{1}{s} \cdot \sum_{i\in S} \frac{d_i k_i}{n_i u_i} \right\} \qquad (16)$$

The solution of this problem will yield the group of **s** services that can provide an optimal combination of accessibility and cost, in respect to the reliability of a certain elementary information.

Finally, Table 2 allows concluding that usage of services with the highest value for expectation of getting accurate information and the service with the highest value for information reliability is not always best approach for collecting information. These values refer to different service, respectively if one service has maximal value for information reliability, the same service does not have maximal value for expectation of getting accurate information.

Table 2. Calculation of the reliabilities for a received elementary information A

сервис	n_i	k_i	V_i (Vmax)	$\chi(i)$	$\chi_A(i)$	V_E	d_i	$(AV)_i$	$(AV)_E$
1	2	3	4=3/2	5	6	7=∑4/1	8	9=8*3/2	10=∑9/1
1	10	8	0.80	1	1		0.7	0.56	
2	9	5	0.56	1	0		0.85	0.47	
3	7	6	0.86	0	1		0.5	0.43	
4	5	2	0.40	1	1		0.3	0.12	
5	8	5	0.63	0	1		0.95	0.59	
6	2	1	0.50	0	0	**0.59**	0.9	0.45	**0.41**
7	6	4	0.67	1	0		0.95	0.63	
8	10	1	0.10	1	1		0.7	0.07	
9	3	2	0.67	0	1		0.4	0.27	
10	4	3	0.75	1	0		0.7	0.53	

n_i – total number of information received by service i
k_i – number of accurate information received by service i
V_i – reliability of the service i
$\chi(i)$ – activation indicator function of the service i (1= active, 0= inactive)
$\chi_A(i)$ – information receiving indicator function for the service i (1 = yes, 0 = no)
V_E – expected reliability of the information
d_i – accessibility of information for service i
$(AV)_i$ – probability for acquiring of accurate information from service i
$(AV)_E$ – expectance of acquiring accurate information from active services

To avoid existed shortcomings in Intelligence Information System, principle of Intelligence should be used. This principle refers to check reliability of collected Intelligence information from minimum three different sources of information. In our case, sources of intelligence information corresponded to services for collecting information in Intelligence Information System. Services that should be used in planning process for collecting information have to be selected in accordance with criteria for maximal value of expectation of getting accurate information.

However, it should be stressed that optimal usage of services in terms of probability of getting accurate information from certain services and information reliability as a product in analyzing process do not correspond with exploiting services that have maximal value by both parameters.

4. Metrics for service availability and service reliability development

Practical and expanded usage of SOA in software developed application is needed to avoid existing shortcomings. One solution is to define metrics for measuring performance of services.

However, current researches for service performance are not enough precise to be used in effective diagnoses that refer to SOA performance [27], [29].

As a result in the section are defined set of precise and practical metrics for measuring service performances. In order to be shown applicability and usefulness of these metrics they are implemented in a Intelligence Information System.

Defined metrics in this section refer to set of metrics for service availability and reliability that are part of Intelligence Information System. Metrics answer on users requirements when they sent a query to services for particular information.

4.1 Service States in Information System - Based on SOA

Generally, each information system that is based on service-oriented architecture depends of services states in particular time moment.

Term service state can be defined as a service activity when request from user/users is sent to service provider for using services. According to this, it is possible to be introduced measurement that can measure service activity. If a service is active then can be used measurement "1". If service is not active then can be used measurement "0".

When request is received by the service provider and service responses on received request then service state is defined as an active state of service and service has activity "1". If service does not response on received request, that state is defined as an inactive service state and service has activity "0".

Number of states in information system that is based on SOA, no matter where they are implemented and what is the purpose of the system, it depends of services state on each separately service that is a integral component of information system.

In order to be estimated number of possible services states in an information system, that depends of service state whether it has activity "1" or "0", we can introduce equation of variation:

$$V_n^k = n(n-1)\dots(n-k+1) \qquad (17)$$

$n -$ number of services in infromation system
$k -$ number of service states [0,1]

If equation (17) is used for presenting information system that is composed of services that can be in both states [0,1], as an example can be introduced following equations:

$$n = 3 \text{ и } k = [0,1]; \qquad V_3^2 = 3(3-1) = 12$$

$$n = 5 \text{ и } k = [0,1]; \qquad V_5^2 = 5(5-1) = 20$$

$$n = 7 \text{ и } k = [0,1]; \qquad V_7^2 = 7(7-1) = 42$$

Elaborated example allows to be concluded that possible states of services grow exponentially depending of number of active services when client request are received.

Importance of determining number of services states has influence on analyzing QoS metric in service-oriented information system.

4.2 Service Availability

Availability is service attribute that describes whether or not service is active or available after received request by a user. More precise estimation of service availability can be done on services that are frequently exploited in short time intervals [28].

Unavailability of services in service-oriented information system is related to different type of errors, failures, fixing computer networks, changing software components that are used from service provider or service [30]. Presumption that information system or services in certain period of time are founded in one of numerous service states whether or not services are unavailable or available allows implementing Markov' models. Markov' models are functions that have two variables: service state X(t) and observation time "t" of information system. Depending of variable values and variable types – discrete or continual – Markov' models can have different character (Markov' chains and Markov' processes). To determinate service availability and reliability, Markov' processes should be composed of variable for service state X(t) that should be of discrete type and time variable "t" that should be of continual type.

In order to analyze service availability, we introduce Markov' models that have countable number of states. Examples of this type of model are the processes of dying and thriving that are used as a model for describing different natural and technical systems.

Analysis for service availability can be based on assumption that availability for services is defined with discrete service states X(t) which means that probability of service transition in other state is equal to result of multiplication by constant λ with time interval Δt when services is founded in state "i" in the time moment t and it transfers in state "j" in time moment t+Δt. Constant "λ" represents number of events in time unit. In a case of service reliability and service availability "λ" is intensity of unavailability or number of service unavailability in time unit.

In the same manner, it is possible to define probability of returning in the previous service state. For example, if services were in state "j" in time interval t, then probability of services to be in state "i" in time interval t+Δt is equal to multiplication of constant μ and time interval Δt. Constant μ represent intensity of availability or number of service availability in time unit.

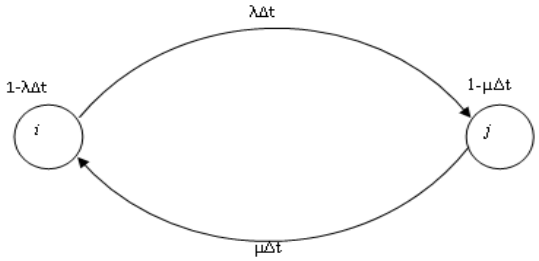


Figure 7. Diagram of transition using different states

Probability in certain time interval that refers to not happen events or service is still in a state "i" after time interval Δt is equal to sum of probability between probability when service was in state "i" in

time moment t ($P_i\ (1 - \lambda\Delta t)$) and probability when service transits from state "j" in time moment t in state "i" in time moment t+Δt ($P_j(\mu\Delta t)$).

$$P_i\ (t + \Delta t) = P_i\ (t)\ (1 - \lambda\Delta t) + P_j\ (t)\mu\Delta t \qquad (18)$$

Probability when service is in state "j" in time interval t+Δt is equal to sum of probability when services was in state "j" in moment "t" ($P_j\ (1 - \mu\Delta t)$)and probability when service transits from state "i" in time moment t, in state "j" in time moment t+Δt ($P_i\ (\lambda\Delta t)$)

$$P_j\ (t + \Delta t) = P_i\ (t)\ (\lambda\Delta t) + P_j\ (t)(1 - \mu\Delta t) \qquad (19)$$

We are planning to research service availability in certain time interval [0, t], where numerous requests are received from different users.

We introduce assumption that service can be found in both states where states can be modeled with Markov' models. First service state refers to assumption that service can respond to client request or more request in certain time moment "t". According to this assumption, service is available or active for using by the service clients. That service state can be marked as an "i".

If service transits in inactive state and it is unavailable for service clients then service state can be marked as "j". (see Figure 7)

Both cases refer to service states marked as "i" and "j" when service is available or unavailable for using. For better presentation of service availability in service-oriented information systems, it is needed to be introduced more service' states for explaining service behavior on appropriate manner.

Service states that can be explained refer to state which services can be found in certain time moment when probability of receiving service response is equal to probability that service does not receive service response. For that reason, we are introducing state "z" that refers to service state when service processing request from service client. As a result of service transitions from one state to another state, it is possible to be concluded that probability of service to be found in state when service response to client request is equal to probability that client does not receive response from service. If client receives service response then service is founding in state "x". If service client does not receive service response then service is founding in state "y" and service transits from state "z" to state "y".

According to previously mentioned, transition states can be represented by diagram presented on Figure 8.

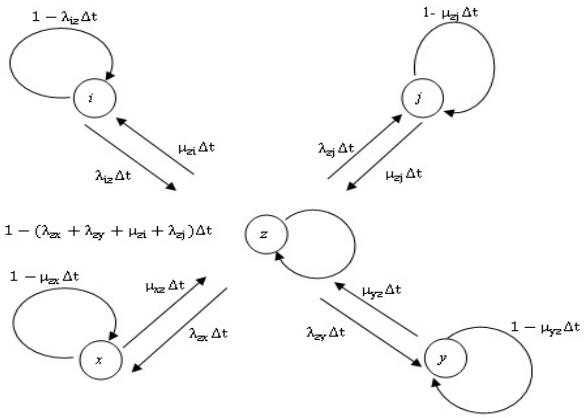


Figure 8. Diagram of transition for service availability

Because state "x" is identical with state "i" which means that service transits from state "z" in certain time moment in active state and it is available for using. As a result both states are overlapping between each other. According to this, state "x" can be replaced with state "i"

State "y" is identical to state "j" which means that service transits from "z" in certain time moment in inactive state and it is unavailable for using. As a result both states are overlapping between each other. In that case, state "y" can be replaced with state "j".

Replacing states afford optimization of transition diagram. There is possibility to avoid complex equations that are created as result of using Markov' models. Simplified transition diagram is given on Figure 9.

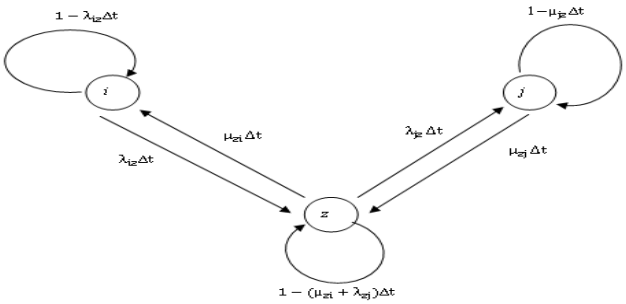


Figure 9. Simplified diagram of transition for service availability

Using simplified transition diagram, equations for probabilities $P_i(t + \Delta t)$, $P_z(t + \Delta t)$ and $P_j\ (t + \Delta t)$ when services are found in different states can be described with formulas (20),(21) and (22).

*)$P_i(t + \Delta t)$, when service is in state "i",

$$P_i\ (t + \Delta t) = (1 - \lambda_{iz}\Delta t)P_i\ (t) + P_z\ (t)\mu_{zi}\Delta t \qquad (20)$$

*)$P_z(t + \Delta t)$, when service is in state "z",

$$P_z(t + \Delta t) = P_i(t)\ \lambda_{iz}\Delta t + P_z\ (t)\left(1 - \left(\mu_{zi} + \lambda_{zj}\right)\Delta t\right) + P_j\ (t)\mu_{zj}\Delta t \qquad (21)$$

*)$P_j\ (t + \Delta t)$, when service is in state "j",

$$P_j(t+\Delta t) = P_z(t)\,\lambda_{jz}\Delta t + P_j(t)(1-\mu_{jz}\Delta t) \qquad (22)$$

Function for service availability in certain time moment is presented by following equation:

$$A(t) = \left(1 - \frac{\lambda_{iz}\lambda_{jz}}{r_2 r_1}\right) - \frac{\lambda_{iz}\lambda_{jz}}{r_1 - r_2}\left(\frac{e^{r_1 t}}{r_1} - \frac{e^{r_2 t}}{r_2}\right) \qquad (23)$$

4.3 Service Reliability

Function of service reliability represents probability of service processing in certain time interval [0,t]. Intensity when service is not available for using can be presented with constant value λ=const.

A Usage of Markov' model is the most convenient for examination service reliability. Service states where service can be found are "i" and "j". When service is in state "j", it is inactive or unavailable for using. When service is in state "i", it is active or available for using. We exanimate service reliability in time interval [0,t].

Probability that service can be found in state "i" in time moment (t+Δt) is equal to multiplication of probability $P_i(t)$ which means that service can be found in state "i" in time moment "t" and probability of service when it is available for using in time interval "Δt" or "1-λΔt" .

$$P_i(t+\Delta t) = (1-\lambda\Delta t)P_i(t) \qquad (24)$$

Probability that services in time moment (t+Δt) can be found in state "j" is equal to sum of probabilities that services can be found in state "i" in time moment "t" with probability$P_i(t)$, and multiplication of probability "λΔt"that service is unavailable for using in time moment "Δt" and probability $P_j(t)$ that means service can wait in state "j" when it is in time interval "Δt"

$$P_j(t+\Delta t) = \lambda\Delta t P_i(t) + P_j(t) \qquad (25)$$

Our research refers to examination of service reliability and availability in certain time interval [0, t], when numerous request are received in information system from different users.

We use assumption that service can be found in both states where states can be modeled with Markov' models. First service state refers to assumption that service can respond to client request or more requests in certain time moment "t". According to this assumption, service is available or active for using by the service clients. That service state can be marked as an "i".

If service transits in inactive state and it is unavailable for service clients then service state can be marked as "j".

Both cases refer to service states marked as "i" and "j" when service is available or unavailable for using which are mentioned in previous section. For better presentation of service reliability in service-oriented information systems, we need to introduce more service states for explaining service behavior on appropriate manner.

Service states that can be explained refer to state which services can be found in certain time moment when probability of receiving service response is equal to probability that service does not receive service response. For that reason, we are introducing state "z" that refers to service state when service processing request from service client. As a result of service transitions from one state to another, it is possible to be concluded that probability of service to be found in state when service response to client request is equal to probability that client does not receive response from service. If client receives service response then service is found in state "x". If service client does not receive service response then service is found in state "y" and service transits from state "z" to state "y". State "x" is identical with state "i" which means that service transits from state "z" in certain time in active state and it is available for using. As a result both states are overlapping each other. According to this, state "x" can be replaced with state "i"

State "y" is identical to state "j" which means that service transits from "z" in certain time in inactive state and it is unavailable for using. As a result both states are overlapping each other. So that, state "y" can be replaced with state "j".

By using approach similar to the one we used for service availability, transition states can be represented by diagram given on Figure 10:

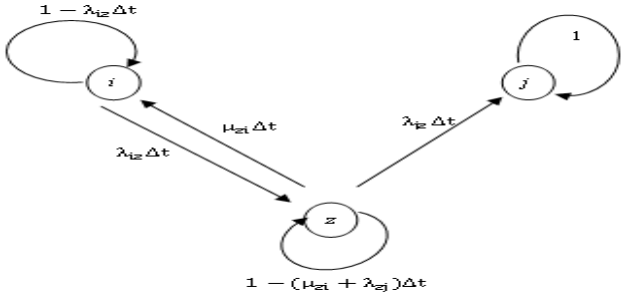


Figure 10. Diagram of transition in case of service realibility

Therefore equations for probabilities $P_i(t+\Delta t)$, $P_z(t+\Delta t)$ and $P_j(t+\Delta t)$ when services are found in different states should be resolved by following:

*)$P_i(t+\Delta t)$, when service is in state "i",

$$P_i(t+\Delta t) = (1-\lambda_{iz}\Delta t)P_i(t) + P_z(t)\mu_{zi}\Delta t \qquad (26)$$

*)$P_z(t+\Delta t)$, when service is in state "z",

$$P_z(t+\Delta t) = P_i(t)\,\lambda_{iz}\Delta t + P_z(t)\left(1-\left(\mu_{zi}+\lambda_{zj}\right)\Delta t\right) \quad (27)$$

*)$P_j(t+\Delta t)$, when service is in state "j",

$$P_j(t+\Delta t) = P_z(t)\,\lambda_{jz}\Delta t + P_j(t) \quad (28)$$

Function for service reliability in certain time is presented by following equation:

$$R(t) = \frac{r_1+\mu_{zi}+\lambda_{zj}+\lambda_{iz}}{(r_1-r_2)}e^{r_1 t} - \frac{\mu_{zi}+\lambda_{zj}+r_2+\lambda_{iz}}{(r_1-r_2)}e^{r_2 t} \quad (30)$$

Business process (Figure 11) that is used for presenting functionality of Intelligence Information System shows that intelligence operation should not be launched if in the information system does not have approval for launching that operation. Approval should be authorized by Intelligence authorities or other stakeholders in Intelligence community according to Intelligence procedures and law.

If intelligence operation is not approved by authorities then it finishes immediately, because of sensitivity in Intelligence.

If Intelligence operation is approved by authorities for certain Intelligence target then business process continues on next steps. Next step is determination of position and time on Intelligence target. In our case study, Intelligence operation refers to follow Intelligence target.

Position of Intelligence target can be determinate when services that are components of Intelligence Information System or peers of external service providers are activated.

Other services can be exploited to determinate target positions that are used as an external peer of Intelligence Information System. Using services from external peers refers to future of Intelligence which means that in a future is possible to be exploited services that will be on a higher level than at this moment.

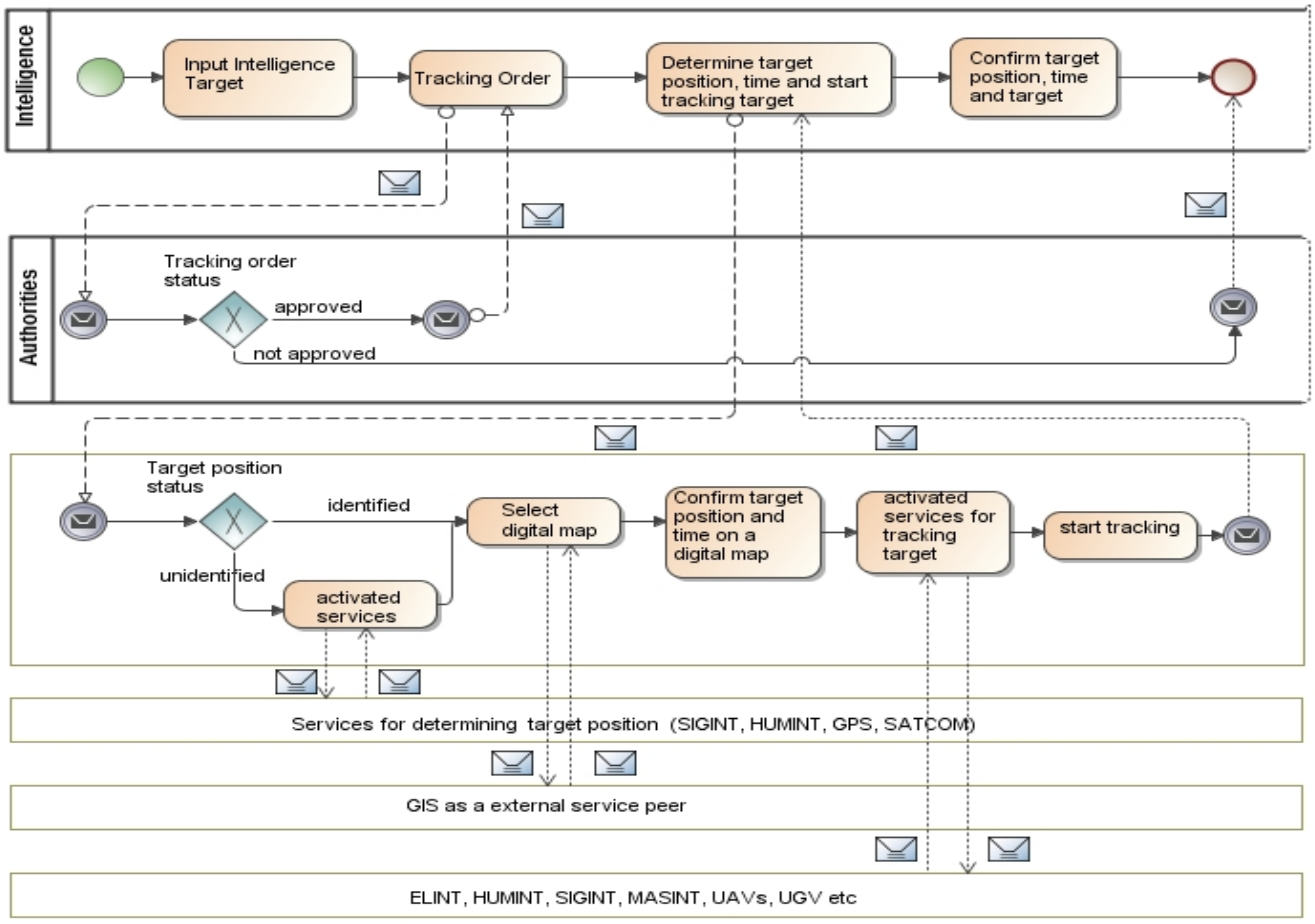


Figure 11. Business process for following Intelligence object

Position of Intelligence target can be marked on digital map which allows implementing Geographic Information System (GIS) as a service. This allows different scenarios for Intelligence target to be created. Also, routes can be estimated and should be used by the Intelligence target.

Services for following target are activated immediately when position of Intelligence object is marked on a digital map.

Common characteristic for previously mentioned services is probability that refers to service availability in certain time during Intelligence

operation. Also, zones (green, yellow, red) for determining functions of probability can be introduced (see figure 12).

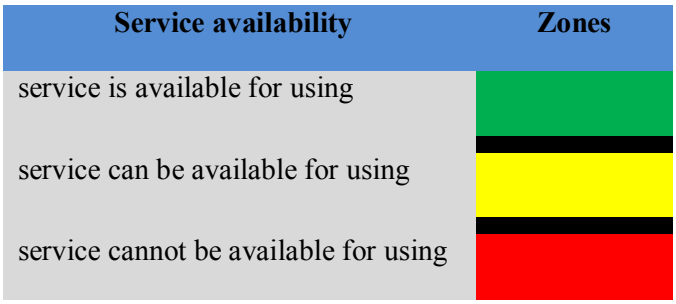


Figure 12. Service availability that is related to appropriate zones

Probability value of service availability allows selecting services that can be exploited in certain Intelligence operation in certain time. Introduced zones contribute to select services that can respond on the most appropriate manner.

5. Conclusion

Intelligence Information System Model gives contribution in Homeland Security and Civil Military Emerging Risks assessment through the possibility of providing information in the appropriate way by implementing pushing and pulling mechanisms into information systems, and then by selection of data and creation of information from raw data, that can be used in creating intelligence products and dissemination reports to the authorities. In this contribution, this is done by IIS based on SOA which follows the five postulates that enables flexible and secure design of IIS.

In this contribution we show that Information system integration should be based on assumption which refers to information sharing between users of information system. Additionally, service-oriented information systems are based on assumption which means sharing information between numerous clients through services.

Presented security approach about Intelligence Information system based on SOA provides secure data stream through services and also it provides strict security policies as a Authentication, Authorization, Privacy, Integrity and Non-repudiation.

We suggest two sets of metrics. The first one is a unifying general metrics that can be used for evaluating services in information system based on service-oriented architecture. The second metrics are information specific metrics that are used for evaluating the informative quality operation of services that are part of the proposed model. Together, they can give a thorough description of the established system of information procurement and quantify various aspects of its structure and operation. An advantage of the suggested metrics is their adoptability, i.e. they can be applied on all services and service compositions that are part of a service-oriented architecture.

Service attributes are important features for services. Developing metrics for service attribute allows determining services that are the most convenient for executing one Intelligence operation. In order to be presented functionality of Intelligence information system through estimation of probability for services in certain time moment, we have developed metrics for determining service reliability and service availability. Assessment of service attributes contributes to be exploited service-oriented systems on most appropriate manner and also it allows to be achieved high optimization in Intelligence processes.

References

[1]. Air Combat Command, - Version 2, *CONOPS UAV*, Section 6 - Communication Integration and Interoperability, http://www.fas.org/irp/doddir/usaf, US Air Force; 3 Dec 1996.

[2]. A. Goel, *Enterprise Integration EAI vs. SOA vs. ESB*, http://hosteddocs.ittoolbox.com/Enterprise%20Integration%20%20SOA%20vs%20EAI%20vsESB.pdf, consulted of January 2011.

[3]. F. Sanati, Jie Lu., *A Methodological Framework for E-government Service Delivery Integration*. Faculty of Information Technology, University of Technology, Broadway NSW. 2007.

[4]. P. Baglietto, M. Maresca, et al.. *Stepwise deployment methodology of a service oriented architecture for business communities* Journal: Information and Software Technology 47(6): 427-436. 2005.

[5]. F. Belanger, and L. D. Carter, *U-government: a framework for the evolution of e-government*, International Journal: Electronic Government 2(4): 426-445. 2005.

[6]. NATO Standardization Agency (NSA), *AAP-6(2002) NATO Glossary of Terms and Definitions*; http://www.nato.int/docu/stanag/aap006/aap6.htm, 2002.

[7]. M. Hepp, *Semantic Web and Semantic Web Services,* IEEE Internet Computing. 2006.

[8]. R. R. Burk, *Enabling Citizen-Centered Electronic Government 2005-2006 Action Plan*,USA, Office of E-Government and Information Technology. 2005.

[9]. M. H. Burstein, *Dynamic Invocation of Semantic Web Services That Use Unfamiliar Ontologies*, IEEE Intelligent Systems (July/August). (vol. 19 no. 4) 2004.

[10]. Castellano, M.. "An e-Government Cooperative Framework for Government Agencies". 38th Hawaii International Conference on System Sciences. Hawaii, IEEE. 2005.
[11]. S. Arroyo, M.-A. Sicilia, et al.. *Choreography frameworks for business integration: Addressing heterogeneous semantics*, Journal: Computers in Industry.2006.
[12]. Yu, K., X.L. Wang and Y. Zhou, *Underlying techniques for web services: a survey*, Journal of Software, 15(3), 428. 2004.
[13]. *IEEE Recommended Practice for Architectural Description of Software-Intensive Systems*, IEEE Std 1471-2000, September, 2000.
[14]. *Ministry of Defence Architecture Framework (MODAF)*, UK, version 1.2, http://www.modaf.org.uk accessed on 15 August 2008.
[15]. *NATO Architecture Framework*, version 3, AC/322-D0048. 2007.
[16]. A. Cernicki - Mijic, A. Martini, *Integracija aplikacija u elektroprivredama*, 7. simpozij o sustavu vodenja EES-a Cavtat, Dubrovnik, 5. - 8. studenoga 2006.
[17]. D. Pintar, *Implementacija stvarnovremenskog skladištenja podataka na temelju principa integracije poslovnih aplikacija*, FER e-Campus, 05.06.2008. http://www.fer.hr/_download/repository/kval_clanak_pintar.pdf
[18]. *Exploring New Command and Control Concepts and Capabilities Final Report*, NATO SAS-050, January 2006.
[19]. J. Achkoski, V. Trajkovik , and M. Dojcinovski "SOA Approach in Prototype of Intelligence Information System" ICT Innovations 2010, Web Proceedings, ISSN 1857-7288 pp. 149-160. 2010.
[20]. J. Achkoski, Vladimir Trajkovik and Danco Davcev: *Service-Oriented Architecture Concept for Intelligence Information System Development*; The Third International Conferences on Advanced Service Computing SERVICE COMPUTATION 2011 (IARIA), Rome, Italy, September 25 - 30, 2011.
[21]. J. Achkoski, V. Trajkovik: *Intelligence Information System Integration*, The 8th International Conference for Informatics and Information Technology (CIIT 2011), Bitola, Macedonia, March 2011.
[22]. J. Achkoski, V. Trajkovik, *Intelligence Information System (IIS) with SOA-based Information Systems*, 33rd International Conference on Information Technology Interfaces, IEEE, Cavtat/Dubrovnik, Croatia, June 27 - 30, 2011.
[23]. J. Achkoski, Vladimir Trajkovik and Danco Davcev, *Security Issues for Intelligence Information System based on Service-Oriented Architecture*, International Conference ICT Innovations 2011, Skopje, Macedonia, September 14 – 16, 2011.
[24]. J. Achkoski, V. Trajkovik and M. Dojchinovski, *An Intelligence Information System based on Service-Oriented Architecture: A Survey of Security Issues*, Information & Security: An International Journal, vol. 27: 91-111, 2011.
[25]. M.Gebhart, & S. Abeck, *Metrics for Evaluating Service Designs based on SoaML*, International Journal on Advances in Software, 4(1&2), 61-75. Retrieved from http://iariajournals.org/software/, 2011.
[26]. M. Gebhart, M. Baumgartner, S. Oehlert, M. Blersch and S. Abeck, *Evaluation of Service Designs based on SoaML*, In Proceedings of the Fifth International Conference on Software Engineering Advances (ICSEA) (Hall J, Kaindl H, Lavazza L, Buchgeher G, And Takaki O), p 7, Nice, France. 2010.
[27]. D. A. Menascé, *Response-Time Analysis of Composite Web Services*, Journal IEEE Internet Computing, Vol. 8, No. 1., pp. 90-92. 2004.
[28]. S. Kalepu, S. Krishnaswamy, S. W. Loke: *Verity: A QoS Metric for Selecting Web Services and Providers*. Proceeding WISEW'03 Proceedings of the Fourth international conference on Web information systems engineering workshops IEEE Computer Society Washington, USA, 2003.
[29]. R. M. Ramović., *Skripta - Pouzdanost sistema elektronskih, telekomunikacionih i informacionih*, Katedra za Mikroelektroniku I tehnicku fiziku, Univerzitet u Beogradu, Elktrotehnicki fakultet, 2005.
[30]. W. Xie†, H. Sun‡, Y. Cao† and Kishor S. Trivedi† *Modeling of Online Service Availability Perceived by Web Users*

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A Fully Personalized Adaptive and Intelligent Educational Hypermedia System for Individual Mathematics Teaching-Learning

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Abstract **– In this study, architecture and development process of UZWEBMAT, an adaptive and individualized environment based on learning styles and supported with expert system, are presented. UZWEBMAT was developed to teach probability unit of 11th grade mathematics course. Three different contents, which are appropriate to Visual-Auditory-Kinesthetic (VAK) learning styles, are presented to learners. Content of each sub-learning style is presented with expert system support. Thanks to this expert system, it is possible for learners with same learning style to take different contents. By this means, highest level of individualized learning environment was tried to be created via UZWEBMAT. Integration of UZWEBMAT to real classroom environment shall be made in future studies. Evaluation of UZWEBMAT and its impact on academic achievements of learners shall be researched.**

Keywords **– Individualized e-learning, individual learning differences, adaptive educational hypermedia and mathematics teaching-learning.**

1. Introduction

Learning is a complicated and difficult process. Many parameters such as perception of information by the individual, his/her processing the information, general abilities, developmental characteristics and environmental factors play a part in this process. Undoubtedly, learning process, being influenced by this many and this much different factors, bears important differences for individuals. Taking into account these differences while designing learning environments shall increase the efficiency of learning activities [1-2]. Many parameters such as general abilities of individuals, their cognitive processes, emotions and tendencies, developmental characteristics, previous information and social environment around them influence their learning. Broadly, Learning Style (LS) can be defined as learning preferences and differences of an individual [3-4]. According to Babadoğan [5], learning processes of individuals shall be planned more easily providing that their learning styles are known. This will facilitate the selection and application of learning environment that will be prepared for individuals. Previous researches indicate that organization of learning environments according to learning styles of learners increase the efficiency of learners' learning. Besides, these studies revealed that learning which takes place in environments that are appropriate for learning styles positively influence students in terms of remembering and using their knowledge and their attitudes regarding the subject [6-8]. Besides, previous studies indicate that organization of education according to learning styles has positive impacts on learning outputs [2, 6, 9-11].

Methods of comprehending the information by individuals can be divided into three categories which are visual, auditory and kinesthetic [1-2, 13-14]. The model that is accepted as learning style based on this fact, Visual-Auditory-Kinesthetic (VAK), was designed by Sarasin [15] and improved by Coffield et al. [13]. According to VAK learning style, learners who learn visually learn best by seeing. For these learners, pictures, flow diagrams and videos are the best learning instruments. Learners who learn audibly learn best by hearing. For these learners, audible lectures are the best learning instruments. Learners who learn kinesthetically learn best by doing-experiencing. For these learners, computer games, interactive animations are the best learning instruments.

1.1. Transition from traditional e-learning environments to individualized e-learning environments

In parallel with rapid development of informatics technologies, e-learning environments change and encounter with innovations as well. Traditional e-learning environment presents pre-fixed contents in the same sequence to all learners. Preliminary information, learning styles and individual differences of learners regarding the subject are not taken into account in these environments. This cannot be accepted in terms of individual learning. Individual differences, preliminary information and needs of learners can be different. These differences

may have an impact on their learning. Adaptive Educational Hypermedia System (AEHS) became alive in this phase and they were suggested as alternatives to traditional hypermedia developed according to "one-size-fit-all" approach [16-18].

AEHS creates a user model determining individual differences such as preliminary information regarding the subject, preferences and learning styles of each learner unlike traditional web based education systems [9, 18-20]. In this sense, learning styles come first among the concepts taken as basis for development of individualized and adaptive e-learning environments. Thus, it is possible to encounter with many adaptive e-learning studies based on learning styles in literature [9]. Major studies among these can be listed as follows. Triantafillou, Pomportsis & Georgiadou [21] developed AES-CS. Witkin and Goodenough LS was employed in this system. Two different LSs which are field dependent and field independent are used in this system. A learning style from general to specific is employed for those who are field dependent while a learning style from specific to general is employed for those who are field independent. Arthur was designed and developed by Gilbert & Han [10]. System is based on VAK LS model and visual-interactive, audial-voiced and text-writing contents were prepared and presented to the learners. System was developed to teach C++ which is a computer programming language. CS383 was developed by Carver, Howard & Lane [22]. Felder-Silverman LS was employed in this system. The system was developed for "Computer Systems" course. Brown, Fisher & Brailsford [23] developed the system they called DEUS. This system is based on Felder-Silverman LS. The system was prepared at primary school level to teach life cycle and flowering plants subjects of biology course. eTeacher was developed by Schiaffino, Garcia &Amandi [24]. Felder-Silverman LS was employed in this system. The system was prepared to teach artificial intelligence course lectured in department of system engineering. iWeaver was developed by Wolf [14]. Dunn & Dunn LS was taken as basis in this system and an adaptive version of it was used. The system intended to teach Java programming course. It was enriched by style based media components and other learning instruments. Four different contents were prepared and presented according to perceptions of individuals. ILASH was developed by Bajraktarevic, Hall & Fullick [25]. Hsiao LS was employed in this system. This system was designed to teach "characteristics of waves" and "solar system" subjects of Physics course. INSPIRE was developed by Papanikolaou, Kornilakis & Magoulas [26]. Honey & Mumford LS was taken as basis in this system. WHURLE-LS is a system built on WHURLE system developed by Moore, et. al [27]. Felder-Silverman LS was taken as basis in this system and visual/oral contents were presented to learners. The system was developed and applied to teach internet and www subjects in Department of Computer Sciences and IT in Nottingham University [1]. Mustafa & Sharif [28] developed AES-LS system which uses VARK LS. This system is intended to teach JavaScript.

This study concentrates on architecture and development of UZWEBMAT, a system designed to teach probability unit of 11th grade mathematics subjects. UZWEBMAT is individualized based on VAK learning style. It is designed as an adaptive and intelligent e-learning environment. Architecture of UZWEBMAT and its components are explained in detail in the next sections of this paper. UZWEBMAT is based on .net technology. The system was developed using C# language in Visual Studio 2010. Learning objects are used in UZWEBMAT were coded with Adobe Flash CS5 and ActionScript 3.0. SQL Server 2008 was used for database. The system developed can be reached via http://www.uzwebmat.com.

2. UZWEBMAT: A Fully Personalized Adaptive and Intelligent e-Learning Environment

System architecture and details of the system called UZWEBMAT are concentrated on in this section. UZWEBMAT system can be analyzed under six categories. These categories can be listed as architecture, expert system supported content, personalized assessment module, learner module, teacher module and messaging module.

2.1. Architecture

Architecture of UZWEBMAT is dealt with in detail in this section. Basic architecture of UZWEBMAT system is shown in Figure 1.

As it is seen in Figure 1, the learner who registers to the system takes Learning Style Inventory (LSI) firstly. LSI was used in order to determine the learning styles of learners. At the end of literature review, we encountered with many LSIs appropriate for VAK learning styles. Five point likert type scale developed by Gökdağ [29] was employed in the study and used in various studies. Cronbach Alpha reliability coefficient of the scale, which divides learners into three that are visual, auditory and kinesthetic, was found as 0.74. Credibility and reliability studies of the scale were conducted by Gökdağ [29].

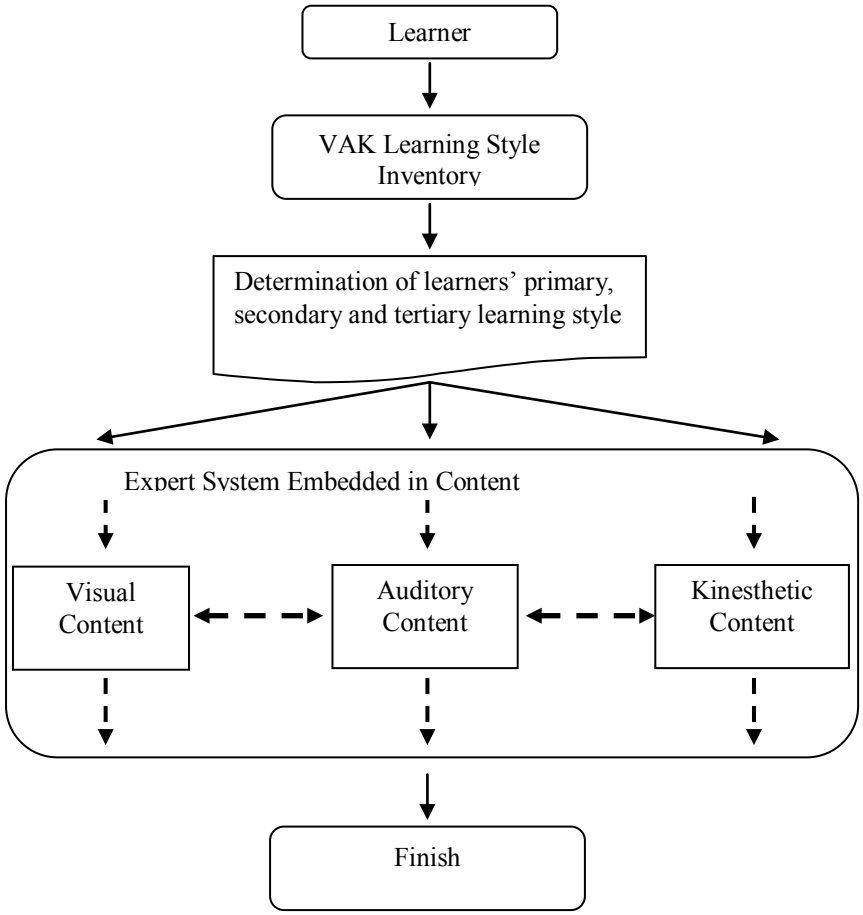

Figure 1. Architecture of UZWEBMAT

2.2. Expert system supported content

Probability unit of 11th grade mathematics curricula constitutes the content of UZWEBMAT. Sub-topics of probability unit are permutation, combination, binomial expansion and probability. Fifty-three learning object (LO) scenarios were prepared in total to teach these subjects. These scenarios are transferred to digital environment as different learning objects of each sub-style of VAK LS. Characteristics of each sub-learning style of VAK LS were taken into consideration while preparing these LOs. Thus, figures, pictures and animations are prominent for visual learners. Voiced instructions, warnings and feedbacks are prominent for auditory learners. Similarly, learning materials were prepared using interactive animations predominantly for kinesthetic learners and an environment enabling learners to learn by experience and practicing was created.

Table 1 shows distribution of fifty-three LOs prepared for each sub-learning style according to subjects.

Subject	LO's
Permutation	1-16
Combination	17 – 27
Binomial Expansion	28-31
Probability	32-53

Table 1. Distribution of 53 LOs according to subjects

One of the most important characteristics of UZWEBMAT is that content is presented with the support of expert system. An expert system was prepared while preparing the content and it was buried in the content. This expert system has two main duties. First of them is determining the questions and solution supports learners will take within LOs according to their answers. Second of them is to enable learners browse between primary, secondary and tertiary learning styles.

Primary duty of expert system within UZWEBMAT is to make directions in LOs and to present solution supports. In this sense, Fig. 2 shows presentation plan of a sample learning object used in UZWEBMAT. Figure 2 shows the presentation plan of 12th LO prepared to teach circular permutation.

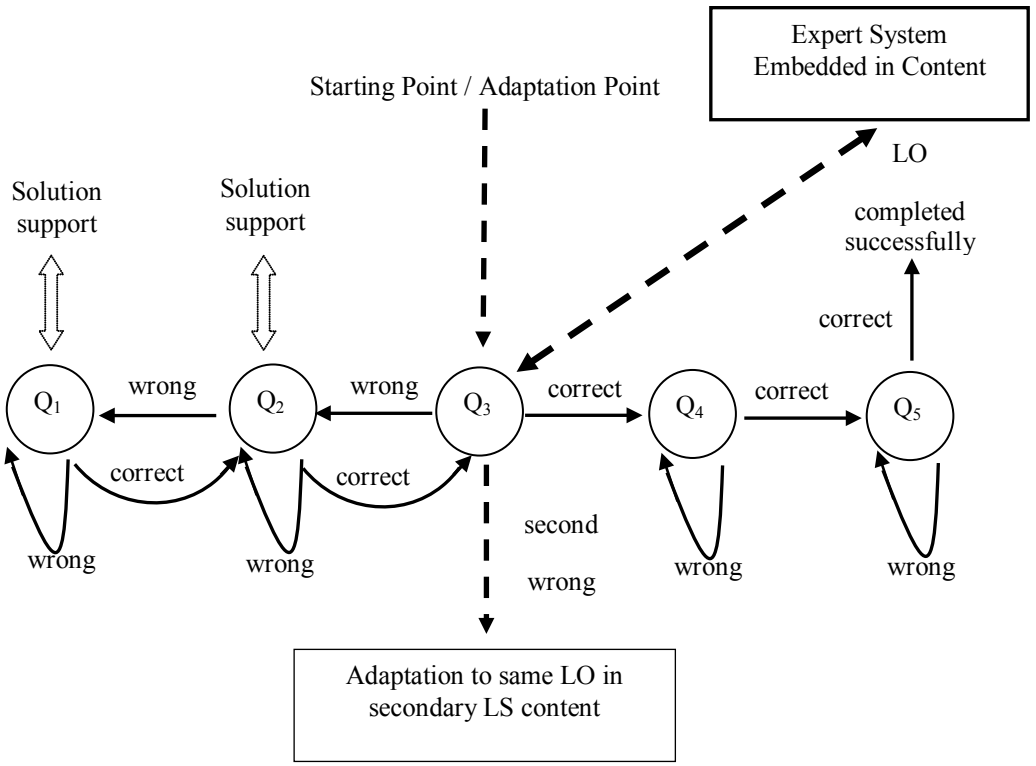

Figure 2. Expert system structure in a sample LO and its process

There are a total of five questions in this LO. The learner initially encounters with the third question in this LO. The learner correctly answering this question will successfully complete the LO on condition that s/he correctly answers the fourth and fifth questions respectively. In this case, s/he will be directed to the next LO. The learner failing in answering the third question for the first time will be directed to simpler second question. The learner correctly answering this question is directed to the first question. Solution support is provided to the learner failed in answering the second question by the system. Should the learner failed in answering this question again, s/he is directed to simpler first question. The learner who gets solution support for the first question will get enough solution support to correctly answer this question. The learner correctly answering this question will be directed to the second question with the same reason. The learner correctly answering the second question will be directed to the third question. Since introduction question of this LO is the third one, this question is considered as the direction point by the expert system. The learner who failed in answering the third question twice will automatically be directed to the same LO of his/her secondary learning style by the expert system.

As it can be seen from Figure 2, each learner does not take the same content in this LO. Solution supports the learner will take and his/her path of progress may change according to the learner answers. All the possible paths in this LO are thus can be listed as below:

First Path: *Q3 → Q4 → Q5 → LO completed.*
Second Path: *Q3 → Q2 → Q3 → Q4 → Q5 → LO completed.*
Third Path: *Q3 → Q2 → Q1 → Q2 → Q3 → Q4 → Q5 → LO completed.*

All the LOs constituting UZWEBMAT were prepared in this structure. In other words, there are graded questions, solution supports and direction points between styles in any of LOs. Expert system is activated according to learner performances and answers and it leads learners to the most appropriate path.

Second duty of expert system buried in content is to direct learners between styles. Fig. 3 shows architecture of a learner's direction to LOs of different styles by the system.

According to Figure 3, learner progressing in primary style of UZWEBMAT is directed to the same LO of secondary learning style at some specific points providing that s/he could not complete the activities of learning objects. Learner taking and successfully completing the LO of secondary learning style is directed to content primary learning style and continues this way. Learner not being able to complete the LO of secondary learning style successfully is directed to the same LO of tertiary

learning style. Learner taking LO of tertiary learning style shall be redirected to content of primary learning style should s/he successfully completes the LO and s/he continues with the next LO of primary style. Learner failing in LO of tertiary learning style is recorded and reported to the teacher. Learner whose situation is reported to teacher is redirected to the content of primary learning style and continues with the next LO. Thus, UZWEBMAT does not present a fixed content to learners even with the same learning style. Learners with the same learning style may progress in different ways due to expert system buried in the content. This indicates that UZWEBMAT is individualized at the highest level.

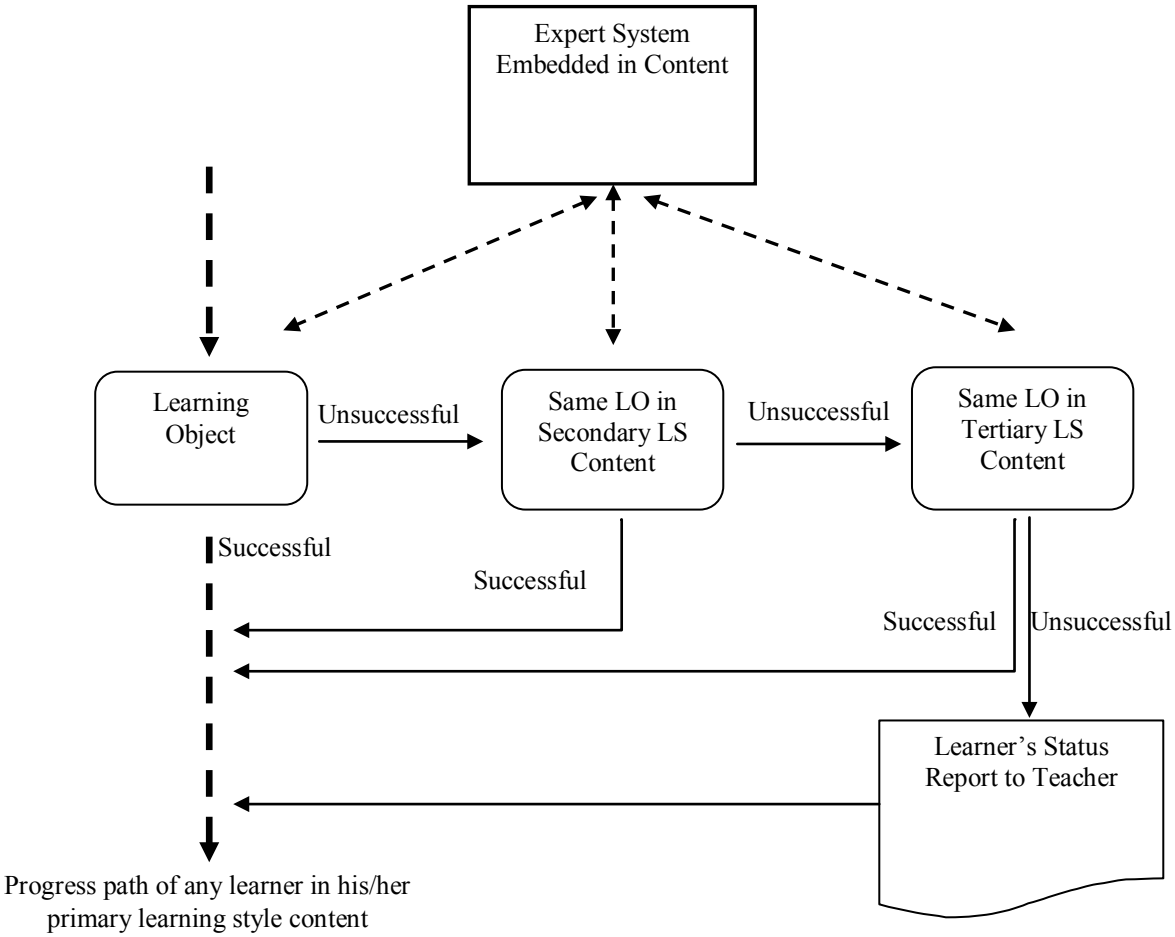

Figure 3. Architecture of expert system supported inter-style direction in UZWEBMAT

2.2.1. A sample LO scenario and screen shots

Screen shots from LOs of different styles constituting the content of UZWEBMAT are given in this section. Scenario and presentation plan of a random selected LO developed for teaching combination is displayed in Table 2.

As seen Table 2, This LO is one the LOs developed for teaching combination. There are two questions in LO. Learner takes the first question initially and the activity is done if his/her answer is right for the first question. The learner is directed to simpler second question if the answer is wrong. The learner is redirected to the first question if the answer is right for the second question and s/he is expected to solve the first problem with the same logic. Learner failing in the second question is given solution support to solve the problem. Learner solves the problem and is redirected to the first question again. Learner's progress between questions and providing solution support are decided by expert system; it makes the necessary guidance. If learner fails in the first question again, expert system does its second duty which is guidance among learning styles. This expert system directs the learner to the same activity of secondary learning style automatically.

Elif, Hale, Pelin and Merve participated in basketball team auditions organized in the school annually. Team coach will choose 2 new players for basketball team this year.

1. How many different selections can be made with these four candidates?
2. How many selections would be made if two player were selected among Elif, Hale and Pelin?

Start Question /Direction Point

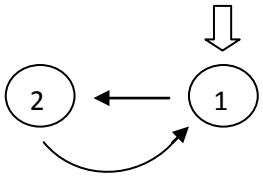

Table 2.A sample LO scenario developed for combination

Figure 4 and Figure 5 shows sample screen shots for visual and kinesthetic learning styles from this LO respectively. No screen shots can be used for audial content since all the feedbacks and solution supports of this LO are voiced commands.

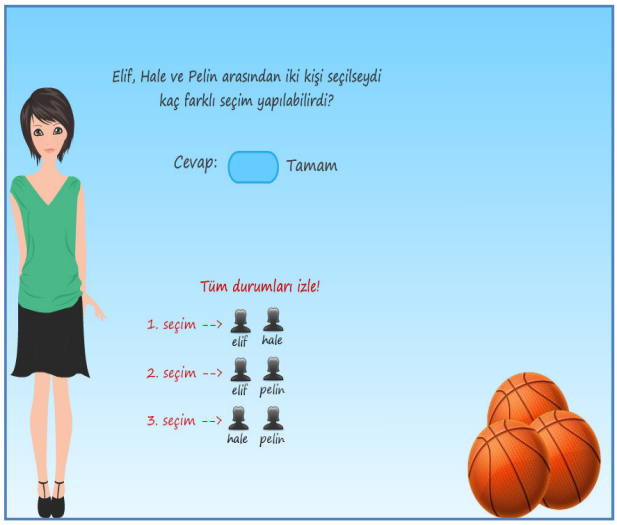

Figure 4. Screen shot of solution support given in case of failing in the second question of LO in visual LS

Figure 4 displays screen shot of solution support given in case of failing in the second question in LO. This question asks how many different couples can be made with two people out of three. If learners correctly answer this question, s/he will be redirected to the first question without any solution support. If learner cannot give two correct answers for the second question, animation in displayed in Fig. 4 will be played gradually. Animation shows selection of two people out of three step by step to the learner. In this way, the learner will see how two people can be selected out of three and total number of selections as solution support.

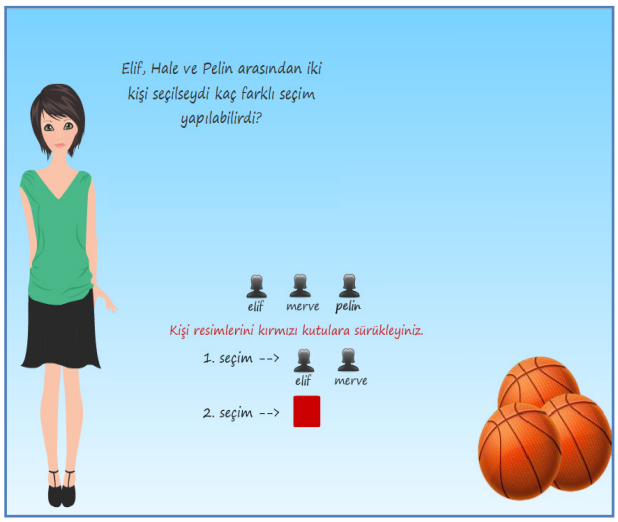

Figure 5. Screen shot of solution support in case of failing in the second question of LO in Kinesthetic LS

Fig. 5 shows screen shot of solution support in case of failing in the second question of LO. This question asks learners how many different selection of two peoples can be made with three people. If learner answers correctly, s/he will be redirected to the first question without getting any problem support and s/he will be expected to answer the question with the same logic. If learner fails for both questions asked in

the same question, animation in Fig. 5 will be played by the learner. By dragging the pictures of people seen on the screen on the boxes, the learner will see each selection. Fig. 5 shows the screen shot of the animation after some part of it was played. Main approach here is to enable learner learn as if playing a game using the animations which is learning by practice. In this way, the learner will see how many selections can be made with two people out of three by doing it himself.

Fig. 6 and Fig. 7 show the feedback given to learner who complete the LO successfully and directed to the next LO and feedback given to learner who failed in the first question which is the direction point and directed to the content of secondary LS respectively.

Fig. 6. Screen shot of feedback given to the learner who completed the LO successfully and directed to the next LO

Fig. 7. Screen shot of feedback given to the learner who is directed to the same LO of secondary LS on adaptivity point

2.3. Personalized Assessment Module

An individualized learning environment is presented to learners via UZWEBMAT. In this context, Item Response Theory (IRT) was employed instead of classical test theory as assessment module and Computerized Adaptive Test (CAT) was developed and integrated into UZWEBMAT using Item Response Theory. IRT is a mathematical model which takes into consideration a person's possibility of giving the right answer to each item and defines the participant independent from the participant and the test [30-31]. In this theory, even if two tests with different questions were to be applied on the same learner, estimated ability level would not be different. IRT uses various models to estimate ability. This estimate ability is known as θ. It is a value between -3 and +3. On θ scala, 0 represents average estimate ability, negative values represent estimate ability lower than average and positive values represent estimate ability higher than average estimate ability [30, 32-33]. IRT uses various models to estimate ability. These models vary from each other in terms of the number and variety of used parameters [31-32, 34-35]. The most common model is 1-parameter logistic model, 2-parameter logistic model and 3-parameter logistic model [30]. Which model will be used is decided by analyzing model-data adaptation in IRT analyses.

CAT systems provide an adaptive test to each participant adapted to his/her estimate ability. CAT systems are based on asking different questions by making adaption of item selection according to person's estimate ability instead of giving the same test for each user. Asking question which are not in compliance with estimate ability of a person may both make him or her bored and negatively influences his or her motivation [33, 36-38].

Success of any CAT system largely depends on a high quality item pool. Item production is the first and maybe the longest phase of development of a CAT system. Final item pool should contain 5 to 10 times more items considering the items to be presented to participants [33, 35]. Five tests in total were designed for the CAT system to be integrated into UZWEBMAT. Four of these tests were organized as subject tests for permutation, combination, binomial expansion and probability respectively. The numbers of questions in these tests are 20, 20, 15 and 20 respectively. As for the fifth test, it was prepared as end of unit test. Questions in this test were prepared taking into account that it will cover all subjects. Total number of questions in this test is 30. Total number of questions in CAT system was planned to be 105. An initial item response consisting 940 questions was prepared for the CAT system and these questions were applied in various

periods on eleven different high schools in city centre of Trabzon and various districts of Trabzon, Turkey during 6 months. MULTILOG 7.0 was used in this study to test model data adaptation and to decide which logistic model to use. According to results of analyses, majority of test items were in compliance with 3-parameter logistic model (3PL). Problematical items which are not in compliance with 3 parameter logistic model were not included in item pool. Parameters (a, b, c) in 3-parameter model were obtained via MULTILOG 7.0. A CAT application was developed using the remaining questions for the application and it was integrated into UZWEBMAT.

Possibility of giving correct answer for each ability level between -3 and +3 in 3PL was calculated using formula 1 [30]. These calculated values are recorded in database. The probability values were calculated for the entire pool of questions.

$$P(\theta) = c + (1 - c)\frac{e^{Da\,(\theta - b)}}{1 + e^{Da\,(\theta - b)}} \qquad (1)$$

a: item discrimination index
b: item difficulty parameter
c: guessing parameter
θ: ability level
D: scaling multiplier (1.7)
e: fixed (2.718)

P(θ): Probability of giving correct answer of a person with θ level of ability

The learner completing each sub-topic in UZWEBMAT is directed to the related end of subject test. Learner completing these subject tests takes the LOs for the next subject and takes the subject tests again when s/he reaches the end of subject tests. An end of unit test is prepared for a learner taking all the subjects. Incorrect answers of learners given to end of unit test is recorded and subjects in relation to these questions are marked as unperceived by UZWEBMAT. Related learner is redirected to these subjects automatically and s/he repeats these subjects. This is recorded and reported to teacher as well.

Maximum Likelihood Estimation (MLE) method was employed to estimate ability levels of learners taking CAT application. This method is commonly used for ability estimation. It finds the value of ability level making the answer set probability highest based on the answers given by participants. Maximum Information Selection (MIS) method was employed to select questions appropriate for ability level estimated from item pool. With this method, the question providing the most extended information about the ability level of participant is selected. Introduction question is selected considering the fact that the participant has a middle level of knowledge [32]. In this study, introductory question for the first subject test of permutation was accepted as 0 which is middle level and the estimated ability level is accepted as 0 as well. The first question was asked from this ability level. In the later end of subject tests and end of unit tests, the ability level estimated in previous test is accepted as introductory level and the question is asked accordingly. System will ask the question which will provide the furthest information about ability levels of learners between -3 and +3 ability levels after selecting it. In this respect, the learner will take the most appropriate question according to his or her ability level. Since fixed number of questions is used in developed tests, fixed numbered stopping principle was based on at the end of the tests.

Learner answers were assessed by the system at the end of the tests and their scores are calculated according to IRT. Test score of learners in IRT are calculated according to formula 2 after determining ability level of learners [30].

$$TS_j = \sum_{i=1}^{N} P_i(\theta_j) \qquad (2)$$

TS_j: score of the test containing j number of questions
θ_j: ability level estimated at j number of item

$P_i(\theta_j)$: Correct answer probability of i item which is correctly answered at the estimated ability level

This scoring system is different from classical test theory. Besides, it is a rather productive method for individual assessment. The learner answering the same number of questions may get different scores in IRT while they are given equal scores in classical test theory. Main reason of this is the questions answered by the learner and the fact that estimated level of ability may be different after completing the test. Learners taking the questions at end of subject test and architecture of ability level estimation are shown in Figure 8.

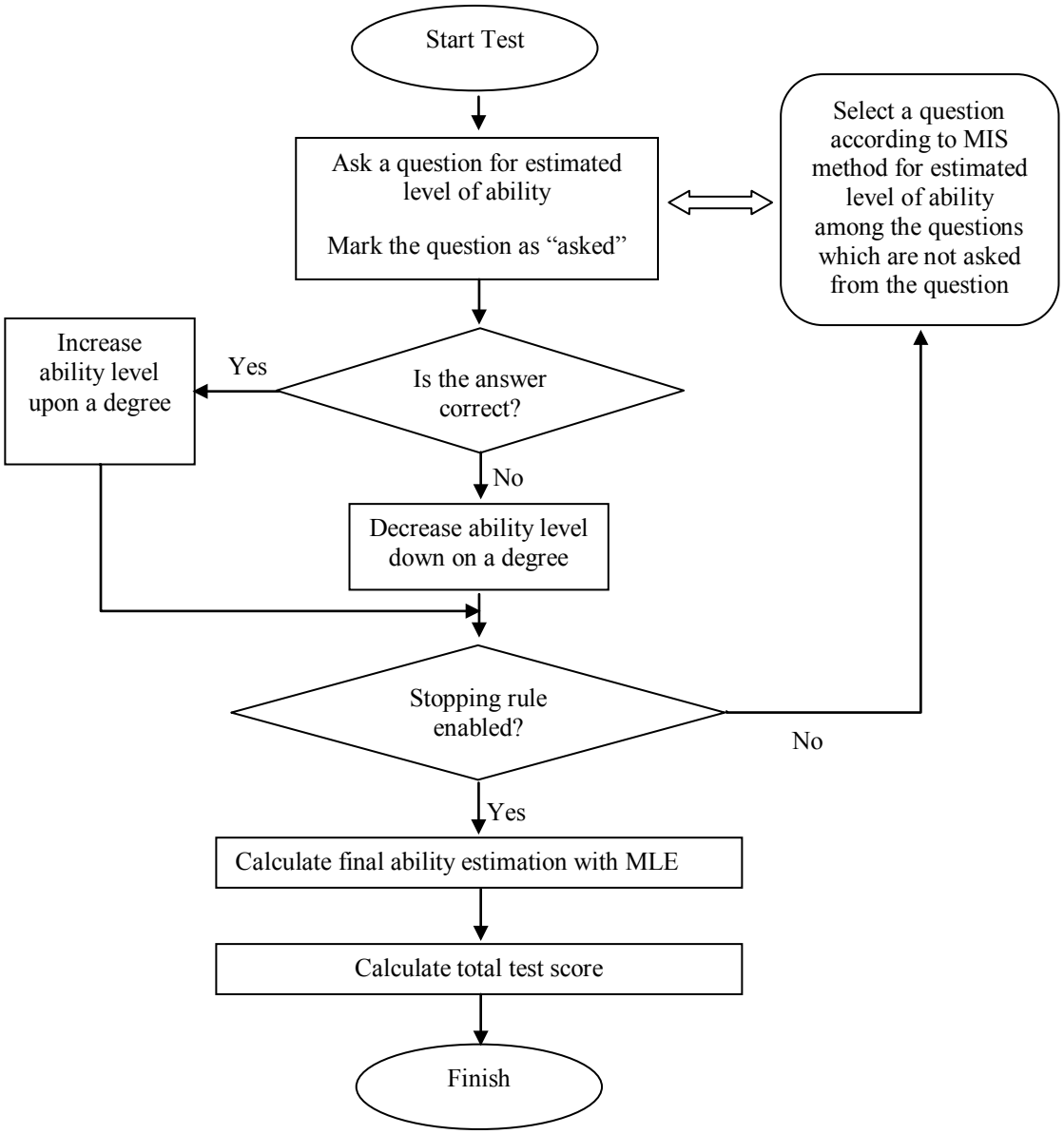

Figure 8. Architecture of question selection and ability estimation in UZWEBMAT and CAT

2.4. Learner Module

Learner module is one of the most important components of AEHS. Learner module in UZWEBMAT was designed as such: learner registers in to the system. Learner registering the system waits for the approval by the teacher. The learner whose registration is not approved by teacher can by no means use system. Learner whose registration is approved takes VAK LSI initially. Primary, secondary and tertiary learning styles of learners are determined and recorded in database. The learner is automatically directed to the content of his/her primary learning style. Learner taking the content of his/her primary style is supported by browsing support between styles when necessary thanks to expert system buried in content. This browsing between styles are recorded in database and reported to the teacher. Teacher can observe the progress of the learner in the system thanks to this data.

The other information kept in learner module is the performance of student in personalized assessment module in UZWEBMAT. All end of subject and end of unit test performances of the student, ability levels and total scores are recorded in database.

2.5. Teacher Module

Teacher module of UZWEBMAT was developed for teachers to login to the system and follow learner activities. When students became a member of UZWEBMAT, they wait for the approval by teachers. Registration of the student which is not approved by the teacher is kept passively. Student whose registration is approved by the teacher can use the system actively.

All activities of the student registered in UZWEBMAT within the browsing between pages and learning styles and their performances in tests can be observed by teacher thanks to this module. In addition to performance of the student, system keeps information such as the times when student logs in and out and how much time s/he spends in one page. The teacher can access to the information of any student by clicking on it. In short, thanks to this module, teachers can follow the learners within UZWEBMAT. Therefore, it is possible for teachers to know his or her learners better individually.

2.6. Messaging Module of UZWEBMAT

This module was created in order to provide messaging between members of UZWEBMAT. All the learners and teachers registered in the system can send e-mails to each other. Thanks to this structure named as "UZWEBMAT e-mail" users can send e-mails to each other when they deem it necessary. Each user can view his or her inbox when they log in the system under this module. The module was designed as a real mail sending-receiving medium. Members can see their mails in the form of inbox, read them and delete them. Information about the inbox is given to the members who log in the system. In this way, members can see whether they have unread mails. Briefly, learner-learner; learner-teacher; teacher-learner interactions are provided thanks to this module.

3. Conclusion and Future Work

Education technology brings many changes and innovations each day. It also encounters you with many alterations. Traditional e-learning environments provide the same content to each student. Due to their aforementioned structures, traditional e-learning environments are especially criticized in terms of individual learning. These criticisms and innovative approaches led to traditional e-learning environments' replacements by individualized and intelligent e-learning environments gradually. Thanks to these new approaches, e-learning environments taking individual differences of students such as learning styles, pre-information about subjects and needs into consideration are being developed and prevailed.

In this study, architecture and design of an individualized adaptive and intelligent e-learning environment named UZWEBMAT are focused on. UZWEBMAT was designed to teach sub-topics of probability unit of mathematics which are permutation, combination, binomial expansion and probability. UZWEBMAT is an individualized adaptive and intelligent e-learning environment based on VAK LS. UZWEBMAT decides learning styles of students and presents the appropriate content to each student according to their own learning styles. Expert system buried in content of UZWEBMAT was used. Solution supports to be given students in LOs and inter-page browsing are decided using this expert system. Thanks to this expert system, different learners with the same learning style may be put subject to different instructions according to their performances and ability levels. Therefore, individual learning has become prominent instead of learners' taking the same content in web mediums. Taking this structure into consideration, it is possible to say that UZWEBMAT is totally a learner centered system and it proposes choices to learners in each step according to their performances. Briefly, UZWEBMAT presents what learners need.

UZWEBMAT will be a beneficial instrument for teachers due to these characteristics. Hence, teachers can use this system in real class environments. From this aspect, this system can be used both for individual learning and formal learning in real class environments. In future studies, UZWEBMAT will be presented to the evaluation of teachers and students and effect of this system on academic achievements of students shall be searched. As a result of these studies, applicability of UZWEBMAT's aforementioned frame for other subjects of mathematics and more broadly for different courses will be searched. As a result of these studies, use of adaptive and intelligent e-learning environments may be become widespread and related studies shall gain speed. Thus, it is thought that development and proliferation of this and similar systems will contribute much to the individualization of e-learning environment.

Acknowledgement

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References

[1]. Brown E, The use of learning styles in adaptive hypermedia, Unpublished Doctoral Thesis, The University of Nottingham, England, 2007.

[2]. Wolf C, Construction of an adaptive e-learning environment to address learning styles and an investigation of the effect of media choice. Unpublished Doctoral Thesis, School of Education, Design and Social Context Portfolio, RMIT University, Australia, 2007.

[3]. Adey P, Fairbrother R, William D, Johnson B, Jones, C, Learning styles & strategies: a review of research, London, King's College, Centre for the Advancement of Thinking, 1999.
[4]. Arı E, The effect of constructivist approach and learning styles in general chemistry laboratory applications on learners' achievements, scientific operation abilities and attitudes, Unpublished Doctoral Thesis, Marmara University, Education Sciences Institute, 2008.
[5]. Babadoğan C, Öğrenme stili odaklı ders tasarımı geliştirme, Milli Eğitim Dergisi, Vol. 147: 61-63, 2000.
[6]. Aşkar P, Akkoyunlu B, Kolb learning style inventory. Egit Bilim, Vol. 87: 37-47, 1993.
[7]. Demirtaş O, Demirkan H, Focus on architectural design process through learning style. Design Study, Vol: 24: 437-456, 2003.
[8]. Kraus LA, Reed WM, Fitzgerald GE, The effects of learning style and hypermedia prior experience on behavioral disorders knowledge and time on task: a case-based hypermedia environment. Comput Hum Behav, Vol. 17: 124-140, 2001.
[9]. Brown E, Brailsford T, Fisher T, Moore A, Evaluating learning style personalization in adaptive systems: Quantitative methods and approaches. IEEE Tlt Vol: 2: 10-22, 2009.
[10]. Gilbert JE, Han CY, Arthur: A personalized instructional system. J Comput High Educ, Vol: 14: 113-129, 2002.
[11]. Liegle OJ, Janicki, TN, The effect of learning styles on the navigation needs of Web-based learners. Comput Hum Behav: Vol: 22: 885-898, 2006.
[12]. Zhang LF, Relationship between thinking styles inventory and study process questionnaire. Pers Indiv Differ, Vol: 29: 841-856, 1999.
[13]. Coffield F, Moseley D, Hall E, Ecclestone K, Learning styles and pedagogy in post-16 learning: A systematic and critical review. Wiltshire: Learning and Skills Research Centre, 2004.
[14]. Wolf C, iWeaver: towards 'learning style'-based e-learning in computer science education. In Proceedings of the fifth Australasian conference on Computing education, Adelaide, Australia, 4-7 February 2003, pp. 273–279, 2003.
[15]. Sarasin LC, Learning style perspectives: Impact in the classroom. Madison, WI: Atwood Publishing, 1998.
[16]. Brusilovsky P, Methods and techniques of adaptive hypermedia. User Model User-Adap: Vol: 6: 87-129, 1996.
[17]. Brusilovsky P, Adaptive hypermedia. User Model User-Adap, Vol: 11: 87-110, 2001.
[18]. Brusilovsky P, Peylo C, Adaptive and intelligent web based educational systems. Int J Artif Intell Educ: Vol: 13: 156-169, 2003:
[19]. Chang Y-H, Lu T-Y, Fang R-J, An adaptive e-learning system based on intelligent agents, Proc. of the 6th WSEAS International Conference on Applied Computer Science, pp. 200-205, 2007.
[20]. Romero C, Ventura S, Zafra A, de Bra P, Applying web usage mining for personalizing hyperlinks in web-based adaptive educational systems. Comput Educ: Vol: 53: 828–840, 2009.
[21]. Triantafillou E, Pomportsis A, Georgiadou E, AES-CS: Adaptive educational system based on cognitive styles. Proceedings of the Second International Conference on Adaptive Hypermedia and Adaptive Web-Based Systems (AH2002), Malaga, Spain, 29-31 May 2002, 2002.
[22]. Carver CA, Howard RA, Lane WD, Enhancing learner learning through hypermedia courseware and incorporation of learner learning styles. IEEE Transactions on Education: Vol: 42: 33-38, 1999.
[23]. Brown E, Fisher T, Brailsford T, Real users, real results: Examining the limitations of learning styles within AEH, Proc. Of the Eighteenth ACM Conference on Hypertext and Hypermedia (Hypertext 2007), 2007.
[24]. Schiaffino S, Garcia P, Amandi A, eTeacher: Providing personalized assistance to e-learning learners. Comput Educ, Vol: 51: 1744-1754, 2008.
[25]. Bajraktarevic N, Hall W, Fullick P. ILASH: Incorporating learning strategies in hypermedia. Proceedings of the Fourteenth ACM Conference on Hypertext and Hypermedia (HT03), Nottingham, UK, 26-30 August 2003, 2003.
[26]. Papanikolaou W, Mabbott A, Bull S, Grigoriadou, M, Designing learner-controlled educational interactions based on learning/cognitive style and learner behavior. Interact Comput: Vol: 18: 356-384, 2006.
[27]. Moore A, Stewart CD, Zakaria MR, Brailsford, TJ, WHURLE - an adaptive remote learning framework. International conference on Engineering Education (ICEE-2003), July 22-25, 2003, Valencia, Spain, 2003.
[28]. Mustafa YEA, Sharif SM, An approach to adaptive e-learning hypermedia system based on learning styles (AEHS-LS): Implementation and evaluation. Int J Lib Inf Sci: Vol: 3: 15-28, 2011.
[29]. Gökdağ M, Collaborative learning, learning styles, academic achievements and gender relations in teaching social sciences, Unpublished Doctoral Thesis. Dokuz Eylül University, Educational Sciences Institute, İzmir, 2004.

[30]. Baker FB, The basics of item response theory, ERIC Clearing house on Assessment and Evaluation, Second Edition, 2001.
[31]. Eggen TJHM, Contributions to the theory and practice of computerized adaptive testing, Unpublished Doctoral Thesis, University of Twente, 2004.
[32]. Boyd AM, Strategies for controlling testlet exposure rates in computerized adaptive testing systems, Unpublished Doctoral Thesis, The University of Texas, Austin, USA, 2003.
[33]. Fetzer M, Dainis A, Lambert S, Meade A, Computer adaptive testing (CAT) in an employment context, PreVisor'sPreView, 2008.
[34]. Wagner TA, Item exposure issues in the wagner assessment test: A computer adaptive testing approach, Unpublished Doctoral Thesis, Faculty of the Virginia Polytechnic Institute and State University, USA, 2004.
[35]. Al-A'ali M, Implementation of an improved adaptive testing theory. Educ Technol Soc: Vol: 10: 80-94, 2007.
[36]. Triantafillou E, Computerized adaptive test – adapting to what?, Proceedings of the Informatics Education Europe II Conference IEEII, 2007.
[37]. Way WD, Davis LL, Fitzpatrick S, Practical questions in introducing computerized adaptive testing for K-12 assessments, Pearson Educational Measurement (PEM), 2006.
[38]. Marinagi CC, Kaburlasos VG, Tsoukalas, VT, An architecture for an adaptive assessment tool, 37th ASEE/IEEE Frontiers in Education Conference, 2007.

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Modernized Beveridge Curve

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Abstract **- The article aims to analyze the economic success of Estonia as a small an economic model of the labour market in general, his persons employed, unemployment and vacant jobs, and compare it to Estonia's main partner countries of the EU. The problem is the large number of vacancies even in a situation of high unemployment and young people move abroad, which could result in the continuation of a qualified workforce. The scientific novelty is job vacancies and unemployment relationship (modernized Beveridge curve) of Estonia and other EU countries and its the mathematical models and suggestions for improvement in the labour market.**

Keywords **- European Union, Estonia, labour market, vacancy, Beveridge curve.**

1. Introduction

During the crisis, and especially after the economic crisis, the current labour market problems being nearly all developed economies, especially in the new European EU countries.

This article analyzes the labour market dynamics and problems of the Estonian-based. Estonia's economy can be seen as a small business model, under which generalizations can be made in Eastern Europe, especially in new EU countries.

Estonia is one of the least-populous members of the EU, Euro zone, NATO, IMF and OECD. The United Nations lists Estonia as a developed country with a Human Development Index of "Very High" (Rank - 34th, 2011). An important element in Estonia's post-independence reorientation has been closer ties with Germany and the Nordic countries, especially Finland and Sweden. Estonia has the lowest ratio of government debt to GDP among EU countries as 6.0% at the end of 2011. A balanced budget, almost non-existent public debt, flat-rate income tax, free trade regime, competitive commercial banking sector, innovative e-Services and even mobile-based services are all hallmarks of Estonia's market economy.

Before the economic crisis, the economic growths of Estonia, Latvia and Lithuania were one of the highest in the European Union. Hence these countries were called Baltic Tigers. The crisis, however, took the three countries to a completely different edge – the fall of their GDPs was one of the biggest in the EU. After the crisis, the economic growth factors of Estonia have again been one of the biggest in the union. In 2011, the real GDP growth in Estonia was 7.6%. [1] Weak spots are, however, the labour market. However, the employment rate and wages in Estonia are one of the lowest in the EU.

A thorough analysis of the development of a small economy such as Estonia will also help make more general conclusions, at least on the European level.

The main goal for the labour market of the EU is to reach the employment rate of 75%. This would significantly increase the future economic growth in Europe [2].

The problem is that in Estonia and other new EU countries is one of relatively high unemployment and low employment rates, and on the other hand not enough skilled labour force and unemployment is not reduced by increasing the rate of job vacancies, on the contrary - is growing. Why?

The problem is that relatively many work abroad. Due to the free movement of people within the EU, the problem in Eastern European countries, including Estonia, is the migration of younger labour force abroad, where the wages are higher. In Sweden and Finland, for example, net salary is 4 times higher than in Estonia, while labour productivity is only 2 times lower.

In order to make recommendations to policy makers and business leaders need to carefully analyze the social situation and to know the theoretical basis of its performance. Should analyze all of the social determinants of changes in laws and their interconnections. The labour market situation, and there be a change depend in particular on the economy (GDP) of the situation, political decisions and yet much more.

Would also need to know the relationship of these changes and the theoretical foundations. The analysis shows that some of the commonly accepted laws relating to labour markets are too vague and require clarification. They are also quite different from region to region.

U.S. and EU rule, the same factors affecting economic development, but also have specific characteristics. Significantly different from the old and new EU Member States' economic development.

Euro zone crisis, however, conditionally speaking Northern and Southern European monetary policy, which can directly affect the labour market situation.

After a thorough analysis of the economic crisis showed that, as has the current economic laws, or must be specified. Contemporary mathematical explain and predict the labour market situation in the future. May be mentioned as to why an increase in unemployment will be a vacancy in the unemployment level to rise.

The article is a modernized or improved Beveridge curve. If the classic Beveridge curve decreases linearly with an increase of the unemployment rate of vacant jobs, then our numerous empirical generalization of a certain extent this is true of unemployment, but the unemployment rate will further increase the number of vacant seats. Germany, which is one of the best labour market, unemployment begins to increase after a slight increase in the unemployment rate while also increasing the number of job vacancies.

Article based on the theoretical foundations recognized of the United States and Europe countries and international organizations labour market analysis, and author of the recently published position.

This knowledge can make better decisions about the labour market and thus improve the situation.

The methodologies used: an investigation of the ILO and Eurostat methodology and definitions of the labour market; comparative analysis of indicators and regression analysis.

2. Analysis of the labour market in Estonia

In a stable period, analysis are conducted annually, but in times of economic crisis, the changes in employment are extremely rapid, therefore data should be analyzed in shorter time periods – quarterly or possibly even monthly. In the years 2000 – 2008, the development of the economy in Estonia [3 - 4] and the EU was stable, in 2009 there was a rapid recession and the in subsequent years showed growth again. 2011th Estonia's GDP growth was 7.6%, which was the largest of the EU [1].

All this is reflected in changes in employment in Estonia and the EU: the economic growth resulting in increased employment. However, detailed analysis by quarter shows that the situation was more complex.

Labour force	2001	2008	2009	2010	2011
Total, thousands	660.8	694.9	690.9	686.8	695.9
Employed, thousands	577.7	656.5	595.8	570.9	609.1
Unemployed, thousands	83.1	38.4	95.1	115.9	86.8
Inactive, thousands	386.4	347.9	348.0	348.0	333.8
Employment rate, %	55.2	63.0	57.4	55.2	59.1
Unemployment rate, %	12.6	5.5	13.8	16.9	12.5

Table 1. Estonia. Labour status of population aged 15-74, 2001 -2011, *Source:* [5].

methods allow for more precise data manipulations. This in turn provides the opportunity to further

The employment rate rose till 2008 and then started to decline slowly – by 2010, the number of employed persons had fallen by 8.1 thousand compared to 2008 year. In the years 2007 – 2010, the number of active participants in labour market decreased by 84.7 thousand and the number of unemployed rose by 83.9 thousand. In the period 2008 – 2010, the respective numbers were -85.6 thousand and +77.5 thousand, the gap being 8.1 thousand; and in the years 2009 – 2010 the gap being only 4.1 thousand.

The highest number of non-active people in the last decade was registered in 2002 – 394.4 thousand; in the years 2008 – 2011, this number was smaller. The highest number of discouraged workers was registered in between 2002 – 2004: 17.7 thousand to 18.1 thousand; and the lowest in 2008 – 5.5 thousand. The largest number of old age pensioners, 148.8 to 152.8 thousand, was also recorded within this period. 2011th the situation improved somewhat, but not yet reached pre-crisis levels.

The current analysis of the Estonian labour market proceeds with looking at the employment data. In Estonia, the fall in employment rate and the growth of unemployment rate was not balanced during crisis. The gap between those figures was considerable. The reason for this is that a number of people had been working without a formal contract, and a number of people who were left unemployed abroad, started to register as unemployed in Estonia; those people, however, had not been counted amongst the employed people in Estonia and had not been the taxpayers of Estonia. Therefore we should first try to focus on the people who were left unemployed, not primarily on those who had been working unofficially. Of course, exceptions also apply here. In 2009, the number of employed persons fell by 60.7 thousand, but the number of the unemployed rose by 56.7 thousand (?), the total number of unemployed persons reaching 95.1 thousand. Employment in 2010 compared to that of 2008 had fallen by 85.6 thousand. The trend shows that in the primary and secondary sector, employment has been decreasing; in the tertiary sector, it had been rising till 2006; ratios it has been rising gradually, reaching 65.3 % in 2010 [6].

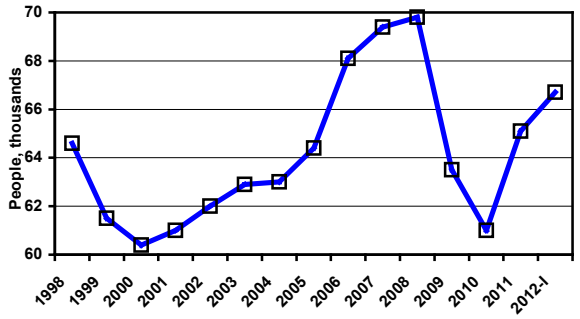

Figure 1. Estonian employment rate, 1998-2012-I, *Source:* [7].

The biggest number of employed persons was registered in QIII; 2007 – 662.1 thousand; and the lowest in Q1-2010 – 553.6 thousand. In the beginning of 1990s, the employment rate was even higher and it was followed by a significant migration to the East. The years 1999, 2009 and 2010 were the ones when employment rate dropped the most rapidly. But already in 2011. and 2012. occupancy was increased, QII-2012 there were 624 thousand. Figure 1 illustrates well the economic crisis of the second half of the nineties, especially the crisis of 1999, the economic growth followed by it and the results of the last economic crisis.

	1998	2001	2007	2008	2009	2010	2011
EU 27	61.2	62.6	65.4	65.8	64.5	64.1	64.3
Germany	63.9	65.8	69.4	70.1	70.3	71.1	72.5
Estonia	64.6	61.0	69.4	69.8	63.5	61.0	65.1
Latvia	59.9	58.6	68.3	68.6	60.9	59.3	61.8
Lithuania	62.3	57.5	64.9	64.3	60.1	57.8	60.7
Finland	64.6	68.1	70.3	71.1	68.7	68.1	69.0
Sweden	70.3	74.0	74.2	74.3	72.2	72.7	74.1

Table 2. Employment rate, age group 15 – 64, %, 1998 – 2011, *Source:* [7]

The smallest employment rates in the 1990s were in Southern-European countries Spain, Greece, but also in Ireland. The countries with the highest employment rate were Denmark, Sweden, Switzerland and the USA. In 1999, the employment rate in the EU-15 was 62.5%; in the USA, the employment rate was 73.9%. In order to be competitive in the global market, the EU has set a goal to reach employment rate of 75%. Here lies a deceptive contradiction: despite quite a high unemployment rate, employment should be increased. In the next decade, a similar trend continued. The highest employment rate was in Sweden in 2007 – 74.2 %; a year before, the highest employment rate had been in Finland – 72.0 %. The employment rate in Estonia has always stayed below 70%. As a general rule, the employment rate of male population has always been remarkably higher than the employment rate of female population, but data shows that the trend of female employment is growing. In Southern European countries, female employment rate is lower than in the Nordic countries. In 2010, the average employment rate of men in EU-27 was 70.1 % and of women, 58.2%. In Estonia, the respective figures were 61.5% and 60.6%. The highest employment rate of women was in Sweden in 2001 – 72.3%; in Estonia, the highest employment rate of female population was in 2008 – 66.3%.

	2010		2011		2012	
	M01	M07	M01	M06	M01	M06
EU 27	9.5	9.6	9.5	10.0	10.1	10.4
Germany	7.3	6.8	6.4	6.1	5.6	5.4
Estonia	19.0	15.9	13.6	12.8	10.9	10.2
Latvia	20.0	18.3	16.3	16.2	15.3	:
Lithuania	17.2	18.3	16.5	15.6	13.7	13.7
Finland	8.7	8.4	8.0	7.8	7.5	7.5
Sweden	8.9	8.5	7.8	7.4	7.6	7.5

Table 3. Harmonised unemployment rates, %, 2010 – 2012, *Source:* [8]

The table shows the change in the unemployment rate after the economic crisis, EU countries, compared to the EU's most important partner country is the U.S. unemployment rate.

Unemployment in the EU decreased in 2000 and in the next 1.5 years, grew again to 9%, stayed stable for three years, and the next three years brought a significant fall to 7%, until the recession. In the two crisis years, since QII 2008, unemployment reached its peak, the reasons of which have already been analysed within this article. The beginning of 2011, however, showed slight fall in unemployment.

In June 2012 were in the EU27 unemployed 25 million men and women, unemployment rate at 10.4% and euro area at 11.2%. Among the Member States, the lowest unemployment rates were recorded in Austria (4.5%), the Netherlands (5.1%), Germany and Luxembourg (both 5.4%), and the highest in Spain (24.8%) and Greece (22.5% in April 2012). Compared with a year ago, the unemployment rate fell in seven Member States, increased in nineteen and remained stable in Sweden. The largest falls were observed in Estonia (13.6% to 10.9%), Latvia (17.1% to 15.3%) and Lithuania (15.4% to 13.7%). The highest increases were registered in Greece (16.2% to 22.5% between April 2011 and April 2012), Spain (21.2% to 24.8%) and Cyprus (7.6% to 10.5%). In June 2012, the unemployment rate was in the USA 8.2%. [9]

3. Job vacancies

In a situation when unemployment rate is high and there is a wish to increase employment, it is proper to

look at the vacancies and the changes within vacancy rates.

	Rate of job vacancies, %			
	Q I	Q II	Q III	Q IV
2005	2.3	2.4	2.6	2.4
2006	2.8	2.9	3.4	3.1
2007	3.3	3.4	3.7	3.0
2008	2.8	2.6	2.7	1.8
2009	1.0	0.8	0.9	0.8
2010	0.9	1.1	1.2	1.0
2011	1.2	1.2	1.5	1.3

Table 4. Estonia. Number of job vacancies and rate of job vacancies, %, Quarter, 2005 – 2011, [10].

Table 4 shows the number of job vacancies by quarters both in absolute and relative numbers. Before the economic crisis, the number of vacancies even reached 3.7% (QIII-2007), but dropped to a mere 0.8% or 3890 vacancies during recession.

In 4th quarter of 2011 the rate of job vacancies was the highest in public administration, defence and compulsory social security (2.6%), and the lowest in mining and quarrying (0.1%). The rate of job vacancies increased the fastest in accommodation and food service activities. The increase in the number of job vacancies was the biggest in transportation and storage and in accommodation and food service activities, where there were over two times more vacancies, compared to the 4th quarter of 2010. A third of the job vacancies were in the public sector and two thirds in the private sector. The rate of job vacancies was 1.4% in the public sector and 1.2% in the private sector. [11]

Table 13 enables to assess the number of vacancies before crisis, during the crisis and after it according to major groups of occupations. Although there has (always) been quite a large number of vacancies in all the economic sectors, the rates of job vacancies in different occupations are quite different. Before the economic crisis, the overall number of vacancies was 17.5 thousand, but even in the peak period of unemployment, the number of vacancies was almost 5 000 and over a 100 in major groups of occupation. Therefore, problems may lie in notifying the unemployed about job vacancies or in the fact that the unemployed people do not qualify for the vacancies.

Different job vacancies were also available in almost all Estonian regions during the peak of unemployment (QI2010).

In QIV, the number of vacancies among professionals, senior officials and managers was slightly smaller than in QI. We face a situation where not everyone wants to work as an unskilled worker; at the same time, employers do not see their abilities to be suitable for working on a job requiring high qualification, for example, on a job of senior official or manager.

When the vacancy rate before the crisis (QI-2010) was high (2.8%), then in 2009, it had dropped to 0.8% in II and IV quarter. The rate of vacancies has been increasing slowly (2011=1.2%), but it is still lower than it was before the crisis. However, the vacancy rate today is higher than in 2010.

In Estonia, there have always been a certain number of job vacancies. Depending on the economic cycle, their numbers change continuously. At first glance, it seems that when unemployment increases, then the number of vacancies decreases and vice versa. Still, this regularities is more complex and varies from country to country. What shows the importance of this issue is the fact that even now, in Estonia and in the whole EU, there is the lack of qualified labour and at the same time, the workers are not willing to work with less suitable conditions.

The following analysis focuses on the relation of vacancies and unemployment and the rules of their distribution laws.

The following analysis focuses on the vacancies and unemployment and the breakdown of law rules.

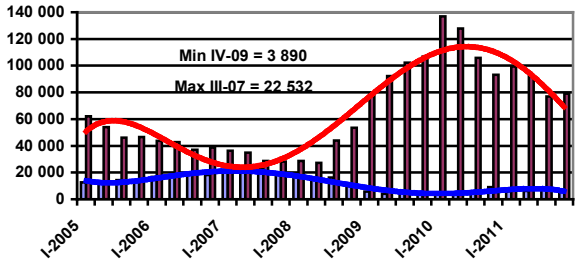

Figure 2. The division of unemployment and vacancies in Estonian, 2005-2011
Source: Author's illustration

Unemployed:

$y = 0{,}2487x^5 - 20{,}969x^4 + 596{,}88x^3 - 6504{,}3x^2 + 22854x + 33800;$ $R^2 = 0{,}9006$

Vacancies:

$y = -0{,}0964x^5 + 7{,}092x^4 - 180{,}24x^3 + 1790x^2 - 5700{,}8x + 17981;$ $R^2 = 0{,}9391$

Two trend lines were approaching each other up until the end of 2007, then their gap was minimal (QIII-07=6168; QIV-07=9824). Then, unemployment was decreasing and at the same time, the number of vacancies was growing. It was getting more and more difficult for employers to find labour force, especially qualified labour. This kind of developments in the labour market started to suppress the development of the enterprises. The employees, on the contrary, had quite good opportunities for choosing jobs, which enabled them

to ponder carefully about the nature of the job, the pay and the working conditions, etc. In the first half of 2008, the number of the unemployed was still decreasing, but the demand for workers started to rise slowly. The employers had to agree with higher demands of employees and this led to the fall in vacancy numbers. In the end of 2008, the effects of economic crisis started to be felt in the labour market. The unemployment rate started to increase quickly and the number of vacancies started to fall. 2010th the beginning of the unemployment rate reached a record size and the number of vacancies fell to a minimum. The gap between the two trend lines was the largest. Next, the two lines started to approach each other again – unemployment rate started to fall and the number of vacancies started to rise. Both trend lines match quite well with the curves of actual value, which shows that unemployment and vacancies in Estonia follow certain rules, because $R^2 \approx 1.0$.

The rate of vacancies in the EU, rose even up to 2.4% in 2007, but 2.5 years later, the economic crisis took it to 1.4%. In 2010, vacancy rate rose to 1.7 %. This trend in the EU is quite similar to the job vacancy trends observed in Estonia. In the III quarter of 2010, the rate of vacancies in the EU countries fluctuated between 3.0% - 0.3%. The highest vacancy rates were in Malta (3.0%), Norway (2.6%) and Germany (2.5%), the lowest in Latvia (0.3%). Despite the Estonian vacancy rate rising in the II and III quarter of 2010, it is still lower (1.2%) than the European average (1.5%).

When the number of unemployed persons in Estonia was 25 – 50 thousand, the number of vacant jobs was in between 23 -13 thousand. Since the number of unemployed reached 80 thousand, the number of vacancies has been stable, around 5 000. When the number of unemployed persons reached 60 thousand, the number of vacancies decreased almost twofold. However, the unemployment rate has risen much more quickly than the number of job vacancies has decreased. When the number of unemployed persons reached 80 thousand, the number of vacancies stayed stable despite of the rapid growth in unemployment.

Estonia as well as the entire EU labour market is a short conclusion brief but shrewd German Dr. Martina Rangers 2011th summary of labour.

„According to results of the labour force survey, some 7.4 million people aged 15 to 74 years wanted to have a job or to work more hours in 2011. Apart from 2.5 million unemployed, the unused labour supply comprised 2 million underemployed part-time workers, 1.7 million underemployed full-time workers and 1.2 million people in the hidden (or potential) labour force in 2011." [12]

If we leave out those who do not work for objective reasons, the potential labour continues in Estonia as well as in Europe. Would need to be able to work on and make better use of their potential abilities. Off hand, it might just bring a certain amount of professionals in your area who is continuing in Europe. Of course, there are also other exceptions.

4. The modernized Beveridge Curves

The following figures show the linkage between job vacancies and unemployment [13, 14]. Beveridge curve the input data is job vacancy and the unemployment rate (age 15-74) investigation of correlations. We will take a look at the modernized or improved Beveridge curves describing Estonia and other countries.

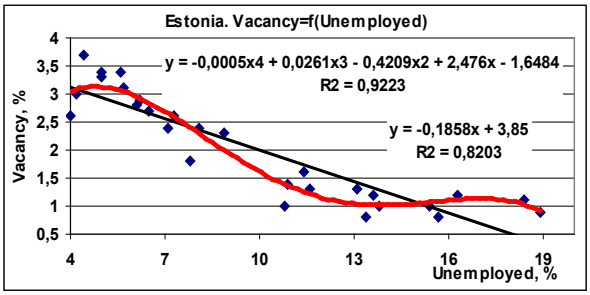

Figure 3. Estonia. Vacancy=f(Unemployed), 2005Q1-2012Q1, *Source:* Author's illustration

Modernized Beveridge curves (Estonia):
$y = -0{,}0005x^4 + 0{,}0261x^3 - 0{,}4209x^2 + 2{,}476x - 1{,}6484;$
$R^2 = 0{,}9223$

Classical Beverage Curve (Estonia):
$y = -0{,}1858x + 3{,}85;$ $R^2 = 0{,}8203$

The changes in vacant jobs (Figure 3) are in strong correlation with the rate of unemployment, which is illustrated by the high value of R^2. In the period since QI-2005, the value of 4 order polynomial R^2=0.9223. Figure 3, where we can see rates by quarters, shows that when unemployment rate exceeds 11%, the number of job vacancies stays stable, fluctuating within 1 percentage point; in case of very high unemployment rates, however, it may even rise, and in the end, fall a little again.

The right-hand part of the curve in figure 3 can be interpreted as part of high unemployment rate, some people are working unofficially, or have temporary or part-time jobs. They have lost hope to find an official job and prefer working unofficially instead of having a low-paid job or a job with unsatisfactory working conditions or microclimate. At the same time, some of them might be registered as unemployed, but are actually working abroad, in Finland, for example. What the employers see in this

situation is this: there is not enough qualified and disciplined labour force, but not everyone can be hired or is able to work even after having received proper training. The abilities of people and their motivation for working vary a lot [3]. Therefore, even in the peak of unemployment, there are those who do not accept all kind of jobs or working conditions. On the other hand, the employers also do not wish to give the job to „anyone".

The vacancy rate decreases until the level of unemployment reaches 16%, and then starts to rise slowly. A linear correlation leads to an even simpler answer: when the number of unemployed persons rises, the number of vacancies decreases. Therefore, the more complex mathematical model enables a more exact explanation of the interrelated changes and gives a stronger correlative dependence.

When compared to the classical Beverage curve described in the theoretical part of the current article, the model created by the authors of this article is more complex, offering a more specific explanation of the correlation between the rates of vacancy and unemployment in a real economic situation. Although the 2nd-order polynomial or simple parabola practically coincides with the classical Beveridge curve, the latter does not present the calculations of the strength of correlation. It may be, of course, claimed that correlation is strong enough without calculating R^2. In most cases, the classical Beveridge curve is referred to, which does not present concrete calculations.

The curve developed by the authors of the current article is considerably more detailed, therefore more suitable labour force analysis, explanations and forecasts. What is especially important is the analysis of pre-crisis, crisis and after-crisis data by quarters, not years, as changes in the labour market have occurred in a very fast pace. Up to now, conclusions in this article have been done on the example of Estonia only. The question is, how do these complex correlations apply to other countries?

In order to make generalisations, Estonian data has been compared with data collected from Lithuania and Latvia, the countries that had an equally strong economic growth, but even a harsher economic downfall. Comparisons have also been made with Estonian partner countries: the EU countries Sweden, Finland and Germany, in order to find out whether the complex correlation discovered by the authors of this article applies there also. As it is known, Estonia came out of the economic crisis considerably more successfully than Latvia, Lithuania, Poland and other.

Suggested by the authors of the curve is much more thorough, which allows a better analysis of labour, explanations and predictions. What is particularly important to analyze the pre-crisis, crisis after crisis, and quarterly data, not years, changes in the labour market in a very fast pace. So far, the findings in this article, it is only in Estonia, for example. The question is how these complex relationships to other countries?

In order to make generalizations, the data are compared with data collected in Estonia and Latvia, Lithuania, a country that was equally strong economic growth, but even more severe economic collapse. Comparisons are also made to the Estonian partner countries: EU countries Sweden, Finland, Germany and United Kingdom similar to the curves.

Let's see more of Poland (the largest economy in the new EU member States), Slovenia (the highest GDP per capita in the new EU Member), but also Austria and the Netherlands (have a lower unemployment in EU countries) and Spain and Greece have the highest unemployment in the EU countries). It is also true that we provide the modernized Beveridge curves?

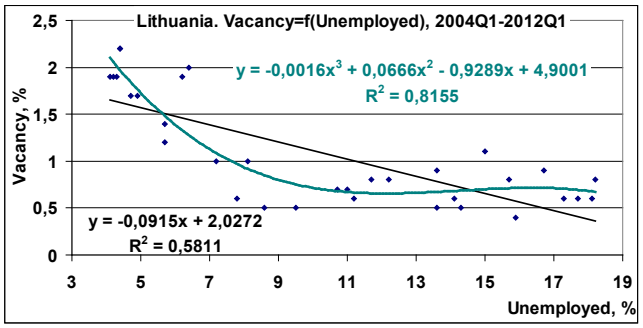

Figure 4. Lithuania. Vacancy=f (Unemployed), 2004Q1-2012Q1
Source: Author's illustration

Modernized Beveridge curves (Lithuania):
$y = -0,0016x^3 + 0,0666x^2 - 0,9289x + 4,9001;$
$R^2 = 0,8155$

Classical Beverage curve (Lithuania):
$y = -0,0915x + 2,0272;$ $R^2 = 0,5811$

Lithuania's economic development before the crisis, the EU one of the fastest as well as the other Baltic states. Economic decline was also great. GDP per capita still lags in Estonia than in Latvia and Lithuania.

Until unemployment rate reaches 8%, the vacancy rate drops rapidly up to the level of 1.0%. When unemployment rate reaches 16%, the number of vacancies starts growing again. Although different polynomial curves differ from each other, a general trend can be observed: in case of very high unemployment rate, the number of vacancies starts growing again.

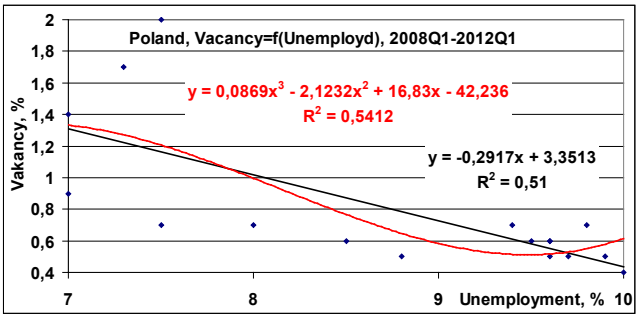

Figure 5. Poland. Vacancy=f (Unemployed), 2008Q1-2012Q1, *Source:* Author's illustration

Modernized Beveridge curves (Poland):
$y = 0,0869x^3 - 2,1232x^2 + 16,83x - 42,236;$
$R^2 = 0,5412$
Classical Beverage curve (Poland): $-0,2917x + 3,3513;$ $R^2 = 0,51$

Poland was the only EU country where there was a global economic crisis, economic decline and a loss, though, that the 2009th the real GDP grew by only 1.6% [1].

Poland Beveridge curve is similar in shape curve Beveridge Latvia, with Poland the unemployment rate is half that of Latvia, but weaker than R^2. Curve of Poland 7-8% as well as a modernized classic Beveridge curves practically coincide, will further modernized Beveridge curve vacancy unemployment grows faster decline than the classical curve at Beveridge. Unemployment rate of 9% after the vacancy is no longer declining, and from 9.5% despite a rise in unemployment will increase rather slowly.

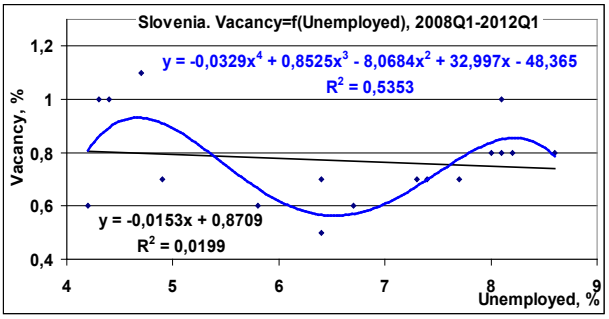

Figure 6. Slovenia. Vacancy=f (Unemployed), 2008Q1-2012Q1, *Source:* Author's illustration

Modernized Beveridge curves (Slovenia):
$y = -0,0329x^4 + 0,8525x^3 - 8,0684x^2 + 32,997x - 48,365;$
$R^2 = 0,5353$
Classical Beverage curve (Slovenia):
$y = -0,0153x + 0,8709;$ $R^2 = 0,0199$

Slovenia GDP per capita in PPS is among the largest of the new EU Member States, in 2011 was 94 (EU-27=100) [15].

Slovenia Beverdge curve is cyclic. The unemployment rate increased to 4.5% of the vacancy, until vacancy decreased to 6.5% as the classical Beverdge curve. However, further increases in unemployment increases the vacancy, which stabilizes unemployment rates of over 8%. Here the classic Beverdge not work, because R^2 is close to zero.

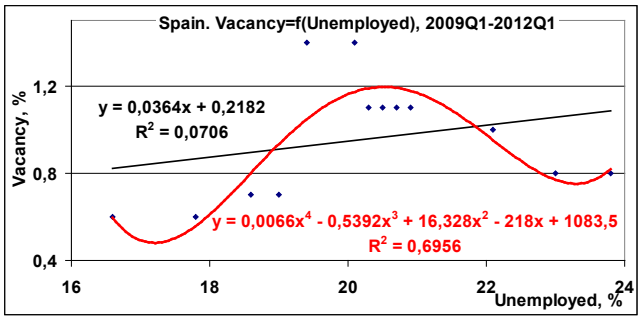

Figure 7. Spain. Vacancy=f (Unemployed), 2009Q1-2012Q1
Modernized Beveridge curves (Spain)
$y = 0,0066x^4 - 0,5392x^3 + 16,328x^2 - 218x + 1083,5;$
$R^2 = 0,6956$

Classical Beverage curve (Spain): $y = 0,0364x + 0,2182;$ $R^2 = 0,0706$

Spain has the highest unemployment rate in the EU countries, in June 2012 was 24.8%.
Spain Beveridge curve is also cyclic. The unemployment rate to 17% decreased the vacancy as the classical Beveridge curve, to 21% increased also vacancy and about 24% decreased again the vacancy, which then stabilizes. Here the classic Beveridge not works, because R^2 is close to zero.

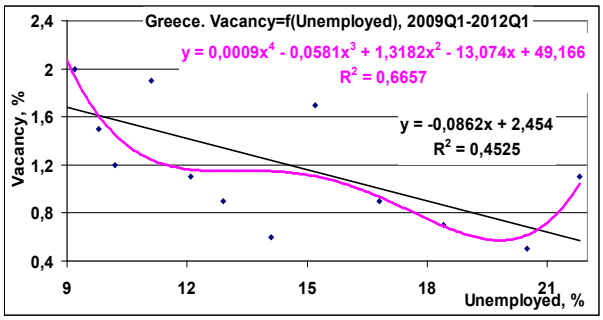

Figure 8. Greece. Vacancy=f (Unemployed), 2009Q1-2012Q1, *Source:* Author's illustration

Modernized Beveridge curves (Greece):
$y = 0,0009x^4 - 0,0581x^3 + 1,3182x^2 - 13,074x + 49,166;$
$R^2 = 0,6657$

Classical Beverage curve (Greece):
$y = -0,0862x + 2,454;$ $R^2 = 0,4525$

Greece has one of the highest unemployment rate in the EU countries, in June 2012 was 22.5%.

Greece's economy is the main cause of the euro crisis.

Here is a classic Beverdge curve quite well, because the R^2 is high. Modern curve, where R^2 is substantially higher, only a relatively small states, and subject to the existence of a situation of high unemployment.

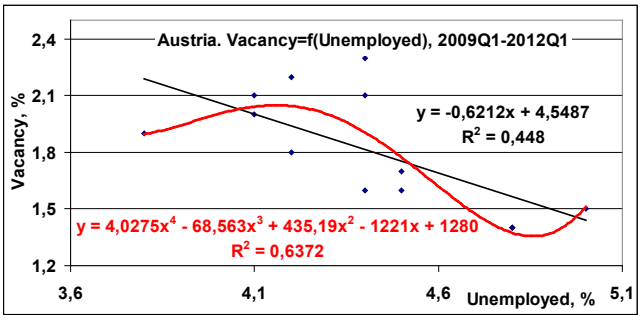

Figure 9. Austria. Vacancy=f (Unemployed), 2009Q1-2012Q1

Source: Author's illustration

Modernized Beveridge curves (Austria):

$y = 4,0275x^4 - 68,563x^3 + 435,19x^2 - 1221x + 1280;$ $R^2 = 0,6372$

Classical Beverage curve (Austria): $y = -0,6212x + 4,5487;$ $R^2 = 0,448$

Austria GDP per capita in PPS is one of the among the largest of the EU Member States, in 2011 was 129 (EU-27=100) [15]. Austria has lower unemployment in EU countries.

Here is also a classic Beveridge curve quite well, because the R^2 is high. Modern curve, where R^2 is substantially higher, gives a more accurate picture. Modern curve, where R^2 is substantially higher, gives a more accurate picture. Unemployment rate increases to 4.2%, the increase in vacancy; vacancy decreases further to 4.8% as the classical Beveridge curve, below the quantity of vacancies stabilizes.

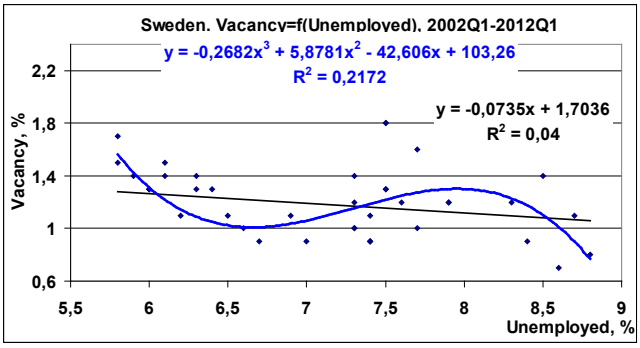

Figure 10. Sweden. Vacancy=f (Unemployed), 2002Q1-2012Q2

Source: Author's illustration

Modernized Beveridge curves (Sweden):

$y = -0,2682x^3 + 5,8781x^2 - 42,606x + 103,26;$ $R^2 = 0,2172$

Classical Beverage curve (Sweden):

$y = -0,0735x + 1,7036;$ $R^2 = 0,04$

Sweden is the country with a stable economy and high ethical standards. Despite this, Sweden was not left untouched by the economic crisis and the rise of unemployment rate. Compared to Eastern Europe, including the Baltic countries, the corruption and unofficial working in Sweden is minimal. The economic growth (GDP) of Sweden has been the highest in Europe during post-crisis years. When analysing the countries of considerable social guarantees, it must be taken into account that peoples savings there are remarkably higher than in the Baltic countries, therefore, people may not need to get back to work immediately after losing their job, nor are they forced to accept any job they are offered. In addition to that, the social benefits of Sweden are one of the highest in the world.

In Sweden is the relationship between vacancies and unemployment the cyclical and too weak (Figure 10). Vacancy rate starts to increase from a certain level of unemployment, in this case, 6.6%; but from the unemployment rate of nearly 8%, it starts to decrease again.

The linear dependence, as in other countries, is very weak. In Sweden, too, the dependence in a shorter period is stronger than in a longer period. Compared to the Baltic countries is significantly weaker correlation dependence.

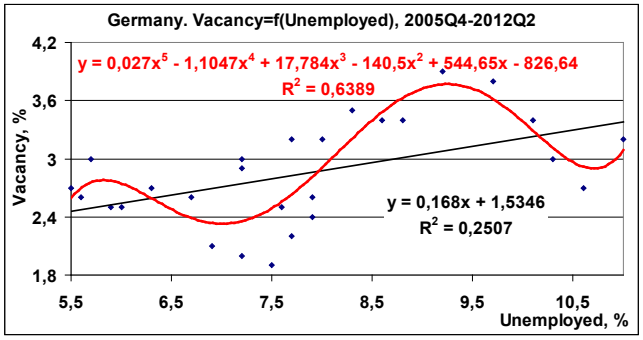

Figure 11. Germany. Vacancy=f(Unemployed), 2005Q4-2012Q2

Source: Author's illustration

Modernized Beveridge curves (Germany):

$y = 0,027x^5 - 1,1047x^4 + 17,784x^3 - 140,5x^2 + 544,65x - 826,64;$ $R^2 = 0,6389$

Classical Beverage curve (Germany):

$y = 0,168x + 1,5346;$ $R^2 = 0,2507$

The dependence of vacancies and unemployment in *Germany* is considerably different from and more complex than the correlative relations of these indicators in the Nordic and Baltic countries.

Opposite trends can be observed in Germany. A certain peculiarity of Germany, as well as of Sweden and of the United Kingdom, is a large number of immigrant workers, especially on jobs of low qualification.

When we look at the linear correlations of shorter and longer periods, then in Germany we can observe an illogical and opposite trend compared to other countries – when there is a rise in unemployment, there is also a rise in vacancies. (!?) Even in a longer period, R^2=0.2314. Opposite trends can also be seen in correlation strengths of shorter and longer periods. The 4th order polynomial of shorter period had an R^2=0.1771 and 5th order polynomial had R^2= 0.2476; figures from the longer period were R^2=0.6794 and R^2=0.7136 respectively. (Quite a big difference!)

Why is the situation like that? It may be concluded that in Germany, unemployment does not usually cause much problems. The unemployment benefits are high. When the employee does not like the offered job, he/she will not take it. At the same time, the low-paid and low-qualified immigrant workers must accept any jobs and conditions. The opening of German labour market to foreigners in May 1st makes the problem even more acute.

The trend lines show that in Germany, when unemployment rate is (around) 7%, the vacancy rate fluctuates in the range of 2.5%. The number of vacancies continues to rise up to the unemployment level of 9%; after that, vacancy rate starts to decline, even though in comparison with Nordic countries, it is still very high (2.7% - 3.9%) – higher than in the starting period of the analysis. Classical Beverage curve Germany would be the opposite, as unemployment increases, the vacancy.

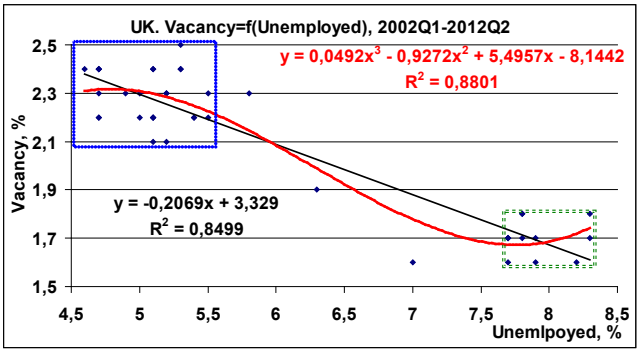

Figure 12. UK. Vacancy=f (Unemployed), 2002Q1-2012Q2

Source: Author's illustration

Modernized Beveridge curves (United Kingdom):
$y = 0,0492x^3 - 0,9272x^2 + 5,4957x - 8,1442;$
$R^2 = 0,8801$
Classical Beverage curve (United Kingdom):
$y = -0,2069x + 3,329;$ $R^2 = 0,8499$

According to data from 32 quarters, the dependency of vacancies and unemployment in the *United Kingdom* (Figure 12) is relatively straightforward and the correlation is very strong. Both the linear correlation (R^2= 0.721) and the correlative relations of 2nd and 3rd order polynomials (R^2= 0.861 and R^2= 0.9) are strong in the shorter period. Therefore, it can be concluded that since the rise of unemployment rate in 2008Q2, there has been a fall in the number of vacancies. This is shown by a direct correlation! But we also have to consider that the unemployment rate in the UK is relatively low (8%), and therefore the rate of vacancies is also small (under 2.5%). The conditional gathering of data into two boxes describes the rapid growth of unemployment in the UK.

At the same time, the UK also gives data on unemployment and vacancy indicators by quarters during a longer period. It is important to note that next to Germany, the labour market of the UK is one of the biggest in the EU; therefore the analysis of the data from UK contributes to the making of more reliable generalisations. The correlative relations of vacancy and unemployment based on data from 32 quarters are very strong, including the linear correlation (R^2= 0.7901). When we compare more complex relations, then the R^2s of 3rd, 4th and 5th order polynomials are respectively 0.8306; 0.8439 and 0.8667 – they do not differ much from each other. Therefore, we can choose a simpler, 3rd level polynomial, where R^2= 0.8306, to describe the relations.

The peculiarity of the UK is that the dots showing relations have gathered mainly into two groups: in the top left hand corner and in the bottom right hand corner. In case of unemployment rate of up to 5.5%, vacancies fall into the range of 2.1% to 2.5 %. From 18 points on the chart, only one presents an exception, therefore the probability of the conclusions is over 0.95. The second group describes unemployment rate of 7.7 – 7.8 and includes five points representing small vacancy, in between 1.6% – 1.9%. This group is not common to the UK; its existence can only be observed in extreme situations such as the economic crisis, where the unemployment rate is over 5.5%. Only three points (9.4%) are left outside these two areas. Here, too, the trend lines show that when unemployment reaches 7% to 7.5%, the number of vacancies starts to rise.

When compared to the classical Beverage curve (linear trend line), the model created by the authors of this article is more complex, offering a more specific explanation of the correlation between the rates of vacancy and unemployment in a real economic situation. The curve developed by the authors of the current article is considerably more detailed, therefore more suitable labour force

analysis, explanations and forecasts. Up to now, conclusions in this article have been done on the example of Estonia only. The question is, how do these complex correlations apply to other countries?

In order to make generalisations, Estonian data has been compared with data collected from Lithuania, Latvia, Hungary, Slovenia, Slovakia, Sweden, Finland, Luxembourg, Belgium, Netherland and another countries, in order to find out whether the complex correlation discovered by the authors of this article applies there also.

Beveridge curve vertices are cyclic. Decreases at a certain level of unemployment in the job vacancy (classic Beveridge curve), but the unemployment rate is increasing with the vacancy. Depending on the country's economic prosperity and population levels (rich countries), the cycle is repeated: again, a certain level of unemployment at the vacancy decreases, but the unemployment rate grows, the rate of vacant seats. The first cycle ends in different countries with different unemployment rates, depending on the standard of living of the people there.

5. Conclusion

Labour market analysis must take into account the cyclical nature of the economy, as well as the intensive periods of economic growth have to be taken into account. During the economic crisis, almost all economic indicators fell in most countries, including Estonia. In the first half of 2010, there had been a considerable progress in the EU, but unemployment rates were still lower than during better times.

All this applies to the labour market as well. Especially during crisis periods, it is beneficial to analyse the labour market by shorter periods than a year – by quarters or even months.

According to „Europe 2020 Strategy“, one of the most important goals is achieving the rapid fall of unemployment and the implementation of efficient labour market reforms, in order to help create more and better jobs. It would be necessary to increase the participation rate of some groups in the labour market, and improve the efficiency of the labour market. Due to the economic crisis, unemployment increased significantly, and the demographic changes ahead threaten to decrease the amount of labour force even more. For sustainable development, achieving lower unemployment rates will not be enough; most member countries of the EU, including Estonia, have to take up measures to increase employment rate up to 75%. The low participation rate in the labour market is one of the long-term structural weaknesses of Europe. Before the economic crisis, the employment rate in Europe was many percentage points lower than in Japan or in the USA. What would help to solve these problems are minimizing the number of vacancies, more efficient use of part-time employees, increasing the employment rate of younger and older people and those of low qualifications; decreasing job changes in the labour market.

Eastern European countries would need to increase workers' attitudes towards work and work culture, their qualifications, work motivation to increase the salaries and other benefits, increased productivity in addition to more efficient use machines, greatly improve the organization of work and the necessary executive level of education and experience of the labour laws to change even more flexible, improve information about vacancies the availability of jobs and the like.

Why do young people moving to live and work in the rich countries of Western Europe? In addition to the local standard of living far higher (wages), also called greater self-realization, the search for new challenges and development (career) options, and want to consult with the wider world search for happiness, adventurer, and the like.

In the labour market analysis, all its components should be looked at according to their relations to each other. In a simpler analysis, only the most important factors will be concentrated on. However, analysing one or two factors does not allow developing the most efficient means to improve the situation in the labour market. This is also shown by the European practice where despite economic growth, the situation of the labour market is improving slowly, and the implemented means are less effective than expected. Due to the free movement of people in the EU, the analysis of labour markets should focus on the changes in employment rates, not unemployment rates. When analysing the reasons of employees´ mobility, the fact that wages differ in the old and new member states should also be taken into account. This has a direct effect on the mobility of employees. When analysing unemployment, one also has to consider that the data may not reflect the actual reality, as in the Eastern European countries, including Estonia, people may be register as unemployed, but may actually be working (part-time) abroad, for example in Finland, Sweden, the UK, or they may be working without a contract in their home country.

The winners of the 2010 Nobel Memorial Prize on Economics cited in this article have also noticed that for those who do not wish to take the normal job they are offered, some kind of measures should be implemented. For doing that, we do not need to analyse the situation in the USA, it is enough if we assess the situation in Estonia more thoroughly. A formal retraining (of the unemployed) does not fix the situation. According to employers, a number of unemployed people should not be hired at all, as the

damage they cause directly or indirectly to the employer and to the society at large considerably exceeds the costs on unemployment benefits. As for Estonia, when we do not count among the unemployed the people working unofficially, the ones who do not pay taxes to the country and the ones who have no desire to work at all, the actual unemployment rate is much lower. At the same time, the transfer unemployment connected to mobility is still inexorably there, along with the higher than normal unemployment rate, which may even be beneficial, because it helps to guarantee the necessary quality of the work and services and gives the employer a better chance to require the fulfilment of the working discipline. The new Labour Act of Estonia [38], which simplified the firing and lay-off procedure of the employees, has also had a positive effect on the labour market. The primitive equalizing of all employees and the wish to see an ideal employee in everyone lowers the quality of the labour market. The abilities and motivation of people vary greatly; therefore contradictions and competition are the basis for development of the labour market. Denying this would lead to economic stagnation.

After the economic crisis, the GDP of Estonia started growing again, but the fall of unemployment rate has been very slow. What are the reasons for this? In order to come out of crisis, enterprises try to minimize labour costs. First, the companies try to get rid of workers who are unqualified, not needed or have conflict personalities. At the same time, we are facing a new problem: there are not enough qualified employees to be found. Estonia is not the only one facing this problem.

After the crisis, economy does not develop extensively any more, instead, it develops along an intensive path. This means that manufacturing will grow mainly due to the use of more efficient machines and devices and more efficient organization of the work process. This lessens the amount of low qualified workers and raises the demand for employees with high qualifications. This does not only concern the unskilled workers, but also those having higher education – engineers, economists and other specialists. Hence we face also the problem of the quality of higher education. The demand for knowledge capital (knowhow) has grown noticeably - this is the greatest value in the information society.

It may be claimed that the classic Beveridge curve suits well for making less complicated conclusions, but for analysing real economic situations, the improved Beveridge curve is much more suitable. In general, the improved curve shows quite similar results in all the countries with certain accuracy, at the same time, it also enables to bring out differences describing the peculiarities of every country and its labour market. When unemployment rises, however, we face a situation when job vacancies also start growing. These relations vary from country to country. For conducting a more thorough analysis, it must be found out why does the number of vacancies in the right side of the curve grow in the situation of high unemployment? What can be done here, considering that the employment rates have to start growing in Europe and other developed countries? One of the solutions would be improving communication in all levels. It is necessary to continue improving the quality of employees, continue with in-service trainings, the wages should be in correlation with labour productivity; working conditions, motivation etc. should be improved, and those not being involved in the labour market should be pressurised to work. Another important factor is to cultivate high ethical norms among employees and employers. All these measures would help to raise employment rate to such a level that there is no need to import immigrant workers from outside the EU.

Developing countries such as China, India etc., are facing other kind of problems. However, analysing those questions and presenting a more complex analysis of the labour market would not fit into the scope of this article. Therefore, this article is able to give a brief analysis of only some components of the labour market.

As a new contribution to research, the current article presents a (thorough) analysis of the Estonian labour market (Estonia being one of the Tiger countries of the EU). As a new contribution to theory, the authors of the article have developed the improved Beveridge curve, which helps to explain the dynamics of vacancies in the situation of high unemployment rates, and based on this, develop measures for finding solutions to these problems.

The improved Beveridge curve is novel not only for Estonia, but for the analysis of the EU labour market as a whole. For global analysis, a more detailed research on the economies of the USA, Japan and other developed countries must be conducted.

References

[1] Table code: tsieb020. Real GDP growth rate – volume. Percentage change on previous year. Eurostat.(21.08.2012). http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tsieb020&plugin=1

[2]European Council. Conclusions - 17 June 2010 http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/ec/115346.pdf

[3] Tanning, L., Tanning, T. (2010). Rahvusvaheline majandus I & II. (International Economy, Vol. I & II). Tallinn. Tallinn University of Technology.

[4] Tanning, T, Tanning, L 2011. Analysis of Productivity and Salaries in East-European Countries. *In: Baltic Horizons No 18(115). December 2011*. Tallinn. EuroUniversity Press, pp. 37 – 56.

[5]Table code: ML330. Statistics Estonia. http://www.stat.ee/37192

[6]Table code: ML207. Employed persons. Statistics Estonia. http://www.stat.ee/37196

[7]Table code: lfsi_emp_a. Employment (main characteristics and rates) - annual averages. Last update: 12-07-2012 http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lfsi_emp_a&lang=en

[8]Table code: teilm020, 2011. Harmonised unemployment rate. Eurostat http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=teilm020&plugin=1

[9] Eurostat news releases 113/2012 - 31 July 2012 http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/3-31072012-BP/EN/3-31072012-BP-EN.PDF

[10] Table code: WSV011. Job vacancies and occupied posts by economic activity. Statistics Estonia. http://pub.stat.ee/px-web.2001/Dialog/varval.asp?ma=WSV011&ti=JOB+VACANCIES+AND+OCCUPIED+POSTS+BY+ECONOMIC+ACTIVITY+%28EMTAK+2008%29+%28QUARTERS%29&path=../I_Databas/Economy/36Wages_and_salaries_and_labour_costs/01Job_vacancies/04Short_term_statistic/&lang=1 11.07.2012.

[11] Vacancy. Unemployment Insurance Fund. Estonia. http://www.tootukassa.ee/public/Vakantsid.xls

[12] Rengers, M. Unused labour supply of 7.4 million people in 2011. Press release 279 / 2012-08-15. StatistischesBundesamt. https://www.destatis.de/EN/PressServices/Press/pr/2012/08/PE12_279_132.html

[13] Table code: tps00172. Quarterly job vacancies and job vacancy rates. Eurostat.

http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tps00172&plugin=1
Last visited: 21.08.2012

[14] Table code: une_rt_q. Unemployment rate, quarterly average.Eurostat. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=une_rt_q&lang=en Last visited: 21-08-2012

[15] Table code: tec00114. GDP per capita in PPS. Index (EU-27 = 100). Eurostat http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tec00114

[16] Estonian Acts of Law I 2005, 54, 430. Labour Market Services and Benefits Act. https://www.riigiteataja.ee/akt/110022012008 \
Last visited: 20.02.2012

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Determination of *WHtR* Limit for Predicting Hyperglycemia in Obese Persons by Using Artificial Neural Networks

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Abstract **– The abdominal obesity is strongly associated with increased risk of obesity-related cardiometabolic disturbances. The proportion of waist circumference and body height, known as waist-to-height ratio (*WHtR*), has been shown as a good risk indicator related with abdominal obesity. This paper presents a solution based on artificial neural networks (ANN) for determining *WHtR* limit for predicting hyperglycemia in obese persons. ANN inputs are body mass index (*BMI*) and glycemia (*GLY*), and output is weist-to-height ratio (*WHtR*). ANN training and testing are done by dataset that includes 1281 persons.**

Keywords **– Artificial neural networks, obesity, waist-to-height ratio.**

1. Introduction

Among the main risk factors for coronary heart diseases, including diabetes, hypertension, dyslipidemia, the obesity is of special importance since the increase of fat mass launches a cascade of adipokine-mediated metabolic, inflammatory and haemostasic disturbances accelerating the process of atherosclerosis [1, 2, 3]. In Serbia 54.4% of adult suffers from excessive body mass, while 36.2% of the population is obese [4]. The highest prevalence of overweight and obesity is observed in the region of Vojvodina and is as high as 58.5% [5].

Based on numerous studies provided by many national and international institutions, the body mass index (*BMI*) is widely accepted and used to measure and define the obesity. The values $BMI \geq 25$ kg/m^2 correspond to the overweight, and values $BMI \geq 30$ kg/m^2 correspond to obesity and indicate increased risk of obesity-related adverse health outcomes [3].

The most intensive changes take place inside the visceral fat deposit of the abdomen and that is the reason why the abdominal or central obesity is particularly associated with an increased cardiometabolic risk. [6, 7, 8]. The waist circumference (*WC*) is often used as an effective marker of abdominal visceral fat content and comorbidities associated with obesity [9, 10, 11]. The values $WC \geq 80$ *cm* for women and $WC \geq 94$ *cm* for men indicate increased risk and are widely used in clinical practice. However, individuals with similar waist circumference and different body heights can differ in their health risks [12]. Based on that, the index obtained as a proportion of waist circumference and body height (*WHtR*) has shown to be a better risk indicator and the values $WHtR \geq 0.5$ should indicate increased risk [13, 14, 15].

Hyperglycemia or high blood sugar represents a cardiometabolic risk factor since by increasing oxidative stress and protein glycolization the increased level of glucose accelerates the process of atherosclerosis [16]. Based on [17, 18], the values $GLY \geq 6.1$ *mmol/l* indicate increased risk.

In this paper, the multilayer feed-forward ANN with back-propagation as the training algorithm has been applied to determining *WHtR* limit for predicting hyperglycemia in obese persons. Our idea is to train ANN to predict *WHtR* based on *BMI* and *GLY*. We will test various ANN architectures in MATLAB and select an optimal. Then, we will consider *WHtR* value for the limits $BMI = 30$ kg/m^2 and $GLY = 6.1$ *mmol/l*.

2. Measurements

The group inquired consisted of 1281 respondents (589 women and 692 men) aged 18 to 67 years, with *BMI* values between 16.60 and 48.00 kg/m^2, *WHtR* values between 0.36 and 0.87 and with *GLY* values between 3.00 and 13.10 *mmol/l*. In the Table 1 are shown the minimal, average and maximal values.

	Minimum	Average	Maximum
Age	18	43.67	67
BMI	16.60	29.89	48.00
WHtR	0.36	0.57	0.87
GLY	3.00	5.16	13.10

Table 1. Characteristics of dataset.

The study was conducted in accordance with the Declaration of Helsinki. The respondents volunteered in the study. All the inquires were taken during the morning hours (after the fasted overnight) at the Department of Endocrinology, Diabetes and Metabolic Disorders of the Clinical Centre of Vojvodina in Novi Sad (Serbia).

Body height (*BH*) was measured using Harpenden anthropometer with the precision of 0.1 cm and body mass (*BM*) was measured using balanced beam scale with the precision of 0.1 *kg*. *BMI* is calculated as the ration of body mass (*BM*) and the square of body height (*BH*):

$$BMI\left[kg/m^2\right]=\frac{BM\left[kg\right]}{\left(BH\left[m\right]\right)^2}\ .$$

Waist circumference (*WC*) was measured using flexible tape with precision 0.1 *cm*, at the level of middle distance between the lowest point on the costal arch and the highest point on the iliac crest. *WHtR* is calculated as the ration of waist circumference (*WC*) and body height (*BH*):

$$WHtR=\frac{WC\left[m\right]}{BH\left[m\right]}\ .$$

Fasting glucose levels were determined by Dialab glucose GOD-PAP method.

3. ANN System, Results and Discussion

This section presents our solution – ANN system for determining WHtR limit for predicting hyperglycemia in obese persons. The ANN input values are vectors:

$$\overline{X}(i)=\left(BMI(i),GLY(i)\right),$$

while the output values are:

$$Y(i)=WHtR(i),$$

where $i=1,2,...,1281$.

The optimal number of hidden neurons can be determined using various approaches, but we have used repeated random subsampling validation. The dataset is randomly divided into two parts with the proportion 90:10. The ANN training set is the first part (1153 persons) and the ANN testing set is the second part (128 persons). In the test phase, ANN estimates *WHtR* based on given *BMI* and *GLY* and the estimation accuracy is:

$$AC\left[\%\right]=100\%\left(1-\frac{\left|WHtR^*-WHtR\right|}{WHtR}\right),$$

where *WHtR* is the exact value and $WHtR^*$ is the value estimated by ANN. Various architectures with one hidden layer and 1-5 hidden neurons (N_h = 1, 2, 3, 4, 5) were trained and tested 100 times. The average accuracy *AC* and standard deviation *SD* were calculated. The trained ANN was tested first on the known data (training set) and the obtained results are given in Table 2.

N_h	AC_{TR}	SD_{TR}
1	94.3385	0.0022
2	94.3745	0.0030
3	94.3810	0.0030
4	94.3985	0.0018
5	94.4319	0.0037

Table 2. The average accuracy AC_{TR} and standard deviation SD_{TR} on the training set.

After that, trained ANN was tested on the unknown data (testing set) and the obtained results are given in Table 3.

N_h	AC_{TS}	SD_{TS}
1	94.3903	0.1879
2	94.3261	0.2077
3	94.3495	0.3719
4	94.2825	0.1508
5	94.1908	0.1798

Table 3. The average accuracy AC_{TS} and standard deviation SD_{TS} on the testing set.

After every testing, given ANN architecture was asked to estimate *WHtR* value for the limits *BMI* = 30 kg/m^2 and *GLY* = 6.1 *mmol/l*. The average estimated *WHtR* values are given in the Table 4.

N_h	*WHtR*
1	0.5781
2	0.5802
3	0.5816
4	0.5829
5	0.5824

Table 4. The average estimated *WHtR* values.

Comparing results from Table 3, we conclude that the single-layered ANN architecture with 1 hidden neuron provides the best results (maximal average accuracy with standard deviation as small as possible), so it is accepted as the optimum and depicted on the Figure 1. From Table 4, the value 0.5781 is *WHtR* limit for predicting hyperglycemia in obese persons.

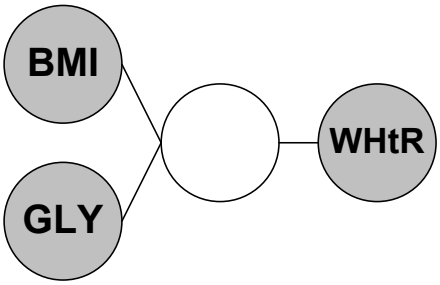

Figure 1. The optimal ANN architecture.

4. Conclusion

In this paper, we have presented an ANN solution for determining *WHtR* limit for predicting hyperglycemia in obese persons. Based on our results, if an obese person ($BMI \geq 30\ kg/m^2$) has $WHtR \geq 0.5781$ then she/he has increased risk of hyperglycemia ($GLY \geq 6.1\ mmol/l$). This approach could be a useful tool in both, individual and public health prevention since it can select persons with increased risk of hyperglycemia in an easy, non-invasive and cheap way.

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References

[1]. Stokić E, Tomić-Naglić D, Djerić M, Jorga J. Therapeutic options for treatment of cardiometabolic risk. Med Pregl 2009;62 Suppl 3:54-8.
[2]. Stokić E, Brtka V, Srdić B. The synthesis of the rough set model for the better applicability of sagittal abdominal diameter in identifying high risk patients. Comput Biol Med 2010 Sep;40(9):786-90.
[3]. Klein S, Allison DB, Heymsfield SB, Kelley DE, Leibel RL, Nonas C, Kahn R. Waist circumference and cardiometabolic risk: a consensus statement from Shaping America's Health: Association for Weight Management and Obesity Prevention; NAASO, The Obesity Society; the American Society for Nutrition; and the American Diabetes Association. Am J Clin Nutr 2007;85:1197–202.
[4]. Strategy for prevention and control of chronic non-infectious diseases of the Republic of Serbia, (*in Serbian*). http://www.minzdravlja.info/downloads/Zakoni/Strategije/Strategija%20Za%20Prevenciju%20I%20Kontrolu%20Hronicnih%20Nezaraznih %20Bolesti.pdf.
[5]. Grujić V, Martinov-Cvejin M, Ać-Nikolić E, Nićiforović-Šurković O. Epidemiology of obesity in adult population of Vojvodina, (*in Serbian*). Med Pregl 2005;LVIII(5-6): 292-5.
[6]. Rutter MK, Meigs JB, Sullivan LM, D'Agostino RB, Wilson PW. Insulin resistance, the metabolic syndrome, and incident cardiovascular events in the Framingham Offspring Study. Diabetes 2005;54(11):3252-7.
[7]. Appel SJ, Jones ED, Kennedy-Malone L. Central obesity and the metabolic syndrome: implications for primary care providers. J Am Acad Nurse Pract 2004;16(8):335-42.
[8]. Berg AH, Scherer PE. Adipose tissue, inflammation, and cardiovascular disease. Circ Res 2005;96:939-49.
[9]. Stevens J, Katz EG, Huxley RR. Associations between gender, age and waist circumference. Eur J Clin Nutr 2010;64:6-15.
[10]. Despres, J, Moorjani, S, Lupien, PJ, Tremblay A, Nadeau A, Bouchard C. Regional distribution of body fat, plasma lipoproteins, and cardiovascular disease'. Arteriosclerosis 1990;10(4):497-511.
[11]. Ashwell MA, LeJeune SRE, McPherson K. Ratio of waist circumference to height may be better indicator of need for weight management. British Medical Journal 1996;312:377.
[12]. Hsieh S, Yoshinaga H. Do people with similar waist circumference share similar health risks irrespective of height? Tohoku J Exp Med 1990;188:55-60.
[13]. Hsieh SD, Yoshinaga H. Abdominal fat distribution and coronary heart disease risk factors in men - waist/height ratio as a simple and useful predictor. Int J Obes 1995;19:585-9.
[14]. Cox BD, Whichelow M. Ratio of waist circumference to height is better predictor of death than body mass index. BMJ 1996;313(7070):1487.
[15]. Ashwell MA, LeJeune SRE, McPherson K. Ratio of waist circumference to height may be better indicator of need for weight management. British Medical Journal 1996;312:377.
[16]. Laakso M. Hyperglycemia and cardiovascular disease in type 2 diabetes. Diabetes 1999;48:937-942.
[17]. Expert Panel on Detection, and Treatment of High Blood Cholesterol in Adults: Executive summary of the third report of the National. Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III); JAMA 2001;285:2486-249.
[18]. Grundy SM, Cleeman JI, Daniels SR, Donato KA, Eckel RH, Franklin BA, Gordon DJ, Krauss RM, Savage PJ, Smith SC Jr, Spertus JA, Costa F: Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. Circulation 2005;112:2735-2752.

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Influence of the low-cost digital contents in improvement of the students' learning experience

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Abstract **– In the study process, the students have problems understanding parts or of the whole course curriculum. The most frequent reasons for these problems are: the student absence of one or more successive lectures, or the student lack to understand parts of the course curriculum.**

Depending on the structure and dependability of the lessons in the course curriculum, the student can have problems with small part or large number of lessons in the course curriculum. These might lead to complete misunderstanding of the course curriculum.

In order to solve this problem, development and deployment of additional digital content is usually needed, which is both time and budget consuming. The high development and maintaining price are most common arguments which cause resistance against deployment of such systems in the educational institutions.

In this article, we propose a model for broadening of the traditional study process by using low-cost digital content and distance learning. This model is inexpensive for deploying, administering and supporting and is simple to use, while the greatest benefit is increasing the students' learning experience.

In the paper, we will describe the distance education model that was used for content sharing together with the student survey reflecting on the achieved quality of learning experience.

Keywords **– QoE, Quality of learning experience, E-learning educational systems, Low-cost digital contents.**

1. Introduction

The students' main goal in the study process is to gain the knowledge that can be applied in solving practical problems in their everyday working activities after finishing studies. According to Gagne (1985), there are two distinct types of knowledge: declarative and procedural. Declarative (context) knowledge includes facts, concepts and principles. It is the factual knowledge within a discipline or skill domain. Procedural knowledge is the knowledge exercised in the accomplishment of a task. The courses in traditional study process are divided into lectures and labs. Lectures cover the declarative knowledge. Lab exercises allow students to gain procedural knowledge through problem solving, using declarative knowledge. According to Jonassen (1997), there are two types of problem solvers: novice and expert. Expert problem solvers (teaching staff) have lots of context knowledge and are able to solve the analogous problem in the same domain or problems in similar domains using their context knowledge and problem solving experience. Novices (students) have less context knowledge then experts and have problems in applying the procedural knowledge in problem solving. Teaching assistants use labs to supply students with the procedural knowledge and guide them how to use this knowledge in problem solving through real world practical examples. Many students need more practical examples to gain and implement procedural knowledge. The time dedicated for course labs is not enough for more practical examples. In many courses, materials for lab exercises are interdependent. Procedural knowledge gained from one lab depends on the procedural knowledge gained from one or more previous labs. If the student is absent from one lab, he will have a problem gaining and using the procedural knowledge from this lab, and lack of procedural knowledge from one or more of the next labs. Traditional instructor-led classroom learning cannot solve this problem.

The fast progress of the information and communication technologies allows another type of learning, distance learning. Greenberg (1998) defines contemporary distance learning as "a planned teaching/learning experience that uses a wide spectrum of technologies to reach learners at a distance and is designed to encourage learner interaction and certification of learning". According to Desmond Keegan (1995), distance education and training result from the technological separation of the teacher and the learner which frees the student from the necessity of traveling to "a fixed place, at a fixed time, to meet a fixed person, in order to be trained". KHAN ACADEMY goes step further, promoting new concept of free learner access to the distance learning system which hosts more than 24000 digital contents with short duration (between five and twenty minutes). The main characteristics of this system are: intuitive use, digital contents with minimal creation and deployment cost, Learner path

chosen by the learner, the speed of learning according to the learner abilities.

Although researchers have not found significant difference in learning effectiveness (Johnson at all (2000), Fallah and Ubell (2000), Ben Arbaugh (2000)) between traditional classroom and distance learning, some researchers underline a high rate of students who commence e-learning and not finish them (Dutton and Perry, 2002) and students dissatisfaction with the e-learning experience (Bouhnik and Marcus, 2006).

Blended Learning is a combination of traditional classroom and distance learning. According to Graham (2005) and Graham and Allen (2005), blended learning is a combination of face-to-face instruction with computer-assisted instruction. It is a new way of learning that combines the advantages of both type of learning and eliminates their disadvantages. In order to take the best from both types of learning, the design of blended learning must be done carefully with the optimal balance between online and face-to face instruction (Christensen, 2003). Another important question in designing the blended learning is choosing the appropriate delivery media (Hoffman, 2006).

Teachers that introduce blended learning in their courses are afraid that they do not have sufficient experience for making proper blending. Another problem is the additional time that they must spend in preparing and practicing blended learning. All of this makes teachers to look with skepticism on blended learning.

In our paper we propose a model of using additional digital contents as a preparation step to blended learning. This model is not time consuming as full blended learning. Teaching staff can make additional digital contents, and make them available to the students using distance learning management systems. Teaching staff can monitor the frequency and time that students spend in using of these additional digital contents and the increase of the students learning effectiveness and efficiency. Also they can review the additional digital contents based on students' demands according to students' goals and abilities. All of this will help teaching staff to be prepared to make proper blending and to introduce and practice blended learning in their courses.

Education is one of the most important processes in human being, in which the students gain knowledge and skills from the society knowledge accumulated with centuries and the moral norms developed by generations.

Researches made by Elmore (1996), Chickering and Gamson (1987) and Chickering and Ehrmann (1997) define the components of education, their correlations and the best practices in education development process.

In traditional classroom education, both professor and students are located in the same space (amphitheater, lecture room, laboratory). They communicate according to exact communication rules, accomplishing previously defined functions and have beforehand defined expectation (Gorham (1988), Gorham and Zakahi (1990), Georgakopoulos and Guerrero (2010)). The quality of professor-student interaction has great influence in the quality of the whole education process (Gorham (1988), Gorham and Zakahi (1990), Kelly and Gorham (1988) and Newman at all (1995)).

Moore (1989) identified three kinds of interactivity which affect distance learning: learner – content interaction, learner - instructor interaction and learner – learner interaction. When interacting with the content, learner interacts with the course materials and the concepts and ideas that they present. Learner – instructor interaction includes the way in which instructors teach, guide, correct and support their students. Learner – learner interaction refers to interaction among learners. The overall success of distance learning depends on the success of these three types of interaction.

Learner - learner interaction provides exchange of opinions, discussions and information sharing between learners. It plays important role in distance learning. According to Moore and Kearsley (1996), students' interaction with their classmates in a distance learning environment can contribute to learning. A study by Fredericksen and colleagues (2000) examining asynchronous learning found that students who reported greater interaction with other students in an online course stated higher levels of perceived learning.

Interactions with instructor can help students to gain better understanding of the learning material. In traditional classroom, learning occurs in physical face-to-face meeting. In the distance learning course, this type of interaction is transmitted by electronic means, such as chat discussions or e-mail communications. The role of the instructor in distance learning has changed from that in the traditional classroom learning. In the traditional classroom, the role of instructor is to be a lecturer. In distance learning format, the role of instructor is to be a facilitator (Gutierrez, 2000). Some researchers have indicated that the quality of interactions between students and instructors in the distance learning courses were equal to, or better than, interactions in the traditional courses (Lenhart et al., 2001).

Learner – content interaction is important part of the distance learning process. According to Moore (1989), there is no education without this type of

interaction. The educational process entails the learner's intellectual interaction with content, which results in changes in the learner's understanding, the learner's perspective, or the cognitive structure of the learner's mind. Content delivered in an online course needs to be complete, relevant, and accurate (Siragusa et al., 2007). Brown and Voltz (2005) maintain that "educational materials that have been effectively designed will facilitate the achievement of desired learning outcomes for students".

Many researchers argue that learners' interactions with learning management systems play important part in distance learning (Kedar, Baruch, and Gruvgald (2003), Carswell and Venkatesh (2002)).

From instructor point of view, instructor - content interaction is important part of distance learning process. Many times the instructors have to include up-to day information on the course content. Content "last minute" changing is demanding and frustrating activity. Using the new technologies and carefully dividing the course content in two parts: invariant and changeable, can lighten and speed up the process of content changing. According to Pearson (1999), the course content may be adapted to suit expressed student needs, perhaps indicated by feedback from the students via discussion forums. The instructor can change the learning content to adapt them to learners' goals and abilities. This can motivate the students to be more active, to learn more and to gain additional knowledge.

2. Research Methodology

In order to show the influence of the low-budget digital contents in the increase of the quality of the students' experience, an initial research has been made. During one semester, in the course Object-Oriented and Visual Programming, the students were offered additional digital contents (video contents) in which through examples was elaborated the material and knowledge which is necessary to finish the homework assignments and successfully pass the mid-term exams.

The research is consisted of three parts. In the first part of the research a cost analysis has been made for the creation and setting up the additional digital contents (expressed in working hours). The second part of the research is the initial evaluation of the students' additionally gained experience with use of the additional digital contents. In the third part of the research a comparison has been performed between the students of this group in the performance and outcome of solving the homework assignments and passing the mid-term exams, and, the students from the previous year for the same course when they did not use the additional digital contents.

2.1. Cost analysis of the additional digital contents

For the needs of the course, additional digital contents have been made. These contents are in Adobe Flash (.swf) video format with resolution 800x600. The digital contents are made with use of open source screen and microphone capturing tool. The duration of the additional digital contents (expressed in minutes) in categories is presented in Table 1.

Additional digital contents category	Duration (minutes)
Assignment Working environment preparation	14
Repetition of contents from previous courses implemented in the new working environment	70
Contents for Mid-term 1	136
Contents for Mid-term 2	222
Total	442

Table 1. Detailed summary of the duration of the additional digital contents by category

The total time needed to finish the additional digital contents is calculated as the total duration of the digital contents multiplied by 4, because for each minute of digital contents three additional minutes are necessary for: preparation before producing, saving and converting the digital contents from internal video format into portable video format.

In this manner, the time for making the additional digital contents is 1768 minutes = (442 minutes * 4). In table 2 a summary of the time spent for creation and setup of the additional digital contents is given.

Step	Duration (minutes)
Installation of the tool for creation of the digital contents	30
Training for using the tool	30
Creation of the additional digital contents	1768
Upload of the additional digital contents on a Content Management System	120
Total	1948

Table 2. Detailed summary of the time spent for creation and setup of the additional digital contents

It can be seen from Table 2 that the total duration for creation and setting up of the additional digital contents is 1948 minutes (32 hours and 28 minutes). This is the additional time that one teaching assistant would spent in the frames of one semester.

As the creation and setup of the additional digital contents does not require any additional technical

conditions except microphone, it can be said that those are low cost additional digital contents.

2.2. Initial evaluation of the additionally gained experience of the students with use of additional digital contents

In our research, there were two main reasons for making the additional digital contents: students' demand and teaching staff estimation. Both of two reasons indicate quality and intensive communication between students and teaching staff. When students were asked whether the teaching material and additional digital contents correspond to their level of goals, their answers were positive. Because of that, our first hypothesis is:

H1: The quality of communication with teaching staff influences choosing the proper level of goals for the teaching materials and the additional digital contents.

Because teaching materials and additional digital contents correspond to students' goals, students actively used them and have success with homework assignments and the midterm exams. Our second hypothesis is:

H2: The proper set of goals for the teaching materials and the additional digital contents highly influences the additional knowledge gained from the additional digital contents.

The students were satisfied with their success in the homework assignments and midterm exams. In communication with them they express their overall course satisfaction. Our third hypothesis is:

H3: The additional knowledge gained from the additional digital contents highly influences the quality of learning experience.

2.2.1. Sample and procedures

In this subsection we discuss sample characteristics and procedures of data collection.

Participants

Participants of this initial evaluation are students enrolled in the course Object and Visual Programming (total=25). Five students only enroll in the course but did not take any course activities. All of the other students (n=20) took participation in the student activities and in this initial evaluation.

Information and Data Collection

At the end of the semester, students responded to the written questionnaire. This questionnaire consists of main part and additional part. Main part consists of 7-point Likert scale questions (1=I absolutely disagree, 2=I disagree, 3=Partially disagree, 4=no opinion, 5=partially agree, 6=I agree, 7=I absolutely agree) and open ended questions. The additional part of this questionnaire contains data such as: demographic data, previous experience with use of additional digital contents, previous experience with use of distance learning management systems. Student's personal data and privacy are protected.

Demographic profile of respondents

Table 3 shows the demographics profile of the students. According to the table, male students comprised about 80%, while female students constituted 20% of the sample. Furthermore, 85% of the students use additional digital contents for the first time and 75% of the students use distance learning management system for the first time.

		Frequency	Percentage
Gender			
	Male	16	80
	Female	4	20
Age			
	Between 19 and 25	20	100
Previous experience with use of additional digital contents			
	Using of additional digital contents for the first time in this course	17	85
	Using of additional digital contents in another course	1	5
	Using of additional digital contents in more than two courses	2	10
Previous experience with use of distance learning management systems			
	First time in this course	15	75
	First time in another course	2	10
	Many times in more than two courses	3	15

Table 3. Demographics profile of the sample (n=20)

2.2.2. Information and data analysis

In the last phase of the research, analysis of the main part of the evaluation data was performed. These statistical analyses were done using IBM Statistical Package for Social Sciences software. The results and the findings are presented in this article.

Input variables

By carefully evaluating student responses on different questions, we have chosen the following list of items from questionnaire:

Item name	Item Description
PLA1	The level of the curriculum corresponds to my abilities
PLA2	The level of the additional digital contents corresponds to my abilities
PLG1	The level of the curriculum corresponds to my goals
PLG2	The level of the additional digital contents corresponds to my goals
QCTS1	The professor was timely responding on the questions
QCTS2	The professor answers were with high quality
AQADC1	The additional digital contents helped me understand the curriculum
AQADC2	The additional digital contents helped me apply the knowledge gained through the curriculum in solving practical problems
AQADC3	Mastering this curriculum gave me significant knowledge that I will use in practice after graduation
QOE1	The declared quality of the course is on a high level
QOE2	The established quality of the course is on a high level

Table 4. Input variables

Statistical information regarding input variables is shown on Table 5.

Variable name	Mean	Standard Deviation	Skewness	Kurtosis
PLA1	6,00	0,858	1,109	1,517
PLA2	6,20	0,951	2,069	6,177
PLG1	6,05	1,146	1,273	1,286
PLG2	6,05	1,146	1,273	1,286
QCTS1	6,30	1,218	2,585	7,955
QCTS2	6,45	0,759	1,017	0,371
AQADC1	6,40	0,681	0,712	0,446
AQADC2	6,55	0,686	1,283	0,542
AQADC3	6,10	0,641	0,080	0,250
QOE1	6,00	0,973	1,522	3,705
QOE2	5,90	0,968	1,331	3,101

Table 5. Statistical information regarding input variables

For all of the input variables, the absolute values of skew are less than 3.0 and the absolute values of kurtosis are below 8.0. According to Curran, West and Finch (1997), input variables in Table 5 are normally distributed.

In our proposed structural model, we have constructed five endogenous variables: quality of communication with teaching staff (QCTS), proper level of abilities (PLA), proper level of goals (PLG), additional knowledge gained from the additional digital contents (AQADC) and quality of learning experience (QOE).

Scale reliability

In order to determine the data reliability for the endogenous variables in our research model, we perform reliability analysis. The results of reliability tests are presented in Table 6.

Item	M	SD	CA*	r**
QCTS			0.877	
QCTS1	6.30	1.218		0.871
QCTS2	6.45	0.759		0.871
PLA			0.870	
PLA1	6.00	0.858		0.773
PLA2	6.20	0.951		0.773
PLG			0.889	
PLG1	6.05	1.146		0.800
PLG2	6.05	1.146		0.800
AQADC			0.776	
AQADC1	6.40	0.681		0.667
AQADC2	6.55	0.686		0.635
AQADC3	6.10	0.641		0.539
QOE			0.974	
QOE1	6.00	0.973		0.950
QOE2	5.90	0.968		0.950

CA* - Cronbach alpha

r** - corrected item-total correlation

Table 6. The mean, standard deviation, Cronbach alpha, corrected item-total correlation (from 1 which means "strongly disagree" to 7 which means "strongly agree")

All of the endogenous variables have a Cronbach alpha's value range of 0.776 and 0.974 which are greater than 0.7. According to (Nunnaly and Bernstein, 1994), the measurements of the variables are valid and reliable.

Correlation analysis

The relationship among variables was examined with the correlation analysis. The results are shown in Table 7.

Table 7. Correlation analysis

	QCTS	PLA	PLG	AQADC	QOE
QCTS	1.000				
PLA	0.242	1.000			
PLG	0.663**	0.364	1.000		
AQADC	0.366	0.459*	0.738**	1.000	
QOE	0.308	0.506*	0.520*	0.709**	1.000

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

According to Hair at all (1998), if there is a case such that the correlation coefficient exceeds the 0.90 there is a possibility of multicollinearity and must be explored. We can see from Table 7 that the highest value of correlation coefficient is 0.738. Therefore we can assume that we have no multicollinearity problem in our research study.

Multiple regression analysis

In order to examine our research hypotheses, multiple stepwise regression analyses were conducted. The results are shown on Table 8, Table 9 and Table 10.

Table 8. Stepwise multiple regression for Proper level of goals

	B	Std. error	Beta (β)	t	Sig.
(Constant)	1.252	1.289		0.971	0.345
QCTS	0.753	0.200	0.663	3.761	0.01

Note1: $p<0.01$
Note2: R^2 (coefficient of determination) = 0.440; Adj. R^2 = 0.409; F (1, 18) = 14.145; N=20

Table 9. Stepwise multiple regression for additional knowledge gained from the additional digital contents

	B	Std. error	Beta (β)	t	Sig.
(Constant)	4.064	0.500		8.128	0.000
PLG	0.378	0.081	0.738	4.642	0.000

Note1: $p<0.01$
Note2: R^2 (coefficient of determination) = 0.545; Adj. R^2 = 0.520; F (1, 18) = 21.549; N=20

Table 10. Stepwise multiple regression for Quality of learning experience

	B	Std. error	Beta (β)	t	Sig.
(Constant)	-1.803	1.825		-0.988	0.336
AQADC	1.221	0.286	0.709	4.265	0.000

Note1: $p<0.01$
Note2: R^2 (coefficient of determination) = 0.503; Adj. R^2 = 0.475; F (1, 18) = 18.189; N=20

2.2.3. Hypotheses testing

H1

As we can see from Table 8, the coefficient of determination (R2) is 0.440 representing that 44% of proper level of goals can be explained by quality of communication with teaching staff. The F(1,18) = 14.145 is significant at the 1% level ($p<0.01$). This indicates that regression is reasonable and the Quality of communication with teaching staff is predictor for the Proper level of goals.

H2

As we can see from Table 9, the coefficient of determination (R2) is 0.545 representing that more than 54% of additional knowledge gained from the additional digital contents can be explained by proper level of goals for teaching materials and additional digital contents. The F(1,18) = 21.549 is significant at the 1% level ($p<0.01$). This indicates that regression is reasonable and the Proper level of goals is predictor for the additional knowledge gained from the additional digital contents.

H3

As we can see from Table 10, the coefficient of determination (R2) is 0.503 representing that more than 50% of Quality of learning experience can be explained by additional knowledge gained from the additional digital contents. The F(1,18) = 18.189 is significant at the 1% level ($p<0.01$). This indicates that regression is reasonable and the additional knowledge gained from the additional digital contents is predictor for the Quality of learning experience.

2.2.4. Conceptual model

Based on our analyses we propose conceptual model that reflects the influence of additional low-cost digital contents in improvement of students' learning experience (Figure 1).

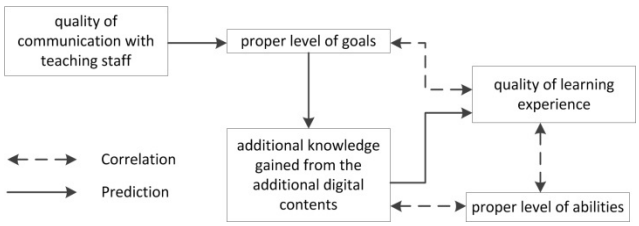

Figure1. Conceptual model of influence of additional low-cost digital contents in improvement of students' learning experience

This model shows the predictive relationships drown from multiple regression analyses (our hypotheses) and the positive correlation between proper level of goals and quality of learning experience and positive correlations between proper level of abilities and additional knowledge gained from the additional digital contents and quality of learning experience.

This model should be tested on larger sample and reviewed if necessary.

2.3. Analysis of the increased success with use of additional digital contents

In this part a comparison has been shown between the students of this group in the performance and outcome in solving the homework assignments and passing the mid-term exams, and, the students from the previous year for the same course, that did not use the additional digital contents.

	Homework assignments success (%)	**Mid-term 1 success (%)**	**Mid-term 2 success(%)**	**Average success of Mid-term 1 and Mid-term 2 (%)**
Group 1 (students who have used additional digital contents)	80,31	60,05	54,75	57,4
Group 2 (students who did not use additional digital contents)	61,22	41,47	22,77	28,7

Table 11. Comparison of the success (homework assignments and mid-term exams)

As it can be seen from Table 11, the students that used the additional digital contents have significantly higher success in the performance of solving the homework assignments and passing the mid-term exams against the students who did not use additional digital contents.

One of the possible reasons for this big discrepancy in the success of the Mid-term 2 is that the Mid-term 1 is eliminatory exam, so the students who did not pass the mid-term 1 did not show up on the mid-term 2, that is, they have 0 points. Anyhow, it does not decrease the obvious discrepancy in the mid-term 2 success.

From the results given in Table 11 it can be concluded that the group of students that used additional digital contents showed significantly better success in solving the homework assignments and passing the mid-term exams than the group of students who did not use additional digital contents. This endorses our statement that using additional digital contents increases the students' overall knowledge gained in a given course, which on the other hand increases and improves level of experience that the student has at the end.

3. Discussion and future work

According to Sabine Moebs, Jennifer McManis (2008), the universities must see the students as learners, as users and as costumers. As customers, students buy the practical and applied knowledge that they hope to gain with finishing the studies and taking the diploma. Universities supply the students with necessary knowledge through the study process. Students use the study process as a service and learning materials as products in this service. In order to supply a quality service, universities must know the goals and the abilities of the students. This can be done through the intensive and qualitative communication between the teaching staff and the students. The teachers who intensively and qualitatively communicate with their students make learning materials that correspond to students' goals and abilities. The H1 hypothesis from our research shows the same, i.e. the quality of communication with teaching staff influences choosing the proper level of goals for the teaching materials and the additional digital contents.

When the proper levels of goals for the teaching materials do not correspond to students' goals, teaching staff can make changes in the current learning materials or can make additional digital contents that correspond to the students goals. These additional contents can supply the students (as learners) with additional knowledge that helps them being successful in solving the homework assignments and midterm exams and can enforce them in solving practical problems. The H2 hypothesis from our research shows the same, i.e. the proper set of goals for the teaching materials and the additional digital contents highly influences the additional knowledge gained from the additional digital contents.

Students who have shown success in their homework assignments and midterm exams (as learners) and are able to use the additional knowledge in solving practical problems have high level of learning experience (as customers). The H3 hypothesis from our research shows the same, i.e. the additional knowledge gained from the additional digital contents highly influences the quality of learning experience.

The main problem of making additional digital contents is the teachers' opinion that the process of their making is very time consuming. Our cost analysis shows that 1948 minutes (=32 hours and 28 minutes) was necessary for making additional digital contents with duration of 442 minutes. For course with 2 hours lectures and 5 hours exercises weekly, or, 30 hours lectures and 75 hours exercises overall, additional teaching assistants' 33 hours is not a too long additional time. This result is encouraging to convince the teaching staff in making the additional digital contents.

The analysis of the increased success with use of additional digital contents shows that the group of students that used additional digital contents showed significantly better success in solving the homework assignments and passing the mid-term exams than the group of students who did not use the additional digital contents. This endorses our statement that using additional digital contents increases the students' overall knowledge gained in a given course, which on the other hand increases and improves level of experience that the student has at the end.

The results of our research will encourage teaching staff to use additional digital contents in their courses. Next step is testing the results of this research for more courses with bigger groups of students. The positive results will encourage faculties and universities to use additional digital contents as a supplement to the regular learning materials.

4. Limitation of this study

The research presented in this paper has some limitations in regards to the generalization of research finding. The first limitation is that the research is done for only one course. The second limitation is the small population of participants. The third limitation is that the research does not focus on Learning Management System as a system for supplying learning materials and additional digital contents and managing the student-student and student-teacher communication. Future researches must go beyond these limitations.

5. Conclusion

The students' main goal in the study process is to gain the knowledge that can apply in solving practical problems in their everyday working activities after finishing studies. The courses in traditional study process are divided into lectures and labs. Lectures cover the declarative knowledge. Lab exercises allow students to gain procedural knowledge through problem solving. Many students need more working examples to gain and be able to apply procedural knowledge. In many courses, materials for lab exercises are interdependent. The procedural knowledge gained from one lab depends on the procedural knowledge from one or more previous labs. If student is absent from one lab, he will have the problem with gaining and using the procedural knowledge from this lab, and procedural knowledge from one or more of the next labs. Traditional instructor-led classroom learning cannot solve this problem.

In this study we have researched the model of using low-cost additional digital contents prepared according to students' goals and abilities in order to help students to solve the problem with gaining and applying the procedural knowledge.

In our initial research analysis we show that additional digital contents can be created and supplied to students at low cost. After that we have created and evaluated an initial model of using low-cost additional digital contents. We have proved that using additional low-cost digital contents increases the students' overall knowledge gained in a given course, which on the other hand increases and improves level of experience that the student has at the end. From analysis of the increased success with use of additional digital contents we see that group of students that have used additional digital contents showed significantly better success in solving the homework assignments and passing the mid-term exams than the group of students who have not used additional digital contents.

The results of our initial research will encourage teaching staff to use additional digital contents in their courses.

In the next researches the results of this initial research will be tested for more courses with bigger groups of students. The positive results will encourage faculties and universities to use additional digital contents as a supplement to regular learning materials.

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References

[1]. Gagne, R. 'The conditions of learning. (4th ed.)'. New York: Holt, Rhinehart and Winston, 1985.

[2]. Jonassen, D., 'Instructional Design Model for Practice and Situated Problem-Solving Learning Outcomes', Educational Technology Research and Development Journal, 1997.

[3]. Greenberg, G. 'Distance education technologies: Best practices for K-12 settings'. IEEE Technology and Society Magazine, (Winter) 36-40, 1998.

[4]. Keegan, D.'Distance education technology for the new millennium: compressed video teaching'. ZIFF Papiere. Hagen, Germany: Institute for Research into Distance Education. (Eric Document Reproduction Service No. ED 389 931), 1995.

[5]. KHAN ACADEMY, http://www.khanacademy.org/

[6]. Johnson, S. D., Aragon, S. R. Shaik, N. & Palma-Rivas, N. Comparative analysis of learner satisfaction and learning outcomes in online and fact-to-face learning environments. Journal of Interactive Learning Research, 11 (1) 29-49, 2000.

[7]. Fallah, M. H. & Ubell, R. Blind scores in a graduate test: Conventional compared with web-based outcomes. ALN Mgazine, 4 (2), 2000, http://www.aln.org/alnweb/magazine/Vol4_issue2/fallah.htm

[8]. Arbaugh, J. B. Virtual classroom versus physical classroom: an exploratory study of class discussion patterns and student learning in an asynchronous Internet-based MBA course. Journal of Management Education, 24, (2), 213-233, 2000.

[9]. Dutton, J., & Perry, J. 'How do online students differ from lecture students?' Journal of Management Information Systems, 18(4),169–190, 2002.

[10]. Bouhnik, D., & Marcus, T. 'Interaction in distance-learning courses'. Journal of the American Society Information Science and Technology, 57(3), 299–305, 2006.

[11]. Graham, C.R., 'Blended learning system: definition, current trends, and future directions'. In Bonk, C. J. & Graham, C. R. (Eds.). Handbook of blended learning: Global Perspectives, local designs (pp 3-21), San Francisco, CA: Pfeiffer Publishing., 2005.

[12]. Graham, C.R., & Allen, S. 'Blended learning: An emerging trend in education'. In C. Howard, J.V. Boettecher, L. Justice & K.D. Schenk (Eds.), Encyclopedia of Distance Learning (99. 172-179). Hershey, PA: Idea Group Inc, 2005.

[13]. Christensen, K. T. 'CASE 1 finding the balance: Constructivist pedagogy in a blended course'. Quarterly Review of Distance Education 4(3), 235–243, 2003.

[14]. Hoffman, J. 'Why Blended Learning hasn't (yet) Fulfilled its Promises: Answers to Those Questions That Keep you up at Night', In Bonk C. J. & Graham, C. R. The Handbook of Blended Learning: Global Perspectives, Local Designs. San Francisco: Pfeiffer, 2006.

[15]. R. F. Elmore, "Getting to Scale with Good Educational Practice", Harvard Educational Review, vol. 66, no. 1, 1996.

[16]. A. W. Chickering, Z. F. Gamson, "Seven Principles of Good Practice in Undergraduate Education", AAHE Bulletin, 39, 3-7, 1987.

[17]. A. W. Chickering, S. C. Ehrmann, "Implementing the Seven Principles: Technology as a Lever", American Association for Higher Education, 1997.

[18]. J. Gorham, "The relationship between verbal teacher immediacy behaviors and student learning. Communication Education, 37, 40-53, 1988.

[19]. J. Gorham, W. Zakahi, "A comparison of teacher and student perceptions of immediacy and learning: Monitoring process and product", Communication Education, 39, 355-367, 1990.

[20]. A. Georgakopoulos, L. K. Guerrero, "Student Perceptions of Teachers" Nonverbal and Verbal Communication: A Comparison of Best and Worst Professors across Six Cultures", International Education Studies, vol. 3, no. 2, 2010.

[21]. D. Kelly, J. Gorham, "Effects of immediacy on recall of information", Communication Education, 37, 198-207, 1988.

[22]. D. Kelly, J. Gorham, "Effects of immediacy on recall of information", Communication Education, 37, 198-207, 1988.

[23]. D. Newman, B. Webb, C. Cochrane, "A content analysis method to measure critical thinking in face-to-face and computer supported group learning", Interpersonal Computer and Technology: An Electronic Journal for the 21st Century, 1995.

[24]. Moore, M.G. 'Three types of interaction'. American Journal of Distance Education, 3 (2), 1-6, 1989.

[25]. Moore, M. G., Kearsley, G. 'Distance education: A systems view'. Belmont: Wadsworth Publishing Company, 1996.

[26]. Fredericksen, E., Pickett, A., Shea, P., Pelz, W., , Swan, K. 'Student satisfaction and perceived learning with on-line courses: Principles and examples from the SUNY learning network'. Journal of Asynchronous Learning Networks, 4(2), 2000.

[27]. Gutierrez, J. J. 'Instructor-student interaction'. USDLA Journal, 14(3), 2000.

[28]. Lenhart, K. A., Lytle, J. S., Cross, C. 'Analysis of large Web-based courses at the University of Central Florida', 2001. Society for Information Technology

and Teacher Education International Conference, 2001(1), 1117-1119, 2001.

[29]. Siragusa, L., Dixon, K. C., & Dixon, R. 'Designing quality e-learning environments in higher educa-tion', 2007. ICT: Providing choices for learners and learning. Proceedings ascilite Singapore 2007, from the World Wide Web: http://www.ascilite.org.au/conferences/singapore07/procs/siragusa.pdf

[30]. Brown, A., & Voltz, B. 'Elements of effective e-learning design', 2005. The International Review of Re-search in Open and Distance Learning, 6(1), from the World Wide Web: http://www.irrodl.org/index.php/irrodl/article/view/217

[31]. Kedar, T., Baruch, R., & Gruvgald, E 'Satisfaction from the e-learning system', Unpublished manuscript, Bar-Ilan University, Ramat Gan, Israel, 2003.

[32]. Carswell, A.D., & Venkatesh, V. 'Learner outcomes an asynchronous distance education environment', 2002. International Journal of Human–Computer Studies, 56, 475–494.

[33]. Pearson, J. 'Lurking, anonymity and participation in computer conferencing': data from a case study on an initial teacher education course, paper presented at the Communications and networking in education: Learning in a networked society, Aulanko, Hämeenlinna, Finland, 1999.

[34]. Curran, P. J., West, S. G., and Finch, J. F. 'The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis', Psychological Methods, Vol. 1, pp. 16–29, 1997.

[35]. Nunnally JC, Bernstein IH. 'Psychometric theory. 3rd edition'. NewYork: McGraw-Hill Inc., 1994.

[36]. Hair JF, Anderson RE, Tatham RR, Black WC. 'Multivariate dataanalysis'. New Jersey: Prentice-Hall International Inc, 1998.

[37]. Sabine Moebs, Jennifer McManis,'A Learner, is a Learner, is a User, is a Customer - So what exactly do you mean by Quality of Experience?',Adaptive Hypermedia and Adaptive Web-based Systems, 2008.

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Strategy development by using SWOT - AHP

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Abstract **–This paper employs combination of SWOT analysis and Analytic Hierarchy Process (AHP) in strategic planning for tourism of small mid-european city Varazdin, which is located in the north west of Croatia. SWOT analysis identifies internal and external factors which are prioritized by expert in tourism domain by means of AHP. The prioritized SWOT factors are used in strategies formulation using TOWS matrix. Results indicate that proactive communication strategy and isolation strategy with effective marketing promotional strategy were the best strategies that could have been implemented.**

Keywords **– SWOT, AHP, strategy formulation.**

1. Introduction

Every organization is faced with a variety of internal and external forces which, on the one hand, can be a stimulus, or on the other hand, can be potential threat regarding the performance of the organization or the goals that the organization wants to achieve. As a first step in strategic planning managers need to identify and evaluate these strategic factors that either help or make difficulties to the organization on the way to realize their full potential [7]. Because each organization operates in a dynamic environment, the relative importance of each strategic factor is exposed to constant change.

Defined strategic factors can be used as a starting point for creating a strategic plan. Their biggest advantage is helping decision makers explore different areas of management, give an insight into the importance of individual components within the enterprise, and allowing them to initiate appropriate action. For a successful business in this regard, the organization must concentrate his future goals on their strengths and turn tendencies associated with weakness. Response to the internal strengths and weaknesses is therefore an essential component of strategic management [7].

Strategic management can be defined as a set of decisions and actions taken by management, in collaboration with all levels within the organization in order to establish long-term activities of the organization [13].

Literature review shows that many approaches and techniques can be used to analyze the strategic cases in the strategic management process. One of them is the SWOT analysis. This article explains the SWOT analysis, provides the theoretical background and an overview of the application of the SWOT analysis. As some authors have identified weaknesses of the SWOT, analysis is combined with a method for multi-criteria decision analytic hierarchy process (AHP) in order to avoid these disadvantages. Therefore, in the second part of the paper AHP method and SWOT AHP hybrid method are described. Following the basic steps method, SWOT AHP is applied to the example of the city of Varazdin strategic marketing plan definition.

2. SWOT analysis

SWOT is an acronym of strength, weakness, opportunities and threats. The first two factors (strengths and weaknesses) are related to internal organizational factors, while opportunities and threats cover a wider context or environment in which the entity operates [4]. The first are likely to be under control of the organization but the latter one, although they are no less important when looking at the impact on the enterprise, are not.

SWOT is one of the most widespread methods of management and is an instrument used by managers in creating strategies [9]. Commonly used as a tool for the analysis of internal and external factors in order to achieve a systematic approach and support to address the situation. Internal and external factors are the most important for the future of businesses. They are called strategic factors and are presented in the SWOT matrix. The ultimate goal of the strategic planning process, of which the SWOT is one of the initial phases, is development and adoption of strategy resulting in a good relationship between the internal and external factors. SWOT can also be used when the alternative appears suddenly and need to analyze the context of decisions with respect to that. SWOT analysis is actually a method to help with strategy formulation. The analysis aims to identify the strengths and weaknesses of the organization and the opportunities and threats in the environment of the organization. SWOT analysis is an important tool that serves as a support for decision-making and is often used as a tool for the systematic analysis of the organization, both internal and external influences on the organization [13]. Identifying their strengths,

weaknesses, opportunities and threats, organizations can build a strategy on their strengths, eliminate weaknesses and exploiting its capabilities, or to use an option in the fight against threats. SWOT analysis summarizes the most important internal and external factors (strategic factors) that may affect the future of the organization.

A comprehensive analysis is important to identify the internal and external factors facing the organization. On the one hand, these factors may include incentives, on the other hand may represent a potential limitation in terms of performance of the organization or the goals that the organization wants to achieve [13]. The resulting information can be systematically presented in a matrix form, different combinations of the four factors of the matrix can help to determine a strategy that will mean long-term progress

2.1. Advantages and disadvantages of SWOT analysis

Collins-Kreiner and Wall emphasize that the SWOT analysis is simple and useful for organizing information , especially for preliminary research, but also as a basis for more applied and theoretical work [4]. One of the advantages but at the same time disadvantage of SWOT analysis is the fact that it is the method of valuation. The emphasis on the evaluation of the work seems more applied than theoretical. SWOT has proved very useful in understanding the environment of the organization and, consequently, in the strategic planning of their growth and development.

Typically used at the enterprise level, but can be applied at higher levels, for example, in strategic plan in tourism of the destination [8]. Strategic planning for the destination could be a difficult task as there are many possible strategies derived from the assessment of environmental factors. But the decision without a systematic approach would result in less effective strategies.

When taking into account disadvantages, SWOT analysis is not able to quantify the effects of weight and strategic factors on alternatives [11]. Although some studies have included such quantitative weighting, none take into account the relationship or dependency factors in SWOT analysis. This is very important because it can`t be assumed that factors of a SWOT analysis are independent and not connected one with another. When used SWOT, there is no possibility of a comprehensive evaluation of the strategic decision-making situations. In addition, SWOT does not include funds for the analytical determination of significance of the factors. SWOT analysis is therefore mainly based on qualitative analysis; skills and expertise of people. As the planning process is often complicated by a number of criteria and interdependencies, sometimes using SWOT is insufficient. In a study from 1997., Hill and Westbrook [6] found that none of the 20 companies that were the subject of their study did not prioritize individual SWOT factors and only three companies use SWOT analysis in defining the mission. In addition, expression of certain factors was very brief and general in nature. Thus, it can be concluded that the results of the SWOT analysis are often only superficial and inaccurate or incomplete list of qualitative testing of internal and external factors.

2.2.Application of SWOT analysis

The beginnings of the SWOT analysis go back in 1960 and the application of the SWOT analysis from then until now extends to a wide range of areas. SWOT is used in many situations, e.g. for planning and development of the situation, as a tool for organizing and interpreting information. SWOT analysis is often used by consultants, but it is rarely by scientists. Chang et. al. stated that external factors can be classified according to its attractiveness and the likelihood of potential: opportunities to succeed and threats that will not materialize. The internal factors may be ranked in terms of their effectiveness and relevance [3]. Furthermore, they summarize internal and external strategic factors in EFAs (Synthesis of External Strategic Factors), the synthesis of external strategic factors and IFAS (Synthesis of Internal Strategic Factors), the synthesis of internal strategic factors. They showed how internal and external factors can be weighted to illustrate how management responds to these specific assessment factors in light of their perceived importance to the company. Weighting was carried out on a scale from 0 (not important) to 1 (most important). The result was a weighted score that indicates how well the company responds to the current and anticipated strategic factors in the environment. In addition to weighting and evaluating individual SWOT factors, they proposed weighting of four SWOT groups and their usage as additional multipliers for individual factors in order to assess their overall significance.

Following this analysis, managers can get some foundations, such as the factors on which we should base the future success of the strategy. However, none of presented approaches does not consist of a systematic technique for determining the importance of factors.

3. AHP method

This chapter describes the AHP method which is used in conjunction with a SWOT analysis in order to avoid the disadvantages of SWOT analysis. Previous studies have recognized the shortcomings of SWOT analysis and point out SWOT AHP as hybrid that deal with the priorities of SWOT factors ([8], [9], [10], [11]). Thus, the idea behind using AHP is to systematically evaluate the SWOT SWOT factors [13]. This chapter provides a theoretical background of AHP method, and the next chapter describes SWOT AHP and emphasizes reasons for integration of two methods.

Analytical Hierarchy Process (AHP) is one of the most popular methods of multiple criteria decision making. It is used to rank the alternatives by taking into account the importance of the different criteria. AHP allows structuring the problem, followed by comparing pairs of elements in the hierarchy. At the end of the process, mathematical model is determined by weighting factors of all elements of the hierarchy. AHP structures the problem of decision-making and monitors the process of decision making by defining objectives, criteria and alternatives, by comparing criteria and alternatives in pairs and defining priorities of alternatives. Results of the AHP method are ranked alternatives and the weight coefficients of criteria in relation to the goal. AHP successfully identifies and indicates the inconsistency of decision making by tracking inconsistencies for the whole process. Results are quantitative indicators that can argue the decision. AHP method is now one of the most popular and commonly used method for multi-criteria decision making in solving real problems. It was developed by Saaty in 1977.

3.1. Application of AHP

Vaidya and Kumar published in 2006. the literature review of 150 publications published in the prestigious international scientific journals in the period since 1983. - 2003, in which the AHP method has been applied to solve certain types of problems. In the period since 1983.to 2003 [12]. AHP method is most often used for the selection, evaluation and decision-making (more than 50% of the application is one of the three areas). Furthermore, the AHP has been applied in the planning, development, and in cost – benefit analysis, and less in medicine and for the purposes of prediction. The same article noted that the AHP method in that period occurred in the five studies combined with SWOT analysis.

4. SWOT AHP method

This chapter describes a hybrid method of SWOT AHP. First, the reasons why combination of these two methods is necessary, followed by a review of SWOT AHP method.

Although SWOT is often used as a planning tool, this analysis also has weaknesses. Some of these weaknesses can be avoided and then the SWOT can be used more efficiently. In previous studies, this is done by connecting a SWOT analysis with AHP method. As a result, a hybrid method is obtained that produces quantitative values for the SWOT factors ([8], [9], [10], [11], [13]). As advantages of derived hybrid method, literature most often states its simplicity, efficiency and the ability to combine qualitative and quantitative criteria [8]. One problem of SWOT analysis lies in the uncertainty related to the future development and the outcome of various factors. This can complicate the comparison. However, the AHP method is able to manage the decision-making in situations of uncertainty. It is recommended that a number of factors (strengths, weaknesses, opportunities and threats) will be limited to 10, but it certainly allows the user to avoid overlap and negligence during construction of SWOT. On the other hand, the limitation is not so strict and the problem of the large number of comparisons it can be avoided by using at least two different techniques. First, grouping variables and second, by adding a new level in the hierarchy. If, for example, there is a large number of opportunities, they can be grouped into two or three subgroups. AHP enables quantization of priorities to support decision making. However, AHP does not include the statistical uncertainty of the results. Consistency measure of comparison and consistency ratio, resulting from AHP calculation, does not give direct information about the uncertainty derived priorities.

Numerical results, prioritized SWOT factors are useful in formulating or selecting the strategy. It is good to compare the external features compared to the internal potential, because all the factors are, at the same, a numerical scale. For example, if it turns out that one weakness is greater than all the benefits, then the chosen strategy may have to be focused on eliminating these weaknesses. Similarly, the selection of the new strategy probably should not be based only on the deletion of the existing opportunities and threats, if they are of equal size. In every situation of strategic planning can be used SWOT analysis and AHP method. SWOT analysis provides the basic framework which conducts analysis of the situation in which the decision was made, while the AHP helps to conduct the SWOT in analytic way. Potential advantages of using AHP in

SWOT analysis lie in the possibilities of quantitative testing of SWOT factors and involvement of decision maker's preferences in the planning. Some of the advantages of AHP method as a systematic approach to decision-making problems can be valuable properties in the SWOT analysis. The added value of the SWOT analysis can be achieved by making comparisons in pairs between SWOT factors and by analyzing the eigenvalues, as it works in the AHP method. This provides a good basis for testing the current or expected situation, or defines a new alternative strategy. After conducting these comparisons, decision makers will have new quantitative information about the situation of making a decision, for example, whether there is a weakness that requires greater attention, or if it is expected that the company will be faced with future threats.

This hybrid method is suitable for many situations of strategic planning. After defining the priorities of SWOT factors, new strategies can be constructed partly on the basis of information derived from the comparison. Furthermore, it is possible to compare two or more strategic options, so find out which is the best match to the SWOT factors. This can be done by adding an alternative strategy to the lowest level of the hierarchy and comparing them with respect to each factor in SWOT list. The result is a quantitative value that indicates the priority or preference of each option.

Combined use of AHP and SWOT proved promising. Making comparisons in pairs forces decision-makers to think about the weights of factors and more accurately analyze the situation. Hybrid method of AHP and SWOT increases and improves the information base for the strategic planning process. It also provides an effective framework for learning in support of strategic decision making in many situations and can be used as a tool for communication and education in the processes of decision-making where multiple decision makers involved.

5.2. Steps of SWOT-AHP method

According to Yeon and Kim, SWOT AHP steps are following: (1) conducting a SWOT analysis, (2) comparisons in pairs between SWOT factors within each SWOT group, (3) comparisons in pairs between the four SWOT groups, and (4) formulating strategies based on the results [11].

Step 1: SWOT analysis.

Relevant external and internal factors are identified and included in the SWOT analysis. When applied to a standard method of AHP, it is recommended that a number of factors within the SWOT group does not exceed 10 because the number of comparisons in pairs that are needed in the analysis is rapidly increasing.

Step 2: Comparisons in pairs between SWOT factors were conducted within each SWOT group.

When comparisons are made, the question to be answered is: which of the two factors being compared is has higher impact: is it strenght, opportunity, weakness or threat. With these comparisons as input, the relative priorities of the local factors are calculated using the eigenvalues. These priorities reflect the perception of the decision maker on the relative importance of factors.

Step 3: Comparisons in pairs between four SWOT groups.

Factor with the highest local priority was chosen from each group to represent the group. These four factors are then compared and their relative priorities are calculated as in step 2.

These are the scaling factors of four SWOT groups and they are used to calculate the total global priorities of independent factors within them. This is done by multiplying the local priorities defined in the second step corresponding to the value of the scaling factor in SWOT groups. The sum of all factors of global priorities is one.

Step 4: Using results in the formulation of strategies and the evaluation process.

Contribution to the strategic planning process comes in the form of numerical values for the factors. New targets can be set, the strategies defined and the implementation plan taking into consideration based on the most important factors.

5.3.Application of SWOT-AHP method

In several previous studies the combined model SWOT and AHP method was used ([8] [9, [10], [11]). Kurttila et. al. stated this hybrid method is often used to improve the usability of a SWOT analysis as AHP quantitatively determines the importance of the factors in SWOT groups [9]. In the above studies, among other things, research subjects are exploring the opportunities and challenges of agroforestry by applying SWOT analysis in combination with AHP, assessing perceptions of stakeholders regarding the suitability of the access control based on the community. Kahraman et.al. have recently used the SWOT and AHP model to, firstly, prioritize strengths, weaknesses, threats and weaknesses of the group, and secondly, to decide and evaluate alternative strategies of e-government [12].

In each of these studies case study approach have been used to examine specific situations.

SWOT-AHP method was applied in even more domains such as environmental protection, project management, agriculture, manufacturing, energy, agriculture, industry, machine tools, etc.

6. Strategic planning of tourism in a small town

In this chapter the use of SWOT AHP is demonstrated in the field of tourism. Development of a strategic plan for a small town in the northwest of the Croatian, Varazdin is presented. Varazdin is a city with less than 50 000 inhabitants, the capital city of Varazdin County and the economic center of the North-West of Croatia.

Systematic approach to strategic planning of Varazdin tourism development is implemented by using SWOT analysis integrated with AHP method. Hybrid method follows the steps of development of described earlier in the paper. The first step is the SWOT analysis. SWOT matrix was developed by consulting an expert in the field of tourism: a person who graduated from the Faculty of Tourism Management. Identified strengths, weaknesses, opportunities and threats are found in Table 1 in the appendix of this paper. The following strengths were identified: characteristics of destination, geographical position and historical value, standard of living, cultural and religious events. Elements of each of these strengths are fully explained in table 1.

Expert has recognized the weaknesses of Varazdin relating to the following characteristics: limited availability, underdeveloped tourism, inadequate marketing promotion, poor coordination between tourism authorities and unstructured tourism management.

Expert has noted the following opportunities that can be exploited: geographical features of the destination recognized the potential for the development of tourism and international reputation. As threats to be aware of are identified: regional rival destinations, economical instability and the absence of controlling authority for active tourism.

In the next step, expert made comparisons in the pairs. First, comparisons were carried out in pairs among the SWOT factors within each of the four groups. Expert`s task was to compare two factors with respect to the goal (development of the best strategic marketing plan). Each question included ranking on a scale of 1 to 9 (Saaty scale) in order to make relative judgment factors. These comparisons were used as input to calculate the local priorities of the factors using the method of eigenvalues described by Saaty. The resulting priorities and ranking factors are shown in Table 2 in the appendix.

Table 2 shows opportunities have the greatest scaling factor. Inside the opportunities international reputation stands out as the strongest because it has the highest priority. International reputation is followed by geographic characteristics of destination. Other opportunities have significantly lower priorities.

As the greatest strength expert identified the characteristics of the destination. It is interesting to be noted that characteristics of the destination has priority higher than following two strengths together. Expert recognized underdeveloped and inadequate marketing of tourism promotion as the main weaknesses of Varazdin as a tourist destination.

The next step of the development SWOT AHP method involves defining strategies using tows matrix. The main objective of the strategy formulation is a change of current conditions or re-establish the image that is currently broken in the region. Tows matrix provides four different combinations: SO, WO, ST and WT. Below are shown strategies identified in this research. For each strategy are listed SWOT combinations that are used in defining strategies (e.g. S1/O4 means consideration of strength No.1 and opportunity No. 4.).

SO Strategies (Maxi-Maxi)

• *Strategy of differentiated approach*: Provides marketing mix in a different way than competitive destinations (including S1/S2/S4/O3/O2).

WO Strategies (Mini-Maxi)

• *Strategy of shareholder involvement in tourism development:* involvement of shareholders in decision-making, improve product quality and concern for consumers (including: W2/W3/W4/W5/W1/O3/O2).

• *The strategy of diversification of distribution channels:* distribution channels have the power to influence it, "when", "where" and "how" people are traveling, and so to some extent, control how many people come to a destination (includes W3/W2/W5/W1 / O3/O2/O1/O3).

ST Strategies (Maxi-Mini)

• *Segmented marketing strategy with product modification:* Segmentation identifies specific

categories of homogeneous preferences among tourists (includes S1/S2/S4/S3/T2/T1).

• *proactive communication strategy:* prevent potential negative image in the minds of visitors, must be centralized, honest, transparent and informative (S1/S2/T2).

WT Strategies: Mini-Mini

• *Launch efficient / flexible marketing promotional strategies:* creating confidence in the target market: special events, billboards, trade shows, TV programs, public relations, advertising ... are the best tactics for promotion (W3/T2/T1).

• *Organizational interrelationships and team work:* tourism is a set of variety services which include many parties, therefore it is necessary to develop a network among them (W2/W1/W3/T2/T1).

Explained strategies are defined with the help of expert, following the theory of tourism. The main advantage of this approach is that it takes into account the internal and external factors that are built into alternative strategies. The disadvantage is that certain combinations are not taken into account.

7. Conclusion

This paper describes two methods used to strategy development, SWOT and SWOT AHP. SWOT is one of the most widespread methods for developing strategies. It creates qualitative and subjective models based on which strategic decisions are made. This method is often combined with AHP method, which creates a SWOT AHP subjective quantitative model. This paper explains implementation of both methods and emphasizes their advantages and disadvantages. Following the basic steps of the SWOT AHP development, research presented in the paper employs this hybrid method in the domain of tourism and presents a case study of defining the strategy for the development of the marketing plan for one tourist destination Varazdin. The research results have the potential for large application in defining the strategy for the development of tourism in the city.

Appendix

POWER **Which forces should be aware of?**	**WEAKNESSES** **Weaknesses that need to be recognized?**
S1: *Characteristics of destination*: a city of culture, baroque and flowers, specific baroque spirit, culture and hospitality	W1: *Limited availability*: no airport
S2: *geographical position and historical value*: the location at the intersection of roads linking the Central and Southeastern Europe, formerly the capital of the Croatia	W2: *The underdevelopment of tourism:* the lack of reputable international airlines and hotels
S3: *The standard of living*: according to Forbes magazine the most desirable city to live in Croatia in 2011., the development of economic zones	W3: *Inadequate marketing promotion*: lack of appropriate marketing strategies for the promotion
S4: *Cultural and religious events*: *Spancirfest* - festival of street walkers, *Baroque Nights*, nearness of Ludbreg ("center of the world") and religious manifestation *Holy Sunday*	W4: *Poor coordination between tourism authorities*: lack of involvement in public-private strategic decision-making
	W5: *Unstructured tourism management*: obsolete laws relating to tourism, an ad-hoc investment, insecure jobs
OPPORTUNITIES **You can take advantage of the opportunities?**	**THREATS** **Threats which we must be aware of?**
O1: *Geographic characteristics of destination*: "transit point" between East and West	T1: *Regional Competitive Destinations*: local competitors are developing a competitive festival tourism to attract tourists of similar profiles
O2: *The potential for tourism development:* a wealth of cultural resources concentrated in a small area	T2: *Political instability*: unfavorable economic situation in country
O3: *International reputation*: branded products (e.g. Varazdin clips)	T3: *The absence of an active controlling authority for tourism:* the lack of tourism development plans

Table 1. SWOT analysis

SWOT group	scaling factor	SWOT factors	Local priorities	global priorities
Strengths	0.2002	S1: Characteristics of destination[1]	0.4334	0.0868
		S2: geographical position and historical value [3]	0.2016	0.0404
		S3: The standard of living [4]	0.1498	0.0300
		S4: Cultural and religious events [2]	0.2152	0.0431
weaknesses	0.2413	W1: Limited availability [4]	0.1454	0.0351
		W2: Underdevelopment of tourism [1]	0.3448	0.0832
		W3: Inadequate marketing promotion [2]	0.2961	0.0715
		W4: Poor coordination between tourism authorities [3]	0.1243	0.0300
		W5: Unstructured tourism management [5]	0.0894	0.0216
opportunities	0.3251	O1: Geographic characteristics of destination [2]	0.2465	0.0801
		O2: The potential for tourism development [3]	0.2187	0.0711
		O3: International reputation [1]	0.5348	0.1757
threats	0.2314	T1: Regional Competitive Destinations [1]	0.4823	0.1116
		T2: Economical instability [2]	0.2654	0.0614
		T3: The absence of an active controlling authority for tourism[3]	0.2523	0.0584

Table 2. Factor priorities

References

[1]. Buble, M., Cingula, M., Dujanić, M., Dulčić, M., Gonan Božac, M., Galetić, L., Ljubić, F., Pfeifer, S., Tipurić, D., Strateški menadžment, Sinergija nakladništvo d.o.o., Zagreb, 2005.

[2]. Chandler, A.D., Strategy and structure, The MIT Press, Cambridge, 1963.

[3]. Chang H.H, Huang W.C., Application of a quantification SWOT analytical method, Mathematical and Computer Modelling 43: 158–169. 2006.

[4]. Collins-Kreiner, N., Wall, G., Evaluating tourism potential: A SWOT analysis of the Western Negev, Israel,Tourism 55 (1): 51-63. 2007.

[5]. Dyson, R.G., Strategic development and SWOT analysis at the University of Warwick, European Journal of Operational Research 152: 631–640. 2004.

[6]. Hill, T., Westbrook, R., SWOT analysis: it's time for a product recall, Long Range Planning 30 (1): 46-52. 1997.

[7]. Houben, G., Lenie, K., Vanhoof, K., A knowledge-based SWOT-analysis system as an instrument for strategic planning in small and medium sized enterprises, Decision Support Systems 26: 125–135. 1999.

[8]. Jeon, Y.,A., Kim, J.S., An application of Swot-ahp to develop a strategic planning for a tourist destination,16th Graduate Students Research Conference, Houston, Texas, 6-8.01.2011.

[9]. Kurttila, M., Pesonen, M., Kangas, M., Kajanus, M., Utilizing the analytic hierarchy process AHP in SWOT analysis a hybrid method and its application to a forest-certification case, Forest Policy and Economics 1: 41-52. 2000.

[10]. Lee, S., Walsh, P., SWOT and AHP hybrid model for sport marketing outsourcing using a case of intercollegiate sport, Sport Management Review (in the process of publishing)

[11]. Osuna, E.E., Aranda, A., Combining swot and ahp techniques for strategic planning, ISAHP 2007, Viña del Mar, Chile, August 2-6, 2007.

[12]. Vaidya,O., Kumar, S., Analytic hierarchy process: An overview of applications", European Journal of Operational Research 169(1): . 1–29. 2006

[13]. Yuksel, I.,Dagdeviren, M., Using the analytic network process (ANP) in a SWOT analysis – A case study for a textile firm, Information Sciences 177: 3364–3382. 2007.

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Model Based Design and Hardware in the Loop Testing in Power Electronics Courses

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***Abstract* – In this paper a low cost virtual test bed for educational purposes is developed and tested. Hardware-In-the-Loop (HIL) design concept as an experimental part of power electronics is considered. Software simulations lead to develop control of the studied system. Before a real-time implementation of the control, HIL simulations could be a very useful intermediary step. Thus a hardware device is introduced in the loop in order to take its real constraints into account. Used equipment is general purposes and can be utilized for controller implementation as well as virtual plant model. Simulations are performed under different conditions and results are presented graphically using virtual instruments on the designed front panels.**

***Keywords* – Hardware in the loop, Power Electronics, DC/DC converters, Buck Converter.**

1. Introduction

Systems are created to solve problems. One can think of the systems approach subject System Analysis and Design, mainly deals with the software development activities. System development life cycle means combination of various activities. In other words we can say that various activities put together are referred as system development life cycle, Fig. 1.

Due to the rapid development of digital-processor technology, embedded control systems (from now on simply called electronic control systems - ECS's) control many devices we use in our everyday life. Moreover, many of these systems operate in safety-critical situations and therefore call for rigorous engineering. This crucial point is the reason why so much research effort is put into the development of methodologies for the design, development, and implementation and, in our case, testing of ECS. In developing such products and systems, the testing and not the design usually is the more expensive, time-consuming and difficult activity [1]. Hardware-in-the-Loop simulation (from now on called HIL simulation or HIL's) is a kind of real-time simulation were the input and output signals of the simulator show the same time dependent values as the real process with various dynamic performance [2]. Such simulators allow us to test the real embedded control system (ECS) [3, 4] under different real working

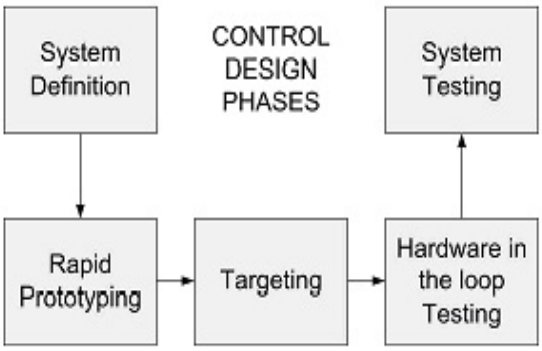

Figure 1. System Development Life Cycle.

loads and conditions. Other simulation methods do not allow us to test the real embedded control system as a complete system. Often the controller part, which is only about 20-30 % of the ECS software, or the software components are tested independently. HIL's makes it possible to test the complete ECS. Moreover, the temporal logic tester and the fault generator allow us to automate the testing procedure, which otherwise is done manually by an operator.

The original motivation behind constructing laboratory scale models of power electronic circuitry was to offer the students an environment for a complete engineering design, starting from modelling and simulation and ending with the experimental verification of a wide range of design strategies. A typical integrated real-time control and simulation environment contains three main parts: analysis and simulation software, a target controller and an experimental set-up. The software includes controller design/analysing tools, real-time code generators and a compiler. The target hardware can be based upon DSP techniques or other low-cost alternatives such as PC-based controllers or microcontrollers can be used.

Usually the costs of the first two components are much lower in comparison with the costs of the experimental setup. Capturing the realism of power electronics problems requires a complex power converters, both costly and inflexible, in some cases potentially dangerous for the students.

The concept of "hardware-in-the-loop" (HIL) method is to use a simulation model of the process and the real target hardware. The simulation model provides all the process signals in real-time that are

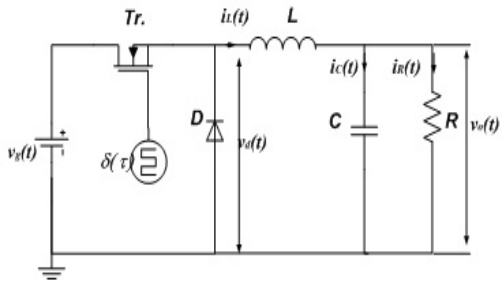

Figure 2. Buck Converter.

next converted by D/A modules and supplied to the controller as voltages. The control signals are produced by the controller and supplied via A/D converters to the simulation model. It is the purpose of this configuration to make the hardware component behave as closely as possible to these that would be encountered in the real system.

The paper is organised as follows. In the next section an overview of the different models of DC − DC converters is given. Section three and four presents the mathematical model development and it implementation to the simulation hardware utilizing LabView development environment [5]. Results of simulation are commented in section five.

2. DC/DC Converters overview

DC/DC converters are widely used in industrial applications and computer hardware circuits [6][7]. DC/DC conversion technique has been developed very quickly.

Buck converter is a step-down converter, which is shown in Fig. 2, the equivalent circuits during switch-on and -off periods are shown in Figs. 3 and 4. Its output voltage and output current are

$$V_2 = DV_1 \tag{1}$$

and

$$I_2 = \frac{1}{D} I_1 \tag{2}$$

This converter may work in discontinuous mode if the frequency f is small, conduction duty D is small, inductance L is small, and load current is high.

3. Model based design

In Model-Based Design there would be a system model at the center of the development process. The significant feature of this design is that it facilitates quicker and more cost-effective development of dynamic systems.

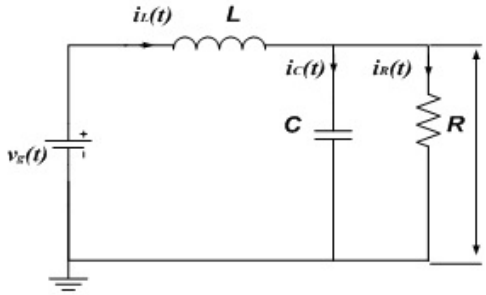

Figure 3. On State - Buck Converter.

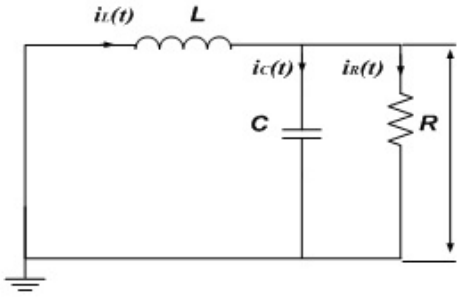

Figure 4. Off State - Buck Converter.

Modeling is the representation of physical phenomena by mathematical means. In engineering, it is desired to model the important dominant behavior of a system, while neglecting other insignificant phenomena. Simplified terminal equations of the component elements are used, and many aspects of the system response are neglected altogether, that is, they are ”un-modeled”. The resulting simplified model yields physical insight into the system behavior, which aids the engineer in designing the system to operate in a given specified manner.

Converter systems invariably require feedback. For example, in a typical *DC−DC* converter application, the output voltage $v(t)$ must be kept constant, regardless of changes in the input voltage or in the effective load resistance R. This is accomplished by building a circuit that varies the converter control input, i.e., the duty cycle $d(t)$, in such a way that the output voltage $v_O(t)$ is regulated to be equal to a desired reference value. To design the system of Fig. 2, we need a dynamic model of the switching converter. How do variations in the power input voltage, the load current, or the duty cycle affect the output voltage? What are the small-signal transfer functions? To answer these questions, we will extend the steady-state models to include the dynamics introduced by the inductors and capacitors of the converter.

Without loss of generality to explain the procedure of model development in LabView environment a simplified circuitry is utilized. Simplifications are performed in the load circuit where a resistive load is

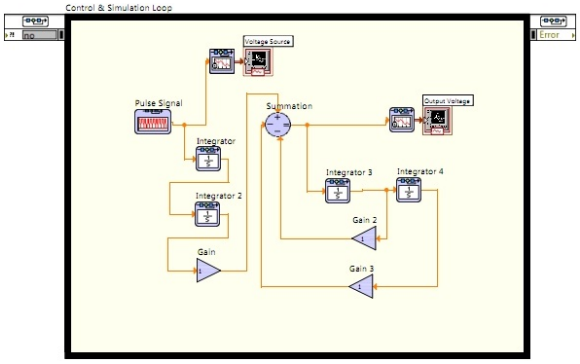

Figure 5. Block diagram model based design of converter.

supposed. For model development a circuit on Fig. 2 is used.

Fig. 2 shows principal circuit of buck converter consisted of ideal elements. Steady state is reached and, therefore, the control signal, $\delta(t)$, consists of pulses with constant width. The time intervals where the control signal $\delta(t)$ is high are called t_{on} and the once where $\delta(t)$ is low are called t_{off}. The switching period, T_S, is the time between two successive positive flanks of $\delta(t)$ and hence equal to the sum of ton and t_{off}. The ratio of t_{on} to T_S is called the duty cycle or the duty ratio and it is denoted by $d(t)$. The duty cycle is constant in steady state and equal to D (the dc value of $d(t)$). During t_{on} the transistor operates in the on state and during t_{off} the transistor operates in the off state. The voltage across the diode, $v_d(t)$, is equal to the input voltage, $v_g(t)$, during ton and equal to zero during t_{off}. The diode voltage is filtered by the $L-C$ low pass output filter. The corner frequency of this filter is chosen to be much lower than the switching frequency to obtain small magnitude of the ripple in the output voltage, $v_O(t)$. Consequently, the output voltages is approximately equal to the mean value of the diode voltage and lower than $v_g(t)$. The voltage across the inductor, $v_L(t)$, is equal to the difference between $v_d(t)$ and $v_O(t)$. During each time interval, the slope of $i_L(t)$) is almost constant since $v_L(t)$ is almost constant. The inductor current is equal to the transistor current, during t_{on} and equal to the diode current, during t_{off}. The capacitor current, is equal to the difference between $i_L(t)$) and the load current. The mean value of capacitor current is zero in steady state. The converter can be described as switching between different time invariant systems and is subsequently a time-variant system. While the transistor is on, the voltage across the diode is equal to the input voltage, as shown in Fig. 3.

The circuit in Fig. 3. can therefore be used as a model of the buck converter during t_{on}.

While the transistor is off, the voltage across the diode is equal to zero and the circuit in Fig. 4. can be used as a model.

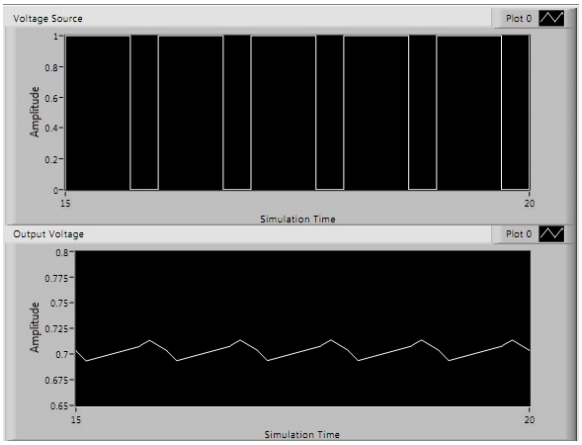

Figure 6. Simulation diagrams.

In this paper O_n state and O_{ff} state model is considered as the same circuit where $v_g(t)$ is a pulse train ideal voltage source. Inductor current can is the sum of capacitor current and load current, as follow,

$$i_L(t) = i_C(t) + i_R(t). \tag{3}$$

Therefore inductor current and voltage relation can be expressed as:

$$v_L(t) = L\frac{di_L(t)}{dt} = v_g(t) - v_O(t) \tag{4}$$

$$i_L(t) = \frac{1}{L}\int \left(v_g(t) - v_O(t)\right)dt \tag{5}$$

Replacing the expressions for capacitor and load current

$$i_C(t) = C\frac{dv_C(t)}{dt} = C\frac{dv_O(t)}{dt} \tag{6}$$

$$i_R(t) = \frac{1}{R}v_R(t) = \frac{1}{R}v_O(t) \tag{7}$$

in equation 3 we obtain

$$\frac{1}{L}\int \left(v_g(t) - v_O(t)\right)dt = C\frac{dv_O(t)}{dt} + \frac{1}{R}v_O(t). \tag{8}$$

If the expression (8) is multiplied with $1/C$ both side and integrated

$$\frac{1}{LC}\int\left(\int \left(v_g(t) - v_O(t)\right)dt\right)dt = v_O(t) + \frac{1}{RC}\int v_O(t)dt. \tag{9}$$

Different arrangement of expression is presented as

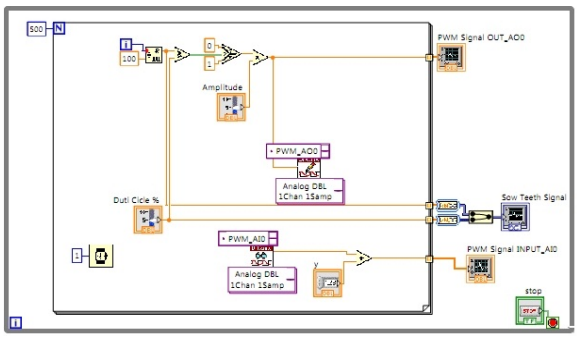

Figure 7. Block diagram of PWM signal generating device.

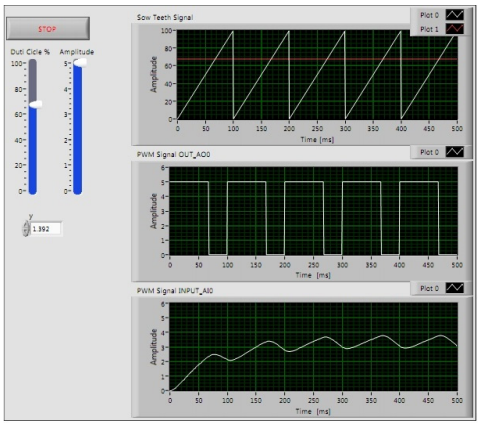

Figure 8. Front panel of PWM signal generating device.

$$v_O(t) = \frac{1}{LC}\int\left(\int\left(v_g(t) - v_O(t)\right)dt\right)dt - \frac{1}{RC}\int v_O(t)dt \tag{10}$$

or

$$v_O(t) = \frac{1}{LC}\int\int v_g(t)dtdt - \frac{1}{LC}\int\int v_O(t)dtdt - \\ -\frac{1}{RC}\int v_O(t)dt. \tag{11}$$

Equation (11) containing integrals and differentials can be presented by the LabView block diagram in on the Fig. 5. Simulations are performed on normalizes values of components of the system and results are presented on the Fig. 6.

4. Test bed design

The core platform of the presented hardware-in-the-loop approach is the Virtual Test Bed (VTB). The VTB is a dedicated environment for simulation and virtual-prototyping of complex systems. The VTB allows for handling natural power flow, signal and data coupling between interconnected devices and offers a combination of both topological and

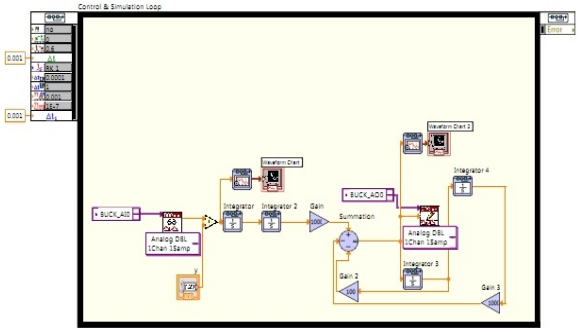

Figure 9. Block diagram of BUCK Converter Model.

mathematical expressions in model formulation for a comprehensive and efficient modeling process. The VTB also supports multiple-layer modeling, wherein each layer can describe a different model complexity or a different behavior. In addition to the powerful capabilities for modeling, the VTB is endowed with mechanisms for both wrapping and co-simulating with models developed in LabVIEW.

A. Controller design

LabView environment is very powerful tool for model design and simulation. To operate with buck converter a Pulse Width Modulated (PWM) signal is required. The Fig. 7 shows simplified model for PWM signal generation.

Pulse width modulated signal can be obtained by a comparison of instantaneous value of sow-tooth signal and referent voltage. Varying the referent voltage the result is the difference between t_{on} and t_{off}, resulting the different duty cycle.

Accompanying front panel to block diagram above is presented on Fig. 8. The diagram on the top of the front panel window shows the comparison between sow-tooth signal and referent voltage. The graph in the middle represents the pulse width modulated signal. The graph at the bottom will be used in the simulation to show the feedback signal generated by the plant model.

B. Virtual Plant Design

Developed Buck converter model is realized utilizing National instruments I/O modules for acquiring and generating analogue signals, Fig. 10. The equipment is further used for behavior testing of prototype of the buck converter governor realized by the I/O modules too. Utilizing the equation 11 obtained earlier the resulting plant model is as follows

Accompanying front panel is presented on the Fig. 11. The diagram on the top represents the excitation pulse width modulated signal at the input of the model. The second diagram represents the output voltage of virtual model of the buck converter.

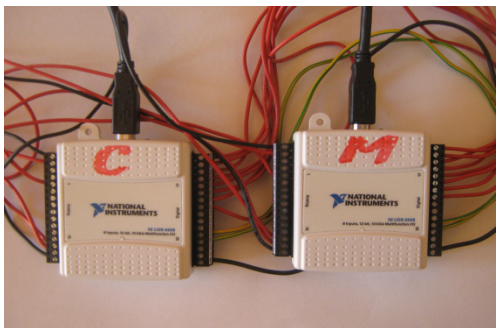

Figure 10. Virtual Test Bed Hardware.

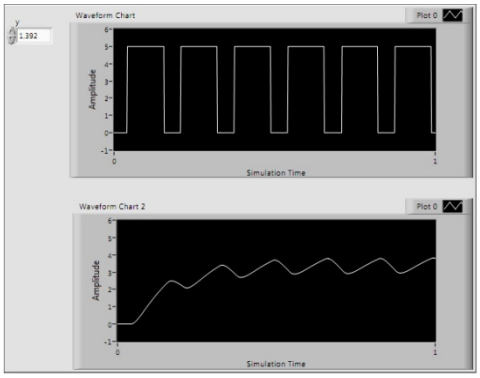

Figure 11. Front panel of BUCK Converter Model.

That output voltage can be returned back to the controller as a feedback control signal for regulation purposes.

C. Controller under test

Buck converter controller algorithm implemented in the I/O National instruments module equipped with digital inputs and outputs as well as analogue inputs and outputs. National instruments I/O module is HIL testing equipment where a buck converter model is implemented and is connected to the controller ports, Fig. 10.

Hardware-in-the-loop (HIL) simulation provides an effective platform by adding the complexity of the plant under control to the test platform. The complexity of the plant under control is included in test and development by adding mathematical representation of all related dynamic systems. These mathematical representations are referred to as the plant simulation. Hardware-In-the-Loop differs from real-time simulation by the addition of a real component in the loop. Plant model should run in real-time, electrical interfaces of the controller are emulated; control model is converted to controller code.

5. Conclusion

HIL simulation reduces development time and enables various tests that cannot be achieved on the actual system for cost or security reasons (fault operation for instance). ”Signal level HIL simulation” is very often used in industry to check controller boards and process controls. Its ”power level” and ”mechanical level” extensions are growing because they are a promising intermediary step before integration of electric drives in actual systems. Because of the increasing complexity of the systems under test, the organization of the HIL simulator is of prime importance to assess the best performance.

References

[1]. Dogan Fennibay, Arda Yurdakul and Alper Sen, ”Introducing hardware-in-loop concept to the hardware/software co-design of realtime embedded systems,” *10-th International Conference on Computer and Information Technology (CIT 2010)*, Jun 2 - Jul 1, 2010, Bradford, UK.

[2]. Santiago Lentijo, Salvatore Darco and Antonello Monti, ”Comparing the dinamic performance of power hardware-in-the-loop interfaces,” *IEEE Transactions on Industrial Electronics, vol. 57, No. 4*, April 2010.

[3]. Kevin Van Kammen, ”Motion controller design consideration for hardware-in-the loop testing,” *IEEE Autotestcon 2008*, Salt Lake City, UT, 8-11 September 2008.

[4]. Bin Lu, Xin Wu, Herman Figueroa and Antonello Monti, ”A lowcost real-time hardware-in-the-loop testing approach of power electronics controls,” *IEEE Transactions on Industrial Electronics, Vol. 54, No. 2*, April 2007.

[5]. National Instruments Corporation, *LABVIEW control design module*, 2004 − 2009.

[6]. Ned Mohan, Tore M. Underland, and William P. Robbins, *Power Electronics: Converters, Applications, and Design*, John Wiley & Sons, NY, 1995.

[7]. Muhammad H. Rashid, *Power Electronics Handbook*, Academic Press, San Diego, California, USA, 2001.

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Application for Warehousing and OLAP Analysis of Data about Unique Bulgarian Bells

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***Abstract* – In this paper, the system *bgBell/OLAP* for warehousing and online analytical processing data about unique Bulgarian bells is proposed. The implemented system provides possibility for retrieving summarized reports and analyzing different characteristics of the bells with the purpose of extracting the previously unknown and potentially useful information.**

***Keywords* – Data Warehousing, Online Analytical Processing, Bells.**

1. Introduction

In recent years, the communication and information technologies have been introduced to all areas of public life. The development of services, which give possibilities for maintenance and dissemination of information, obtained from the examination of a national cultural–historical inheritance of the separate peoples is very important and actual.

The aim of [13] is to propose a Web based approach to managing an audio and video archive for unique Bulgarian bells. The developed client/server system provides users the possibility of accessing information about different characteristics of the bells according to their specific interests. The data of the archive is accessible from [15]. The storage of the collected data about the bells in a database makes suitable conditions for their analyzing with the purpose of extracting the previously unknown and potentially useful information. This is the basic motivation for applying the data warehousing and OLAP (*online analytical processing*) technology on the data about the bells.

The main purpose of the system *bgBell/OLAP* is to provide a possibility for monitoring and comparing the characteristics of the bells.

More concretely, the implemented system can be utilized for the following:

- Analyzing the data about the bells collected from the usage of the client/server system for managing an audio and video archive for unique Bulgarian bells;
- Outputting the summarized reports about the sizes, the weights, the frequencies of the partials and the number of the bells by location, year of creation, state of the bells, type of the bells, material of the bells, creators of the bells, notes of the first partials of the bells.
- Discovering the most frequent notes in the first five partials of the bells.

The basic features of the system *bgbell/OLAP* are divided by four groups:

- Loading the data in the data warehouse periodically by a given schedule;
- Calculating and maintaining the summarized data in the data cube;
- Browsing the summarized data with the purpose of their analyzing by different dimensions in tabular and graphical view through Microsoft Excel application;
- Exporting the summarized data in PDF, HTML, XML, others formats.

2. OLAP systems and bells

2.1. OLAP systems

OLAP systems can be used for periodic reporting and data integrity checking. Analysts can interactively browse hierarchical and summarized data in order to extract new knowledge from the database. The traditional relational systems for database management that does not support OLAP, are appropriate for storing the data needed for daily activities and transactions processing. They are not suitable for performing complex queries that access large datasets and make multiple scans, joins and summaries, because they require more time for answer [1, 5]. Minimizing the response time of these queries proves crucial influence at designing OLAP applications.

2.2. The system bgBell/OLAP and other OLAP systems

Applying OLAP technology could solve important issues regarding databases storing

information that is obtained from studding our cultural–historical inheritance. According to our research OLAP systems are not being implemented on the databases containing data about the bells. An earlier and shorter version of this paper appeared as [14].

In this paper, the system *bgBell/OLAP* is represented, whose purpose is applying OLAP technology to exploring the data obtained from the client/server system for managing an audio and video archive for unique Bulgarian bells. The developed system allows analyzing the sizes and the sounds of the bells by years, by locations, by creators, by types, etc.

3. Designing and implementing the system *bgBell/OLAP*

The development of the system *bgBell/OLAP* includes designing and implementing a data warehouse; a package for loading the data in the warehouse; data cube; a client application for visualizing the results.

3.1. Architecture of the system bgBell/OLAP

The architecture of the system *bgBell/OLAP* is represented in figure 1.

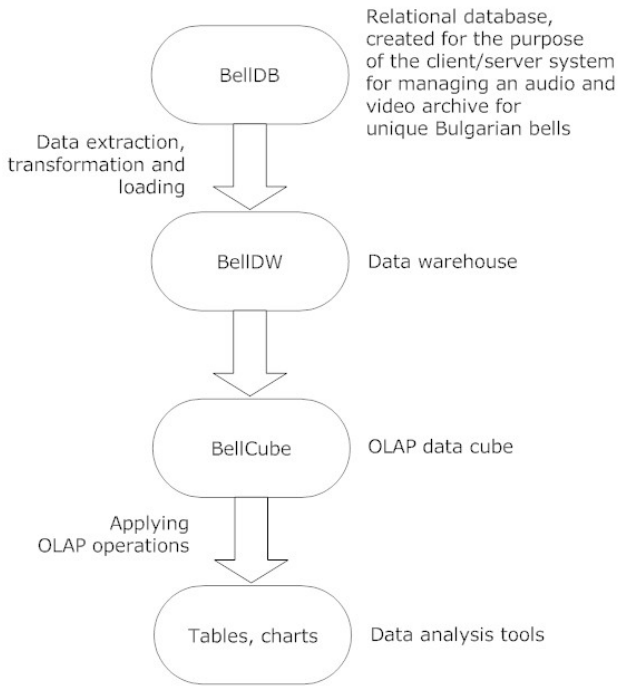

Figure 1. Architecture of the system *bgBell/OLAP*

The relational database `BellDB` is designed and created for the purposes of the client/server system for managing an audio and video archive for unique Bulgarian bells. The structure of this database is described in detail in [13].

The structure of the data warehouse `BellDW` and the implementation of the process of data extraction, transformation and loading (*ETL*) are represented in section 3.2.

On the basis of the dimension tables and the measures in the fact tables defined in the design of the data warehouse, the dimensions and the measures of the OLAP data cube `BellCube` are determined. The structure of the data cubes is described in section 3.3.1.

The usage of the OLAP data cube `BellCube` for analyzing the data about the bells is performed with an application that is implemented for the purpose with the means of Microsoft Excel. In section 3.3.2, an exemplary table and graphs, which visualize summarized data from the data cube, are represented.

3.2. Warehousing the data about the bells

The data warehouse serves for the data accumulation and organization with the aim of providing this data for analyzing. The purpose of the data warehouse determines the data model used for its designing.

3.2.1. Data modeling in data warehouse

The design of the data warehouses is based on the multidimensional model of the data [1, 5]. This model includes several numeric measures, which are liable for analysis. Each measure depends on a set of dimensions. The normalization of the data is used for designing databases in OLTP (*Online Transaction Processing*) environment, but it is unsuitable for designing data warehouses. The physical implementation of the multidimensional model requires two types of tables: dimension tables and fact tables.

The multidimensional model can be represented with a star schema, a snowflake schema or a galaxy schema. The model of the data warehouse `BellDW` is designed in conformity with the star schema (fig. 2).

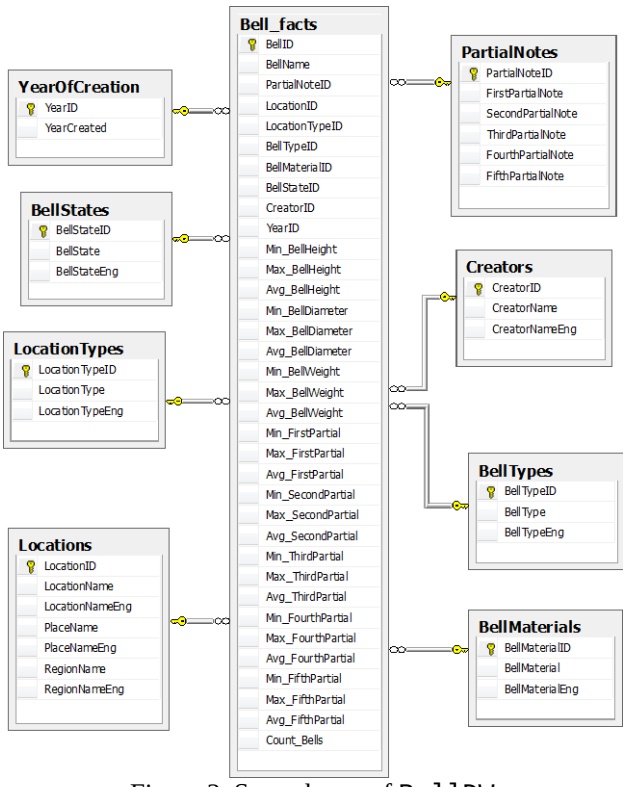

Figure 2. Star schema of `BellDW`

The dimension tables in the data warehouse `BellDW` store the data about the bell's location and its type; the year of the creation of the bells; the state of the bells; the type of the bells; the material of the bells; the creators of the bells; the notes of the first five partials of the bells. The fact table *Bell_facts* include attributes which refer the dimension tables and the measure attributes: *Min_BellHeight*, *Avg_BellHeight*, *Max_BellHeight* – the minimal, average and maximal outer height of the bells; *Min_BellDiameter*, *Avg_BellDiameter*, *Max_BellDiameter* – the minimal, average and maximal bottom diameter of the bells; *Min_BellWeight*, *Avg_BellWeight*, *Max_BellWeight* – the minimal, average and maximal weight of the bells; *Min_FirstPartial*, *Avg_FirstPartial*, *Avg_FirstPartial*, *Min_SecondPartial*, *Avg_SecondPartial*, *Max_SecondPartial*, *Min_ThirdPartial*, *Avg_ThirdPartial*, *Max_ThirdPartial*, *Min_FourthPartial*, *Avg_FourthPartial*, *Max_FourthPartial*, *Min_FifthPartial*, *Avg_FifthPartial*, *Max_FifthPartial* – the minimal, average and maximal frequency of the first five partials of the bells; *Count_Bells* – the number of the bells.

We have taken advantage of the database management system MS SQL Server [2, 3, 4, 8, 9, 10, 12] to implement the data warehouse `BellDW`.

3.2.2. Data extraction, transformation and loading in the data warehouse

The data loading into the data warehouse `BellDW` is performed with a package created by using *SQL Server Integration Services* [7].

The following tasks are included in the package (fig. 3):

- populating the dimension tables: *Locations*, *LocationTypes*, *BellTypes*, *BellMaterials*, *BellStates*, *Creators*, *YearOfCreation*, *PartialNotes*;
- populating the fact table *Bell_facts*.

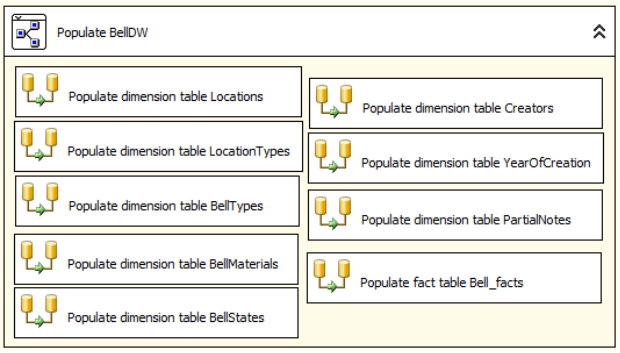

Figure 3. Loading data in `BellDW`

The service SQL Server Agent provides a possibility for creating a package job, which includes performing the package for data extraction, transformation and loading on given schedule.

3.3. Online analytical processing the data about the bells

Computing and sorting the summarized data, which are stored separately from the data sources for online transaction processing, decreases the quantity of the data for processing, when it is necessary for the users to analyze large amount of information. The organization of the data in the data warehouse into the structures corresponding to the multidimensional model and their previously processing provides maximal performance for the queries, which summarize the data by different ways.

3.3.1. Designing and building the data cube

The data cube is a structure intended for providing fast access to the data in the data warehouse. It is a basic target for analytical processing the data. The data cube stores previously computed summaries of the data. The creation and the usage of the data cube eliminate the necessity from joining the tables and re-computing the values returned from the most frequent executed queries.

The dimensions and the measures in the data cube are determined by the dimension tables and the measures in the fact table in the data warehouse. In the data cube `BellCube` the following measure is defined:

- Minimal, average and maximal outer height of the bells – *Min_BellHeight*, *Avg_BellHeight*, *Max_BellHeight*;
- Minimal, average and maximal bottom diameter of the bells – *Min_BellDiameter*, *Avg_BellDiameter*, *Max_BellDiameter*;
- Minimal, average and maximal weight of the bells – *Min_BellWeight*, *Avg_BellWeight*, *Max_BellWeight*;
- Minimal, average and maximal frequency of the first five partials of the bells – *Min_FirstPartial*, *Avg_FirstPartial*, *Avg_FirstPartial*, *Min_SecondPartial*, *Avg_SecondPartial*, *Max_SecondPartial*, *Min_ThirdPartial*, *Avg_ThirdPartial*, *Max_ThirdPartial*, *Min_FourthPartial*, *Avg_FourthPartial*, *Max_FourthPartial*, *Min_FifthPartial*, *Avg_FifthPartial*, *Max_FifthPartial*;
- Number of the bells – *Count_Bells.*

The values of the measures are obtained in correspondence with eight dimensions:

- Bell's location – *Locations*;
  A hierarchy is defined for the dimension of the location and the place, the region where the bells are situated (fig. 4). Therefore the summarized data can be returned for chosen places and/or regions.

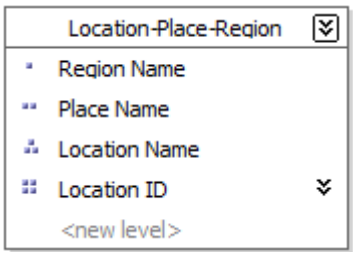

Figure 4. Hierarchy for the dimension Locations

- Type of the location – *LocationTypes*;
  The possible types of the locations are: churches, monasteries, museums, castles, etc.
- Bell's type – *BellTypes*;
- Bell's material – *BellMaterials*;
- Bell's state – *BellStates*;
- Bell's creator – *Creators*;
- Bell's year of creation – *YearOfCreation*;
- Notes of the first five partials of the bells – *PartialNotes*.

The structure of the data cube `BellCube` created with *SQL Server Analysis Services* [11] is shown in figure 5.

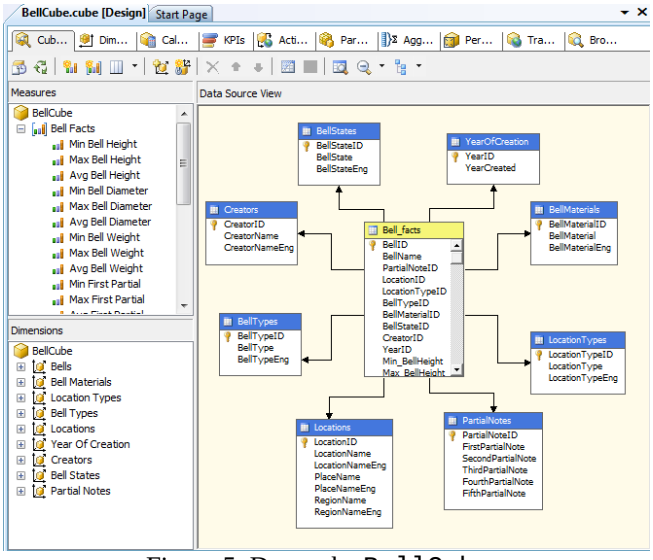

Figure 5. Data cube `BellCube`

3.3.2. OLAP analyzing the data about the bells

For the end user, an application is implemented with the means of Microsoft Excel [6, 11]. This application allows extraction of the summarized data from the data cube `BellCube` and their representation in tabular and graphical views. The users can access multiple reports with the application and some of them are:

- the most frequent notes in the first five partials of the bells (fig. 6);
- the frequencies of the first five partials and the number of the bells by the palces (fig. 7);
- the frequencies of the first five partials of the several bells; the frequnecies of the first five partials of the three bells are shown in figure 8 – one of the bells (2_01_01) is situated in the church "St. Alexander Nevski", Sofia, and the others two (2_02_01 and 2_02_02) are from National historical museum, Sofia;
- the sizes and the weights of the bells by the notes of the first five partials of the bells;
- the sizes, the weights, the frequencies of the the first five partials and the number of the bells by the type of the location (i.e. church, monastry, museum, etc.);
- the frequencies of the the first five partials and the number of the bells by their year of creation.

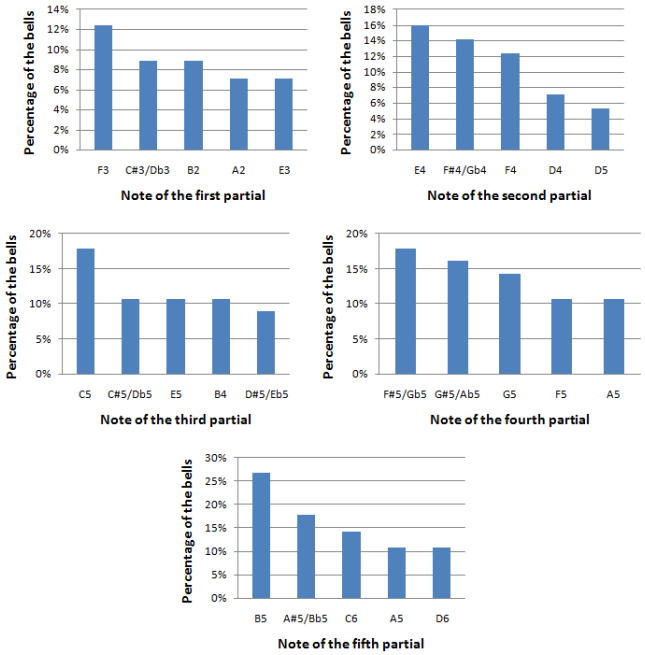

Figure 6. The most frequent notes in the first five partials of the bells

Values						
Row Labels	Max First Partial	Max Second Partial	Max Third Partial	Max Fourth Partial	Max Fifth Partial	Count Bells
Velko Tarnovo	450	750	920	1100	1330	19
Kapinovo	450	600	920	1100	1240	6
Kilifarevo	330	750	810	1050	1330	2
Lyaskovets	190	380	650	870	1170	1
Veliko Tarnovo	330	600	750	910	1140	10

Figure 7. The frequencies of the first five partials and the number of the bells by the palces in the region of Veliko Tarnovo

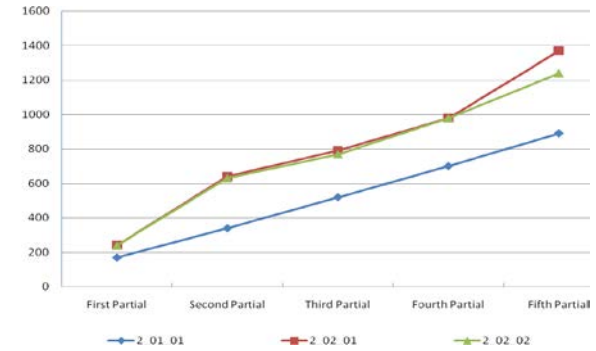

Figure 8. The frquencies of the first five pratials of the bells

4. Conclusion

In the present paper, an application of OLAP technology for analyzing the data about the unique Bulgarian bells is represented. The structure of the created data warehouse is described, as well as the implementation of the ETL process, the structure of the OLAP data cube, the features of the application designed for the end user.

Our future work includes applying the algorithms for data mining and development of an application providing possibilities for mining the data about the bells.

References

[1] A. A. Barsegyan, M. S. Kupriyanov, V. V. Stepanenko and I. I. Holod, "*Technologies for data analysis: Data Mining, Visual Mining, Text Mining, OLAP*", BHV-Peterburg, 2008.

[2] I. Ben-Gan, L. Kollar, D. Sarka and S. Kass, "*Inside Microsoft® SQL Server® 2008: T-SQL Querying*", Microsoft Press, 2009.

[3] M. Coles, "*Pro T-SQL 2008 Programmer's Guide*", Apress, 2008.

[4] L. Davidson, W. K. Kline, S. Klein and K. Windisch, "*Pro SQL Server 2008 Relational Database Design and Implementation*", Apress, 2008.

[5] W. H. Inmon, "*Building the Data Warehouse*", Wiley Publishing, Inc., 2005.

[6] J. Krishnaswamy, "*On Accessing Data From An OLAP Server Using MS Excel*", 2005, http://www.aspfree.com/c/a/MS-SQL-Server/On-Accessing-Data-From-An-OLAP-Server-Using-MS-Excel

[7] Microsoft Corporation, "*SQL Server Integration Services*", 2008, http://msdn.microsoft.com/en-us/library/ms141026.aspx

[8] J. Mundy, W. Thornthwaite and R. Kimball, "*The Microsoft Data Warehouse Toolkit: With SQL Server 2005 and the Microsoft Business Intelligence Toolset*", John Wiley & Sons, 2006.

[9] P. Nielsen, M. White and U. Parui, "*Microsoft® SQL Server® 2008 Bible*", Wiley Publishing, Inc., 2009.

[10] V. Rainardi, "*Building a Data Warehouse: With Examples in SQL Server*", Apress, 2007.

[11] J. Shumate, "A Practical Guide to Microsoft OLAP Server", Addison-Wesley, 2000.

[12] G. Spofford, S. Harinath, C. Webb, D. H. Huang and F. Civardi, "*MDX Solutions, Second Edition: With Microsoft® SQL Server™ Analysis Services 2005 and Hyperion® Essbase*", Wiley Publishing, Inc., 2006.

[13] T. Trifonov and T. Georgieva, "Client/server system for managing an audio and video archive for unique Bulgarian bells", *WSEAS Transactions on Information Science and Applications*, Vol. 6, No. 4, 2009, pp. 660-669.

[14] T. Trifonov and T. Georgieva-Trifonova, "Warehousing and OLAP analysis of data about unique Bulgarian bells", *In Proceedings of the Forty First Spring Conference of the Union of Bulgarian Mathematicians*, Borovets, 2012, pp. 266-272.

[15] The Bell Project "Research and Identification of Valuable Bells of the Historic and Culture Heritage of Bulgaria and Development of Audio and Video Archive with Advanced Technologies" Website, http://www.math.bas.bg/bells/belleng.html.

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Devising new Software Project Risk Management Model: MARUNA

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Abstract **– The focus of this research is the development of a practical risk management technique and its assessment. This study systematically tested the correlation between critical activities and critical paths and risk scenario case management applied in project planning since its early beginning up to end. Risk management is critical to success in complex projects but is seldom applied effectively and its integration within software life cycle is missing. Based on the literature review discovered a high rate of ICT projects failure. What were the causes of these expensive and seemingly uncontrollable failures of ICT projects? Despite the review of considerable published literature on the risk management for ICT software projects and their frequent failure did not discover a satisfactory Risk Management framework and model specific to ICT software projects. In order to investigate these issues a research study was realized and as contribution a MARUNA risk management model was created. Its main contribution is that it integrates all the project planning stages. The results of applying the MARUNA Risk Management Model have been tested and the findings and recommendations are derived from the extensive body of evidence collected, in both written and oral form.**

Keywords **– Risk management, risk scenarios, it project management, project failure, risk management model**

1. Introduction

Different studies consistently show the same thing that 30–40 percent of all ICT projects fail while a large percent of them can not finish because of the 90% syndrome -missing functionalities and cannot pass the acceptance testing.

[1] suggested that 70% of ICT projects are doomed by practitioners' inability to deliver projects on time, within budget, and with appropriate quality that work as required.

A study by [2] of 800 IT managers across eight countries shows that three problems with IT projects stand out from the rest and these are:

1. Overrun on time (62%)
2. Budget overrun (49%)
3. Higher than expected maintenance costs (47%)

According to [1] a study on the state of IT project management in the UK carried out by Oxford University and Computer Weekly reported that a mere 16% of IT projects were considered successful.

Striking a balance between the principles of IT with the planning, structure and accountability of managing a successful software project especially its return on investment ROI is difficult. Moreover, over half of all software systems projects overrun their budgets and schedules by up to 100 percent or more according to [1]. Of the projects that fail, approximately half of all those that are restarted fail again. Yet management tools and techniques, as well as software development techniques, are constantly improving. What are the causes of these expensive and seemingly uncontrollable failures of ICT projects?

[6] suggests that software project Risk Management is often overlooked in project management. Risk Management ensures that the project scope allows realistic schedules, cost and performance expectations.

2. Background Research

The literature review provides an understanding of past research into Risk Management in the context of IT software projects. The published literature documents common strategies for assessing and managing risk. Many writers have proposed, tested, and evaluated methods for assessing and minimizing IT software project risk ([3], [4], [5], [6]).

[3] analyzed why ICT software projects continue to fail, arguing that organizations need to improve Risk Management if they are to reduce high project failure rates.

According to [6] software project risk Management should be costed and included in the total cost of the project; organizations need to realize that Risk Management is intrinsic, is unavoidable , and will cost less if it is recognized has an essential part of project management.

[5] suggest that Risk Management is orientated towards identifying and controlling project variation and foreseeable uncertainty.
[4] identified the major causes of project risk as lack of planning and lack of top management control during the project life cycle. He proposed a Risk Management cycle, comprising four phases, each of which must be executed and, if necessary, repeated as required to minimize risk. The four phases were: 1) Establish that a risk exists; 2) Analyze the risk severity and probability; 3) Plan to manage the risk using the risk's severity and probability of occurrence; and 4) minimize risk consequence.
These four phases are analogous to Edward Deming's quality cycle that comprises the four phases Plan, Do, Study, Act.
[7] argued that many organization continue to fail when implementing IT projects such as Enterprise Resource Planning systems (ERP). He argues that the high cost of ERP system implementations and failure to adopt appropriate risk strategies endangers the entire organization.
Most of the studies reviewed ([1]-[7]) argue the importance of incorporating Risk Assessment early in the process of software development as risk can affect the time and budget constraints.
Despite the review of considerable published literature on the risk management for ICT software projects and their frequent failure did not discover a Risk Management framework and model specific to ICT software projects.

3. Devising the MARUNA Model

MARUNA is an acronym that stands for:

- Managing and
- Assessing
- Risks
- Using
- Network
- Analyses

Steps in Constructing the Network Analyses Diagram

1 Do a work breakdown.
2 Estimate the duration of activities.
3 Establish logical sequence between activities (dependencies).
4 Draw the basic network in rough.
5 Calculate the total project time and floats.
6 Identify activities on the critical path.
7 Allocate resources.
8 Smooth out the network.
9 Check the network.
10 Discuss and refine the plan until it is appropriate.

Work breakdown, by carefully analysing all aspect of the project both the technical and non-technical , a list can be made of the activities that need to be completed in order to achieve the project aims. This list is the basic data for drawing up the project network.

Duration, the time required for the completion of the activity. This may be calculated knowing the resources available or may be calculated knowing how much time is available to complete the activity (the appropriate resources may be allocated later). See notes on activity timings at the end of this tutorial

Dummy Activities, one of the fundamental differences between the activity on arrow and activity on node networks is that the latter does not make use of dummy activities. Dummies are added to a network in order to clarify dependencies where an ordinary arrow cannot reflect this correctly. Dummy activities have no duration. They may be used freely when first drawing the network. Unnecessary dummies should be eliminated later to simplify the diagram

Events or nodes are points in time, do not have a duration but represent the start and finish of activities. They often coincide with a deliverable (some significant tangible products that has to be completed) or a milestone (a point in the project where an assessment of progress made) of some sort. They are a point in time and have no duration but they can be used to show the earliest time at which following events may start and the latest time at which preceding events may finish. Events which are the focal point of a large number of activities can be elongated as a vertical sausage to allow parallel activities to be drawn horizontally.

Earliest Event Time, the earliest time by which this event can be reached and subsequent activities can begin. For the first event this is zero, for other events it is calculated by adding all the durations of events leading up to that event. It there are two or more paths into an event then the one with the longest duration becomes the earliest event time.

Latest Start Time, the latest dates at which an event can occur if the end date is not to be affected. Working from right to left calculate and enter latest event times by subtracting duration times. Where there is more than one path the correct latest time will be the smallest of the alternatives.

Critical Paths, this is a path through the project where a series of tasks have no slack or float in their

duration such that if one task on the path goes beyond its deadline then all the subsequent tasks slip and the project deadline is jeopardise. The critical path is the longest path from start to finish. For all activities on the critical path the Earliest Event time and the latest start time are the same. There may be more than one critical path in a system.

Float, the float is the difference between the time available to complete the activities and the estimated duration (actual time required) for the activity.

Sub networks, when the initial drawing is completed, significant activities on the network should be expanded into more detailed networks. For example the activity 20 "Evaluate package" in figure 1 could be drawn as in figure NN. Sometimes a large project may involve many different departments, groups or other natural divisions. It may involve hundreds of interdependent tasks in which case the different interested groups may compile there own network diagram for their part of the system. Separate diagrams for parts of the project can then be brought together to see how they fit in with the "Project Master Schedule". This combining of a bottom up and top down approach to scheduling the project is often a successful way of getting many people committed to the plans.

Resource Requirements, in drawing the networks in figures 3 and 4 only the tasks to be done have been considered and not the resources needed. For instance it is assumed that someone is available to prepare the potatoes whilst someone else is available to make the kebabs. If this were not the case and the same resource (person) had to do all the tasks then the diagram and the Bar B Que would not be ready for four and a half hours. Also there is a new critical path through the project.

Note that "heat the charcoal " has a duration of 1.5 hours. This is the elapsed time from lighting the charcoal until it becomes warm enough to cook the food. There is no labour involved; the activity itself takes two or three minutes. However there is a waiting period that is part of the logic of this network and effects other activities so it must show up on the network.

Resource constraints, planning and scheduling has to be carried forward one step at a time and consideration of resources constraints is a step that is taken after the initial network is drawn. The first step is scheduling is to draw he network to establish the logic. The second step is to estimate the duration and calculate the overall project timetable. The third step is to examine the resources and smooth out the schedule. Inevitably this procedure is repeated several times before the optimum (or an acceptable solution is found)

Drawing of the diagram, the number of people involved in drawing a network depends on the size and of the project and the degree of interaction between departments and activities. At the smallest end, individuals will draw networks simply to plan their activities. For larger complex planning, a representative from the different responsible groups may be involved. Those involved should have the authority to commit resources and agree the final plans. On large projects, actually drawing the network may be the job of an assistant who is skilled in that tasks and not necessarily part of the team making the decisions. The network is drawn quickly and roughly to start with and is gradually refined as the ramification of decisions become obvious. The network are drawn for all to see on paper , a blackboard on a white board .or whatever. After the meeting the diagram will be taken away and cleaned up for publication. It is highly likely that this job will be done now a week's using a Project Management Software Package of some description.

4. Calculating activity timings

Calculating activity timings for each activity in the network is given a time. It is estimated as being the time required for the work to complete the task. In PERT (programme evaluation and review techniques) , three such estimates are required for every activity these are:

1. Optimistic time (the best time possible for completing the activity)
2. Pessimistic time (that is, worst possible time)
3. The most likely time

These three times are used to give a weighted mean form the formula:

$$\text{Time} = \frac{\text{Optimistic time} + 4*\text{MLT} + \text{Pessimistic time}}{6}$$

This calculation is repeated on all activities in the network and is used to predict the probability of completing the project by the required deadline. Some organizations recognize that technical staff are eternally optimistic and so the normal distribution curve is not really suitable for predicting the spread of estimating errors . Such organizations may decide to skew the distribution curve deliberately and use a variation on the formula such as below.

$$\text{Time} = \frac{\text{Optimistic time} + 3*\text{MLT} + 2*\text{Pessimistic time}}{6}$$

5. Case Study

In order to apply the MARUNA technique we have used the following case study project. A Software project involves developing a financial software system for a small cash and carry organization. The design is complete and there is a need for the following activities to take place. The work breakdown has been done and compiled is the following list.

	ACTIVITY	DURATION	DEPENDANCIES	$0t_1$	Pt_1	OT_2	PT_2
10	Requirements Analyses	2		1 (1-2)	4 (2-3)		
15	System Design	6				5 (1-2)	8 (2-3)
20	Write data entry software	9	15			8 (1-2)	12 (2-3)
25	Test Hardware	2	20			1 (1-2)	3 (1-2)
30	Create Data files	3	10				
40	Detailed Design	5	30				
50	Create Help docs	3	40				
60	Write Program Specs.	3	10	2 (1-2)	7 (3-4)		
70	Construct Programs	12	60	11 (1-2)	15 (2-3)		
80	Unit Testing	5	25, 70, 40	4 (1-2)	7 (2-3)	4 (1-2)	6 (1-2)
90	Integration Testing	2	10				
100	Implementation	6	90				
110	Acceptance Testing	2	100, 80, 50	1 (1-2)	4 (2-3)	1 (1-2)	3 (1-2)

Table 1. Work breakdown structure

6. Risk management analyses

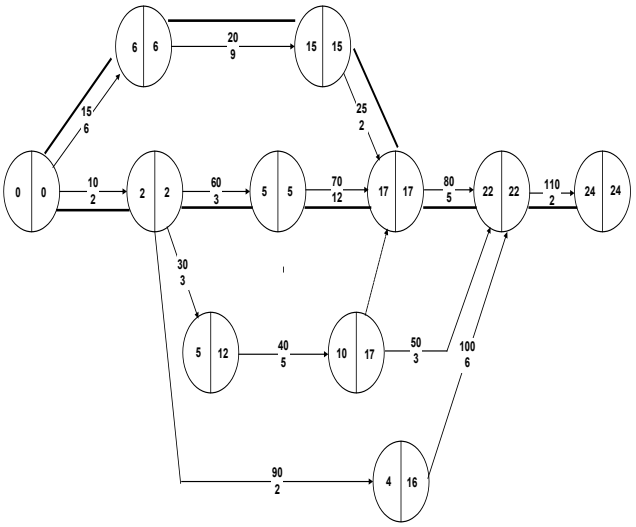

Figure 1. Solution using Network analysis

In our project we have two main critical paths. The critical path is a path through the project where a series of tasks have no slack or float in their duration.

Critical paths:
Cp1. 10-60-70-80-110
Cp2. 15-20-25-80-110
Calculating the estimation
MLT = 24 weeks
Td1=25
Td2=25

This project will approximately be finished in 25 weeks including all possible delays.

The MARUNA risk management analysis is realized focusing in analyses of risk case scenarios for the critical activities and accordingly for each of the critical paths. Risk case scenarios have been anticipated and accordingly solution for such cases to use resources from non-critical activities has been estimated.

The risk management scenarios have been closely interrelated with PERT pessimistic time calculations and reviewed and checked for compatibility of data.

Risk management analysis for the first critical path CP1: 10-60-70-80-110

10 Requirement Analyses
Risk case scenario:
1) Change of requirement
2) Human factor
If Case 1 happens then resources from activity 15 (System Design) will be used to solve in additional 2 weeks.
If Case2 happens then resources from activity 20 (Write data entry) will be used to solve in additional 3 weeks.

60 Write Program Specs
Risk case scenario:
1) Specification forgotten to be added
2) Lack of time
For Case1 resources from activity 30 (Create Data files) will be used to solve in additional 1 week.
For Case2 resources from activity 20 (Write data entry) will be used to solve in additional 2 weeks.

70 Construct Programs
Risk case scenario:
1) Error construct programs
2) Additional specification
For Case1 resources from activity 20 (Write data entry) will be used to solve in additional 2 weeks.
For Case2 resources from activity 25 (Test Hardware) will be used to solve in additional 1 week.

80 Unit Testing
Risk case scenario:
1) Change of requirements
2) Additional specification
For Case1 resources from activity 40 (Detailed Design) will be used to solve in additional 2 weeks.
For Case2 resources from activity 50 (Create Help docs) will be used to solve in additional 1 week.

110 Acceptance Testing
Risk case scenario:
1) Change of requirement
For Case1 resources from activity 100 (Implementation) be used to solve in additional 2 weeks.

Risk management analysis for the second critical path CP2: 15-20-25-80-110
15 System Design
Risk cases
1) Change of requirement
2) Latency in time
For Case1 resources from activity 90 (Integration Testing) will be used to solve in additional 1 week.
For Case2 resources from activity 100 (Implementation) will be used to solve in additional 2 weeks.

20 Write data entry
Risk cases
1) Error in design
2) Latency in time
For Case 1 resources from activity 40 (Detailed Design) will be used to solve in additional 2 weeks.
For Case2 resources from activity 50 (Create Help docs) will be used to solve in additional 1 week.

25 Test Hardware
Risk case scenario:
1) Human factor
For Case 1 resources from activity 30 (Create Data files) will be used to solve in additional 1 week.

80 Unit Testing
Risk case scenario:
1) Change of requirements
2) Additional specification
For Case1 resources from activity 40 (Detailed Design) will be used to solve in additional 2 weeks.
For Case 2 resources from activity 50 (Create Help docs) will be used to solve in additional 1 week.

110 Acceptance Testing
Risk case scenario:

1) Change of requirement

For Case1 resources from activity 100 (Implementation) will be used to solve in additional 2 weeks.

7. Forming Quality Project Team

After the Risk Management Plan has finished the Team Staffing Plan can start based on the Risk Management report.

In the beginning each activity is assigned a Team leader by choosing the best expert in that activity. The team leader after the risk Management report is final is posting to all members the list of all the primary and secondary skills (if they are supposed to help to another activity) necessary for this activity as well as secondary if the activity is planned to help with its resources in some critical activity. Based on the posted list of skills members are chosen for each activity. Those members that in secondary skills are missing experience a training plan is devised from the team leader and delivered to the project manager before the project actually starts.

8. Conclusion

This study attempted to resolve some of the definitional and methodological difficulties encountered by previous researchers. It involved the development of a risk management model called MARUNA that connects all the stages of the project planning.

This study systematically tested the correlation between critical activities and critical paths and risk scenario case management applied in project planning since its early beginning up to end.

Despite the review of considerable published literature on the risk management for ICT software projects and their frequent failure did not discover a satisfactory Risk Management framework and model specific to ICT software projects.

Therefore a research study was realized and as result a MARUNA risk management model was created. It connects all the stages of the project planning starting from the calculation of the most likely time for finishing a project, finding critical activities, critical path, and then optimistic and pessimistic times in order to calculate the Time of delivery of the software project.

Afterwards once we have all this data the is connecting with all this data and creating risk scenario cases for all critical paths and devising a solution scenario based on all assessed risks scenarios.

Once the risk management plan is finished this is used to form effective and quality project teams by using the data from previous analyses.

The results of applying the MARUNA Risk Management Model has been tested with different student working groups in the framework of the subject Software Project Management and Software Engineering and we have concluded that it showed highly organized ability for working and improved attention and concentration, which can be seen from the progression in the obtained new knowledge from the staff training.

The findings and recommendations are derived from the extensive body of evidence collected, in both written and oral form, from more than 70 individuals, encompassing senior directors, managers, project managers and software engineers from the public and private sector, as well as academic experts.

Therefore recommended is the use of the MARUNA risk management model when undertaking ICT projects since it integrates all the project planning stages and can provide better results for use as new subject-matter is explored; and facilitate review of main planning issues and essential details for time of delivery, critical paths, assessing risks and creating ready procedures for each anticipated risk scenario and finally creating quality teams based on the risk management plan and calculations from the time estimations.

References

[1] Chris Sauer and Christine Cuthberts (2003) The State of IT Project Management in the UK, Templeton College, Oxford, November 2003

[2] Dynamic Markets Limited, (2007), IT project failure, Online: http://www.tcs.com/thought_leadership/Documents/independant_markets_research_report.pdf

[3] Jiang, J., Klein, G. and Ellis, T. S. (2002a). A Measure of Software Development Risk, Project Management Institute, 33, 30-41.

[4] McManus, J. (2001). Risk in Software Projects, Management Services, 45, 6-10.

[5] Meyer, A. D., Loch, C. H. and Pich, M. T. (2002). Managing Project Uncertainty: From Variation to Chaos, MIT Sloan Management Review, 33, 60-67.

[6] Schwalbe, K. (2000) Information technology project management, Cambridge USA.

[7] Weston, F. C. (2001). ERP implementation and project management, Production and Inventory Management Journal, 42, 75-80.

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Preparing the Camera Ready Paper for TEM Journal

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Abstract **– In this paper the instructions for preparing camera ready paper for the TEM Journal are given. The recommended, but not limited text processor is Microsoft Word. Insert an abstract of 50-100 words, giving a brief account of the most relevant aspects of the paper. It is recommended to use up to 5 keywords.**

Keywords **– Camera ready paper, TEM Journal.**

1. Introduction

In order to affect high quality of Papers, the authors are requested to follow instructions given in this sample paper. Regular length of the papers is 5 to 12 pages.

2. Instructions for the authors

Times New Roman 11 point's font should be used for normal text. Manuscript have to be prepared in a two column separated by 5 mm. The margins for A4 (210×297 mm2) paper are given in Table 1.

Paper size	A4
Top margin	20 mm
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Regular paper may be divided in a number of sections. Section titles (including references and acknowledgement) should be typed using 11 pt fonts with **bold** option. For numbering use Times New Roman number. Sections can be split in subsection, which should be typed 10 pt *Italic* option. Figures should be one column wide. If it is impossible to place figure in one column, two column wide figures is allowed. Each figure must have a caption under the figure. For the figure captions 10 pt font should be used.

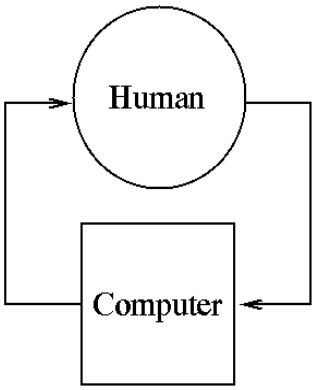

Figure 1. Text here

3. Conclusion

Be brief and give most important conclusion from your paper. Do not use equations and figures here.

Acknowledgements (If any)

These and the Reference headings are in bold but have no numbers.

References

[1]. Wong BBM, Kokko H, *Is science as global as we think?* Trends Ecol. Evol 20: 475–476. 2005.

[2]. S. Haykin, *Neural Networks,* New York, IEEE Press, 1994.

[3]. Akerlof, George A. , Kranton, Rachel, Identity Economics, The Economists' Voice*:* Vol. 7: Iss. 2, 2010.

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