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APEIRON

THE AIM AND SCOPE

The aim and scope of the Journal of Information Technology and Applications (JITA) is:

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Contents

Editorial

Dear Readers,

Out of the submitted papers, reviewers have selected five papers that will be presented in this issue of JITA journal.

The paper titled „Selection of telecommunication access networks“ by Predrag Katanić represents a systemized approach to the future telecommunication access network choice, which has usage in the business environment. The suggested methodology and defined input parameter evaluation model can represent a base for making the decision about the access network choice in other environments as well, with the input parameters correction.

The paper „Influence of resolution and frame rate on the linear in-stream video ad QoE“ by Miloš Ljubojević, Zdenka Babić and Dušan Starčević focuses on the possibility of modeling the video Quality of Experience (QoE) during Internet video advertising. In such modeling, if network environment affects the quality of video content, it is possible to improve QoE by selecting the resolution and frame rate values. This research is also significant because it uses a widely accepted methodology, adjusted for the assessment of the QoE within a specific application as it is linear in-stream video advertising.

The paper titled „The application of information and communication technologies in dance sport in Bosnia and Herzegovina“ by Velibor Srdić and Milan Nešić is based on research performed with the aim of determining the frequency and ways of application of information and communication technologies (ICT) in dance sport in Bosnia and Herzegovina.

The paper „Customer satisfaction as a significant measure of successful ERP implementation“ by Bojan Ivetić, Tončo Marušić and Dragica Radosav represents attention trying to find the best way to measure the success or the effectiveness of ERP solution. In this paper you can see what effect the other measurements will have on the „customer satisfaction“, respecting the correlation between particular crucial categories in creating the model of implemented ERP system's success.

The fifth paper titled “Full text search and indexing in languages with two alphabets” focuses on different alfabets Cyrillic and Latin, used equally in Bosnia and Herzegovina. This is an additional problem with indexing and full text searching. In this paper this problem is analised. Using the tools available on PostgreSQL and ispell dictionaries, the solution is made.

We thank the authors for the effort they have invested in order to present the results of their research in a qualitative manner. We wish for our presented papers to be recognized both by the readers and scientific community.

Selection of Telecommunication Access Networks

Predrag Katanić

University of East Sarajevo predrag.katanic@gmail.com

Contribution to the state of the art

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Abstract: The development of Internet technology and computer networks leads to the convergence of traditional systems voice, video and data into a unique IP-based TriplePlay system. Differences in implementing TriplePlay service basically come down to the choice of technology of data transmission from the last aggregation point (node) to a subscriber (Last Mile).

Analyzing Internet market, the Organization for Economic Co-operation and Development (OECD) made trend in increasing demand for bandwidth during the period from 2007 to 2017. The analysis is based on SmartHome concept which includes broadband internet as well as multimedia services such as IPTV, cell phones and so on. The results of the analysis to a great extent confirm increasing trend of the consumers' demand for bandwidth defined by Jakob Nielsen. His theory is based on the previous period and predicts that the need for bandwidth will rise by 50% every year. Nielsen's diagram resembles that of Moore which predicts that CPU power will double every 18 months, that is 67% a year.

The constant alterations in market and technology causes dilemma to operators in terms of investment. It is quite difficult to answer the question about the choice of technology of connecting the subscribers from the aspect of both technological and economic justification. Finding the answer to this question is the main goal of this paper.

Keywords: Internet technology, Triple Play, VoIP, IPTV

Introduction

The developments of the broadband access to the internet, as well as internet applications and services in the world are known as key initiators of the total economic growth of society. Broadband internet has become the inevitable factor of insurance for more effective health, education, science, culture, tourism, etc. In the past years the telecommunication market has increased the amount of internet ports and the development of services which rely on broadband access to the internet. However, Bosnia and Herzegovina, when it comes to the number of ports, stays behind in comparison to the countries nearby and the countries of the European Union.

In this paper, evaluated different models of the development of the future regional network for data transferring are also shown. An accent on choosing the future model is put on giving the NGS (Next Generation Services), which are completely based on IP technology. The model must fully support existing services and the existing user equipment, or the service of analog television and analog telephone, as well as to be totally acceptable in the observed environment.

Starting analysis

Within the starting analysis, a research has been done which should describe the model of the future network. The future network should have quality service delivery to the final user, with minimal expenses of implementation and maintenance.

At the beginning of the research, approximate requests have been defined, which the future model

should fulfill. Besides the technical and technological aspect, it is necessary to process the economical, social and political aspects, which can affect the model of the future network. In order to better perceive these factors, we made a PEST analysis (Political, Economic, Social and Technological analysis), which was done before the research. The conclusions of the PEST analysis were needed as directions in the research itself. [3]

Economic, social and political analyses have shown advantages and disadvantages of the development of the future regional network. The conclusion of those analyses has shown necessities of the development of the new regional network model for broadband access to the internet and multimedia services based on IP technologies.

Analysis of the technological development has shown the necessity of overcoming the technology gap, which appeared as a consequence of the lack of investments in this region. For that cause, at the beginning of the research technological-technical requests have been defined, which the future network must fulfill. Some of the requests were partially in collision with the others. That collision often comes from the need to retain the existing service models. The solution is a compromise, which occurred as a consequence of the sudden technological leap and the economic incapability of the user to quickly change his equipment. The technological-technical requests are:

1. Future network must ensure access to next generation services (NGS), based on the internet protocol (IP).
2. It is necessary to preserve the existing analog television service on the second and third device at home, as well as the traditional analog telephone, which represents a standard offer from telecom operators.
3. The future network must be adapted to the Digital Agenda for Europe (DAE) requests, that forecast the development of internet technologies until the year of 2020. This comes from the facts that this is an infrastructure project which should have long term service without any big infrastructural changes. [1]
4. Energetic acceptability, the network must acquire the minimum of energy charges.
5. Optimization of maintenance charges, which considers the expenses of taking care of the equipment and the expenses of hiring competent workers.
6. Service control from the beginning to the end, or in other words, from the service source, through the complete network until the final service user.
7. Maximum service flexibility, i.e. complete adjustability to user's requests. A simple service choice which is handled by the user.
8. The Management, Provisioning and Billing system which can support all of the requests of the existing and future users.
9. Besides the PEST analysis it is necessary to research potential market from the aspect of interest with services, which are offered through the future available network. As a research method, a survey and the analysis of received results after data processing was suggested. The survey is done over the complete area of the future access network and has a goal to collect data about future users and their needs for certain types of services. In order for the results of the survey to show a real image of interest and the needs of future users, rules were defined for processing the survey.

INPUT PARAMETERS FOR DESIGN

While defining the input parameters for the design of the future telecommunication network it is necessary to maximize performances with minimal costs. The compromise solution should be made and the set technological requirements should not be neglected. On the basis of these hypotheses the following groups of input parameters have been defined:

1. Network capacity,
2. Services,
3. Construction costs,
4. Costs of maintenance,
5. Expansion of infrastructure and service,
6. Possibility of transferring the excess capacity to other operators.

Network capacity. While defining this parameter and due to the lack of national strategy, it has been used the recommendation provided by the European

commission for telecommunication development, which has defined the strategy and goals for telecommunication development in the European Union in the project called Digital Agenda for Europe (DAE). Out of the defined goals certain parts are singled out which are related to the recommended capacity of the broadband access. It has been defined that 50 % of household will have had the Internet access faster than 100 Mbit/s by 2020 and 100% of the household will have had the Internet access faster than 30 Mbit/s. According to these goals, two input parameters are defined. [1]

Input parameter 1: *The initial installation has to secure the broadband access to Internet with minimal speed of 100 Mbit/s, regardless of current commercial packages and speed offered.*

Input parameter 2: *The future expansion of the broadband access to Internet with speed greater than 100 Mbit/s has to be replaced with active components, without any interventions done on the passive infrastructure.*

Services. As a basis for defining future services which should be transmitted to the end-user, it is necessary to take into consideration the current condition of the user equipment and trends of the service development. The existing equipment for video service is usually based on analog camera, with constant growth in number of modern digital TV and SMART equipment. Mobile devices also grow in importance as well as services based on IP protocol (Game, VoIP, and IPTV). In order to enable the continuous operations of analog equipment and introduction of SMART devices based on IP protocol two new parameters are defined.

Input parameter 3. *Continuous usage of analog equipment (analog TV and telephone devices) of end-user with the option to replace the outdated equipment with new, without significant change of service.*

Input parameter 4. *The possibility to use the next generation services, which implies open architecture to new technologies and greater flexibility in terms of application of different regulations and business rules.*

Construction costs. The construction costs include potential costs that can appear in the process of construction of infrastructure. They can be easily presented in the following stages:

- Project development costs,
- Obtaining necessary permits,
- Construction of telecommunication infrastructure,
- Laying PVC pipes and fiber optic cabling,
- Passive network components,
- Active network components,
- Customer-premises equipment,
- Testing and commissioning.

The total amount of expenses is not measurable and therefore cannot be used as an input parameter. That is why it is necessary to rationalize and present the total expenses of network construction for one future subscriber. In order to simplify the matter, the future network expansion is not included in the total expenses of an end-user. It is a fact that the future network expansion will make the new subscribers have lower costs of connecting, but due to its unpredictability and great initial uncertainty, this parameter is excluded.

As an indicator of the future network construction costs, one input parameter is defined and presented in a nominal monetary value. This parameter can also be found in the commercial offers when activating the existing cable operators in Bosnia and Herzegovina. The different network models can rationalize certain parts of telecommunication infrastructure and thus cut construction costs. In order to place all future models in the same position concerning infrastructure construction costs, the analysis is based on the universal telecommunication infrastructure. The infrastructure project is done according to standards ISO11801 and EN50173.

Input parameter 5. *Future network infrastructure construction costs.*

Costs of maintenance. When cost of maintenance is concerned, it is necessary to observe and assess regular maintenance practices which include energy costs and hiring of the qualified and skilled workforce. Therefore, while assessing the costs of maintenance, the method of analysis of costs in the

previous period on the network segments which have the similar structure as the observed network has been used. This kind of cost is presented in relation to the individual user.

Input parameter 6. *Costs of maintenance of future network infrastructure.*

Expansion of infrastructure. The recommended network has to enable as simple and effective expansion as possible in terms of the number of users without significant alterations in the basic infrastructure. It is also necessary to secure the expansion of capacity on the central location and POP dots arranged in the area. This request is closely related to the potential changes of the future services which would require expansion of aggregate links from the user to the POP dots and further to the central location. This parameter is divided into three other parameters that the future network should enable.

Input parameter 7. *Network should enable simple duplication of capacity of access port in order to increase the number of new users up to 100% without significant alterations in infrastructure.*

Input parameter 8. *It should be possible to segment parts of network into smaller subsystems with the aim of increasing capacities of aggregate and access ports.*

Input parameter 9. *The future network should enable transferring of the excess capacity to other operators on the commercial basis.*

Input parameters 7 and 8 suggest simple procedure of capacity expansion of access network without any new investments in infrastructure. It is assumed that by segmenting network we can divide the growing segment into numerous smaller ones thus increasing the number of users.

Input parameter 9 denotes the legal regulation which defines this area and relates to the operators with significant market shares. Moreover, the tendency of stratification and decomposition of service providing will lead to division on several kinds of providers, such as content providers, Bitstream providers, access providers. This implies that in the near future this network can become part of both access providers and Bitstream providers.

ASSESSMENT OF INPUT PARAMETERS THROUGH FUZZY MODEL

Analyzing all the defined input parameters for the design of the future access network, we can notice quite different criteria for its assessment. Some input parameters can be numerically assessed, whereas most of them need to be descriptively assessed. Speaking about descriptive marks, it is quite difficult to make a scale for assessment of parameters. The lines between some descriptive marks are very small and often overlap. Descriptive marks are indefinite, which causes a problem when defining the final mark which should indicate the optimal choice.

In such cases one of the possible approaches in assessment is applying fuzzy model of assessment. Contrary to conventional logic, fuzzy logic model does not precisely define an individual element to be part of agglomeration. That element can be copied, but not every element has to be copied [4].

Fuzzy logic is closely related to human perception and denotes rather valuable logic. On the other hand, there is traditional logic with sets of answers (yes/no), (black/white), etc. Fuzzy logic uses precise linguistic variables and counts the correct measures for the features in question according to the approximate observations.

Before applying fuzzy logic model, it is necessary to choose the degree of belonging through a function μ(x), which defines what values (x) meet the condition of belonging to the set A.

$$0 \le \mu(x) \le 1, \quad \forall x \in A \tag{1}$$

$$\mu_A : X \to [0,1]$$

Fuzzy set is defined as a set of definite pairs.

$$A = \left\{ \left(x, \mu_A(x)\right) \middle| \, x \in X, \quad 0 \le \mu_A(x) \le 1 \right\} \tag{2}$$

The most frequent forms of functions μ(x) are trapezoid and triangle. We have used the triangle in

our example, as in Figure 1.

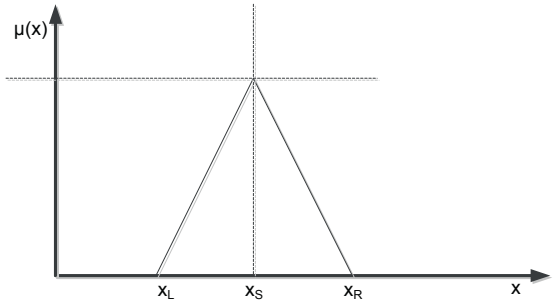

Figure 1. Triangular shape of the fuzzy number

Fuzzy number is calculated according to the following formula:

$$A_f = \frac{x_L + x_R + x_S}{3} \quad (3)$$

x_L, x_R – interval boundary
x_S – maximum of the observed number
A_f – value of fuzzy number.

In order to clarify the measure for fuzzy logic mark, the term fuzzy integral should be defined, which is also known as Sugeno integral. Let X be a finite set and S a subset of X.

$$\mu : S \to [0, \infty] \quad (4)$$

Where μ has the function of positive fuzzy measure.

Let *f* be the finite measurable positive function for the set X,

$$f : X \to [0, \infty] \quad (5)$$

And that the set $F_\alpha = \{x \mid f(x) \geq \alpha\}$ for every positive α which belongs to the series S. The conclusion to this is that it is possible to determine the *fuzzy* measurement F_α for every function $\mu(x)$.

Sugeno defined the integral of the approximate function *f* for the set X through the following definition:

Let X, S μ be fuzzy measure and let *f* be the positive measurable function defined for the set X. Then we have the following formula:

$$(S)\int f \circ \mu(x) = \sup_{\alpha \in [0,\infty]} [\alpha \wedge \mu(A \cap F_\alpha)] \quad (6)$$

Where:

$$F_\alpha = \{x : f(x) \geq \alpha\}, \ \alpha \in [0, \infty] \quad (7)$$

The formula 6 denotes Sugeno integral. If we observe the final score of values in the set X, then there is: [5]

$$(S)\int f \circ \mu(x) = \max_{i=1..n} [\min\{x_{\sigma_i}, \mu(F_{\sigma_i})\}] \quad (8)$$

Where σ is a permutation of input measurements for which it is valid $x_{\sigma_1} \leq x_{\sigma_2} \leq \ldots \leq x_{\sigma_n}$.

After analyzing input parameters, four degrees of marks should be defined, that is to say descriptive forms which describe input parameters. The Table 1 shows the defined descriptive forms.

Table 1. Ratings in the literary forms

No	Literary forms	Shortcut
1.	Non-supporting	N
2.	Partially supporting	DP
3.	Supporting	P
4.	Absolutely supporting	PP

Non-supporting (N) – assumes the total mismatch between the model and criteria, th at is the model does not meet the conditions of the criteria.

Partially supporting (DP) – the model could support the set criterion but needs improvement. Quite frequently such improvements are rather expensive and economically unjustified.

Supporting (P) – the model supports the criteria but needs only minimal improvements and costs.

Absolutely supporting (PP) – the model supports the set criteria absolutely without any additional expenses and investments.

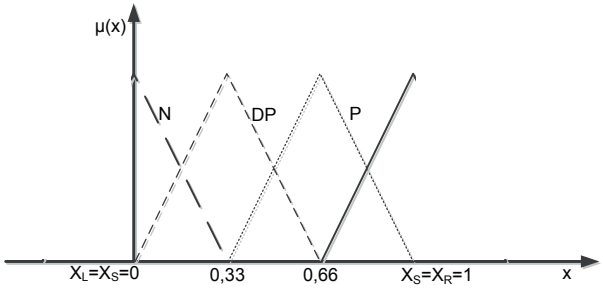

Figure 2. Fuzzy linguistic assessment

Figure 2 shows the triangular position of fuzzy function of the measure $\mu_A(x)$ for every descriptive

mark. If we apply these values to the formula 3 we will get the following values for fuzzy numbers.

$$N_f = \frac{0+0+0.3}{3} = 0.1$$
$$Đ_f = \frac{0+0.3+0.6}{3} = 0.3$$
$$P_f = \frac{0.3+0.6+1}{3} = 0.6 \quad (9)$$
$$P_f = \frac{0.6+1+1}{3} = 0.8$$

The obtained number of descriptive marks quite matches the description of the possible conditions of input parameters. The increase in the number of descriptive marks increases the threshold of sensitivity between input criteria. This might be interesting only if we get two or more different assessments which are very similar or identical. In that case, it would be necessary to increase the number of descriptive marks and repeat the whole process of assessment.

Descriptive marks are presented in the chart in order to be able to clearly determine the correlation between input parameter and its mark for the actual model, and to compare the correlations between the recommended models. Table 2 shows the pattern for evidencing descriptive marks.

TABLE 2. LINGUISTIC EVALUATION OF THE INPUT PARAMETERS (CRITERIA)

Criteria	Model M_1				Model M_2				Model M_3			
	O_1	O_2	O_3	O_4	O_1	O_2	O_3	O_4	O_1	O_2	O_3	O_4
g_1												
g_2												
g_3												
...												
g_n												

O_x – linguistic marks for the observed model and criterion,

g_x – criteria for choosing models of the future network,

M_1, M_2, M_3 – models that are assessed.

For all input parameters which can be numerically presented, we have defined the model of assessment which assumes normalization of values according to the coefficient denoting the lowest value. The formula 10 shows the way we have reached the marks for numerical values.

$$koef = \min\{v_1, v_2, ..v_n\}$$
$$O'_x = \frac{koef}{v_x} \quad (10)$$
$$0 \le O'_x \le 1$$

koef – normalization coefficient,

$v_1, v_2, ..v_n$ – values of the observed model,

O_x – normalized mark.

This way we have got the marks in the same value scope (0….1), and applying the fuzzy model we have got fuzzy marks. These marks could be rearranged with the aim of gaining the final one.

ASSESSMENT OF THE REGIONAL NETWORK MODEL

Applying Sugeno integral we have obtained a separate mark for every input parameter and observed network. The marks are based on different groups of criteria in order to show the correlation between input parameters within the same group. We have got the final mark for every network as arithmetic mean of all other marks for different groups of criteria, which is shown in the following formula. [2]

$$O_{MREŽE} = \frac{1}{n}\sum_{i=1}^{n} O_i(g_i) \quad (11)$$

n – total number of group criteria

$O_i(g_i)$ – mark for the i set of criteria.

It should be stressed that there is no difference between the observed groups of criteria when applying arithmetic mean. All marks take equal part in making the final mark of the future network model. If we want to analyze the impact of every group of parameters on the model, then we should adjust the way of assessing. It can be done by making one set of criteria more important than others. This means that the observed group of criteria should be singled out and its marks put on scale with a *k* factor the values of which range from 0 to 1. The other groups of criteria equally distribute the value of the factor *1-k*. Table 3 shows the scaling factor. The chart presents the correlation of the first factor and the same principle is applied for the rest of the factors as for the *k1* factor.

Table 3. scaling factor (k)

k_1	k_2	k_3	k_4	k_5	Σk_i
0	0,25	0,25	0,25	0,25	1
0,2	0,20	0,2	0,2	0,2	1
0,4	0,15	0,15	0,15	0,15	1
0,6	0,1	0,1	0,1	0,1	1
0,8	0,05	0,05	0,05	0,05	1
1	0	0	0	0	1

$$O_{MREŽE} = \sum_{i=1}^{n} O_i(g_i) \times k_i(g_i) \quad (12)$$

n – total number of group criteria
$O_i(g_i)$ – mark for the i set of criteria.
$k_i(g_i)$ – coefficient of scaling for the i set of criteria.

Applying the formula 12 and scaling values k_i in the set interval [0..1], we can make a graph presenting the function of model correlation in relation to the observed scaling factor k_i. Figure 3 shows the characteristic cases of impact of the k_i factor on the value of the mark presented through the functions $f_1(x)$, $f_2(x)$ *and* $f_3(x)$ which represent the observed models M_1, M_2 and M_3.

Let us consider the functions in the cases 1 and 2. The choice of optimal network changes in the points A and B, which are the breakpoints of the observed functions. The values of factors in the points x_A and x_B denote the final value of optimization for model comparison. If the observed values for x_A and x_B points are bigger than 0.35, then we can conclude that after the increase of the impact of 100% in comparison to other factors, the k_i factor offers the function $f_1(x)$ as an optimal solution for the future model M_1.

The cases 3 and 4 show that the observed models are absolutely unrelated and the k_i factor has no impact on the model choice. It is unnecessary to analyze the impact for such cases.

The cases 5 and 6 combine the previous ones. They only show the correlation between two models. If the observed models are correlated, then we can reach the same conclusions as in the cases 1 and 2.

The Table 4 shows the results of the analysis of model assessment in the cases 1 and 2 after defining the optimal distribution of coefficient. The maximal value of the marks for every model defines the optimal model choice. [2]

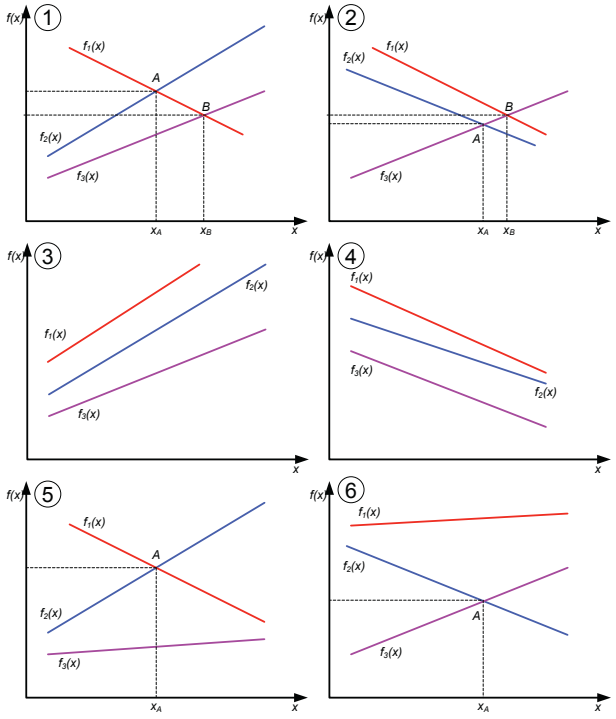

Figure 3. characteristic cases of impact of the K_i factor

Table 4. Scaled mark values with optimal coefficient distribution

Grupa kriterijuma	Faktor pond.	Model M_1		Model M_2		Model M_3	
		$O_i(g_i)$	$O_i(g_i) \times k_i$	$O_i(g_i)$	$O_i(g_i) \times k_i$	$O_i(g_i)$	$O_i(g_i) \times k_i$
g_1	k_1						
g_2	k_2						
g_3	k_3						
..	..						
g_n	k_n						
Σ	Σk_i		$\Sigma O_i(g_i) k_i$		$\Sigma O_i(g_i) k_i$		$\Sigma O_i(g_i) k_i$

Model Implementation: The case study

While searching for the optimal way to evaluate the suggested future access network models, a hybrid model of evaluation was defined. It consists of literal marks on which the *fuzzy* logical model was applied, and numeric marks which we rationalized. To this we were guided by the very fact that the most of input parameters could not be expressed by numerical values and that we did not want the expenses of building a network to be set up as a base. The application of the *fuzzy* model has its

own specificities, which depend on many parameters, just like it is shown in the PEST analysis. The PEST analysis has also pointed at complexities of making a decision about the choice of the future model.

As it is defined in the suggested model for evaluation, we did the analysis of the result in two steps, as a prime analysis and as an analysis with scaled influences of group criteria. During the scaling, we wanted to show dependence of the final result compared to the observed group criteria. It is needed to keep in mind the fact that the final result depends a lot from the outside factors. That means that during the defining of input parameters, the PEST analysis has to proceed.

The model was made for a particular area, which has its specificities. In the observed area a survey was done with adjusted content for the chosen area and potential future users. If it is about another area, especially an urban environment, which has an already built infrastructure and available some of the technologies, it is necessary to alternate the model. The outcome of that model can be different than the suggested one, but it can also have a very high level of a result match. That would mean that during the making of the decision about the choice of the access network model, a hybrid form the solution made from combinations of different technologies should be considered.

The suggested model of evaluation and the methodology of access the prescribed criteria can be used as a pattern for evaluation of other network models. The model accents the necessity of the complete overlook of aspects which affect the choice, and not just the short-term economic investment costs effectiveness.

Evaluation of input parameters

Keeping in mind the literal mark defined in Table 1 and the previously mentioned equation, we can calculate the *fuzzy* number for input parameters-criteria. The *fuzzy* number is calculated for the group of input parameters, so we would consider the mutual influence of parameters inside every group.

The criteria for establishing the optimal network choice are divided into four groups, as it is shown in Table 5. We apply the Sugeno integral on the groups with literal marks, while the group with numerically shown marks was defined in the previous chapter.

In Table 5 are shown linguistic marks for the influence of the observed parameter on the model, which came to be as expertise of set out advantages and disadvantages for every suggested model.

For the evaluation of every individual input parameter it is necessary to define the function of the network mark f_{NETWORK} . To this function, the values from the group of marks {0.11, 0.33, 0.66, 0.88} are added, which are received based on the group of available literal marks and transformations of those marks in the *fuzzy* value.

Analysis of the evaluation results

For every network model after applying the Sugeno integral, we received an individual mark. Table 6 showcases the marks for all observed criterion groups. The final mark for every network we get as an arithmetic mean of all individual marks from the formula 11. The last column of Table 6 shows the value of the mean. Optimal model choice is represented by the model with the highest average mark.

TABLE 5. LINGUISTIC MARKS FOR INPUT PARAMETERS (CRITERIA)

Group marks	Input parameters	HFC				xDSL				FTTH			
		N	DP	P	PP	N	DP	P	PP	N	DP	P	PP
Network capacity	UP1		X				X						X
	UP2		X				X						X
Services	UP3				X	X							X
	UP4		X					X					X
Construction costs	UP5	Numeric marks											
Costs of maintenance	UP6												
Expansion of infrastructure	UP7		X					X				X	
	UP8				X			X				X	
	UP9		X					X					X

Table 6. The values of the Sugeno integral for observed marks

Model network	Network capacity (KM)	Services (SU)	Costs		Expansion of infrastructure (SI)	Final marks
			UP5 (TI)	UP6 (TO)		
HFC	0.33	0.80	1.00	0.90	0.60	0.726
xDSL	0.33	0.60	0.79	0.96	0.66	0.668
FTTH	0.88	0.88	0.72	1.00	0.66	0.828

From this we can make a conclusion that by applying the arithmetic mean of individual marks, the network model candidate based on FTTH technology, represents the optimal choice of the future access network.

It should be accented that while working with the classic arithmetic mean, a difference should not be made between the observed criterion groups. All marks are equally participating in the forming of the final future network model mark.

While using the suggested methodology in the previous chapter and the suggested coefficients for scaling in Table 3, an analysis of individual influence of all input criteria for the optimal access network choice was made. By using the formula 12 in the tabular data record shown in Table 4, we received the following results.

By scaling the influence of investment expenses (TI) in the range from 0 (the investments do not affect the final choice) to 1 (only the investments affect the final choice), we received the results shown in Table 7. The received results show that the breaking point for the coefficient value $0.4 < k < 0.5$. At this point, the coefficient influence is bigger than 100% compared to other coefficients. By applying the defined methodology, we can consider that after increasing the influence of group criteria for the investment expenses (TI) for 100% compared to other criteria, the choice of optimal future network model stays on the FTTH access network.

Table 7. The influence of investment expenses (TI) on the future model choice

TI	KM	SU	TO	SI	HFC	xDSL	FTTH
0	0,25	0,25	0,25	0,25	0,6575	0,6375	0,855
0,2	0,2	0,2	0,2	0,2	0,726	0,668	0,828
0,4	***0,15***	***0,15***	***0,15***	***0,15***	***0,7945***	***0,6985***	***0,801***
0,6	0,1	0,1	0,1	0,1	0,863	0,729	0,774
0,8	0,05	0,05	0,05	0,05	0,9315	0,7595	0,747
1	0	0	0	0	1	0,79	0,72

By scaling the influence of future services (SU) in the range from 0 (no affect on the final choice) to 1 (it only affects the final choice), we received the results shown in Table 8. The table shows that for any coefficient k ($\forall k$), the optimal future network choice is the FTTH access network. The received results show the nonexistence of breaking points.

Table 8. The influence of future services (SU) on the future model choice.

SU	KM	TI	TO	SI	HFC	xDSL	FTTH
0	0,25	0,25	0,25	0,25	0,7075	0,685	0,815
0,2	0,2	0,2	0,2	0,2	0,726	0,668	0,828
0,4	0,15	0,15	0,15	0,15	0,7445	0,651	0,841
0,6	0,1	0,1	0,1	0,1	0,763	0,634	0,854
0,8	0,05	0,05	0,05	0,05	0,7815	0,617	0,867
1	0	0	0	0	0,8	0,6	0,88

By scaling the influence of network capacity (KM) in the range from 0 (no affect on the final choice) to 1 (it only affects the final choice), we received the results shown in Table 9. The table shows that only in the case that the observed coefficient is not being considered k=0, the future network choice changes for the advantage of the HFC model. For all of the other coefficients k, the optimal future network choice is FTTH access network. This scenario is workable in practice only when the network is being built *ad hoc* in order to reach faster acquisition (sale). In all of the other cases, the future access network model choice is the FTTH network.

Table 9. The influence of network capacity (KM) on the future model choice

KM	SU	TI	TO	SI	HFC	xDSL	FTTH
0	0,25	0,25	0,25	0,25	0,825	0,7525	0,815
0,2	0,2	0,2	0,2	0,2	0,726	0,668	0,828
0,4	0,15	0,15	0,15	0,15	0,627	0,5835	0,841
0,6	0,1	0,1	0,1	0,1	0,528	0,499	0,854
0,8	0,05	0,05	0,05	0,05	0,429	0,4145	0,867
1	0	0	0	0	0,33	0,33	0,88

By scaling the influence of maintenance expenses (TO) in the range from 0 (no affect on the final choice) to 1 (it only affects the final choice), we received results shown in Table 10. The table showcases that for any coefficient k ($\forall k$), the optimal future network choice is the FTTH access network. The

received results show the nonexistence of breaking points.

TABLE 10. THE INFLUENCE OF MAINTENANCE EXPENSES (TO) ON THE FUTURE MODEL CHOICE

TO	KM	SU	TI	SI	HFC	xDSL	FTTH
0	0,25	0,25	0,25	0,25	0,6825	0,595	0,785
0,2	0,2	0,2	0,2	0,2	0,726	0,668	0,828
0,4	0,15	0,15	0,15	0,15	0,7695	0,741	0,871
0,6	0,1	0,1	0,1	0,1	0,813	0,814	0,914
0,8	0,05	0,05	0,05	0,05	0,8565	0,887	0,957
1	0	0	0	0	0,9	0,96	1

By scaling the influence of infrastructure spreading (SI) in the range from 0 (no affect on the final choice) to 1 (it only affects the final choice), we received results showcased in Table 11. The table shows that for any coefficient k $(\forall k)$, the optimal future network choice is the FTTH access network. The received results show the nonexistence of breaking points.

TABLE 11. THE INFLUENCE OF INFRASTRUCTURE SPREADING (SI) ON THE FUTURE MODEL CHOICE

SI	KM	SU	TI	TO	HFC	xDSL	FTTH
0	0,25	0,25	0,25	0,25	0,7575	0,67	0,87
0,2	0,2	0,2	0,2	0,2	0,726	0,668	0,828
0,4	0,15	0,15	0,15	0,15	0,6945	0,666	0,786
0,6	0,1	0,1	0,1	0,1	0,663	0,664	0,744
0,8	0,05	0,05	0,05	0,05	0,6315	0,662	0,702
1	0	0	0	0	0,6	0,66	0,66

After the executed analysis and showcased results in Tables 7, 8, 9, 10 and 11, and the discussion of the received results, we can make a conclusion that the change of group criteria scaling factors does not influence the choice of the future regional access network model.

FROM THIS WE CAN MAKE A CONCLUSION THAT THE SUGGESTED FTTH NETWORK MODEL IS THE OPTIMAL SOLUTION FOR BUILDING ACCESS NETWORKS.

Conclusion

In this paper, a completely new model of input parameters evaluation is represented. It has a goal to choose the future telecommunication network. The results are received by applying the model to an actual situation. They confirmed the initial expectations that were received in the previous analysis.

This paper represents a systemized approach to the future telecommunication access network choice, which has usage in the business environment. The suggested methodology and the defined input parameter evaluation model can represent a base for making the decision about the access network choice in other environments as well, with the input parameters correction.

Authorship statement

Author(s) confirms that the above named article is an original work, did not previously published or is currently under consideration for any other publication.

Conflicts of interest

We declare that we have no conflicts of interest.

LITERATURE

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Influence of Resolution and Frame Rate on the Linear In-Stream Video Ad QoE

Miloš Ljubojević[1], Vojkan Vasković[2], Zdenka Babić[3], Dušan Starčević[2]

[1]*Academic and Research Network of Republic of Srpska, Bosnia and Herzegovina, ljubojevic.milos@gmail.com*

[2]*Faculty of Organizational Sciences, University of Belgrade, Serbia,*
vaskovic@bvcom.net, starcevic.dusan@fon.bg.ac.rs

[3]*University of Banja Luka, Faculty of Electrical Engineering, Bosnia and Herzegovina, zdenka@etfbl.net*

Contribution to the state of the art

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Abstract: An increasing number of services and facilities that are of interest to users is based on video streaming. Technical characteristics of video have a strong impact on the quality of a video streaming service and its perception by users. The most important measure of quality, which focuses on the user, is the Quality of Experience (QoE). Given that video advertising is a typical video streaming application, it is necessary to analyze the effect of the change of video characteristics on the QoE. This paper examines the impact of resolution and frame rate change on the QoE level by using objective and subjective QoE metrics. It also looks at the possibility of mapping the objective QoE metrics into subjective ones, if the QoE in Internet video advertising is analyzed. It was demonstrated that the values obtained by the objective assessment of quality can be mapped to the results obtained by subjective assessment of quality when the quality of experience of linear in- stream video ads is analyzed. The results indicate that temporal aspects of video quality assessment, e.g. influence of resolution and frame rate change to the level of the QoE, can be achieved by implementation of objective methods. Therefore, quality of experience can be improved by the proper selection of video characteristics values.

Keywords: Quality of Experience, Quality of Service, Linear Internet Video Ad, Objective and Subjective Video Quality Metrics

Introduction

Internet video streaming is one of the fastest growing business concepts and it has the largest share in the Internet traffic realized so far. The users have to be satisfied with the viewed content, and the marketed services must be profitable as well. Therefore, it is necessary to ensure the maximum possible level of customer satisfaction in circumstances where it is influenced by the transmission, video compression, content type, user devices, and many other factors [7]. This problem is greater when different services and business concepts are integrated, which is a trend in modern Internet communication and business.

Unlike Quality of Service (QoS) concept, which has been a subject of research in the field of information technology for a long time, and which is clearly defined and studied in detail, it can be said that a precise and universally accepted definition of the QoE does not exist yet. The working definition of the QoE states: "The quality of experience is the degree of users' satisfaction or dissatisfaction with an application or service. It is the result of fulfilling their expectations in terms of certain benefits and/or entertainment provided by using the application or service, whereby everything is considered in relation to the personality and character of the user and his/her current condition" [5]. It is important to emphasize that the QoE strongly depends on the content delivered to users, as well as the area of application. Unlike the QoS parameters that are primarily influenced by technical features of the system, the QoE parameters are influenced not only by technical aspects, but also by the subjective perception of the users' needs and users' be-

havior models, the adequacy of the content, context, the opportunities for content placement, etc.

The quality of video and quality of video service is commonly assessed by using subjective tests. These tests involve the presentation of test video sequences in a controlled environment and their evaluation by the respondents. It is obvious that these procedures are complicated and time-consuming, so it is necessary to investigate the methods to automate and speed up the process. Introducing the objective metrics, the expensive and complicated tests and a subjective evaluation of the results can be avoided. Some objective metrics can provide results that correlate highly with human perception of the video. The result of assessment obtained by using objective method is commonly referred as the objective quality of experience [12]. Both methods of evaluating quality of experience are important in their own way, so the best solution is to combine both methods as much as possible. In addition, it is desirable to compare and interpret the results obtained by using both methods in the best possible way.

This paper is organized as follows. In the second section, the important characteristics of linear in-stream video ad QoE are introduced and methodology for mapping objective QoE metrics into subjective QoE metrics is presented. In the third section, method for assessment of influences of resolution and frame rate change on linear in-stream video ad QoE is proposed. The experimental results are presented in fourth section. And, finally, we outline the conclusions.

Linear In-Stream Video Ad

Linear in- stream video ads, as one of the most common methods of placing video ads, are analyzed in detail in terms of the use of different modes of ads delivery in relation to the main content that the user consumes. In its recommendations, Interactive Advertising Bureau (IAB) defines appropriate guidelines, standards and best practices of digital video in-stream video ads [1]. Two categories of recommended characteristics can be emphasized: characteristics concerning the format defined by IAB and other technical characteristics of video ads, such as resolution, types of codec, number of frames per second, color depth, etc.

Temporal aspects of linear in-stream video ad

Three basic formats of linear in- stream video ads are: pre-roll, mid-roll and post-roll video ads. Pre-roll video ads refer to the display of video ads before the video user wants to consume; mid-roll ads refer to the display of ads during consumption of the video; and post-roll ads to display of ads after the desired video has been viewed. These video ad formats and their impact on the level of users' attention represent an important time aspect of video ads. Duration of video ads is also an important feature that contributes to the QoE analysis from the point of impact of the factors related to the temporal aspect of the Internet video consumption.

In addition, various technical features of video ads, as well as their recommended range of values, are presented in the IAB recommendations. Characteristics of video ads usually comply with the characteristics of the basic video. Bearing in mind that the recommendations refer to a large number of characteristics with different values, it is desirable to analyze the impact of some video ads parameters that can directly affect the level of customer experience. The implementation of appropriate values of certain technical characteristics as early as the phase of Internet video ad modeling could provide the maximum possible quality of users' experience with the viewed video. The aforementioned characteristics of video ads are the basis for the definition of the metrics that can also be used for the study of the efficiency of video advertising.

QoE and QoS of linear in-stream video ad

QoE does not just represent an extension of QoS concept, but it can be used also a particular component in the evaluation of the quality of the application and service. Although the QoE is dependent on many factors (subjective, psychological, cognitive, social, environmental, etc.), the ones that directly impact the level of the QoE are the QoS parameters (video bit rate, packet loss, jitter etc.). For this reason, when designing video ads, attention must be paid to the characteristics of the videos that differently influence QoS and QoE. It is also essential to determine the possibility of establishing correlations between QoS and QoE parameters.

The possibility of a connection between the objective and subjective methods of evaluating the

quality of experience is indeed of great importance, and mapping of appropriate values is one of methodologies often used for this purpose. The value of the QoS parameters, which can be easily monitored and controlled, should be mapped into the values which are difficult to control, as is the case with the QoE parameters. Mapping QoS parameters into QoE parameters allows for easier and more complete evaluation of multimedia services and applications.

In general, Internet video services, the mapping of the QoS parameters to QoE parameters is based on the layered protocol stack, Figure 1. It is a known that the QoS refers to a set of measures whose objective is to improve the network performance, as well as the performance of the system and application. Therefore, we can talk about the network, system and application layers of the QoS. The authors in [16] illustrated the complexity of the QoS and pointed out that the QoS application parameters directly affect the QoE. The mutual relationship between QoS and QoE in terms of the impact of QoS parameters of the different layers on the level of the QoE is shown in Figure 1.

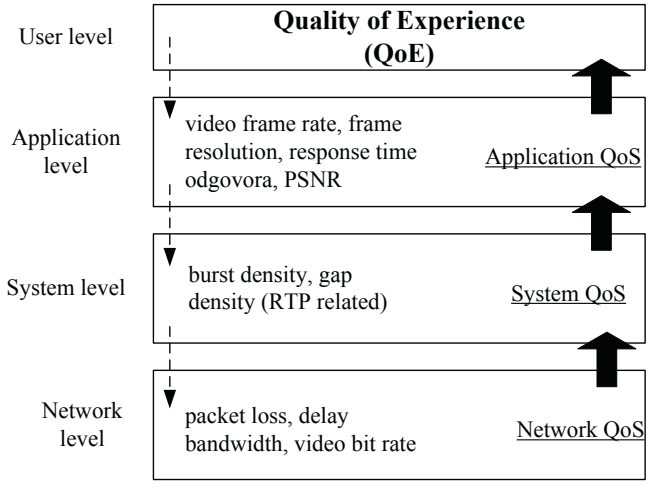

Figure 1. QoE and the layered protocol stack QoS, [16].

Arrows in Figure 1 illustrate the impact of QoS on QoE and vice versa. It is obvious that there are effects in both directions. Due to the stratification of QoS, it is important to identify QoS factors in the protocol stack, as well as their potential impact on the QoE. The QoS parameters that are present in different layers can be mapped into each other, and in this way the effects of the parameters of the lower layers are transferred to the higher ones. Hence, direct and indirect influences of environment, that are expressed with QoS, to the user's QoE, are both present. On the other hand, QoE factors do affect the QoS. This effect can be described as an impact of users' specific requests and responses regarding the offered service on the modification of the QoS parameters.

Translation between the Application QoS parameters and users QoE is often called service adjustment. Service adjustment enables the video to be displayed at the appropriate level of perception quality (high, medium or low). In addition, it enables the internal mapping of the quality of perception of video into the Application QoS, along with the use of media characteristics such as frame rate and resolution. Service providers adjust the values of the system and application QoS parameters in accordance with the rules of translation between them. For example, if the bandwidth is changed, the service provider adjusts the frame rate or resolution to fit the current situation in order to provide the required level of the video quality [13]. This directly affects the level of customer satisfaction, or results in the changed level of QoE.

The process relevant for this study is mapping of QoS parameters of the application layer into the user's QoE parameters, or precisely the impact of frame rate and resolution change in video with in-stream video ad to the user's quality of experience. It is assumed that the parameters of the remaining layers have constant values.

Mapping objective into subjective QoE metrics for linear in-stream video ad

Classification of objective metrics in three categories (*Full Reference-FR, Reduced Reference-RR the No-Reference-NR)* is mainly motivated by the availability of reference video sequences. When it comes to Internet video advertising, many forms of video are available for the realization of an experiment aimed at evaluating the quality of experience in a simulated environment, as well as for the realization of advertising campaigns. For example, not only original, ("reference" or "undamaged") video ads are available, but also video ads that users will consume after their placement ("degraded" video ads). These two video contents (reference video ad and placed video ad) can be compared using full-reference metric.

One of the full-reference metrics is the SSIM (Structural Similarity Index Metric), presented in a study [17] where image is the subject of analysis, whereas another study [15] demonstrates that when SSIM is used, there is a high correlation between the assessment of image quality and the assessment of video quality. For this reason, SSIM has been widely adopted as a metric for assessing the quality of video. The most important feature of SSIM, which is important for this research as well, is that it is based on the same principles that characterize human visual perception. This metric, compared to other objective metrics for the video quality assessment, is better adapted to the selection of the structural information, which is one of the characteristics of the visual system.

Easy testing and the possibilities for integrating with subjective methods results are significant features of the objective assessment method. The authors in [19] proposed a solution that is based on the mapping results obtained by the SSIM and VQM (Video Quality Metric) objective metrics into the nominal MOS (Mean Opinion Score) scale with 5 levels which is the result of the subjective assessment of video quality. SSIM metric correlates well with the human perception of video and has been used in our research also.

The way of creating a relation between the objective and subjective methods of video QoE assessment by mapping SSIM objective metric into MOS scale is given in [19]. Authors in [19] used test video sequences without video ads to generate mapping as it is described in the Table 1.

Table 1. Mapping of objective QoE metrics into subjective QoE metric [19].

MOS	SSIM
5 (excellent)	<0,99 ; 1]
4 (very good)	[0,95 ; 0,99>
3 (good)	[0,88 ; 0,95>
2 (satisfactory)	[0,5 ; 0,88>
1 (unsatisfactory)	[0 ; 0,5>

Mapping of objective QoE metrics into subjective QoE metric enables a fast and simple establishment of connections between these metrics. If the SSIM value is under 0,5, the mean value of the score is unsatisfactory (1), whereas when the SSIM value is over 0,99, the score mean value is excellent (5). Such principle of establishing correlations makes possible a quick control of obtained values and it is often used for scientific purposes.

This methodology based on the mapping of objective QoE metrics into subjective QoE metrics has been used in this research also, but we investigate these relationships for linear-in stream video ads.

We used this method to assess influence of resolution and frame rate to user's QoE in online video advertising. In the rest of the paper we will see that maping of objective quality metrics to objective quality metrics is possible if QoE analysis of linear in-stream video ads is performed.

The Influence of Resolution and Frame Rate on Linear In-Stream Video ad QoE

Experimental testing of the quality of experience by using subjective and objective methods should be in accordance with generally accepted recommendations and standards of the QoE evaluation. The authors in [11] proposed a methodology for the efficient design of the objective model that describes the effect of packet loss when a transfer of high-resolution video occurs. The principles on which the proposed methodology is based are usually used in research related to the study of the video quality of experience. Experimental procedure consists of several key steps:

a. Selection of test video sequences,
b. Designing environment in which the simulation will be conducted,
c. Selection of the subjective and objective metrics for quality assessment,
d. Subjective video quality assesment and objective video quality assesment
e. Establishing correlations between results obtained by subjective and objective quality assesment methods.

A similar methodology was used in this paper, but with all the modifications that must be made in order to be implemented in the analysis of the linear in-stream video ad QoE. We analyzed the impact of those characteristics whose change is possible during

video service delivery. In order to improve the level of user's QoE their value can be modified and adapted to current conditions and to network requirements. Video frame rate and resolution change are of interests for practical use. The level of the QoE in linear video in-stream advertising was evaluated by using objective methods, in this case the SSIM. In order to confirm the results obtained by using the objective SSIM, a subjective test was performed as well. Mapping the objective QoE metrics into subjective ones is performed using previously described methodology.

Test Video Sequences

The test video sequences, created especially for this research, that enable the testing of the impact of the frame rate and resolution were used in the experimental part of the study. Since the linear in-stream video ads are embedded in the primary video content, technical characteristics of video ads often correspond to the technical characteristics of the primary video content consumed by users. Given that the impact of the changes in the characteristics of video ads that are inserted into the main video content is the topic of our research, test sequences consist of two segments: video ads and a part of the primary video content.

Bearing in mind that testing the impact of resolution and frame rate on the quality of the users' experience with displayed video ads is the task of the experiment, and taking into account the recommendations made by the IAB, we tested video ads with three different resolutions (640x480, 400x296 and 352x288 pixels) and three frame rate values (25fps, 20 fps and 15 fps). Video sequences were encoded by using the MPEG-4 codec. The content of the video sequences was designed to contain different spatial changes of the video content scene in the test video sequences. The duration of a test video sequence is 30 seconds, with 15 seconds for a video ad and other 15 for the main video content, Figure 2.

video ad (15 second)	primary video (15 second)

Figure 2. Example of test video sequence format.

Simulation Environment and Testing Methodology

The methodology for video streaming QoE assessment requires the provision of adequate video delivery to the end user. This includes the functionalities of streaming video over the network infrastructure and the possibility of viewing with the option to save placed video. An environment enabling a full functionality of these tasks was created to perform experimental part of this research.

The testing environment for this experiment consists of three blocks: a video server, a communication infrastructure emulator and a client on which video is placed. The architecture of the network environment is shown in Figure 3, and it is based on the architecture and video distribution process proposed in [10]. The software solutions that are not subject to licensing i.e., open source solutions were selected. It makes the implementation of the research simple and efficient.

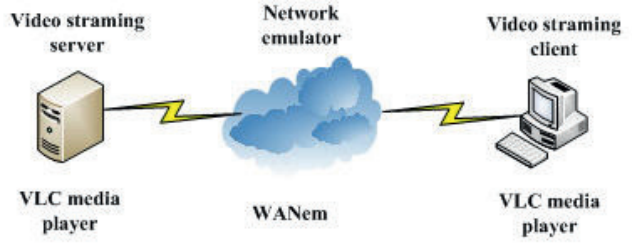

Figure 3. Experimental network environment for the linear video placement

The video server and the client are a free Video LAN streaming software solution. VLC media player is used as a video streaming server and as client software used for the consumed video stream viewing and recording [4]. The RTP protocol, which is widely used for multimedia streaming, was used for video streaming in this research as well. A similar concept of analysis was used in the studies by authors [6], [8].

WANem emulator *(Wide Area Network Emulator)* [9] was used as the network environment emulator. WANem is open-source software and free to download and use in one's own network environment. A study [3] shows that WANem can be used for emulation of real WAN networks in a test environment realized within the LAN network. It was demonstrated that this tool can be used for analyzing and exploring the functionalities of applications in a variety of situations. The analysis, based on the observation of environmental problems such as delay, package loss, limited bandwidth, etc., of the effects of the network environment on services and applications, is an example of this process.

The possibility of the emulator application in the LAN testing environment was explored in this research. The WANem software which emulates the WAN network in which two hosts are communicating was used. The two hosts representing a video streaming server and a client device are used for video placement and consumption. The performances of the network environment emulated by WAN amulator have an impact on the transmission of video from the video server to the client. Under these circumstances, it is possible to emulate and involve, different network influences, such as package loss, delay, bandwidth limitation into the experimental environment.

The simulation of video streaming was carried out in three phases by using simmilar methodology presented in [11]. The first phase represents a video streaming in an 'ideal environment', where the package loss and delay emulated by WAN emulator are equal to zero. In that way were obtained the video sequences, which are considered as 'reference sequences'. These sequences are considered referential because the package loss in the network environment emulator was set on zero value. Transmission flow, package losses or delays do not interfere with these sequences, and they have to be treated as referential to eliminate influences which cannot be fully controlled, such as the influence of the streaming software, client software and etc. Such influences are not present in the same form only in referential sequences, but also in consumed, damaged sequences.

The second phase is based on video sequence streaming in the network environment where the 0,5% of package loss is emulated. The selected value of the package loss percentage is in the range of tested values of packet loss that has also been used in the studies dealing with the analysis of the users' quality of experience of the consumed video content [18]. Obtained results are denoted as 'damaged' sequences.

Together with referential sequences, 'damaged' sequences are used in the implementation of objective, Full-reference method of testing and SSIM calculation. Mean values of SSIM for all frames of tested sequences were also calculated. SSIM values were calculated with MSU Video Quality Measurement Tool (VQMT) [14]. This program is commonly used for an objective assessment of video quality. It makes possible the testing in the presence of a reference (two videos are analyzed, one referential and the other after the distortion) and testing without a reference (only one video is analyzed). This program enables the testing of quality by using different metrics, and SSIM was also used in our research [14]. Finally, in phase three, we carried out a subjective assessment of the placed video QoE by applying procedures described in the ITU-T Recommendation-P.910 [2].

Experimental Results

Test video sequences were in the form of pre-roll video ad, consisting of 15 second advertising content and 15 seconds primary video content. The influence of content context and video ad duration were not investigated in this research. Referent and damaged video sequences are generated using different resolution (640x480, 400x296 and 352x288) and three different frame rates (25fps, 20 fps and 15 fps). For emulation of network impact the WANem emulator is used, and the packet loss was set to 0,5% when damaged sequences were delivered.

Respondents were watching the test video sequences obtained by inserting of the pre-roll video ads in the main video content. They evaluated the quality of video by using a five-level MOS scale, while the grading system was from unsatisfactory to excellent. After the testing which included the previously described phases, analyses and processing of the results, the corresponding SSIM and MOS values were obtained. The SSIM values were calculated by using the program for objective quality evaluation (MSU Video Quality Measurement Tool) and previously obtained 'reference' and 'damaged' video sequences. The results are presented in Table 2.

Table 2. Results of objective and subjective video quality assessment

SSIM			
Resolution	**Frame rate per second (fps)**		
	15	20	25
640x480	0.93477	0.93083	0.93171
400x296	0.93311	0.92781	0.92921
352x288	0.9292	0.92474	0.92471

MOS			
Resolution	Frame rate per second (fps)		
	15	20	25
640x480	3.6	3.45	3.8
400x296	3.4	3.2	3.4
352x288	3.05	3.1	3.05

The values obtained after the objective assessment can be mapped in the results obtained by a subjective quality assessment, as the case was in the research that authors presented in [18]. Namely, base on those authors findings it is possible to assess the quality of the placed video by applying an objective SSIM, under conditions where the package loss amounts to less than 0,5%. Based on that research in this experiment emulated packet loss was 0,5%.

Obtained results of the subjective MOS assessment are in line with the value findings presented in [10]. Consequently, it was confirmed that the usual quality assessment principles, used in other areas of the Internet video content application, can also be used for an application such as Internet video advertising. The results of the impact of the frame rate and resolution on SSIM and MOS values are illustrated in Figure 4.

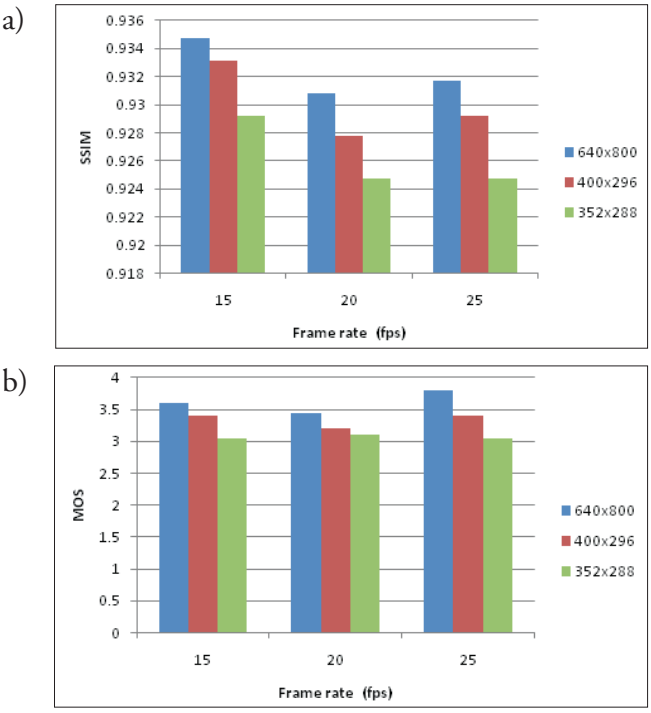

Figure 4. Illustration of the impact of resolution and frame rate on: a) objective SSIM and b) subjective MOS assessment

It can be concluded that for resolutions 352x288 and 400x296 mapping SSIM to MOS in video ads QoE is in accordance with Table 1 [19], that is valued for general video assessment. Small deviation can be seen at higher resolution. Therefore, further research are necessary to find more precisely SSIM to MOS mapping when packet loss belongs to wider range.

Conclusion

The purpose of this research is to point out the possibility of modeling the video Quality of Experience during Internet video advertising. In such modeling, if network environment affects the quality of video content, it is possible to improve QoE by selecting the resolution and frame rate values. This research is also significant because it uses a widely accepted methodology, adjusted for the assessment of the QoE within a specific application as it is linear in-stream video advertising. It was demonstrated that the values obtained by the objective quality assessment can be mapped in the results obtained by subjective assessment, if the quality of experience of linear in-stream video ads is being assessed, and packet loss was 0,5%.

Experimental results show that the mean value of SSIM metric for all test video sequence frames increases with the increased video content resolution. Such increased value of SSIM is in line with the results of subjective video content quality assessment expressed in MOS, as the MOS value increases with the increased resolution. Considering the effects of frame rate on SSIM metric, the specific rule for change of SSIM value is not identified. They were analyzed because they are in the range recommended by IAB.

The obtained results make possible, through the implementation of subjective and objective methods, a more detailed analysis of the QoE with a specific Internet video ad application. Unlike previous research, the mapping of SSIM values in MOS values, aimed at improving the assessment of the QoE, was carried out on a specific Internet video advertising application. Moreover, compared to previous research, when testing video sequences were mostly used, testing video sequences that include linear in-stream video ad were specially designed for this occasion. The design was adapted to fit the research goals which depend on the actual tested application. In this research, the application was in-stream video advertising.

Owing to the obtained results, it is possible to include the effect of changed technical features in the unified model for the assessment of the QoE of linear in-stream video ads. The subjective assessment, due to its complexity, is rarely carried out in the course of the placed service design or testing. Therefore, quality assessment of the QoE of linear in-stream video ads can be improved by integrating the results of the objective assessment with the results of subjective assessment.

Authorship statement

Author(s) confirms that the above named article is an original work, did not previously published or is currently under consideration for any other publication.

Conflicts of interest

We declare that we have no conflicts of interest.

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The Application of Information and Communication Technologies in Dance Sport in Bosnia and Herzegovina

Velibor Srdić[1], Milan Nešić[2]

[1]Pan-European University "Apeiron", College of Sport Science, Banja Luka, BiH
[2]Edukons University, College of Sport and Tourism, Novi Sad, Serbia

General survay

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Abstract: The research was performed with the aim of determining the frequency and ways of application of information and communication technologies (ICT) in dance sport in Bosnia and Herzegovina. The research was conducted on the sample of 33 dance clubs, that is, their representatives, with the condition for the clubs to belong to one of the two national dance associations of Bosnia and Herzegovina. The data were collected via interviews, associations' web pages and their archives. The research utilized analysis and induction method. The results showed weak application of ITC in everyday work of dance clubs, but they also indicated the appropriate usage of ICT by dance associations (as the "umbrella" organizations of dance sport) at dance competitions. In this sense, it is advisable to steer finances towards improvement of dance clubs' equipment and IT training of employees.

Key words: information and communication technologies, dance sport, application.

Introduction

Sport is characterized by a multitude of interactions involving so much information that human brain cannot memorize, compare and analyze it all in a fast and effective way. Modern ICT have become an integral part of everyday life of individuals and groups in all areas of human activity. It can be stated with certainty that this is a phenomenon of globalization which enables fast, safe and transparent flow of information. A long time ago in 1983, Paul Westhead, American basketball coach of LA Lakers, said that "we are just scratching the surface" [13] when it comes to informatization; today, informatization in all life spheres and in the work of kinesiologists is to be accepted as inevitable and as such it should be supported [6]. Information technology accelerates overall social progress, where sport is also one of the more significant factors [17]. According to available statistical data, the number of Internet users in Bosnia and Herzegovina has been steadily increasing; it was 65.36% in 2012, as compared to only 1.08% in 2000. Considering the numbers, Bosnia and Herzegovina is a regional leader in the Internet use (Croatia 63.00%, Serbia 48.10%, and Montenegro 56.84%) [9].

In the Sports Law of BiH [21], IT in sport is mentioned as an activity related to the professional sport (Article 45i). In this manner, a legal directive is given with the following goals to strive for: systematical monitoring and recording of the situation in sport, professional, scientific and publishing activities through the organization of the universal information system in sport, which should be built according to the European standards of the sports information network. The elements of the universal information

system in sport are more clearly defined in the Article 142 of the Sports Law of Republic of Srpska [22], and these are related to basic registration of members, sport facilities, sport experts, experts in sport, athletes, sport results, financial management, and so on.

Unlike other technologies which are supposed to follow the development of a certain sports branch and discipline, the application of ICT in them has happened relatively quickly, and these technologies have become a vital part of dance club organization, associations and competitions. Information technology, programs, staff, organizational conditions, and structured IT activities are all necessary components for the existence of information system [14]. Information system in sport entails information support system for sport organizations, support system for decision making and system for communication, cooperation and individual work [20] [16].

Development of training technology in sport is directly related to the development of information technologies, which are part of organizational changes in sport. These changes are defined by the following factors: environment, knowledge, learning and management [18]. Information and communication technologies are increasingly present in higher education as compared to traditional learning methods [11]. In his research on modeling of the support system in decision making process related to athlete's preparation, Havaš (Havaš et al.) deals with development of telematics system based on the current potential of an athlete, information feedback in a database and data storage in this system [8]. The application of information and communication technologies in dance clubs is primarily connected to the needs of business management, training process and dance competitions. However, it can be used in much wider context (production technology of dancing costumes and shoes, booking of airplane tickets, sales of tickets for competitions, exchange of experts' opinions, etc). Scientific dance research is unimaginable today without the application of ICT, considering that it involves a large amount of data and different descriptive and comparative statistical procedures.

The aim of this study is to determine the frequency and ways of application of information and communication technologies in dance sport in Bosnia and Herzegovina.

Method

This research utilized methods of analysis and induction. The data for the research were collected via official websites of dance clubs and from the archives of the Dance Sport Association of BiH, Modern Dances Association of BiH, and a dance club "Gemma" from Banja Luka, as well as through interviews of representatives from the aforementioned dance sport organizations.

Results and discussion

On the basis of the analyzed data that were collected from the two main dance associations, there are 32 dance clubs registered in Bosnia and Herzegovina which are characterized by the following: 8 clubs have a website; they all have a profile on one of the social networks (Facebook, Twitter), 9 clubs have a computer, and only one dance club has a software support system with a database containing members' information and necessary files (Table 1). These data indicate the low level of IT (hardware and software) support in dance clubs in BiH. It can be asserted that this result was expected, considering the general socio-economic situation in the country, and thus, in sport. Likewise, these data show that only a small number of clubs has necessary logistic support which led us to conclude that the external environment is not well informed about club activities. On the other hand, judging by the ITC presence, it seems that the internal awareness of the club activities is satisfactory, especially if one has in mind internal stakeholders of dance clubs [19].

When the aforesaid is regarded in a broader perspective, it has been noticed that the ministries of sport in two Bosnian entities are relatively well equipped with hardware; nonetheless, their universal information system does not have efficient software, so if there is a need for certain information (information that is useful for professional development and existence of sport organizations as main agents of sport system in BiH), its inadequacy and inaccuracy of available information becomes evident. Even

though, the elements of universal information system are outlined by law, however, subordinate legislation does not offer precise enough or systematical plan for standardization of the recording operations and procedures. For this reason, dance clubs are unaided when it comes to creation of databases. Taking into account this aspect of sports management, the enormity of the gap between dance sport and sport in Bosnia and Herzegovina and world standards is clearly seen from the fact that as early as 1983 there was only one sport organization in San Francisco without IT support in business management (for ticket sales, scouting or statistical analyses) [13].

Through the research of dance clubs in BiH, it was found that dance clubs have relatively young managing executives (33.81 years old), who perform tasks in different roles (managers, coaches-operating managers, administrative staff, finances).

All dance clubs' representatives stated that they use computers with Windows operative system regularly in their work to maintain the club functioning. Programs being used by them are Word, Winamp, and Acrobat Reader (28 clubs or 87.5%), and a smaller number of them said they use Excel, WinZip, Power Point, Acrobat Reader, JPEG, Corel Draw and Tif (7 clubs or 21.45%). For the bookkeeping purposes all dance clubs have contracts with accounting bureaus, which have their own licensed bookkeeping program, thus providing them full software support.

Only one dance club has software support for its everyday operations (Table 1). The interview with the IT administrator of the dance club "Gemma" Banja Luka revealed the basic information about the software, its functions and architecture of the application. The program has been used for two years by all employees in the club (all management levels). The software functions as a network application with the central database, and the employees have access to it through their accounts. The application access is enabled from any computer inside the local network that is installed in the club's premises. The basic version of the software has the following functions:

- Free creation of user accounts for access: tutor, administrator (account creation, deletion, deactivation);
- Limitation of access depending on the type of user (different users have different interface

Table 1. The application of information and communication technologies in clubs in BiH entities

City	Dance clubs	Websites	Social network profile	Computers in club	Software support system
Banja Luka	4	2	4	2	1
Sarajevo	5	1	5	3	-
Cazin	1	-	1	-	-
Tuzla	3	2	3	2	-
Bosanska Krupa	1	-	1	-	-
Mostar	4	1	4	1	-
Teslić	1	-	1	-	-
Bihać	1	1	1	1	-
Srbac	1	1	1	-	-
Zenica	4	-	4	-	-
Trebinje	1	-	1	-	-
Sokolac	1	-	1	-	-
Bijeljina	1	-	1	-	-
Pale	2	-	2	-	-
Lukavica	1	-	1	-	-
Gračanica	1	-	1	-	-
Republic of Srpska	12	3	12	2	1
Federation BiH	20	5	20	7	-
Total	32	8	32	9	1

and therefore limited access to certain program functions);
- Work with users' profiles: tutors and members (data entry, deletion, updates);
- Creation of members' groups and appointment of a tutor for each group;
- Log-in and log-out records of all users;
- A list of log-ins/log-outs/presence of all users accessing the system;
- Members' salary management (payments entry, overview, deletion, other changes).

The software has the following reports ready in its program, as well as export of each report as a PDF file:
- Members: members' list, log-ins, their presence in groups and with different tutors, view of payments, date of entries and payments. Each report also includes additional search criteria (sex, age).
- Tutors: list of all tutors, their log-ins. Each report also includes additional search criteria (sex, age)
- Payments: list of payments for each member, delays, dates.

Aside from these basic functions, the software has additional functions:
- Sending of emails to members/tutors by different criteria (cancellation of scheduled activity, change of schedule, and various other information);
- Sending of text messages to members/tutors by different criteria (cancellation of scheduled activity, change of schedule, and various other information);
- The accessibility of program from the outside via Internet (the access enabled to members so that they can view their profiles, payments, and such);
- Automatic notifications to administrators/tutors about members' overdue fees.

The application was created via Java technology, while the database itself uses MySQL server. All software used by clients is free after installation and there is no need for purchase of additional licenses. The most important hardware requirements of the 'server' computer with the installed application are processor, RAM memory and free space on the hard disc: CPU Intel/AMD on 2GHz+ (the processor should preferably be multi-core), RAM 2GB+ and minimum space on the hard disc 2GB+.

Hardware requirements of other computers which could also be used for accessing the application, are not so important and 'the average' computer is sufficient. It is a network type of application set in the central computer together with the database. It is also possible to access the application from the outside via Internet. There is also a local network, so that one can access the application from other computers, and for data backup, there is an additional memory in the form of stick/external disc/other computer.

Naturally, the application of this software requires a computer literate user, which is in accordance with the labor market research in Bosnia and Herzegovina [1], where 24% of the employers stated that there is a lack of necessary IT knowledge, skills and training (general and specialized knowledge about different program packages).

Application in the training process

A large amount of information that trainers operate with every day is, to a large extent, based on the previous experience and knowledge of experts and is stored in databases. The mobile phone networks with their multimedia functions are especially significant today for the information flow. Many sports branches and dance use very much computer animations of different movements to help visualization of movements [4] [12] [10] [3] [7] [2]. Biomechanical uninvasive diagnostics based on the use of ICT is greatly used in numerous sports branches, but not in dance. Thus, for example, computerized isokinetic diagnostics can determine potential weak spots and muscle forces for different flexing and extending movements. This type of diagnostics is merely used therapeutically when it comes to dancers in BiH, that is, only when they are already injured.

In relation to psychological preparation of dancers, modern technologies enable dancers to get acquainted with images, sounds and atmosphere of a competition where they would be performing. You-

Tube channel is especially important in regards to this, as it enables dancers from BiH, who are mostly inexperienced in world competitions, to see the top quality world dancers. For example, dancers used to wait for years to see other top dancers, or perhaps they did not see them at all, while today that is almost impossible and they can even say that they know them virtually through social networks. It is certain that social networks increased flow and exchange of information among dancers and they are an essential factor of socialization in the process of globalization.

Dancers are shown videos of top dance couples from competitions and their own videos from trainings or competitions for the purpose of visualization, indication of mistakes, and self-evaluation. This constitutes an integral part of technical, tactical, choreographic and psychological preparation in dance. Digital cameras, LCD projectors, DVD players and USB sticks are used for this purpose. Other than for demonstration of dance elements, modern technologies are also used for: monitoring of each athlete's qualities and abilities (sports diagnostics), timely changes of plans and programs (planning and programming), realization of training tasks and evaluation of training effects and so on. Based on the acquired information in this research (via interviews), a conclusion can be drawn that ICT as a part of methodical and methodological procedure in training is used very rarely. One reason for this could be that dance sport employs relatively young couching staff (young coaches in dance clubs), and that they have a great ability to demonstrate dance elements; on the other hand, it is obvious that most dance clubs are not well equipped technically in order for them to use this instruction method. Some experts' opinion is that a dance couple being photographed while performing dance choreography must display clearly defined posture in each captured moment (their posture, position of arms and legs, body line, movement).

It is almost impossible to have dance training without music, which is usually stored on some external memory (DVD, CD, USB stick, Internet, external hard disc, iPad, iPod); these, in any case, are more functional and durable than those vinyl records and cassettes from the past era. Modern devices for music reproduction have a rhythm control option (slowing down and accelerating), which is used a lot in teaching of new dance elements and choreographies, regardless of the teaching method (analytical, synthetic and combined).

ICT cannot replace specific composition of movement (5), that is, the coach and his/her living word, creativity and originality in application of different work methods, nevertheless, ICT make a great support in the training process.

Application in dance competitions

The analysis of dancers while they are performing in a show or competition is nearly impossible without the appropriate ICT support, considering the artistic aspect (expression of emotions, presentation, rhythmic interpretation, originality and expressiveness). Modern technology helps to a great extent with determination of prescribed parameters to structural basis of dance: music rhythm with a certain number of dance measures in a minute and duration of music, sound, acoustics and light effects and lighting of a dance floor in general. So, for example, typical "scoreboards", which are used at sport matches, are not used in dance sport competitions.

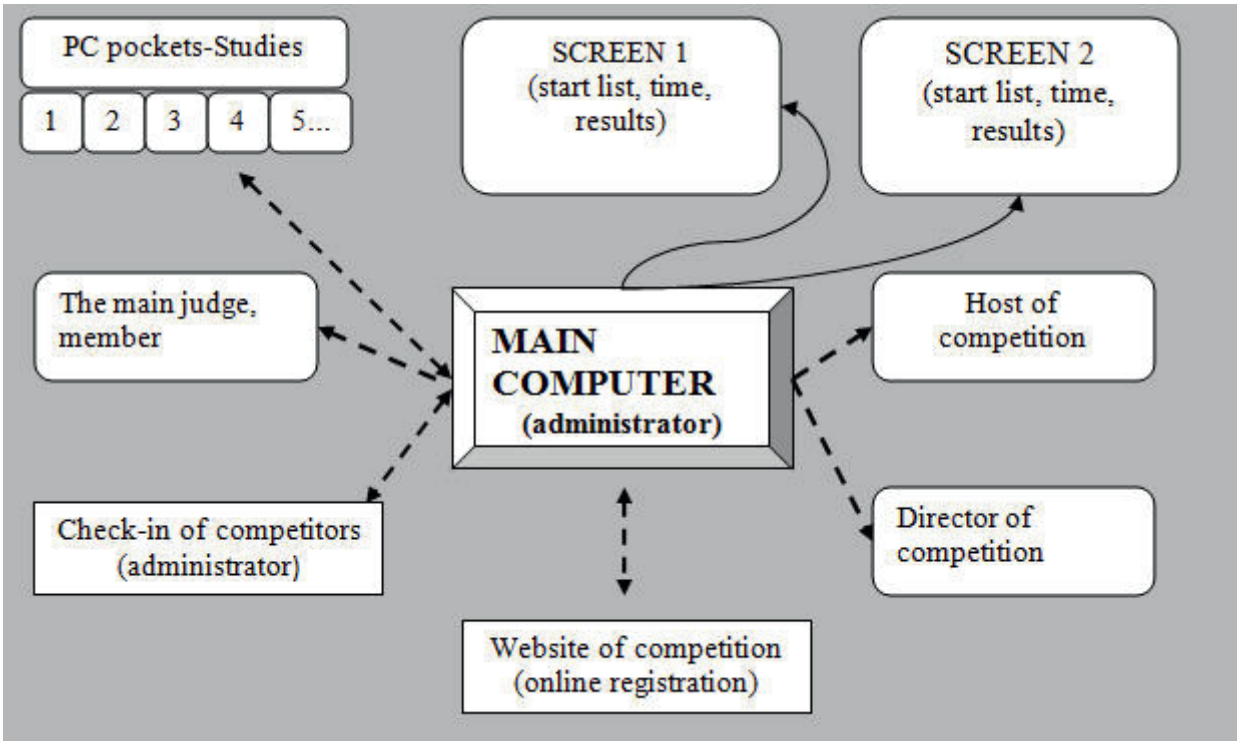
Dance sport competitions are characterized by very long duration (they usually start in the morning and end late in the evening), with a lot of different age categories (juveniles 1, juveniles 2, juniors 1, juniors 2, youth, seniors, veterans), qualitative groups (A, B, C, D, E), and disciplines (dance couples, formation dance, and Latin and standard dances). When it comes to modern dance sport, the situation becomes even more complex, because there can be anywhere from 500 up to 1000 competitors per day. This means that the process of competitors' registration and checking out, work hours and analysis of results are extremely demanding. On top of this, data analysis of sports results follows a specific set of rules (Dawson's rules) demanding specifically educated human resources (there is a special exam to be taken for this in dance associations). Thanks to software solutions and technological advancement, this process is much easier, so preparation and reaction time to frequent changes during dance competitions is relatively short. All dance competitions (in both

dance associations in BiH) utilize a software system for registration of competitors and analysis of results, and owners of the software are dance associations.

There is one particular dance program which is featured in dance sport in BiH (it is the only one currently featured in BiH, and it is also typically used in ex-Yugoslavian region). The owner of the program is a company called Mastersoft from Niš, and basic information about this program was recorded in the interview with their representative. The program can track 999 different competitions during one tournament, and it can perform different operations with the equal number of competitors. If the organizers require, marks for 3-15 judges may be entered into the program (there is always an odd number of judges in dance competitions). Judges can write their marks on paper or enter them into their PC pockets (PDA), and on PC pockets they can also view categories and disciplines that they are judging. It is possible to announce start lists by different categories, results, and timings on maximum three screens and video projectors. All data are sent from the computer (it has to be online), which has a specially designed software, managed by a professional trained for that purpose especially. All mentioned data can be available to both the host of the program and competition's main judge on his/her laptop which is connected to the main computer. At the end of a competition, the results are sent via Internet as HTML directly to the website of associations. For online registration of competitors, there is a specifically created program which is compatible with the main program that is used for analysis of results, so by a single click, administrator can automatically generate the start list (the attempts are made to distribute start numbers evenly across clubs, countries or quality). On the day of competition all registered competitors check-in on a special computer which is connected to the main computer used for analysis of results (Graph 1).

The program has the ability to print diplomas, start numbers, and a bulletin with all data, judges, participants and results of competitions; it can also store information and generate dancers' rang list according to the predetermined scoring criteria stated in the book of rules for competitions. The most recent function of the program enables one to play music

GRAPH 1. COMPONENTS OF THE PROGRAM FOR ANALYSIS OF A DANCE COMPETITION RESULTS AND COMMUNICATIONS



Explanation:

wireless connection (two ways), wireless connection (one way), cable connection

for a certain dance act in modern dances, and this is possible if a competitor sends music together with its online registration. The installation of the program is not very demanding (Win 5 or Win 8), the application was created via several technologies (Visual basic EVB for PDA, Visual basic, Visual C# - basic program and other segments - host, screen, division), the application for online registration (HTML, PHP, JS), and the part for android smartphones or android tablets was created in Android OS. The World DanceSport Federation (WDSF) certified the program and it is one of the eight programs which are currently used in the world.

Conclusion

Based on this research, it can be concluded that technological equipment of dance clubs in BiH is at a low level implying furthermore insufficient software support. This condition can be linked to unfavorable financial situation in sport and in society as a whole. All dance clubs in Bosnia and Herzegovina are present on social networks and they probably use them to inform their members (internal public) about activities, nonetheless, the non-existence of websites can be a reason why broader public is uninformed and why there is weak popularization of dance in general. Unless they have a computer in the club, managers of dance clubs probably use their home or work computers (or from other place) to perform everyday tasks in a dance club. The necessity for ICT in dance is great because ICT are used on a daily basis by all management levels in a dance club.

The research verified that only one dance club has a software support system that is used for its everyday operations. The program is utilized by all business sectors in the club (administration, management, finances and coaches) and it could serve as a design model for some future similar software that would be used for the operations of dance and sports clubs in general. The application of ICT in the training process is chiefly related to the diagnostic of anthropological characteristics and abilities, and also related to this is planning, programming, realization and evaluation of the training process. The integral part of each dance training is music, which is reproduced from external memory devices. In dance training, ITC have been used in visualization of dance movements, choreographies and introductions, as well as for the self-evaluation of own dancing.

All dance competitions have software support owned by associations, which makes organization of competitions much easier, considering the number of participants, categories and disciplines. Only two administrators work on registration of competitors, timing, analysis and announcement of results during competition and on associations' websites, printing of diplomas and competitors' rang list.

With all this said, it can be concluded that the application of ICT in dance clubs in Bosnia and Herzegovina is insufficient and unsatisfactory, having in mind legal, market, and professional demands in dance sport. Contrary to this, dance competitions are completely supported by ICT, so it can be asserted that in this area there is a full ICT support. The existing software solutions which are used in dance sport in BiH are simple, but they entail previous education and a certain level of computer literacy. All work programs in the club and associations are functioning with minimum technical requirements and with the Internet connection.

In the future, the focus should be on getting the attention of authorized institutions on dance clubs so that they provide them with computers and basic IT equipment, on creation and application of software programs for everyday work and staff training for the work with ICT.

Authorship statement
Author(s) confirms that the above named article is an original work, did not previously published or is currently under consideration for any other publication.

Conflicts of interest
We declare that we have no conflicts of interest.

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Customer Satisfaction as a Significant Measure of Successful ERP Implementation

Bojan Ivetić[1], Tonćo Marušić[2], Dragica Radosav[3]

[1]Oil Factory Banat AD, Zrenjanin, ivetic.bojan@gmail.com

[2]Faculty of Science and Education, Mostar, tonco.marusic@gmail.com

[3]Technical faculty "Mihajlo Pupin", Zrenjanin, radosav@tfzr.uns.ac.rs

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Abstract: The measuring of implemented ERP system's efficiency is in any case multidimensional. Various researchers dedicated a lot of attention trying to find the best way to measure the success or the effectiveness of ERP solution. „Customer satisfaction" as a measure represents the crucial point in creating the model for Measuring the success of implemented ERP systems and therefore it is the subject of this work. In this work we shall see what effect the other measurements will have on the „customer satisfaction", respecting the correlation between particular crucial categories in creating the model of implemented ERP system's success.

Keywords: ERP, informational systems, success measurement, customer satisfaction

Introduction (Introductory remarks)

In order to obtain an adequate answer to the needs of the clients, the corporations need to update their business infrastructure and alter their work ethic. The key of competiveness lies in the ERP systems' infrastructure which is coordinated with the basic business processes and developed to support the delivery of products of high quality and services to clients in an optimal time [15].

ERP system provides an advanced functionality, global orientation and flexible options of expansion which are needed for achieving the maintainable competing advantage on the market, on which the company is running a business and providing the conditions for the company's profitable development [8]. According to the collected and analysed data in one study [19], it can be concluded that the role of ERP system's usage is recognized in many companies, but there are still certain problems regarding the implementation, such as workers' negligence, resistance and indifference.

Organizations from all over the world see the modern ERP systems as a main tool for the improvement of effectiveness, efficiency and competiveness. The business information systems are expensive and can represent one of the biggest financial and human resources' investments. They also very often bring the significant changes of business processes in organization by integrating so-called best practices into management. Today, more and more organisations from all over the world, under the pressure of the changes in the business's environment, integrate the business information systems in their management as a base for the successful management.

The understanding of advantage which brings the ERP system and ability to qualify those advantages become of crucial importance for managers which

have to justify the expenses and operative system's influence on organization [9]. The advantages are not usually realized straight away, and they are not widely accepted during system's start-up but very often many months or years need to pass by so that all changes brought up by the new system can be completely integrated in an organisation [10]. Especially in the times of crisis organisations tend to reduce the budgets and lower the costs in order to avoid the redundancy and sometimes bankruptcy.

Due to the costs, the investment into new business information system or just an update of an existing one is a very difficult decision and a great challenge for any organisation. Investments into technology, as well as other investments, are derived from the careful analysis and evaluations. Organisations want to know if technology investment will pay off in a sense of corporation's future success. Therefore, The Success, or the effectiveness of ERP is a very important subject in the field of IS.

Measuring the implemented ERP's effectiveness is multidimensional. The various researchers have dedicated lots of attention trying to find the best way of measuring the success, or effectiveness of ERP solution [7, 5, 11, 1]. What is exactly meant by success-effectiveness of ERP has never been totally clear, nor could the researchers agree on it. Success-effectiveness is the one of the disputable questions that preoccupies the researchers.

The problem is more complex because The Success, or the effectiveness is a multidimensional concept, which can be evaluated on different levels such as: technical, group, individual, organizational, etc. and by using a large number of necessarily complementing criteria such as: economical, financial, cognitive, etc.

Customer satisfaction as a measure represents a crucial point in creating the model for Measuring the success of implemented ERP systems and therefore it is the subject of this work. In this work, we shall see what an effect the other measures have on the customer satisfaction, that is to say, we shall examine the correlation between some key categories in creating a model of the implemented ERP system's success.

ERP sistems (Enterprise Resource Planning)

ERP systems in every realisation represent the software solutions for management support. They consist of many modules which support a large number of different functions such as: marketing, finance and accounting, sales, customer support, supplies, distribution, resource planning, production, maintenance and quality and human resources. The architecture of ERP system provides integrity of modules in a way that it enables the constant and visible exchange of information.

The definitions of ERP system vary in accordance with the context, especially considering the different views of stakeholders. The different stakeholders of the ERP system will, regarding their position in organization, have completely different opinions and experiences with ERP system [16]. Deloitte Consulting defines ERP system in their report published in 1998 as a business software set which enables organization to:

- automatize and integrate the most of their business processes
- share common data and good practice throughout the whole organization and
- create and access information in a real time

APICS defines ERP in the following way: "ERP anticipates and balances the supply and demand. That is a set of tools for anticipation; planning and distribution of resources on the company's level which:

- connects buyers and suppliers in a complete chain of supplying
- applies the approved best practices in the decision making
- coordinates the sales, marketing, operations, logistics, supplies, finance development of products and management of human resources.

Its aims include the high level of customer service, productivity, the costs cuts, inventory trade and it offers the basis for the efficient organization's management.

This is achieved by developing the plans and schedules so that the real resources – manpower,

materials, machines and money – are available on a right scale when needed" [20].

Gable, defines ERP system as a comprehensive software solution – a set that attempts to integrate a complete range of business processes and functions, in order to represent a complete account of business from the unique information-communication architecture [6].

Somehow differently, Roseman defines ERP system as adjustable, standard application software which offers an integrated business solution for the basic processes (e.g. production planning and warehouse management) and main administrative function of organization (e.g. accounting and human resources management) [17].

Al-Mashari and Al-Mudimigh define ERP system as an information-communication infrastructure which enables the flow of information within the organization and communication with the suppliers and other members of a supply chain. Davenport, Harris and Cantrell and Laframboise and Reyes indicate that ERP combines business processes in organization and represents a way of running a business, not only a software set [2, 14]. Kumar and Hillsgersberg define ERP systems as and "upgradable and exchangeable sets of information systems that secure the integration of information of all functional parts within organization" [13].

Marious Alexandrou defines ERP in the following way:

"ERP is an industrial term which describes the wide spectrum of business activities supported by multi-module software's applications. ERP can include the following modules: production planning, supply in interaction with suppliers, stock etc. It also includes modules for finances and human resources [21].

Why implement ERP?

Koch points out 5 main reasons why companies introduce ERP systems [12]:

- Integration of financial information – In companies without ERP system, every business unit has its own report version as well as its own analysis and anticipation of profit, e.g. finances have their own report version on profit according to the statements on income and expenses' account, while the sales department has its own version of reporting according to the trade. In such conditions, it is difficult to understand the entire management of the company. By applying ERP system it is possible to have a unique version of reporting which is not questionable as every business unit uses the same version.
- Integration of information about buyer's orders – ERP system tracks down the buyer's order from the time the order is received to the delivery of the goods and invoice. With the unique information, the company can easily track down the orders, coordinate the production and plan the delivery of goods on the different locations at the same time.
- Standardization and acceleration of production processes – ERP system applies standard methods for automatization of some steps of production processes, which saves time, increases productivity and reduces the main costs.
- Stock reduction – ERP systems provide an easy business processes, which improve order fillings. That leads to the reduction of production material, makes the planning of delivery to the buyers better and delivery from the warehouse which reduces the stock of finished products. For the real improvement of supply chain's process, the software for the supply chain is needed, but also the ERP system can be applied in monitoring and implementation of that process.
- Standardization of information on human resources – In companies with multiple business units, a unique human resources department does not have to exist, but it can be achieved with ERP system. The most ERP systems are designed in a way so that the production can easily use them.

One of the main advantages of ERP system is integration of the previously non-integrated tasks through the usage of the same software. The compa-

ny decides upon introduction of ERP system when it wants to integrate the operational processes and apply the best practice at the same time. However, as it comes to the company's business on the whole and achievement of the competitive advantage on the market, the new technology as well as the software alone is not a key to success.

Kay Roman states 10 main benefits of ERP implementation [22]:

- Improvement of technology
- Efficiency
- Integrity of information
- Reporting
- User-friendly surrounding
- Data access
- User's service
- Functionality

It has been understood that the facts such as: project leader, training, general views, understanding the easy usage, understanding the usage and attitude towards usage, are important for making a decision about usage of ERP system. The results of one study support the concept that the systems and methods considered easy to use and understanding are accepted as more useful by the final user [18].

The Success – the effectiveness of ERP system

By implementing ERP system, organizations can benefit from it, but on the other hand the project alone can be catastrophic for organizations which are failing to manage the process of implementation. Despite the existence of empirical studies in the domain of success – effectiveness of information system, it is still unclear what is exactly meant by the term The Success or effectiveness of informational system, nor the researchers managed to agree on it. Informational system has different stakeholders, such as engineers, management and end users, and they all differently define The Success of informational system. For example, the projects' managers and implementation consultants very often define success in terms of ending a project in time and within a budget. The employers, whose task is to ensure that organization adopts ERP system (integrates ERP system in management of organization) and to continue using it, define The Success as a smooth passage to the stable management with the new system, intended for achieving the improvement of business such as: stock reduction and achieving the capability for improving the support of decision-making [16]. The optimal success refers to the best results which could be achieved by organization by integrating ERP system into its management, considering the business environment, measured according to the operational and business results in the longer term [16]. From the perspective of the system's end users, the successful system is the one that improves the job performance without additional efforts and unpleasantness.

The efficacy of ERP system (IS) cannot be measured directly, but can be valuated by using many measures relevant to The Success. Since the seventies, many authors developed an approach to assessment of ERP's efficacy. They suggested a variety of variables, indicators and measures, such as: satisfying users, or system's acceptability, users' involvement, users' participation, or users' competence, (palpable, tangible) quality of information, or quality of system, usefulness of IS, the need of IS for a support of specific tasks and many others. Amongst the mentioned measures the most prominent one is the user's satisfaction with the implemented ERP system's solution. The subject of this work is what it represents and what measured influence it.

Customer satisfaction with ERP solution

Customer satisfaction, together with system's usage is the most widely applied measure for the success of IS. The popularity is possibly helped by the existence of widely applied 39-piece instrument developed by the Bailey/Pearson, which supports comparison with other analyses by the fact that data is easy to use if it is expressed by the measuring unit which is comparable with other measures.

The successful 'cooperation' between management and information system can be measured in the terms of customer satisfaction. Several researchers have suggested customer satisfaction as a measure of success for their empirical researchers [4]. These researchers have discovered that the measures which include the customer satisfaction's category are very suitable in the case of specific informational systems. The key question is: whose satisfaction should be

measured here? The subject of manager's satisfaction is dealt by MIS effort, McKinsey and Company in their study of 1968. In 2 empirical studies on system's implementation success from 1981, Ginzberg chose the customer's satisfaction, as well as its dependable variables. In one of those studies, besides customer satisfaction, he also adopts measures which belong to the group "system's usage".

In the following table we can see the research listing on "customer satisfaction" subject:

Table 1. The researches on the customer satisfaction subject

Customer satisfaction analyzed measures or titles of research work	Researcher and year of research
General satisfaction	Alavi and Henderson 1981
Customer satisfaction	Baitey and Pearson 1983
Satisfaction with the user information	Baroudi, Olson and Ives1986
Satisfaction with the user information	Barti and Huff 1985
Customer satisfaction	Bruwe 1984
Top management satisfaction	DeSanctis 1986
Customer satisfaction	Doll and Ahmed 1985
Customer satisfaction	Edmundson and JefFery 1984
General satisfaction	Ginzberg 1981
Satisfaction with software Satisfaction with hardware	Lehman, Van Wetering and Vogel 1986
General satisfaction	Mahmood 1987
User satisfaction	Mahmood and Becker 1985-1986
Satisfaction with a developing project	McKeen 1983
Satisfaction with information, differences between needed and gained information	Olson and Ives 1983
Satisfaction with decisions	Sanders and Courtney 1985
Customer satisfaction	Taylor and Wang 1987

In previous researches, customer satisfaction represented an important measure in the works of DeLone-Mclean, [3] as well as in Gable and Co's work [6] and which permeates through all 4 defined perspectives in a model balanced scorecard approaches –BSC: financial, buyer's perspective, perspective of internal processes and perspective of innovations and studies.

Research (methods, techniques and instruments)

The research is conducted in companies in Bosnia and Herzegovina and Serbia. One of the research's aims is to paralelly compare the gained results for companies of different sizes, different categories and business domains, and the respondents are carefully chosen in order to satisfy this need. All questions (definitions) in a questionnaire are given by the Likert's scale from 1 to 5. Questions are chosen in order to satisfy the wider spectrum of measures classified by categories. The majority of questions are taken from the DeLone-McLean's study [3].

In order to prove the set model it was necessary to prove the relations between the set categories. In the same aim, the following analyses are used:

- Regression
- Correlation
- Pearson's test of linear correlation
- The multiple linear regression

The analysis is conducted in software SPSS in which the majority of analysis is processed. Also, along with this tool, Microsoft Excel 2007 has been used.

Presentation of research results

The research has included economic subjects which have implemented ERP systems. Economic organizations of different profiles took place in this research. 80 users of ERP system filled the questionnaire.

The structures of organizations which are the subject of this research are given in the following table:

Table 2. Structure of researched organisations

	Number	Percentage
Public company	7	8.8
production	30	37.5
sales	28	35.0
services	10	12.5
other	5	6.3
Total	80	100.0

When we talk about the size of organisation the results are the following:

Table 3. The size of organisation

	Number	Percentage
1. small company	13.8	13.8
2. medium company	35.0	35.0
3. large company	51.3	51.3
Total	100.0	100.0

The respondents come from different service sectors. In the following table and chart we can see the structure of respondents according to their service sectors:

Table 4. Structure of respondents according to their service sectors

	Number of respondents	Percentage
Finances and accounting	19	23.8
IT department	12	15.0
Sales	19	23.8
Buying/purchase	9	11.3
Marketing	6	7.5
Human resources	2	2.5
Production	3	3.8
General director	2	2.5
Other	8	10.0
Total	80	100.0

Also, it is significant when and **how many years ago ERP system has been implemented.** The research has shown the following results:

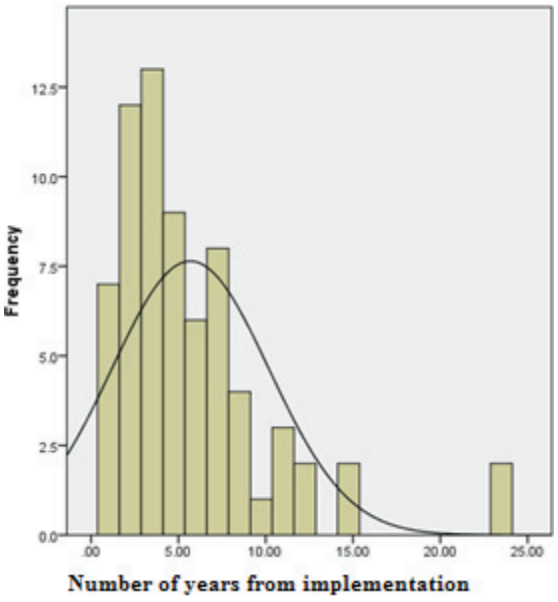

Figure 1. Number of years from ERP implementation

Descriptive statistics for measure "Customer satisfaction"

This category is covered with the following questions from the questionarre and whose statistics is shown in the following table. In the same table we can see medium marks as well as measures of deviations.

Table 5. Descriptive statistics for questions that characterize the category of customer satisfaction

	N	Min.	Max.	Medium value	Std. Deviation
Informational system increases individual's creativity	80	2	5	4.15	0.843
Informational system saves time for individual jobs and tasks	80	3	5	4.31	0.739
Informational system increases productivity of individual	80	2	5	4.41	0.774

Table 6. Statistic's descriptive summary

	N	Min.	Max.	Medium value	Std. Deviation
Average customer (user) satisfaction	80	2.67	5.00	4.2917	0.59623

The review of measuring scale's reliability – Customer satisfaction

One of the measures of scale's reliability which can be marked is its inner approval. That is a degree to which the values that make the measuring scale have the same corresponding attribute (that is to say: to which they are interconnected). The inner approval can be measured in many ways. The most commonly used is Cronbach's coefficent alpha, which can be calculated by SPSS as well.

That is an average correlation between all values on the scale. The amount of that indicator is of course between 0 and 1, by which the larger number (higher/larger correlation) shows bigger reliability.

Depending on the nature and purpose of the scale, different levels of reliability are demeanded, but Nunnaly (1978) does not recommend the reliability which is less than 0,7. Cronbach's coefficient alpha changes depending on the number of values on the scale. For the small number of values on the scale (less than 10), Cronbach's coefficient alpha is sometimes very small. In that case it is better to calculate and state in a report the medium value of correlation between each pair of values.

Optimal medium value/the average value of correlation between couples/pairs values amounts to between 0,2 and 0,4 (according to the recommendation stated in Briggs & Cheek, 1986).

Table 7. Statistics of measuring scale's reliability Customer satisfaction

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.729	0.728	3

Correlation of "customer satisfaction" measure with other measures

The relationship between two or more variables is analysed by regression and correlation. Correlation assumes (includes, implies) analysis of strength and direction of their coherence. Regression implies analysis of shape and direction of correlation and analysis in terms of independent/dependent (predictors/outcome) variables in the aim of prediction. In a regressive model, knowing the values of independent variables enables the prediction of dependent variable's values.

Different authors interpret correlation in different ways. We quote Cohen's interpretation which gives the following guidelines for the size of correlation:

- correlation is small if r is from 0,1 to 0,29
- correlation is medium if r is from 0,3 to 0,49
- correlation is large if r is over 0,5

The abovementioned guidelines are valid regardless whether there is a negative sign in front of r and which only shows a connection/link's direction.

Considering all limits derived from the choice and size of sample and the way the research is undertaken, it can be noted that the results are relevant and enough reliable for conclusion. The questions in a questionnaire are 'closed-limited' with an offered mark on the fifth-level Likert's scale with a preadvanced evaluation criterion.

Surveying the scheme of McLean/DeLone's model [3] we can see that the system's quality, information quality and quality of IT service influence this category. The correlation between these categories has been analysed and it has been attempted to confirm the strength of the connection, or see which category has the strongest influence on intention of system's usage on the basis of the results.

We shall now see the results of correlation between the mentioned items by using the Spearman's rank coefficient and Pearson's test of linear correlation.

Table 8. Influence on customer satisfaction – Pearsono's test

		Average customer satisfaction
Average evaluation of system's quality	Pearson Correlation	0.57*
	Sig. (2-tailed)	0.000
	N	80
Average evaluation of information quality	Pearson Correlation	0.593
	Sig. (2-tailed)	0.000
	N	80
Average evaluation of IT service	Pearson Correlation	0.604
	Sig. (2-tailed)	0.000
	N	80
Average intention of usage	Pearson Correlation	0.606
	Sig. (2-tailed)	0.000
	N	80

The results of Person's test show somehow smaller correlation of "system's quality", "quality of information" and "quality of IT services" with category "customer satisfaction" than with "intention of use", but still has a high correlation according to Cohen. The lowest correlation is realised between "system's quality" and "customer satisfaction", and highest with "intention of use" and "quality of IT services", but the differences in correlation are higher than smaller (rather than smaller). Also, the level of statistical significance (sig) shows the value under 0,01 that is to say that the level of confidence is extremely high. Scatter charts, given below, only show the strong correlation between the categories.

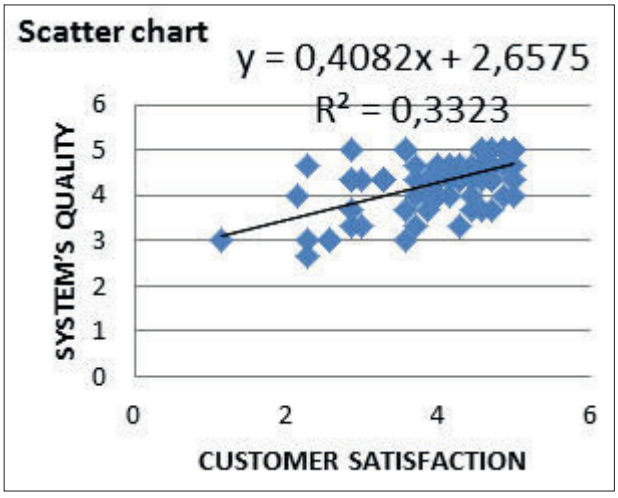

Figure 1. Scatter chart of system's quality – customer satisfaction

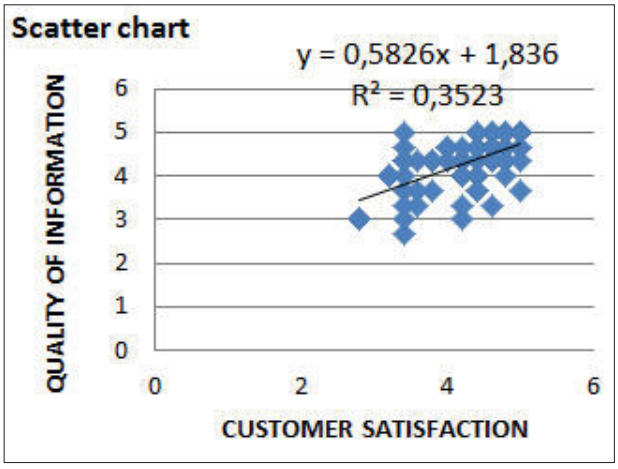

Figure 2. Scatter chart of quality of information-customer satisfaction

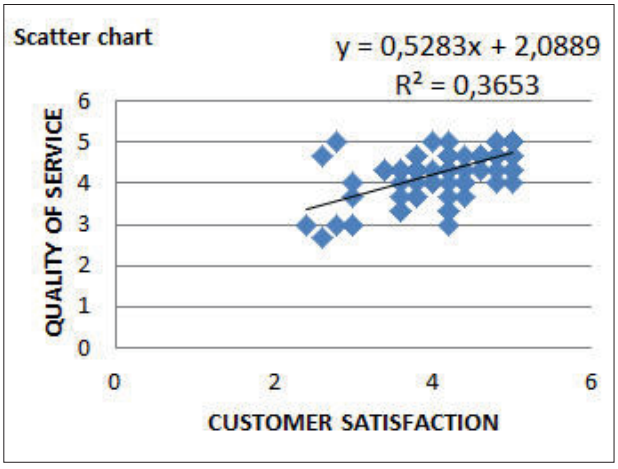

Figure 3. Scattering of IT quality – customer satisfaction

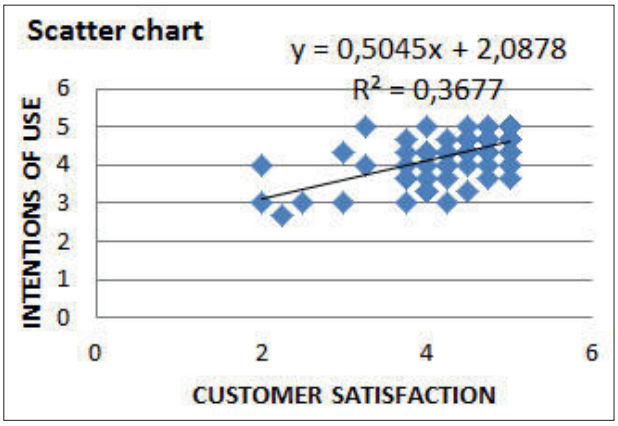

Figure 4. Scattering of intentions of use-customer satisfaction

By further analysis of using the multiple linear regression we want to make sure how well the set of categories can predict the evaluation of customer satisfaction with ERP system, as well as which variable in a set is the best predictor of the certain outcome.

Table 9. Summary dana of multiple regression – Customer satisfaction

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0.653[a]	0.427	0.396	0.46332	2.015

a. Predictors: (Constant), Average use intention, Average evaluation of IT service, Average evaluation of quality of information, Average evaluation of quality's system

b. Dependent Variable: Average customer satisfaction

The following table shows dependence of "customer satisfaction" category on other measures:

Table 10. Indicators of multiple linear regression for dependent variable Customer satisfaction

Model	Unstandardized Coefficients		Standardized Coefficients	Sig.	Correlations		
	B	Std. Error	Beta		Zero-order	Partial	Part
(Constant)	1.63	.397		.000			
Average evaluation of system's quality	.018	.127	.025	.890	.576	.016	.012
Average evaluation of quality of information	.192	.163	.196	.242	.593	.135	.103
Average evaluation of IT service	.240	.140	.275	.089	.604	.195	.150
Average intention of use	.178	.146	.214	.226	.606	.140	.107

The indicators of multiple regression show that the category "quality of IT service" has the biggest influence on customer satisfaction category.

On the basis of the previous analysis we can perform an equation of the multiple linear regressions if we can mark the following categories as such:

- average evaluation of system's quality –QSYS
- average evaluation of information quality – QINF
- average evaluation of quality of IT services – QIT
- average evaluation of intention of use – QNAM
- average evaluation of intention of use – QZADOV

then the equation will be:

$$QZADOV=0.025 * QSYS + 0.196* QINF+0.275 * QIT + 0,214*QNAM+1,63$$

If we look at the value of column Sig of the previous table for the stated independent variables we can conclude that variables (since their value amounts to sig<0.05) give a significant, unique contribution to the prediction of dependent variable.

If we see the results in Beta column, we can see individual contributions to the state of dependent variable "customer satisfaction". In this case independent variable "quality of IT service" has the biggest coefficient, which means that this category has the biggest individual influence on category "customer satisfaction". The category "system's quality" has the smallest contribution. That confirms the column part on the previous table. However, the column part shows the item's participation in the entire (total) determination (R2), or shows how much R2 would be if this independent variable is taken out of the model.

Conclusion

All previously said in this chapter proves and confirms the following:

- Increase of quality of information will have a positive influence on customer satisfaction in the context of ERP system.
- Increase of quality of service will have a positive influence on customer satisfaction in the context of ERP system.
- Increase of system's quality will have a positive influence on customer satisfaction in the context of ERP system
- Higher intention of use will have a positive influence on customer satisfaction in the context of ERP system.

Authorship statement

Author(s) confirms that the above named article is an original work, did not previously published or is currently under consideration for any other publication.

Conflicts of interest

We declare that we have no conflicts of interest.

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Full Text Search and Indexing in Languages With Two Alphabets

Tijana Talić

Paneuropean University APEIRON, Banja Luka, e-mail: tijana.t@apeiron-uni.eu

Case study

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Abstract: The languages spoken in Bosnia and Herzegovina use both Cyrillic and Latin equally. This is an additional problem with indexing and full text searching. In this paper, we are analyzing this problem. Using the tools available on PostgreSQL and ispell dictionaries, we made a solution. As part of the solutions, we created a dictionary of stop words, adjusted the affix file for both alphabets and from the list of words made functional vocabularies for indexing and searching. We made a full search configuration which is useful for indexing texts in both alphabets.

Key words: Semantic full-text search; Indexing; Artificial intelligence

With the rapid development of information technology there has been an exponential increase of the available data. To process and use such information, we need a new and faster way of using the data. One of the current problems is text searching, which apart from the speed requires a minimum disk space. This technology has emerged as a necessity due to the presence of a large number of digital documents we have.

Full text search provides the ability to identify the documents in natural, spoken languages, that satisfy the search condition, and also it sorts them according to the query criteria. The most common type of search is: finding all documents containing specified query terms and returning them in order of similarity to your inquiry. Query terms and similarities are very flexible and depend on the particular program. The simplest search observes the query as a set of words, and it observes the similarity as the word frequency listed in the document.

This technology has an increasing importance, especially in archiving overall achievements of a particular community, or of all humanity, whether they are in domain of art or scientific research and achievements.

Operators for text search in databases have existed for years. Operators "Like (~, ~ *)" and "iLike" for text data types, are available in most databases, but they lack many essential features required for modern information systems:

- There is no linguistic support, even for the English language. Regular expressions are not enough, because they cannot process derived words easily. It is possible to use OR in the search for more derived forms, but this is demanding and inaccurate (some words can have several thousand derivatives);
- There is no ranking (sorting) of search results, which makes them ineffective, especially when it has been found over thousands of documents that contain the searched terms;
- They are slow because there is no support for indexes and they must process each document at each time.

When we talk about full text search system a document is defined as a unit of searching whether it is in terms of a data base column or text file.

Full text searching in documents can be made directly, without prior processing, i.e. without index-

ing. In this mode, text search is performed by successive reading and comparison with query criteria. The main feature of this search method is that it is very slow. For any criteria change we reiterate the reading and search again.

Full text indexing allows documents to be preprocessed and obtained indexes to be saved for later quick search. In this way, practically we have a processed document located in an index base in which we perform only the final comparison. This avoids constant reinterpretation of the document. Document Processing for full text comparison and indexing includes:

- Parsing document to tokens. It is useful for identifying different classes of tokens, for example, numbers, words, compound words, e-mail addresses. Each of these categories is treated differently in the further search. In general, the category tokens depend on the application. The most modern databases have a predefined category. For example, PostgreSQL has a defined category of tokens for the majority of searches.
- Conversion of tokens into lexemes. Lexeme is a string just as a token, but it is normalized so that different forms of the same word are equal. For example, the normalization almost always involves the conversion of large to small letters, and often includes the removal of extensions. This allows search engines to find various forms of the same word, without boring entering all possible versions. Normalization regularly includes the elimination of so-called stop words. Stop words are those words that frequently occur in the document and whose search is pointless, such as auxiliary verbs, conjunctions ... For this purpose there are special programs called dictionaries.
- Indexing involves saving pre-processed documents optimally adapted to search. Each document is presented as an organized row of normalized lexemes. For the purpose of doing the ranking range it is desirable with the lexeme to save the data about the place of their occurrence. A document that contains part in which the term appears frequently is ranked higher than the one in which the term is scattered in the text. This technology significantly uses *ispell* and *stem* dictionaries, which are, unfortunately for the languages spoken here, generally arranged poorly.
- Comparison occurs to this group of normalized lexemes. Criteria queries are processed in the same manner and the words within it are also converted to lexemes, then the comparison is made. This is the way in which the adjustment of the natural spoken language research is made. For the realization of this process we use:

Parsers

Parsers are responsible for dividing the document to tokens and for the recognition of the tokens' type. The set of possible token types is defined by the parser itself. It should be noted that the parser does not modify the text, but only determines the acceptable word barrier.

Dictionaries

Dictionaries are used to normalize words and remove words that should not be taken into account during the search (stop words). Normalization does not always have linguistic meaning, and generally depends on the semantics of the application.

Dictionary is a program that accepts input symbols and it returns:

- • *string* of lexemes if the token is known to the dictionary (one token can produce more lexemes)
  • an empty string if the token is known to the dictionary but it is recognized as a stop word
  • NULL if the dictionary did not recognize the symbol

The stop words are words that are very common, occurring in almost every document, and they are irrelevant to the search. Thus, they can be ignored in the context of the full text search.

Simple Dictionary converts the uppercase letters of the input token to lowercase and checks it in the dictionary of stop words. If the token is found in the file then it returns an empty string, or token is rejected. If not, then the token converted to lowercase returns as lexeme. Dictionary can be configured

to report all regular words as unrecognized, allowing them to be passed to the next dictionary in the list.

Synonym Dictionary is used to create dictionaries that replace the word to its synonym.

Thesaurus is a collection of words that contains information about the relationship of words and phrases.

Basically thesaurus replaces all non-priority terms to prioritize one and optionally keeps the original terms for indexing. The current implementation of PostgreSQL vocabulary thesaurus is a dictionary of synonyms expansion by adding support for the phrases.

Template ***Ispell dictionaries*** supports morphological dictionaries, which can normalize the different linguistic forms of the word in the same lexeme. For example, English Ispell dictionary can match all declinations and conjugations of the search term bank, for example: Banking, banked, banks, banks' and bank's. ***Snowball dictionary*** template is based on the Martin Porter's project. He is the creator of the popular Porter stemming algorithm for English. Snowball now provides stemming algorithms for many languages. Each algorithm understands how to reduce common variations of word forms to its base or stem, using the language spelling. Snowball dictionary requires a language parameter to identify which stemmer to use, and if it is necessary it may indicate the term of the stop word file that provides a list of words that should be removed.

Configuration

Functionality, dictionary combining and adjusting the needs in the PostgreSQL, is done by configuration. Configuration determines how the search is performed, by which dictionaries and in what order. Dictionary can have multiple different configurations and depending on the application, we can define different types of configurations. For example, for search mathematical texts we can define a special dictionary.

In this paper, for the purpose of archiving systems, we consider making a full text search configuration in conditions of the use of languages with two alphabets out of English and Russian speaking areas. On the territory of Bosnia and Herzegovina, Cyrillic and Latin alphabet are used equally. We want to create a configuration that will perform the search on both alphabets. For this purpose, we use PostgreSQL. Its built-in full text search system is very flexible. It allows the definition of the user dictionaries and making configuration of the text search by the combination of these dictionaries.

Parser RDBMS satisfies our needs.

The basis of every search is right dictionary. An indispensable element of every dictionary is a dictionary of stop words. In our case, this dictionary had to be made from the scratch, because in the available resources we have not found anything. Using grammar, spelling of the language and the method of text analysis in the spoken language, we defined a dictionary of stop words for general purposes. It looks like this:

a	ja	mojem	oni	ste
ako	je	mom	ono	su
ali	jer	na	onom	t
bi	jeste	nama	ova	ta
bismo	ji	naše	ovaj	taj
biste	k	ne	ove	tako
biti	ka	ni	ovi	te
će	kad	niti	ovim	tebi
ćemo	kako	njega	ovo	ti
ćeš	kao	njemu	ovom	to
ćete	kod	njihov	pa	tom
ću	koja	njihovi	po	u
da	koje	njihovom	pri	uz
do	koji	njima	s	vam
g	kojima	njoj	sa	vama
ga	koliko	o	sam	vaše
i	kom	od	se	vi
ih	kome	on	še	za
ili	li	ona	si	
iz	mi	one	smo	

Table 1. Stop words dictionary

For the forming of the configuration, we use ISPEEL configuration template. For the *affix* file, we exploit a file that is for the Croatian language made by Denis Lackovic [2]. List of words we took from the available *ispell* and *myspell* sources. We made two dictionaries, one for Latin and the other for Cyrillic. The basis of the Cy-

rillic *affix* file is taken from the previously mentioned file by Denis Lackovic.

Then, we process the list of words with this command:

```
munchlist -l ./bsh.affix bsh-list.dict > bsh.dict
munchlist -l ./bsh_c.affix bsh-list_c.dict > bsh_c.dict
```

In this way we get two configuration files for the vocabulary. We played with a thesaurus. For example, often in search, if we search for "bijelo", we want to find also "belo". Sometimes in the search for specific purposes we want to index some of the words equally in the Cyrillic and Latin text. For verifying, we made a dictionary of synonyms:

carina	carina
carinski	Carinski
carinske	Carinske
zakon	Zakon
pravilnik	Pravilnik
procedure	Procedure
postgresql	Pgsql
postgres	Pgsql
belo	Bijelo
mleko	mlijeko

Table 2. Synonym dictionary

Note that we only use dictionary for verifying functionality and there is no linguistic meaning.

Now we will create configurations of dictionaries:

```
CREATE TEXT SEARCH DICTIONARY bsh (
      TEMPLATE = ispell,
      dictfile = 'bsh', stopwords = 'bsh',
afffile = 'bsh');
CREATE TEXT SEARCH DICTIONARY bsh_c (
      TEMPLATE = ispell,
      dictfile = 'bsh_c', stopwords =
'bsh_c', afffile = 'bsh_c');
CREATE TEXT SEARCH DICTIONARY bsh_syn (
      TEMPLATE = synonym,
      synonyms = 'bsh');
```

We created configurations of dictionaries for two imaginary languages and a thesaurus. Now, we can configure full-text search.

```
CREATE TEXT SEARCH CONFIGURATION bsh (
PARSER = "default");
ALTER TEXT SEARCH CONFIGURATION bsh ADD MAP-
PING FOR asciihword WITH bsh_syn,bsh,bsh_c;
ALTER TEXT SEARCH CONFIGURATION bsh ADD MAP-
PING FOR asciiword WITH bsh_syn,bsh,bsh_c;
ALTER TEXT SEARCH CONFIGURATION bsh ADD
MAPPING FOR email WITH simple;
ALTER TEXT SEARCH CONFIGURATION bsh ADD
MAPPING FOR file WITH simple;
ALTER TEXT SEARCH CONFIGURATION bsh ADD
MAPPING FOR float WITH simple;
ALTER TEXT SEARCH CONFIGURATION bsh ADD
MAPPING FOR host WITH simple;
ALTER TEXT SEARCH CONFIGURATION bsh ADD
MAPPING FOR hword WITH bsh_syn,bsh,bsh_c;
ALTER TEXT SEARCH CONFIGURATION bsh ADD
MAPPING FOR hword_asciipart WITH bsh_
syn,bsh,bsh_c;
ALTER TEXT SEARCH CONFIGURATION bsh ADD
MAPPING FOR hword_numpart WITH simple;
ALTER TEXT SEARCH CONFIGURATION bsh ADD MAP-
PING FOR hword_part WITH bsh_syn,bsh,bsh_c;
ALTER TEXT SEARCH CONFIGURATION bsh ADD
MAPPING FOR int WITH simple;
ALTER TEXT SEARCH CONFIGURATION bsh ADD
MAPPING FOR numhword WITH simple;
ALTER TEXT SEARCH CONFIGURATION bsh ADD
MAPPING FOR numword WITH simple;
ALTER TEXT SEARCH CONFIGURATION bsh ADD
MAPPING FOR sfloat WITH simple;
ALTER TEXT SEARCH CONFIGURATION bsh ADD
MAPPING FOR uint WITH simple;
ALTER TEXT SEARCH CONFIGURATION bsh ADD
MAPPING FOR url WITH simple;
ALTER TEXT SEARCH CONFIGURATION bsh ADD
MAPPING FOR url_path WITH simple;
ALTER TEXT SEARCH CONFIGURATION bsh ADD
MAPPING FOR version WITH simple;
ALTER TEXT SEARCH CONFIGURATION bsh ADD
MAPPING FOR word WITH bsh_syn,bsh,bsh_c;
```

Above we configured all types of tokens, although for our purposes it would be useful to exclude some types of tokens.

Let us look at the result of this configuration in the example of the noun "izvor" and its cases:

```
SELECT * FROM to_tsvector('izvor izvora
izvoru izvore izvorom');
```

```
          to_tsvector
---------------------------------
 'izvor':1,2,3,4 'izvori':2,3,4,5

SELECT * FROM to_tsvector('izvor izvora
izvoru izvore izvorom');
          to_tsvector
---------------------------------
 'izvor':1,2,3,4 'izvori':2,3,4,5
```

We can see that cases of the word "izvor" give as a result two lexemes: nominative of singular and nominative of plural, indicating that this dictionary works as expected.
Let us look at how our dictionary processes query condition:

```
SELECT * FROM to_tsquery('bsh', 'izvor &
izvoria');
          to_tsquery
---------------------------------
"'izvor' & 'izvorima'"
```

It is as we expected.
Now if we perform the comparison we got:

```
SELECT to_tsvector('bsh' , 'izvor izvora
izvoru izvore') @@ to_tsquery('bsh' , 'iz-
vor');
     ?column?
----------
```

From this, we can see that our configuration successfully handles with language, when is concerned more derivative of the same word. In this case, it successfully identifies the different word cases of the same word. Further, by detailed analysis, we determined that we should continue to work on developing *affix* configuration file, which is essential for machine recognition of linguistic features of spoken language.

CONCLUSION

In this paper, using the tools available in the RDBMS PostgreSQL and *ispell* system we made a configuration: such that each text is indexed in the alphabet by which was actually written.

If we would like to index all text in one alphabet, we had to work on the construction of custom parsers that in determining of the token perform transliteration. The process of transliteration is slow and tedious. The configuration that we composed in this paper, has the best use if we make application for searching that forward two queries. We transliterate the original query from one alphabet to another and forward to compare both queries. We merge the obtain result and display to the user. With this, we satisfied determined conditions for ensuring the preservation of the language purity. At the same time, the application provides an efficient search despite the alphabet of the language. The text indexes remain consistent with the original texts and enable an access to the index through another application in a different way.

Authorship statement
Author(s) confirms that the above named article is an original work, did not previously published or is currently under consideration for any other publication.

Conflicts of interest
We declare that we have no conflicts of interest.

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