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MULTIVARIATE MODELS FOR FORECASTING DEMAND IN AMBULANCE SERVICES

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Abstract: *A highly complicating, but challenging factor that influences demand of health care services is randomness. Thus, the traditional planning techniques, which assume that the demand of ambulances is known upfront, are not applicable to this scientific problem. It is necessary to take into account demand variations over time and to implement them into forecasting models. In this paper original data are collected from local ambulance service in Subotica. Complex data analyses on the number of ambulance requests per day are performed in order to identify certain correlations and seasonal patterns based on the day of the week and the month of the year. In the next step multiple regression models are applied to obtain the forecast of demand. By checking goodness of fit to our data and accuracy of their short term forecasts, the models have been compared. Also practical relevance and usage of those models is discussed.*

Keywords: *forecasting, multivariate time-series models, multiple linear regression, health care management, modeling emergency medical services*

1. INTRODUCTION

In life-threatening situations where every second is important, an effective response of ambulance services can make difference between life and death. Thus, managing operations of ambulance services and other health care organizations is a question of extraordinary social relevance. Nowadays, health care systems are facing extreme pressures to obtain a desired service level in spite of the rapidly changing environment, scarce resources and financial challenges. Effective resource allocation is both a consequence and a solution for overcoming these challenges. Moreover, today's health-care systems are characterized by multiple objectives, multiple evaluation criteria, and multiple decision-makers within the system, while resources and budget are extremely limited. Managing scarce resources on the best possible way is the main task of operations research, since it focuses on the application of analytical methods to facilitate better decision-making. Application of operations research techniques can surely be very valuable for managing health care organizations, in order to achieve their objectives and obtain desired service level. The World Health Organization report stated that, “One of the most important roles of the World Health Organization is to assist countries in making optimum use of scarce health resources.” This is also a role for operations researchers. These public safety systems have received a great deal of attention in the operations research community, since they provide important services and the problems are amenable to mathematical modelling and solution.

Operations Research or Management Science exists as a scientific discipline since the 1930’s and the first papers dealing with the health care problems date from 1950’s. Despite the proliferation of papers in the academic literature, there are still major issues around getting quantitative models widely accepted and used as part of mainstream decision-making by clinicians, health managers and policy makers. Some possible reasons for this include (Teow K.L., 2009):

- Low levels of managerial/mathematical background in the health care sector
- Scientific papers are often written for operations research professionals, focusing on specialised and technical topics, and not reaching healthcare professionals
- Lack of process-related data for modeling
- Lack of in-house operations research expertise
- High cost of engaging external operations research consultants

The main goal of this paper is to present advantages that can be obtained by using quantitative models to aid decision making in health care sector, specially addressing demand forecast in ambulance service.
Most cities in the developed world have organizations that provide pre-hospital care and transport to medical facility. Demand for such services is increasing and the same trend is expected in the future. On the other side, due to global economic crisis and serious financial difficulties in most of the countries budgets became even more limited and reduced. Tighter budgets make efficient use of resources extremely important.

Goldberg (Goldberg J.B., 2004) mentions that “ability to predict demand is of paramount importance”, but this area has seen little systematic study. A highly complicating but challenging factor that influences the demand of ambulance services is randomness. Call arrival patterns tend to be highly time and location dependent. Also the availability of ambulance vehicles and personnel is random due to uncertainty in their occupancy times. Mostly, demand forecast for ambulance services can be divided into two categories, first dealing with spatial distribution of demand and second that investigates how demand evolves over time. In this paper we will examine if there are some patterns and regularities that explain variations of demand for ambulance services over time.

2. DISPATCHING PROCESS AND PRELIMINARY DATA ANALYSIS

In this paper we will investigate the data provided to us by Ambulance Service in Subotica, city of Vojvodina province, Serbia. Demand for emergency medical services (EMS) is presented as daily number of calls that arrived to the ambulance station. The data set which we use in this research provides us information about the daily number of EMS calls for three years period, from February 15th 2009 until February 15th 2012. We will use the data from February 15th 2009 to January 21st 2012 to estimate multiple regression models. The rest of the data will be used as a test set to validate models and forecasts. The analyses are carried out by Statistica and EViews software packages.
The preliminary data analysis is done to explore if the data of the number of ambulance requests show correlations and typical yearly and weekly arrival patterns. During three years period approximately 30 calls per day were dispatched. Figure 1 shows number of daily ambulance rides throughout our data set, so we can conclude that there is no clear trend visible over time. On 1st of January and 1st of May there are visible peaks, so larger number of emergency calls can be expected on these holidays. Figure 2 shows that the busiest months are May and March, and the less frequent months are September, June and August. On the figure 3 we can see that the largest amount of calls arrives on weekends and on Monday and the middle of the week is less frequent period.

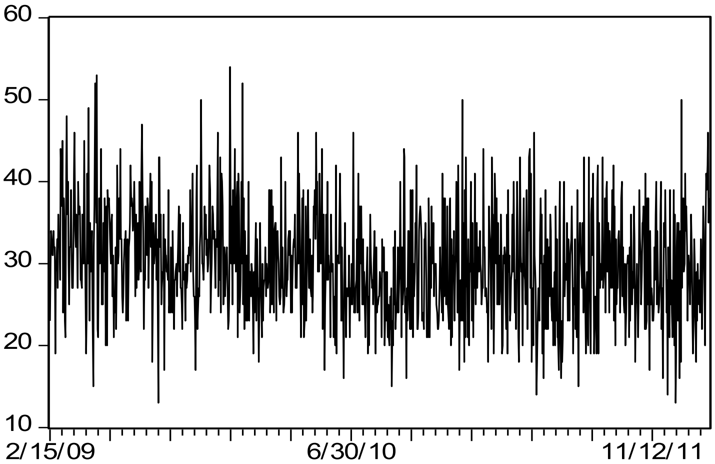

Figure 1: Number of daily ambulance rides

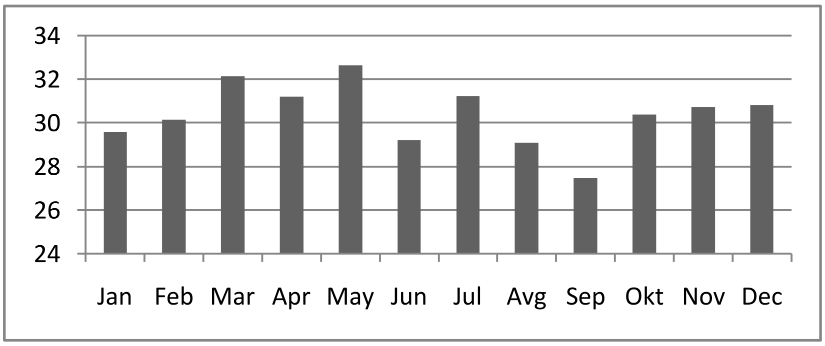

Figure 2: Mean number of ambulance rides per day, for each month of the year

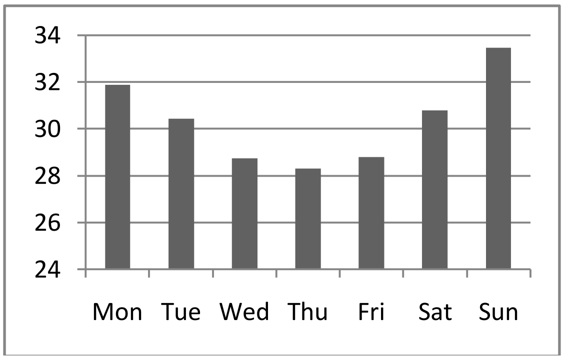

Figure 3: Mean number of ambulance rides per day, for each day of the week

3. TEST FOR CORRELATION OF THE DAILY NUMBER OF AMBULANCE CALLS

Figure 1 indicates that on a number of days a large number of rides occurred. To make a good analysis of the data first we need to determine the outliers and to omit them from further analysis. We define a data point as an outlier when its value is lower than the first quantile minus 1.5 times the interquantile range, or when its value is higher than the third quantile plus 1.5 times the interquantile range. In our dataset we identified eight outliers and they are omitted from analysis for correlation.

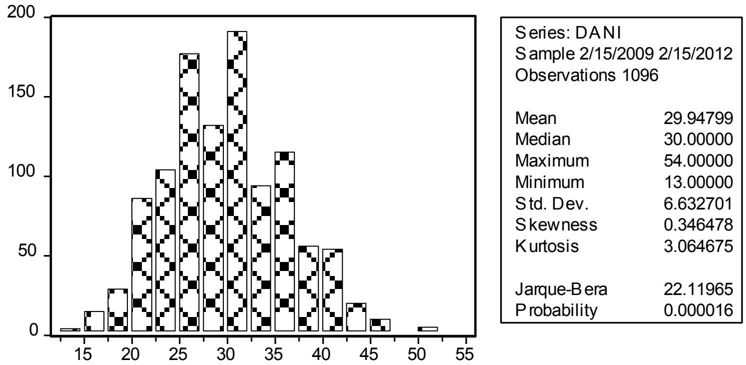

Figure 4: Histogram and basic statistics for number of ambulance rides per day

By looking for extreme values, yearly and weekly patterns we are able to categorize the number of daily calls by their distinct behaviour. Based on the value of Jarque Bera test of normality, that incorporates both skew and kurtosis, we reject the null hypothesis that the distribution is normal. Spearman's rho statistic is used to estimate a rank-based measure of association between bivariate data. This test is non-parametric and can be used if the data does not necessarily come from a normal distribution (Diebold F.X., 2004). The Spearman's rho statistic is based on the coefficient of correlation of the two groups of rank numbers x_i and y_i. For a sample of size *n,* the n raw scores X_i, Y_i are converted to ranks x_i and y_i, and ρ is computed from these:

$$\rho = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2 \sum_i (y_i - \bar{y})^2}} \tag{1}$$

After performing tests based on Spearman's rho we can conclude that the number of ambulance rides per day is positively correlated with the number of ambulance rides on a previous day ($p < 0{,}05$). The number ambulance rides per day is also positively correlated to the number of rides two days earlier and seven days earlier, both with $p < 0{,}01$.

4. MULTIPLE REGRESSION MODELS

Our preliminary analysis confirms the presence of the month of year and day of week effects, so we can use multiple regression to model behavior of number of ambulance rides per day. We have multiple explanatory variables, month of the year and day of the week, which we model in a linear manner. The multiple regression model, which we will use to forecast the daily demand of EMS is

$$Y_t = a + \sum_{i=1}^{12} b_i B_{i,t} + \sum_{j=1}^{7} c_j C_{j,t} + u_t \tag{3}$$

where Y_t is the t-th observation of the number of daily rides, indicator $B_{i,t}$ has value 1 if the month of day t is the i-th month of the year and value 0 otherwise, and the indicator $C_{j,t}$ has value 1 if day t is the j-th day of the week and 0 otherwise. Parameters of the regression model are b_i, c_j and u_t is the error term. The application of the regression model demands that residuals are i.i.d. Gaussian distributed. Estimates of the parameters are obtained by using least square method to minimize the sum of squares of the residuals. To avoid the problem of multicollinearity it is necessary to set the linear constraints on parameters as following:

$$\sum_{i=1}^{12} b_i = 0, \quad \sum_{j=1}^{7} c_j = 0 \qquad (4)$$

Estimated multiple regression model for daily number of EMS calls is:

$$Y_t = 29{,}79 + 2.060C_{1,t} - 0{,}403C_{2,t} - 1{,}852C_{3,t} - 1{,}808C_{4,t} - 1{,}252C_{5,t} + 0{,}336C_{6,t} + 2{,}918C_{7,t} - 1{,}026B_{1,t} + 0{,}937B_{2,t} + 1{,}136B_{3,t} + 1{,}225B_{4,t} + 0{,}476B_{5,t} - 1{,}191B_{6,t} + 0{,}440B_{7,t} - 0{,}181B_{8,t} - 1{,}539B_{9,t} - 0{,}127B_{10,t} + 0{,}190B_{11,t} - 0{,}341B_{12,t} + u_t \qquad (5)$$

In this multiple regression model significant factors for the parameters month of the year and day of the week, ($p< 0{,}05$) are April, June, September, Tuesday, Wednesday, Thursday, Saturday and Sunday. Based on the results shown in the table 1, the largest amount of EMS demand can be expected in April, especially during the weekend.

Table 1: Significant parameters of multiple regression model

Parameter:	*a*	*b4*	b_6	b_9	
	Constant	April	June	September	
Coefficient:	29.79027	1.224539	-1.19056	-1.53877	
Parameter:	c_2	c_3	c_4	c_6	c_7
	Tuesday	Wednesday	Thursday	Saturday	Sunday
Coefficient:	-1.851524	-1.80774	-1.25211	2.918253	2.059951

To obtain relevant and adequate forecasting model it is necessary to examine the presence of autocorrelation of residuals. We applied the Ljung-Box test to the residuals after fitting the regression model to our data. The p-values are plotted in the next figure and since some p-values are smaller than 0,05 presence of autocorrelation of residuals can be identified. Hence, we need to improve the examined multiple regression model in order to exclude residuals' autocorrelation. It has been achieved by fitting an autoregressive (AR) model of order p to the residuals u_t.

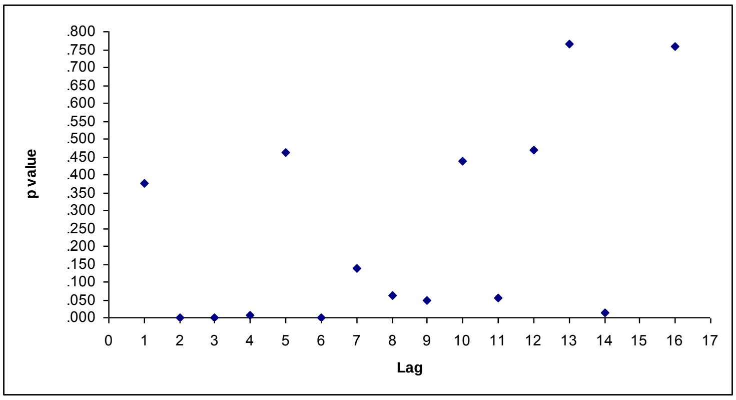

Figure 5: p-values of the Ljung-Box test applied to the residuals for the regression model with factors day of the week, month of the year

The improved multiple regression model for daily number of EMS demand becomes:

$$Y_t = a + \sum_{i=1}^{12} b_i B_{i,t} + \sum_{j=1}^{7} c_j C_{j,t} + \alpha_1 u_{t-1} + \ldots + \alpha_p u_{t-p} + e_t \qquad (6)$$

where e_t is i.i.d. normal distributed. In the previous section we tested for correlation between the number of rides per day and the number of rides seven days earlier. The outcome was significant hence we will take *p* equal to 7, the parameters α, which appear to be insignificant to the model will be omitted later on. The estimated improved multiple regression model with all parameters is presented by the following equation:

$$Y_t = 29{,}681 + 2{,}160C_{1,t} - 0{,}499C_{2,t} - 1{,}904C_{3,t} - 1{,}848C_{4,t} - 1{,}128C_{5,t} + 0{,}181C_{6,t} + 3{,}037C_{7,t} - 1{,}511B_{1,t} + 1{,}202B_{2,t} + 1{,}155B_{3,t} + 1{,}309B_{4,t} + 0{,}332B_{5,t} - 0{,}944B_{6,t} + 0{,}438B_{7,t} - 0{,}028B_{8,t} - 1{,}479B_{9,t} - 0{,}149B_{10,t} + 0{,}281B_{11,t} - 0{,}608B_{12,t} + 0{,}009e_{t-1} + 0{,}055e_{t-2} + 0{,}051e_{t-3} + 0{,}028e_{t-4} + 0{,}090e_{t-5} + 0{,}048e_{t-6} + 0{,}023e_{t-7} + u_t \qquad (7)$$

The estimated improved multiple regression model with significant parameters only ($p<0{,}05$) is presented by the following equation:

$$Y_t = 29{,}681 + 2{,}160C_{1,t\,t} - 1{,}904C_{3,t} - 1{,}848C_{4,t} - 1{,}128C_{5,t} + 3{,}037C_{7,t} + 1{,}309B_{4,t} - 1{,}479B_{9,t} + 0{,}090e_{t-5} + u_t$$

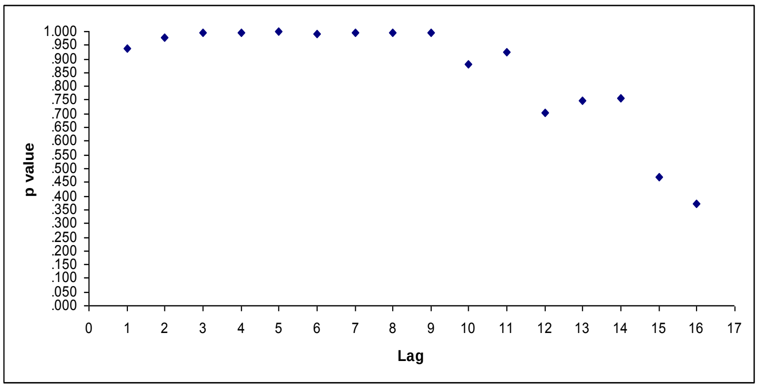

Figure 6: p-values of the Ljung-Box test applied to the residuals for the improved regression model with factors day of the week, month of the year

5. FORECASTING

In order to obtain adequate short-term forecast for daily number of ambulance rides we will discuss two regression models. First, we will use the improved multiple regression model with all introduced parameters (7) and secondly the model with only significant parameters (8). To decide which of the models is the most accurate to forecast the ambulance calls per day we look at forecasts generated by our models and compare them to our test set. Extrapolation will be done to generate forecast for the next 14 days.
There are different ways to measure the exactness of a forecast. In this research we will use three indicators: Root Mean Square Error (RMSE), Mean Absolute Error (MAE) and Mean Absolute Percentage Error (MAPE).

$$\text{RMSE} = \sqrt{\frac{1}{S}\sum_{s=1}^{S}(Y_{t+s} - P_{t,s})^2} \tag{9}$$

$$\text{MAE} = \frac{1}{S}\sum_{s=1}^{S}\left|Y_{t+s} - P_{t,s}\right| \tag{10}$$

$$\text{MAPE}=\frac{1}{S}\sum_{s=1}^{S}\left|\frac{Y_{t+s}-P_{t,s}}{Y_{t+s}}\right| \cdot 100\% \tag{11}$$

Those indicators examine the exactness of a forecast by calculating the forecast error, as the difference between original value Y_{t+s} in the test set S (s= 1,2 ..., S) and forecast value $P_{t,s}$ at day s. The smaller values of indicators suggest the better quality of forecast. The next table presents the values of RMSE, MAE and MAPE for both multiple regression models, for estimation period (February 15th 2009 to January 21st 2012) and for the test period (January 21st 2012 to February 15th 2012).

Table 2: Values of RMSE, MAE and MAPE for Multiple Regression Models

	Estimation period			Interpolation (test period)		
	RMSE	MAE	MAPE (%)	RMSE	MAE	MAPE (%)
Improved Multiple Regression Model	6,268113	2,541237	0,17875	4,211435	2,102894	0,19779
Improved Multiple Regression Model (significant parameters only)	6,54172	2,64712	0,18021	4,05712	2,185642	0,199785

By comparing the RMSE. MAE and MAPE values for regression models, we can conclude that the multiple regression model with all parameters generate the better forecast than the model with only significant parameters.

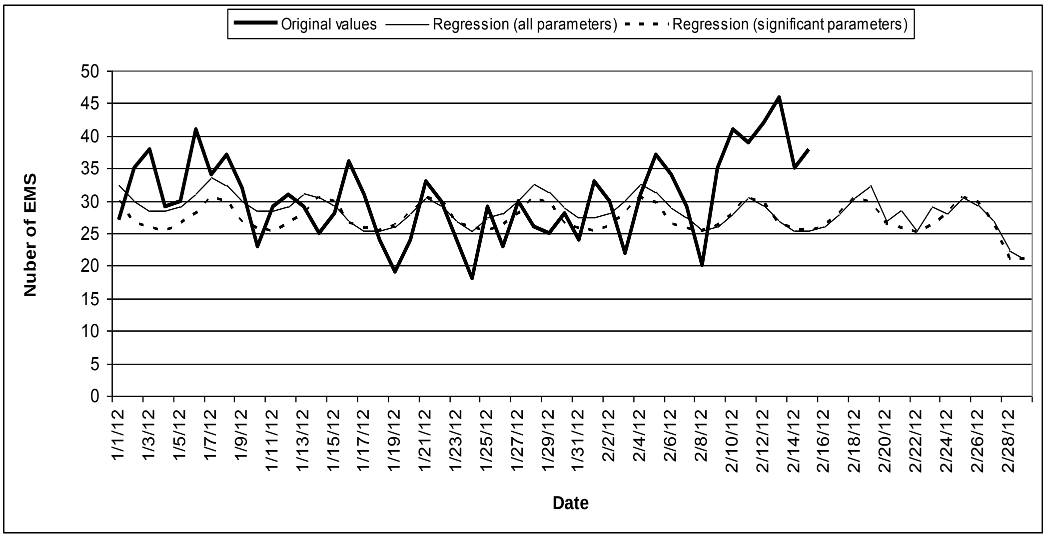

Figure 7: Original data and forecasts obtained by multiple regression models

6. CONCLUSION

Modelling the practical issues in field of health care management is a great challenge, both for health care specialists and managers. Implementation of obtained results provides the valuable basis for decision making process and leads to efficiency improvement, which is one of the most important goals for health care system.

This paper showed that the number of ambulance rides per day follows some patterns, which depend on the month of the year and the day of the week. These regularities can be of great importance for decision makers, when they determine the staff level or the necessary number of vehicles. Multiple regression models that take into account influence of the day of the week and the month of the year were used to forecast the daily number of ambulance services. In further research different forecasting models will also be examined in order to find even better way for predicting future number of daily ambulance rides.

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COMPARATIVE REVIEW OF ICT DEVELOPMENT IN THE FIELD OF HEALTH CARE SYSTEM IN SLOVENIA AND SERBIA

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Abstract: *Strategy of each country is care and maintenance of a healthy population. Information and communication technologies in the health care system have led to many changes. Their introduction has improved the quality of health care services to patients, rational spending time and reduce costs. This paper presents a parallel review of the development and implementation of e-health system in Slovenia and Serbia. Slovenia is a very good example of a successful development of information and communication technologies in healthcare system. Slovenia was one of the first countries to introduce health insurance chip cards and IT solutions are widely used in healthcare. In Slovenia, there is a project called eZdravje. eZdravje project consists of five modules. These are: A National Health telecoms network, e-Health portal, electronic health record, an Organizational module featuring the creation of the National Centre for e-Health, and a Training and Skills Development module. The implementation of electronic services in the health system of Serbia will be concluded in 2015. At this point, the implementation phase of hospital information systems is taking place. Introduction to hospital information systems and training is done by the team prepared for educating hospital staff and configuring and customizing the hospital information systems for the needs of the hospital.*

Keywords: *e-health, hospital information systems, Serbia, Slovenia*

1. INTRODUCTION

A state health care system is one of its most complex. Due to the importance and impact upon the status of health of its population and stemming from the relevant economic influence thereof, the state implements a large number of measures in health care system planning and management in order to ensure steady financing and a rational, high quality health care system, as well as to ensure basic health protection to all of its citizens within its available resources (Jovanovic Milenkovic, 2011, Frenk, 2010, Vujin, Jovanovic Milenkovic, 2012).

It should be noted that one of the major problems in health care and modern medicine in general, is the collection, handling, processing and use of data collected on a daily basis in large quantities and in the form of extensive documentation within medical institutions. Persons in their lives visit various medical facilities that are, by their geographical position, very often distributed. Therefore, sources of medical data generation are also distributed. Data can be also generated in the field (in temporary clinics or during home visits) which presents an additional factor of physical distribution (Jovanovic Milenkovic, Radojicic, Milenkovic, Vukmirovic, 2009).

Information and Communication Technologies (ICT) offer great opportunities and have an overall impact on national economies and global competition in the health care system. There are many papers that emphasize the importance of ICT through the inclusion of Internet users and IT literacy as indicators of socio-economic development (Jeremic, Markovic, Radojicic 2011, Jeremic, Vukmirovic, Radojicic, Djokovic (2011). ICT have the potential to be used in order to help citizens and health professionals for safer, better, more rational and better integrated health care. ICT is a mean to achieve the strategic goals of the health care system, i.e. (Jovanovic Milenkovic, 2011):

- Developing and improving management in all aspects of the system, by making decisions based on evidence from health professionals, consumers.
- Creating conditions for sustainable financing of health care system.
- Measuring critical dimensions of the health care system, such as accessibility, parity, quality and efficiency.

Ten years of experience in the medical application of information technology in health care in developed countries has shown high economic and medical reasons for investing in this area (Al-Lagilli, Jeremic, Seke, Jeremic, Radojicic, 2011). The relative costs of investing in medical informatics today are very low compared to other costs in health care, and the effects of proper use are greater savings through rationalization of costs and the possibility for better planning and management in all aspects of the system. These effects are based on information generated and shared between the segments of the system, which allows for making better decisions and plans based on quality and updated information about the needs and the state of resources (Hillestad, Richard et al. 2008, Blaya, Fraser, Holt, 2010).

2. RANKING OF EUROPEAN HEALTH CARE SYSTEMS BY EHCI 2013 INDEX

Today, health systems in all countries play a bigger and more influential role in people's lives than ever before. Health systems of some sort have existed for as long as people have tried to protect their health and treat diseases (World Health Organization, 2000). The Euro Health Consumer Index (EHCI) 2013 is the seventh study made on European health care systems. The Index takes a consumer and patient perspective. This ranking takes into account six sub-disciplines:

- Sub-discipline 1 - Patient rights, information and e-health;
- Sub-discipline 2 - Accessibility (waiting times);
- Sub-discipline 3 - Outcomes;
- Sub-discipline 4 - Range and Reach of services provided;
- Sub-discipline 5 - Prevention;
- Sub-discipline 6 - Pharmaceuticals.

Index for year 2013 already includes all 28 European Union (EU) member states, Albania, Iceland, FYR Macedonia, Norway, Switzerland and Serbia (Björnberg, 2013). According to the survey, Slovenia is located at 18th position and Serbia occupies the last place on the list. Of the possible 1,000 points, the Serbian health system received 451 points (Figure 1.). The graph shows that the Netherlands is in the first position with 870 points.

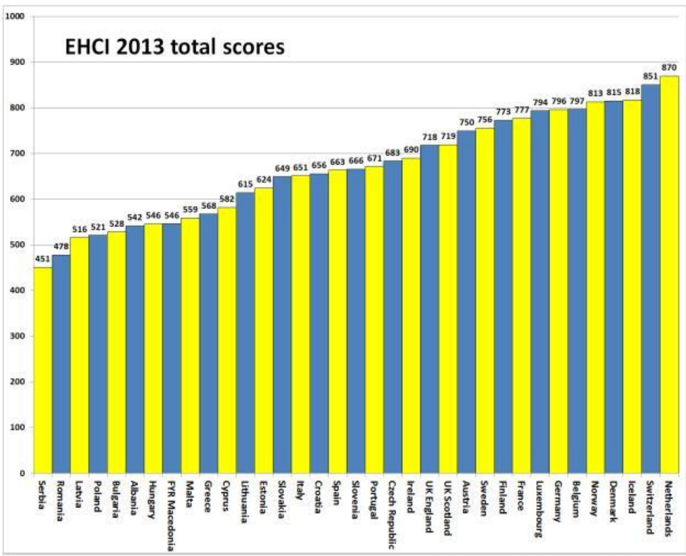

Figure 1: Ranking of European health care systems by EHCI 2013 Index (Björnberg, 2013)

Slovenia and Serbia are two countries which until 1991 constituted the former Yugoslavia. Due to this fact, the paper will provide a parallel review of the health systems in these countries. Considering the sub-discipline e-health included in the study EHCI 2013, the paper will review the development of e-health in Slovenia and Serbia.

2.1. DEVELOPMENT OF E-HEALTH IN SLOVENIA

Slovenia was the first of the former Yugoslav republics that became a member of EU, in 2004.

Slovenia is advanced in the area of social determinants of health (SDH)/health inequalities (HI), and yet there is need for a national framework which will clearly establish coordinated objectives and priorities for different sectors at the national and local levels, and enable the measurement of the effect of various policies on health (WHO Regional Office for Europe, 2014, Prijatelj V., Rajkovič, U., 2009).

Table 1. shows the basic statistical data related to the population of Slovenia and their life expectancy.

Table 1: The basic statistical data related to the population of Slovenia and Serbia and their life expectancy (WHO, 2014)

	Slovenia	Serbia
Total population (2012)	2,068,000	9,553,000
Gross national income per capita (PPP international $, 2012)	27,240	11,430
Life expectancy at birth m/f (years, 2011)	77/83	72/77
Probability of dying under five (per 1 000 live births, 2012)	3	7
Probability of dying between 15 and 60 years m/f (per 1 000 population, 2011)	118/51	175/86
Total expenditure on health per capita (Intl $, 2011)	2,519	1,195
Total expenditure on health as % of GDP (2011)	9.1	10.4

In terms of infrastructure 97% of Slovenian doctors use computers. 82% of practices have Internet connection. When it comes to the use of e-Health applications, 86% of Slovenian doctors use electronic patient data (European Commission, 2010).

Slovenia was one of the first countries to introduce health insurance chip cards and health care professionals are avid users of health ICT solutions. The missing piece was infrastructure to connect local systems allowing exchange of information to facilitate care coordination (Marand, 2014).

The objectives that the Slovene national project aims to meet are the following (EUREGIO III Case study - National e-Health Project, 2011):

- Offer to all health care providers, specialists, general practicioners, pharmacists unified, secure and reliable access to all key patient information via a standardized Electronic Health Record (EHR) and other data sets;
- Facilitate better planning and management of the national health care system on the basis of good quality, accurate administrative, clinical, and economic data; improve access to all necessary information and the ability of citizens to participate in the development of quality health care services;
- Promote an active role and responsibility of citizens for their health and health care services;
- Improve access to health care for persons excluded due to disability, age or other reasons.

In Slovenia, there is a governmental project called eZdravje. It was initially designed to comprise five project modules (Figure 2.). These are:

- Three system delivery modules of

(a) A national health telecoms network - *zNET*,
(b) E-Health portal - *zVEM* and
(c) EHR dataset, components of the national electronic Health Information System (eHIS),

- An organizational module featuring the creation of the National Centre for e-Health, and
- A Training and Skills Development module.

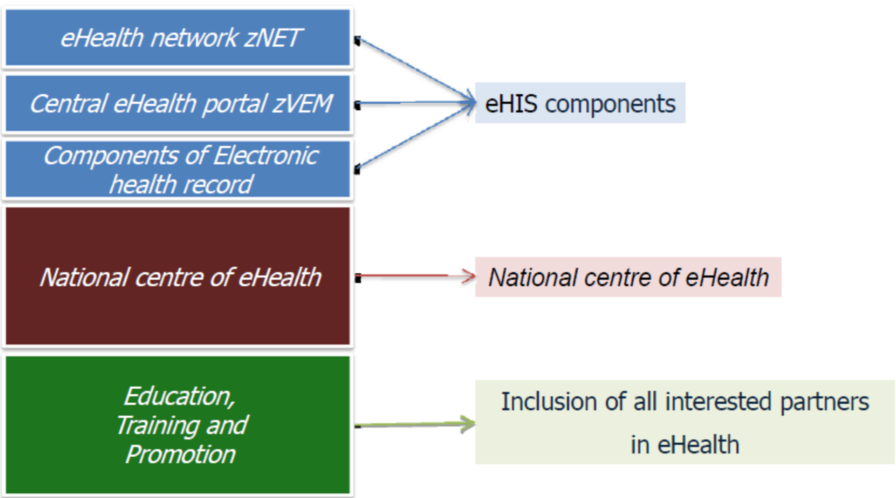

Figure 2: Project *eZdravje* and five project modules (EUREGIO III Case study - National e-Health Project, 2011)

Innovations anticipated by expert informants during the operational phase of the *eZdravje* system modules include (EUREGIO III Case study - National e-Health Project, 2011):

- Collaboration between ministries in operating the e-health telecoms network;
- The operation of the national EHR, and the perceived right and responsibility of individual citizens to access and keep their records updated;
- Use of the national electronic health insurance (HIC) user terminals for authentication.

Certain pilot projects progressed, *Lab-Poštar*, a pilot electronic personal health data exchange between laboratories and physicians by e-mail, moved into implementation during 2011. Work started on the EHR in late 2010 and resumed in 2011. Creating a team of experts to form the National Centre for e-Health also commenced, with them based at the Ministry of Health in the first instance. The Education and Training module progressed according to plan (EUREGIO III Case study - National e-Health Project, 2011).

A new pilot project has also been introduced, ePrescription, and is scheduled for implementation in regions where system platforms of stakeholder organizations are already interconnected. EPrescription will include the eTransmission of a prescription to the pharmacy and into a medication record.

The Health Insurance Institute of Slovenia has announced that it will introduce a new electronic health insurance card system across the country. Initially will be used to obtain information on insurance. The electronic health card is the basis for access to EHR and getting e-prescription.

The national roll-out follows a pilot at the Dr Franc Deganc General hospital in the Nova Gorica region of Slovenia, which was completed in March 2009. After the pilot ended the system was extended to more than 100 organizations in the Gorenjska and Primorska regions. In 2010 electronic health cards were used by more than 30,000 health professionals and two million patients. The system is the first in the country to cover both public and private insurance organizations (EHealth Insider, 2009).

Currently there are no telemedical services implemented at the national level in Slovenia. However, there are some pilot projects in the field of telemedicine carried out by specialized hospitals.

2.2. DEVELOMPMENT OF E-HEALTH IN SERBIA

Serbia is a democratic state located in the central part of the Balkan Peninsula, on the most important route linking Europe and Asia. Serbia has made significant progress in recent years, as it has seriously pursued social, economic, and political reforms in order to continue its progress towards eligibility for EU membership.

The Table 1 shows the basic statistical data related to the population of Serbia and their life expectancy.

Serbian Healthcare, for the second year in a row, took the last – 35th – place in Europe in the ranking of health care systems, according to a survey conducted for the needs of European Parliament. The World Health Organization (WHO) Country Office in Serbia was requested by the Ministry of Health and the EU to implement the EU IPA-funded Project: “Implementation of the Hospital Information System (HIS)”. One of the main goals of this Project is to customize and implement HIS proposed by the Ministry of Health in selected hospitals and to integrate them with the EHR system.

In Serbia, in line with the strategic implementation of the document e-Health 2015, hard-work on the development of health information systems has been done (Figure 3). In this moment, the development of HIS have three phases. The first phase of the project was health information Think Thank and IT development. The second phase was pilot testing and the third phase is full implementation of proposed IT solutions. The third phase will be completed during 2014.

According to the Action Plan, a strategic document e-Health 2015 first iteration of computerization of the health sector will be completed by year 2015 (Jovanović Milenković, et al. 2012). In an integrated health information system, all institutions and facilities in the health system will be interconnected (Ministry of Health, National Health Insurance Fund, the institutes of public health, health centers, hospitals, clinical centers, pharmacies ...) (Ausford et al. (2005).

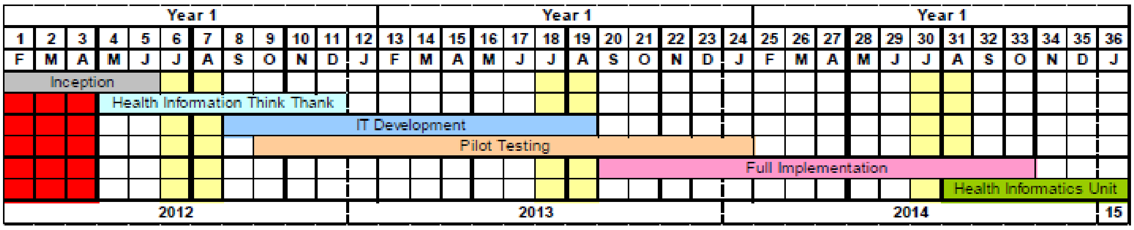

Figure 3: Phase of the project (The EU-IHIS project, 2013)

An analysis of the introduction and implementation of health information systems has been performed for three observed years: 2007, 2010 and 2013 (Table 2). The results showed that (The EU-IHIS project, 2013):

- Year 2007 was a base of policyholders and that only 40% of the insured were entered into the information system.
- Year 2010 was characterized by adoption of information systems in health centers and hospitals use, but EHR is still not used.
- In 2013 HIS was installed in 50% of hospitals, central base of insured beneficiaries is completed and usage of the EHR is in progress

Table 2: Analysis of the introduction and implementation of health information systems (The EU-IHIS project, 2013)

	Base of insured	Cental resource base	Hospital health care	Primary health care	EHR
2007	40%	0%	0%	5%	0%
2010	85%	60%	15%	15%	0%
2013	90%	100%	50%	85%	9%

The implementation of computerization of medical institutions of primary health care was in accordance with the project plan and the indicator of 85% computerized institution is achievable by the end of the project.

The introduction of HIS into organizations included in the project is designed to provide a set of elements that enable the improvement of the work process in health care sector. It is done in order to enable users to obtain a functional unit that will improve the quality of hospital business by a milestone. The implemented solution will become a foundation for improved internal communication and availability of information, avoiding multiple entries or copying data, data entry at the source with the implementation of appropriate coding, as well as better tracking of items that are billed to health insurance.

Introduction to HIS and training is done by the team prepared for educating hospital staff and configuring and customizing the HIS for the needs of the hospital. The introduction of the HIS aims to improve the treatment of the patient support, management and increasing the efficiency of administrative work. End-user training includes familiarization with the system, its features and functionality, as well as complete introduction to practical use in the workplace.

Project introduction of HIS shall be concluded by February 2015. The introduction of the HIS is planned in 19 hospitals, which will lead to further development and improvement of integrated health information systems in Serbia.

For now the introduction has been concluded in the following hospitals:

- The University Children's Hospital in Belgrade, in addition to previously implemented using ICT in the ambulatory work, HIS is covers full clinical practice.
- HIS in The Institute for Oncology and Radiology of Serbia - In addition to the system used in the wards and clinics, online appointment system of consultative examinations has been implemented successfully.
- Activities General Hospital Smederevo are completed on time and in the daily work of continuously increasing use of the system in the treatment of patients, approximately 20% per month. With such tendency of growth we soon expect all data on the treatment of patients to be administered through HIS.
- While the system was introduced during the summer months in general hospital Pančevo, professional approach to hospital management and employees is important to facilitate the work of the EU-IHIS team, which resulted in more than 90% of the users being trained for daily use of HIS.
- Implementation of HIS in the General Hospital Sombor, introduced in October 2013, resulted in much shorter times used for following the health card protocol. The program is easy to use and significantly reduces administration times.

EU IHIS project teams began the process of implementing HIS at the General Hospital Kruševac in January 2013, and in February 2013 at the General Hospitals in Čačak, Kikinda and Pirot. Until the end of May 2013, over 95% of users and IT staff at the General Hospital Kruševac were trained and the system was implemented in outpatient rooms and departments despite the lack of equipment necessary for full production. Even though the Health care Center “Dr Dragiša Mišović” in Čačak is in the process of separation from the General Hospital and the Primary Health care Center, the focus of hospital’s management and health professionals remained using HIS. At the General Hospital Čačak, approx. 90% users have been trained. The work is also completed in the General Hospital Kikinda and the system is being used in the entire hospital, even though the hospital has only one IT expert. Thanks to the professional approach of hospital's management and commitment of users, HIS was implemented on time in all outpatient rooms and departments of the General Hospital Pirot. Thereby, the experience in HIS implementation in this hospital represents an example of good practice that will serve as a role model for system implementation in other hospitals involved in the project.

The Republic Fund of Health Insurance introduced electronic health cards during 2013. The cards were first introduced during the pilot project. The pilot project is taking place in Valjevo. Valjevo was chosen because all health centers, hospitals and pharmacies share a computer network with The Republic Fund of Health Insurance. The Fund plans to change million cards in 2014, and the rest in the following three years (The Republic Fund of Health Insurance, 2012). This kind of medical identification will enable faster and easier communication between medical doctors and pharmacies.

Early in 2015, patients will no longer receive paper prescriptions in health centers. Prescriptions to pharmacies will be forwarded electronically. All physicians in 158 medical centers in Serbia and 1,000 pharmacies will be networked into a system of making and issuing electronic prescriptions. Annually more than 60 million paper prescriptions are issued. They will be replaced by electronic prescription.

3. CONTRIBUTION AND FURTHER DEVELOPMENT

Development and implementation of electronic services in the health care system will contribute to the overall development of the health system of any country.

Implementation of the system should speed up organized and synchronized computerization of health care institutions in accordance with standards and accepted rules. Gradual interconnection of a larger number of computerized health care institutions will increase representativeness, importance and usefulness of data stored in databases (Jovanovic Milenkovic, Radojicic, Milenkovic, Vukmirovic, 2009).

All partners in the system must give contributions to the development of e-Health. Advantages of using this system are:

- Better communication between partners in electronic health system,
- Data collections for better patients care,
- Better medical documentations,
- Increase efficiency of work in health institutions,
- Increase standards of health care,
- Advanced statistical data analysis,
- Increased safety for patients and health care professionals (Rajkovič, Dinevski, Šušteršič, Rajkovič, 2011.)

4. CONCLUSION

The health care system and the directions of its development are the subject of interest of international organizations, agencies and other institutions, such as the World Health Organization, World Bank, the International Committee of the Red Cross and others. Application of ICT has fundamentally changed medical practice in developed countries, allowing for increased quality and efficiency of health services. Years of experience in applying ICT in the health care system show high economic and medical reasons for development and investment in this area.

This paper describes the main ICT trends in the field of health care systems. The paper provides a parallel view of two analyzed countries, Slovenia and Serbia.

Slovenia is a very good example of a successful development of ICT in health care system. Its major benefits can be summarized by a check-list as follows: benefits for citizens: speed, ease of use; benefits for the health care administration: costs control, and time savings. Development of the Slovene HIS is an on-going intensive process, and at present, provides a good opportunity for introducing of others solutions.

The introduction of electronic services in the health system of Serbia was launched. We conducted a pilot project. The implementation of health information systems in hospitals in Serbia is in progress and shall be concluded by the end of 2015. The speed of development and application of these systems in the world indicate that the implementation in Serbia is not a matter of necessity and cost-effectiveness, but only a matter of time.

This paper provides further perspective of using e-Health applications, through the use of specific electronic services. Health care requires continuous and systematic innovation in applying ICT for effective and timely decision-making quality.

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UPGRADING THE EHCI INDEX: A STATISTICAL APPROACH

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Abstract: *Healthcare systems are one of the EU major concerns, and during the past years, more and more initiatives have been taken at the international and national levels in order to strengthen national healthcare systems as core components of the global health system. EHCI is one of the most popular methodologies for evaluating healthcare systems, which is introduced more than a decade ago, and in 2012, for the first time, it included Serbia in the evaluation process. This paper strives to upgrading the ECHI, using the I-distance methodology, and thus improving its flaws and drawbacks. It gives the special concern to Serbia and its position in the overall healthcare system ranking, and points out to the most wholesome directions to improve the Serbian global health.*

Keywords*: EHCI, I-distance, health, healthcare system*

1. INTRODUCTION

The topic of health is the subject that could never become obsolete. In the terms of globalisation, global health, as the public health of populations in a global context, is becoming more and more compelling. Therewithal, the term of the healthcare system has been defined, and, since 2000, more and more initiatives have been taken at the international and national levels in order to strengthen national healthcare systems as the core components of the global health system (WHO, 2014).

Healthcare systems can vary substantially from country to country, and in the last few years, comparisons have been made on an international basis. Back in 2000, the World Health Organization (WHO, 2014) have provided a ranking of health systems around the world according to criteria of the overall level and distribution of health in the populations, and the responsiveness and fair financing of health care services. Still, direct comparisons of health statistics across nations are quite complex.

This is why healthcare systems have attracted a significant amount of researchers' attention (Kringos et al., 2013; Smith, 2013; Parkhomenko, 2013; Schnitzer et al., 2013), especially regarding their economic impact and their efficiency (Hadad, Hadad, & Simon-Tuval, 2013). According to Bohm et al. (2013), there are five types of OECD healthcare systems, with three core dimensions: regulation, financing, and service provision, and three types of actors: state, societal, and private actors. Similarly, Lima de Freitas and da Silva (2013) argue that they have a large impact on optimal economic growth. Some countries invest a large amounts of money in their health (Blank, 2012), and until today, they have already entered the healthcare systems transformation process (Blank 2012; Lin, 2012; Steel & Morris, 2013). In this regard, due to reduced financial means and increasing demands on provision of service in healthcare and nursing, the time will come when prioritization in healthcare systems will be necessary (Beske, 2012).

A good healthcare system delivers quality services to all people, when and where they need them. The exact configuration of services varies from country to country, but in all cases requires a robust financing mechanism; a well-trained and adequately paid workforce; reliable information on which to base decisions and policies; well-maintained facilities and logistics to deliver quality medicines and technologies. One of the most popular healthcare systems methodologies is the Euro Health Consumer Index (EHCI), which was created in 2005. Therewith, EHCI was presented in Belgrade on December 18, 2013, along with the health outcomes of Serbia.

EHCI methodology consists of six indicators, and their sub-disciplines, and is described in detail in Section 2. The main limitation of the EHCI methodology is the fact that the weights assigned to each of these indicators are biased weights, as comprehended by experts who participated in ECHI construction. In order to overcome the limitations, we proposed an upgrade to ECHI methodology by applying I-distance method to set of six consisting indicators. Mathematical modelling of healthcare systems and e-health has always been a common topic (Zaitseva & Rusin, 2012; Milenkovic, Milenkovic, & Dobrota, 2012; Grigoroudis & Phillis, 2013; Hadad, Hadad, & Simon-Tuval, 2013; Adeyemi, Demir, & Chaussalet, 2013). I-distance method creates the synthesized multi-criteria indicator, which does not imply the biased weights proposed by experts, but is based on the multi-criteria distances between entities instead. Furthermore, it can provide the insight to which of the indicators are most important for ranking countries. This is the main precedence for upgrading the original EHCI index, using the proposed I-distance methodology. The methodology is explained in detail in Section 3.

2. EHCI INDEX

The Euro Health Consumer Index (EHCI) is the study made on European healthcare systems, which takes consumer and patient perspectives in consideration. The EHCI 2013 is seventh study in a row, published by the Health Consumer Powerhouse (HCP, 2013), which offers reality checks for policy makers, empowerment to patients and consumers and an opportunity for stakeholders to highlight weak and strong aspects of healthcare (EHCI, 2013). In order to become a powerful actor, building the necessary reform pressure from below, the consumer needs access to knowledge to compare health policies, consumer services and quality outcomes. The Euro Health Consumer Index (EHCI) is an effort to provide healthcare consumers with such tools.

The HCP has become a centre for visions and action promoting consumer-related healthcare in Europe. It monitors and compares healthcare systems among 35 countries, including all EU member states as well as Canada, providing guidance to patients and citizens and reality checks to governments. In 2005, the HCP launched its first EHCI, which provides country policy recommendations for improvement, advising governments and healthcare systems on how to improve performance and strengthen the position of the healthcare consumer. Today the European Commission regards the EHCI to be the most informative and influential assessment of European healthcare (EHCI, 2013).

For a decade, the HCP has been publishing a wide range of comparative publications on healthcare in various countries. By ranking the 21 county councils by 12 basic indicators concerning the design of ”systems policy”, consumer choice, service level and access to information, they introduced benchmarking as an element in consumer empowerment. HCP aimed to select a number of indicators describing to what extent the national healthcare systems are “user-friendly”, thus providing a basis for comparing different national systems. Furthermore, since 2008 the HCP has enlarged the existing benchmarking program considerably. Last year's edition of Euro Health Consumer Index covers 48 healthcare performance indicators for 35 countries (EHCI, 2013).

The EHCI is built up with indicators grouped in six sub-disciplines, which cover 48 different indicators. The aim has been to select a limited number of indicators, within a definite number of evaluation areas, which in combination can present a telling tale of how the healthcare consumer is being served by the respective systems.

The ECHI 2013 sub-disciplines:

1. Patient rights and information
    - 1.1. Healthcare law based on patients' rights
    - 1.2. Patient organisations involved in decision making
    - 1.3. No-fault malpractice insurance
    - 1.4. Right to second opinion
    - 1.5. Access to own medical record
    - 1.6. Registry of *bona fide* doctors
    - 1.7. Web or 24/7 telephone HC info with interactivity
    - 1.8. Cross-border care seeking financed from home
    - 1.9. Provider catalogue with quality ranking
    - 1.10. EPR penetration
    - 1.11. Patients' access to on-line booking of appointments?
    - 1.12. e-prescriptions
2. Accessibility/Waiting time for treatment
    - 2.1. Family doctor same day access
    - 2.2. Direct access to specialist
    - 2.3. Major elective surgery < 90 days
    - 2.4. Cancer therapy < 21 days
    - 2.5. CT scan < 7days
    - 2.6. A&E waiting times
3. Outcomes
    - 3.1. Heart infarct case fatality
    - 3.2. Infant deaths

3.3. Cancer deaths relative to incidence
3.4. Preventable years of life lost
3.5. MRSA infections/Abortion rates
3.6. Undiagnosed diabetes
3.7. Depression
4. Range and reach of services (“Generosity”)
4.1. Equity of healthcare systems
4.2. Cataract operations per 100 000 age 65+
4.3. Kidney transplants per million pop.
4.4. Is dental care included in the public healthcare offering?
4.5. Informal payments to doctors
4.6. Long term care for the elderly
4.7. % of dialysis done outside of clinic
4.8. Caesarean sections
5. Prevention
5.1. Infant 5-disease vaccination
5.2. Blood pressure
5.3. Smoking prevention
5.4. Alcohol
5.5. Physical activity
5.6. Undiagnosed diabetes
5.7. HPV vaccination
5.8. Sugar intake
6. Pharmaceuticals
6.1. Rx subsidy
6.2. Layman-adapted pharmacopoeia?
6.3. Novel cancer drugs deployment rate
6.4. Access to new drugs (time to subsidy)
6.5. Arthritis drugs
6.6. Schizophrenia drugs
6.7. Antibiotics/capita

The performance of the respective national healthcare systems were graded on a three-grade scale for each indicator, where the grades have the rather obvious meaning of *green* equals good, *amber* equals medium, and *red* equals not-so-good. A green score earns 3 points, an amber score 2 points and a red score (or a *not available*, *n.a*.) earns 1 point.

Having six non-EU countries in the Index, who should not be stigmatized for not being EU member states on indicator *Free choice of care in another EU state*, forced the introduction of a new score in the EHCI 2009: *not applicable*. These countries therefore receive the *n.ap*. score, which earns 2 points. That score was also applied on indicator *Provider catalogue with quality ranking* for Iceland and Malta, as they essentially have only one real hospital each.

In 2013, a *purple* score, earning 0 points, was introduced for particularly abominable results. It has been exclusively applied on indicator *Abortion rates* for countries not giving women the right to abortion.

Since the 2006 Index, the same methodology has been used: for each of the sub-disciplines, the country score is calculated as a percentage of the maximum possible (e.g. for *Waiting times*, the score for a state has been calculated as % of the maximum 3 x 6 = 18). Thereafter, the sub-discipline scores were multiplied by the weight coefficients given in the Table 1 and added up to make the final country score. These percentages were then rounded to a three digit integer, so that an *all green* score on the 48 indicators would yield 1000 points, while *all red* gives 333 points.

Table 1: Sub-discipline weights

Sub discipline	Relative weight (max 1000)	Points for a *green* score in each sub-discipline
Patient rights and information	150	12.5
Accessibility/Waiting time for treatment	225	37.5
Outcomes	250	35.71
Range and reach of services (“Generosity”)	150	18.75
Prevention	125	15.63
Pharmaceuticals	100	14.29

Consequently, as the percentages of full scores were added and multiplied by (1000/Total sum of weights), the maximum theoretical score attainable for a national healthcare system in the Index is 1000, and the lowest possible score is 333. The preview of EHCI 2013 is given in Figure 1.

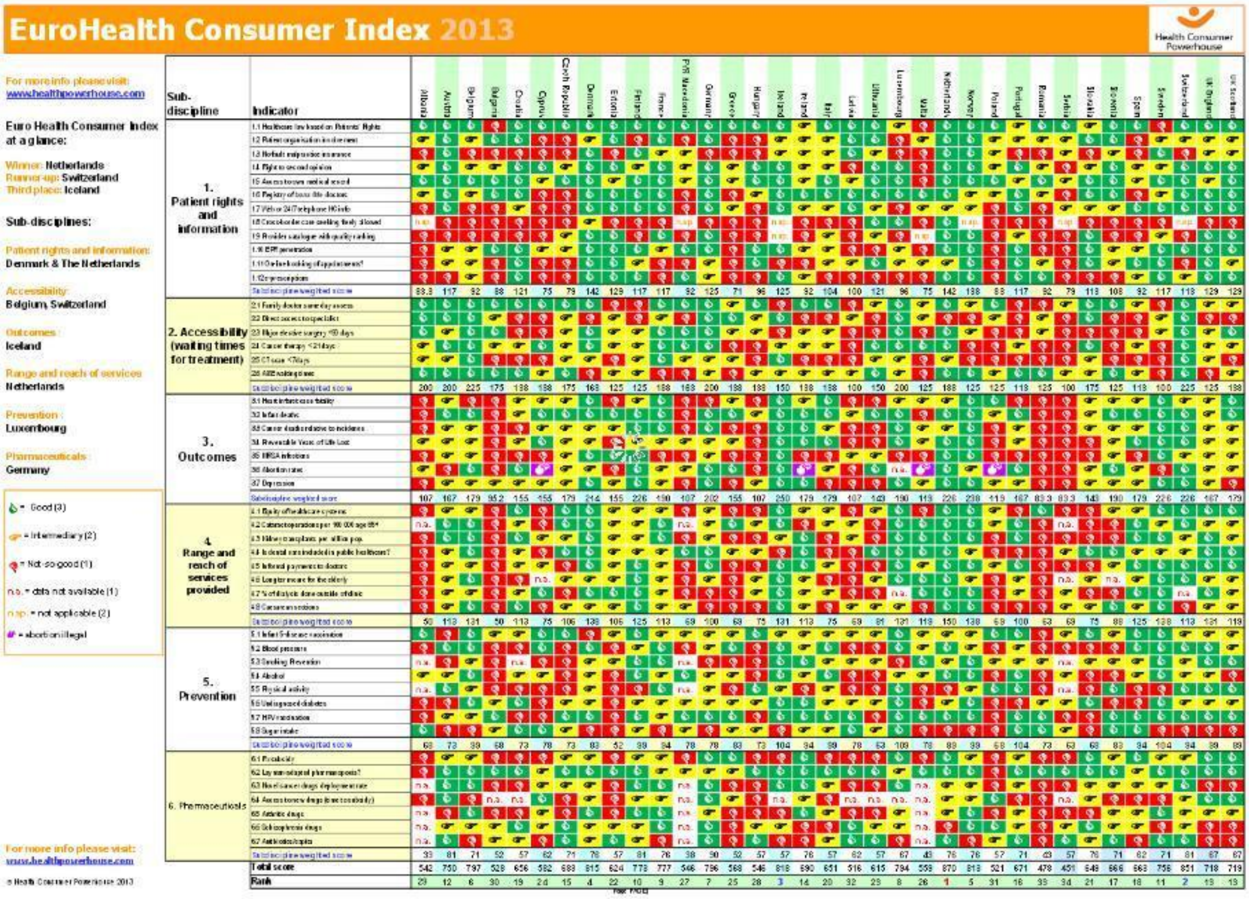

Figure 1: EHCI 2013 (EHCI, 2013)

3. I-DISTANCE METHODOLOGY

The common case with different ranking methods is that their bias and subjectivity can affect the measurements and evaluation. This problem can somewhat be surpassed using the I-distance method, a metric distance in an n-dimensional space, which has recently made a significant breakthrough (Jeremic et al., 2011a; Radojicic & Jeremic, 2012; Jeremic et al., 2012; Dobrota et al., 2012; Jeremic et al., 2013a; Jeremic et al., 2013b). It was originally defined by professor Branislav Ivanovic (Ivanovic, 1973; Ivanovic & Fanchette, 1973), who devised this method to rank countries according to their level of development based on several indicators, where the main issue was how to use all of them in order to calculate a single synthetic indicator, which will thereafter represent the rank.

For a selected set of variables $X^T = \ X_1, X_2, ...X_k$ chosen to characterize the entities, the I-distance between the two entities $e_r = \ x_{1r}, x_{2r}, ...x_{kr}$ and $e_s = \ x_{1s}, x_{2s}, ...x_{ks}$ is defined as

$$D(r,s) = \sum_{i=1}^{k} \frac{\left| d_i \ r,s \ \right|}{\sigma_i} \prod_{j=1}^{i-1} \ 1 - r_{ji.12...j-1} \qquad (1)$$

where $d_i(r,s)$ is the distance between the values of variable X_i for e_r and e_s, e.g. the discriminate effect,

$$d_i \ r,s \ = x_{ip} - x_{is} \quad i \in \ 1,...k \qquad (2)$$

σ_i the standard deviation of X_i, and $r_{ji.12...j-1}$ is a partial coefficient of the correlation between X_i and X_j, $j < i$ (Ivanovic, 1973; Ivanovic, 1977).

In order to surpass the problem of negative coefficient of partial correlation, which can occur when it is not possible to achieve the same sign mark for all variables in all sets, it is suitable to use the square I-distance. It is given as:

$$D^2(r,s) = \sum_{i=1}^{k} \frac{d_i^2(r,s)}{\sigma_i^2} \prod_{j=1}^{i-1} (1 - r_{ji.12...j-1}^2)$$

The I-distance measurement is based on calculating the mutual distances between the entities being processed, whereupon they are compared to one another, so as to create a rank. It is necessary to fix one entity as a referent in the observing set using the I-distance methodology. The ranking of entities in the set is based on the calculated distance from the referent entity.

4. RESULTS

The results of the I-distance method, as well as a comparison of the I-distance and the EHCI ranking, are shown in Table 2.

Table 2: ECHI Scores and Ranks, and its comparison to I-distance Scores and Ranks for 2013.

Country	EHCI Score	EHCI Rank	I-distance Score	I-distance Rank
Switzerland	852	2	35.56	1
Netherlands	871	1	34.81	2
Norway	814	5	31.49	3
Germany	795	7	29.91	4
Iceland	817	3	29.35	5
Denmark	816	4	28.68	6
Belgium	797	6	28.02	7
Finland	773	10	27.01	8
Luxembourg	793	8	26.7	9
Sweden	756	11	26.03	10
France	778	9	24.8	11
Austria	751	12	22.82	12
UK England	718	14	19.37	13
UK Scotland	721	13	18.38	14
Portugal	672	17	17.49	15
Ireland	692	15	16.98	16
Czech Republic	683	16	15.05	17
Slovenia	665	19	14.68	18
Slovakia	650	22	14.37	19
Spain	665	19	13.83	20
Italy	652	21	13.6	21
Croatia	657	20	11.25	22
Estonia	624	23	10.51	23
Lithuania	615	24	9.24	24
Albania	541	30	8.16	25
Cyprus	583	25	7.72	26
Greece	568	26	6.78	27
Bulgaria	528	31	6.09	28
Latvia	516	33	5.5	29
FYR Macedonia	547	28	5.39	30
Hungary	546	29	5.07	31
Malta	559	27	4.92	32
Poland	521	32	3.66	33
Romania	479	34	2.36	34
Serbia	451	35	2.2	35

Before commenting on the results, it is important to note that I-distance methodology as apposite for measuring the European healthcare systems, as ECHI is, since the Pearson correlation coefficient between the two is significant ($r=0.98$, $p<0.001$). Spearman correlation of ranks is also significant and strong ($r_s=0.98$, $p<0.001$).

As can be seen from Table 2, Switzerland obtained better score than the one gained by simple EHCI addition method, thus forcing its way to the top position, and repressing Netherlands to second position. Top five countries are Switzerland, Netherlands, Norway, Germany and Iceland, and thereby Norway and Germany have significantly improved their positions, while Iceland and Denmark were thrown back. Hungary, Malta, Poland, Romania and Serbia are the worst positioned countries, where Malta has significantly fell down, while for example Albania dug its way up the ranking list.

Some explanations for these changes in ranking positions can be found in Table 3.

Table 3: Importance of consisting indexes

Consisting index	Correlations
Outcomes	0.905**
Range and reach of services (“Generosity”)	0.796**
Pharmaceuticals	0.758**
Patient rights and information	0.667**
Prevention	0.652**
Accessibility/Waiting time for treatment	0.470**

** p<0.01

Table 3 presents the importance of the six consisting indicators that constitute EHCI. Most important indicator for the ranking process is *Outcomes*, and this is in accordance with the EHCI weight. It is followed by *Range and reach of services*, and *Pharmaceuticals*. Here within, differences are more conspicuous: *Range and reach of services* is middle weighted and *Pharmaceuticals* is least weighted by original EHCI. *Accessibility/Waiting time for treatment* is secondly weighted by EHCI, but according to I-distance method it is the least important for the ranking process. These results indicate that the weights assigned by experts are biased and non-objective, and, since I-distance is a statistically based methodology, it is obvious that it would generate nonbiased, objective, and more realistic results.

It is surely interesting to examine the position of Serbia within these results. Serbia takes the last place according to both EHCI and I-distance methodology. Figure 1 could somewhat explain these bad results: Serbia has very bad results regarding *Outcomes*, scoring the lowest (all red), which is similarly to Romania, who takes second worst position. Very bad results are also for *Range and reach of services* and *Prevention*. Since *Outcome* and *Range and reach of services* are most important for the ranking process, Serbian bad scores are somewhat expected, and it is clear that Serbia will have to work hard in order to improve its overall healthcare system position.

The first step has already been made. In the Serbian parliament health committee, there was a strong wish to learn from the EHCI findings, on how to improve Serbian healthcare, placed last in 2013 Index. When EHCI 2013 results were published, Serbia reacted very quickly by inviting HCP to come to Belgrade, to explain the outcomes and advise how Serbian healthcare can improve. Accordingly, Dec 18-19 the HCP management visited Belgrade as guests of the Serbian parliament (EHCI Belgrade, 2013).

Consequently, a number of reports emerged from these efforts. According to Milovanovic (2014), antiquated equipment and a lack of medical experts, as well as the poor condition of the health infrastructure itself, are only some of the problems in Serbia. Yet, Serbia took steps to improve its troubled healthcare system, as it started negotiations with the European Union. "We are working hard to improve the situation, but we are encountering numerous problems," Health Minister Slavica Đukić-Dejanović said. She also said that major changes are expected next year regarding patient waiting lists, and that an electronic information system, that will provide up-to-date data, is being rapidly developed (Milovanovic, 2014). The first centralised acquisition of medical supplies for hospitals in Serbia is also under way, a procedure that could save the state up to 25 million euros. The new procedure will be under the supervision of the health ministry, reducing the opportunity for corruption.

5. CONCLUSION

This paper’s results can lead to many various conclusions. As evidenced from Figure 2, European healthcare generally continues to improve but medical outcomes statistics is still appallingly poor in many countries.

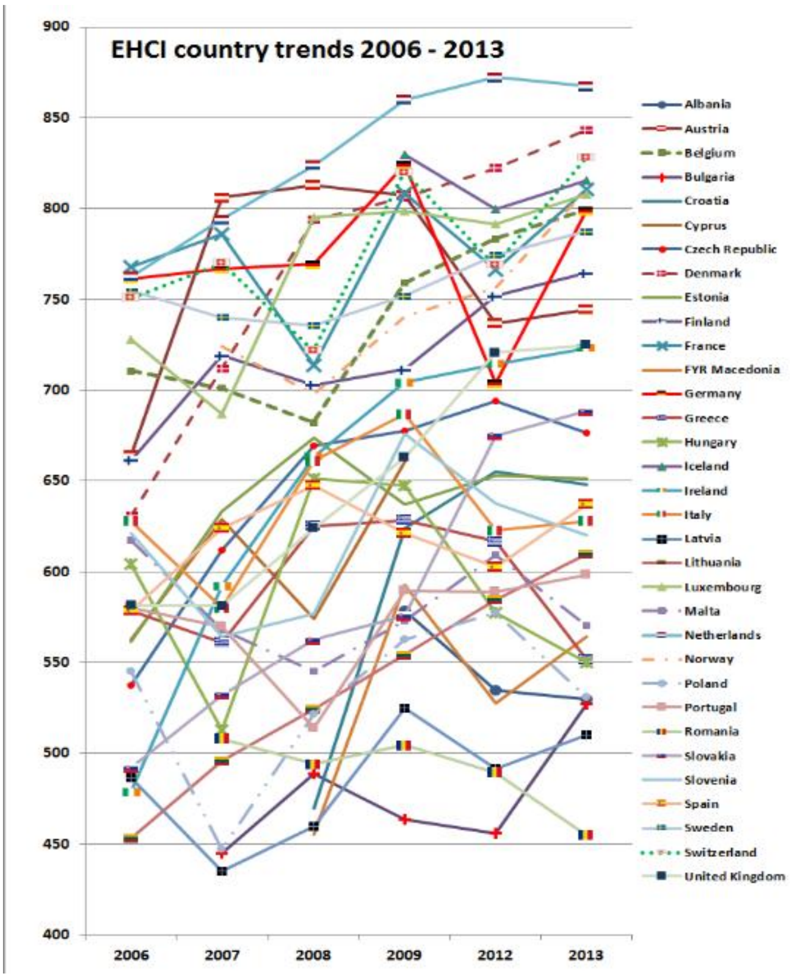

Figure 2: EHCI country trends (EHCI Belgrade, 2013)

Though still a somewhat controversial standpoint, HCP advocates that quality comparisons within the field of healthcare is a true win-win situation: the consumer will have a better platform for informed choice and action; governments, authorities and providers will have the sharpened focus on consumer satisfaction and quality outcomes; to media, the ranking offers clear-cut facts for consumer journalism with some drama into it. This goes not only for evidence of shortcomings and method flaws but also illustrates the potential for improvement (EHCI, 2013). This paper provides an important improvement regarding the introduction of unbiasness and objectiveness into healthcare systems ranking process.

Special attention is regarding Serbia, and the interpretation of its currently last position within ECHI 2013. Officials said that in order to reach European standards, Serbia needs to have more modern medical equipment and instruments in hospitals, and more medical residents and specialists, especially radiologists, cardiologists and oncologists (Milovanovic, 2014). "We need to have better organisation in our healthcare system. We have to use our sources and our knowledge in the most productive way," Djukić-Dejanović said.

What the EHCI was evaluating is of crucial importance for patients, such as rights of patients to information, waiting time for medical treatment, outcome of medical treatment, range of offered services and pharmaceutical means. Serbia does need to focus to improving these elements, especially the outcomes of medical treatments, as well as investments in healthcare system, in order to keep up.

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CONFLICT MANAGEMENT - CONFLICTS IN PRIMARY HEALTH CARE

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Abstract: *Conflicts are a general phenomenon that can be observed at all levels of human life. They appear in the form of relationship between individuals, groups, families and in workplaces. This paper deals with the conflicts in health care organizations that are very specific regarding the types of services they provide, as well as the specificity and diversity of service users or patients who come to health facilities for various health needs. It also analyzes the factors that have resulted in the appearance of a conflict, and finds the possibilities of more efficient management and conflict resolution. The survey was conducted in private and public institutions of primary care, and displays reasons, origin, development, management, and possible ways of resolving the conflict. The paper provides the background how to identify latent conflict, remove it, manage and solve it.*

Key words*: Conflict, health care, conflict management, primary care*

1. INTRODUCTION

Conflict is a social condition in which at least two parties (individuals, groups, states) that have different starting points at first glance irreconcilable and when the differences which are important come to the surface making it impossible to continue working in harmony. The parties then seek different objectives that can be achieved and use different means for achieving certain goals. The differences are emphasized, whether they are real or perceived in relation to the objectives, needs, ideas or starting points between the parties.

The term *conflict* is of Latin origin *"conflictus"* which means "to hit each other." Ross (Ross 1993) defines conflict as a "conflict of motives ... a situation where a person is due to the conflict of motives called a conflict situation". Krkeljić and Slobig (Krkeljić and Slobig, 2001) define conflicts as "a state of antagonism with conflicting needs and desires (included at least two parties who want to win)." By analyzing the different views of conflict, many of them can be subsumed in whole or in part, on the one of the two views, or at least to contain some of their characteristics. They all agree that conflict is a process, is inevitable and is a normal part of life.

The simplest definition of a conflict is that it represents disagreements between human beings. It means that conflicts are part of life and every change with the ability to transform into a source of energy provides the ability to manage, in a constructive way. Creative potential conflict situations are emphasized in this paper as a part of our approach to resolving conflicts bearing in mind that there is no universal definition for such complex concepts. Much more important than the definition is the understanding of the nature of the conflict. The nature of conflict is two-fold, while on the one hand, conflicts can lead to violence and unintended consequences, on the other they may be a chance to change the current situation for the better and establish a new, productive relationships in the community in which we work. All interpersonal relationships are much more complex than we realize at a first glance. By analyzing various factors and circumstances that have an impact on the level of quality of interpersonal relationships, we come to the fact that the conflict in all spheres of human life is usually inevitable. There are many studies on interpersonal relations in various domains of psychological, sociological, cultural and other fields of knowledge, but as long as we are trying to expand their awareness of the information that we receive from different forms of science, we never have a complete picture about themselves or about others. Because of these different perceptions it comes to a halt in communication, which is usually manifested in the form of a conflict. There are many possibilities for the development of a conflict situation within a group, between the two groups, between the two people, as well as within the same individual. The essential feature of any form of conflict is a conflict of interests of opposite sides, the conflict of nations, ideologies and political groups, conflicts of race and religion, family conflicts or conflict at work.

Conflicts, however it seemed to have a social dimension that takes place between two or more persons, basically have a psychological core in which usually lies the frustration of basic needs. Importance of psychological dimensions of conflict is particularly important in the process of resolving or managing them. Conflict resolution implies that conflicts can be finished, completed, overcome, or permanently settled. Conflict management suggests a process view of the choices and behaviors that come into play during conflicts implying that it is not an "on" or "off" phenomenon.[1] Some conflicts are enduring and the best we can hope for is to manage the level and manifestation of conflict - to sustain a good working relationship free from negative behaviors or violence.

2. CAUSES AND TYPES OF CONLICTS

2.1. Causes of conflicts

Causes of conflicts can be varied events in living and working environments arising from different interests and values which represent the core of all conflicts. The conflicts are caused by different factors: disagreements, differences, difficulties, or competition. It is impossible to give a precise list of all the possible causes of conflict. One of the reasons for the large individual differences between people is that one can never be completely sure that the behavior of someone causes adverse reactions. Many professionals involved in the conflict have tried to categorize of large number of possible causes of conflict. Christopher Moore (Moore, 1986) classifies the causes of conflicts in five categories of interests, values, data structures, relationships. In real life, people still do not comply with the satisfaction of a need for a specific order. Therefore, it is important to find out how the participants in conflict define their needs and priorities of the moment. Identifying the basic needs behind the views expressed in conflict situations is further complicated by the fact that the world around us perceives everyone in a different way.

2.2. Types of conflicts

The types of conflicts indicate the seriousness of the conflict, its intensity, and the approach to the solving process. Deutch (1969) created a view of conflict that remains a usable framework today claiming that the negative or positive nature of conflict can be determined by people's behaviors and produce either dysfunctional, destructive and unproductive responses (destructive conflicts) or, on the other hand, functional, constructive and productive responses (constructive conflicts). Finding compromise solutions within the objectives of the organization that will partially satisfy the demands of the opposing party is the best and the final outcome of each conflict.

2.2.1. Destructive conflicts

These conflicts usually reflect behaviors from rigid, competitive systems and are difficult to resolve and transformed into constructive conflicts. The characteristics of destructive conflicts are inability of the groups whose members are in conflict to find a solution to the problem so the conflict parties forget the substantive issues and transform their purposes to getting even, hostile to each other, which causes a negative emotional charge. In destructive conflict, no one is satisfied with the outcome, possible gains are not realized and the negative taste left over at the end of one conflict episode is carried over to the beginning of the next conflict

2.2.2. Constructive conflicts

Constructive conflicts are the conflicts characterized by the search for the solution of the problem. They are adaptive to the situation; person and issues of the moment are functional and constructive.These conflicts are assessed as a positive phenomenon in which optimal solution is promoted because they appropriately balance the interests of both parties to maximize the opportunities for mutual gains. In constructive conflict two sides are contradicted and may be in conflict showing an acceptable level of hostility or even aggression followed by an increased level of intolerance. Conflicts at the level of tolerance should be maintained and led to finding optimal solutions. Sometimes these conflicts transform into apathy and then nothing happens between the parties, which demands to express opinions and arguments of both parties, organize discussions and solve conflicts. Constructive conflicts contain creative adaptation born from a realization that one must know both one's own and the other's interests and goals and is able to find a mutually acceptable outcome.

[1] http://www.cios.org/encyclopedia/conflict/Cnature1.htm (27/03/2014 13:52)

2.3. Conflicts in Primary Health Care

The National Health Service Act[2] defines health as a state of complete physical, mental and social wellbeing and not merely the absence of disease or incompetence. This definition of health has been amended and according to the Ottawa Declaration[3], "health means a positive concept emphasizing social and personal resources, as well as physical capacities". Health and providing health services constitute the core of the primary health-care and is a conceptual model that relates to the processes and the ways it is organized as an integral part of national health care system. The essence of the primary health care in the narrow sense means prevention of illnesses and promotion of health guided by the principles of access, equity, essentiality, appropriate technology, multisectoral collaboration, and community participation and empowerment (WHO, 1978). Basis of primary health care lies in the affordability, fairness, equality, and continuity of these processes within the national health system and represents the first level of contact of individuals and families.

In primary care health institutions we usually encounter interpersonal (between two people), intergroup (between two groups), intrapersonal (within the individual) and organizational conflicts. Their cause may be found in the discrepancy of two or more members of the organization, which occurs due to sharing of scarce resources, tasks and different goals, attitudes or perceptions. Conflicts between patients and health care workers belong to external conflicts, affect and carry emotional frustration, unhappiness, sufferings, and usually cause psychosomatic illnesses. Therefore, the importance of studying the problem of conflicts in primary health care is essential very complex and requires a multidisciplinary approach.

3. SURVEY

The survey presented here was initiated by the findings of the experimental survey conducted for the purpose of collecting data based on our hypotheses about conflict management. The starting point of our assumption was that there was a greater level of conflicts that have led into worsening of the relationships in primary health care. The conflicts in this area can have various causes on the personal, group, organizational and inter organizational level, but also often negative consequences for individuals, groups and whole organization. The survey provided basic guidelines for working on this subject and outlined a general form and scale of the problem in the treated area. The survey has been done in the field of primary care (PC) denoting the health care services which play a role in the local community and providing services to patients same day with appointment or walk-in bases. Consequently, the health care employees must possess a wide breadth of knowledge in many areas.

3.1. Aim of Survey

The overall aim of our survey was to provide an insight into the current state of conflict management in primary health care while its particular aim was to gain insight into the issues related to which extent and in which way the conflicts could be resolved and managed. The results of this analysis may help facilitate mutual understanding of conflict situations and predominantly contribute to the harmonisation of relationships and better communication since primary health care professionals act as a first point of consultation for all patients within the health care system.

3.2. Sources of Survey

A specific target group, a poll of 168 respondents of four institutions of primary health care has been questioned – three private primary health care centers “Vizim” and “Jedro” from Belgrade and “Hemikal” in Valjevo and Public primary health care center in Valjevo. The tested employees at public and private health care institutions systematically provide personal and population-based preventive, curative and rehabilitative care services in primary care. These professionals are divided into two groups consisting of 79 primary care physician, such as a general practitioner (35 from public and 44 from private health centers) and 89 physician assistants or nurse practitioners (42 from public and 47 from private health centers).

[2] The National Health Service Act, 1946

[3] The Ottawa Charter for Health Promotion, First International Conference on Health Promotion, Ottawa, November 1986

3.3. Questionnaire analysis

A survey in the form of a questionnaire was conducted and conclusions were drawn on respondents' answers. The questionnaire consists of questions divided into Block A and Block B. Block A comprises questions that directly relate to personal information about respondents, while block B examines their views and answers to the posed questions.
The questions are divided into several categories and investigate the socio-economic characteristics of respondents, the nature and frequency of occurrence of certain types of conflicts, the reasons and the consequences of conflicts, the ways and solving strategies of conflict situations including questions which sought to understand how conflicts affect individuals and what their views on various aspects of the conflict are. We obtained interesting results and identified several problems.
The collected data were categorized and tailored for entry into Excel spreadsheet. By using the available functions and program measures data were separated and compared. Classification was made according to two parameters: educational level (university level and vocational affiliation level) and the type of health institutions (private and public).
For the purpose of this paper we are presenting some important figures showing some of the results of the treated problems.

3.3.1. Defining conflicts

We observed significant differences between employees in the private and public sector, regardless of the educational level in provided answers relating to the essential understanding of the onset of conflicts. In the private sector respondents think that none of the definitions of the conflicts represent the essence of the conflict, while in the public sector respondents agree with the given definitions. In both types of health care institutions, the most common reason for the conflict is a conflict with superiors as a type of interpersonal conflicts, followed by confrontation with patients as shown in public institutions, and disagreement with individuals from other departments in private institutions. The conflict generated from the relationship with patients is characteristic of the public sector in which, because policy makers under the present public health system, the end user - the patient is not highly valued and properly treated. In the private health sector the relationship with the patient is highly valued, and the complex demands of patients are not recognized as a source of conflict, or considered very rare. There is a noticeable difference regarding the educational level since respondents with university education see a source of conflict in relation to the patient three times more than those with a high school diploma. Perceived principle suggests that a sense of health care as a service activity is constantly fading with the level of education.

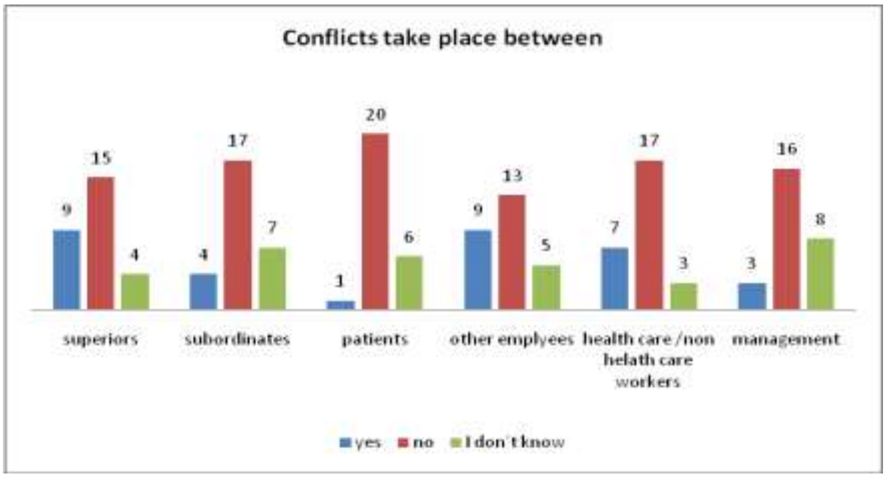

Figure 1 Defining conflict

In regard to the types of conflict that arise in primary health care, the analysis has shown that there are two groups of conflicts with the high frequency of appearance: the conflict between the individual and conflicts among groups. There is no statistical difference in the perception of values as the cause of conflict between levels management (adjusted on the table rarely/often). Also, there is no statistically significant difference in the distribution of responses among levels of education in terms of clearing the goals as conflicts. There was no statistically significant difference in the incidence of conflicts due to cultural characteristics among respondents of different education levels.

3.3.2. Causes of conflicts

The most common cause of conflict in both private and public sector including both levels of education is the lack of information. This suggests that conflicts arise mainly due to organizational problems in both types of institutions and in insignificant number due to personal problems. Here we present two figures showing two most common causes of conflicts in primary health care: personal and organizational causes of conflict.

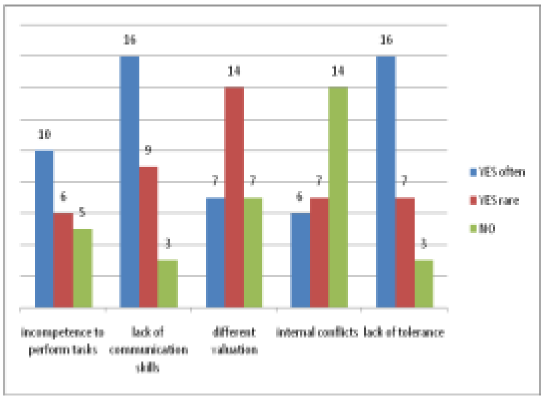

Figure 2 Personal causes of conflict

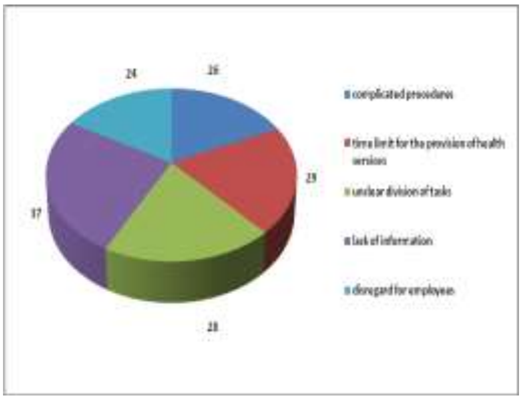

Figure 3 Organizational causes of conflict

Relating to personal causes of conflict, lack of tolerance has been chosen as the principal cause of conflicts by the largest number of respondents with high school education, connected with their view that the conflict relates to the relationship with superiors. Both groups pointed out that the lack of communication skills is the distinctive source of conflict and misunderstanding. The internal conflict in both groups is less frequently identified as a cause of conflict, but those respondents with a university degree are as double self-critical when it comes to this cause.

Significant number of respondents in the public health centers noticed that the causes of the conflict are the organizational issues and solutions offered by the management of the institution. The respondents from the public health care with high school education see the cause of the conflict in the disregard for employee and an unclear division of tasks, while respondents with university education state that the problem lies in the lack of time to provide health services. The private sector respondents with university education believe that the primary organizational causes of conflict are unclear division of tasks and a time limit for the provision of health services while the respondents with high school education have a problem with complicated procedures.

Lower wages, poorer working conditions, lack of equipment and a large flow of patients are seen mainly by employees in public institutions. In private sector, which creates a climate of better organization and concern for employees, those factors are less present.

3.3.3. Resolving and managing conflicts

The respondents in public health care express the process of resolving and managing conflicts in a different manner than employees in the private health centers. The difference is observed in the segment of the time limit for the provision of health care as stated by the public employees, especially those with a university degree, and to a much milder extent this problem is highlighted in the private sector. The introduction of a third party in conflict situations is acceptable for employees with higher education unanimously. Employees with a high school diploma are much more likely to opt for withdrawal. The position of both groups is balanced in terms of confrontation, ignorance and coercion.

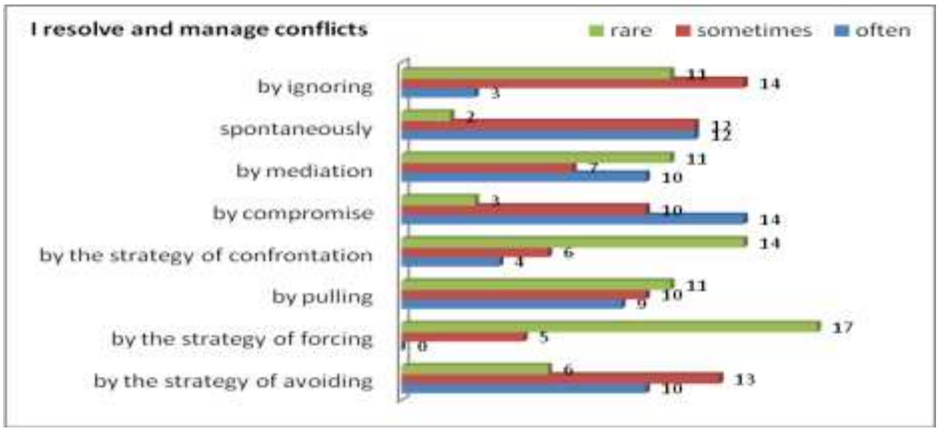

Figure 4 Conflict resolution

Compromise as the most common form of conflict resolution is represented in most of those employed in public and private health centers with a university degree. Employees with a high school degree in public health centers rather resort to ignorance and avoidance, as well as to methods of silencing conflict. The maximum deviation is noticeable in the method of mediation, which is almost totally avoided in public health centers, as opposed to private institutions, suggesting the existence of a relationship in which the focus is on the preservation of secure public position, without orientation towards resolving the conflict for the sake of development and achievement of goals. As a confirmation of this analysis, there is a deviation in terms of coercion. It is completely unacceptable in the private health centers, and appears as a method of public health centers under the auspices of tenure within the public health sector.

3.3.4. Respondents' Opinions on Conflict

Respondents were unified in their view that conflicts are not desirable in health care institutions. A significant difference is noted in the fact that respondents with high school education in a considerable number think that conflicts have negative effects and consequences on the health care institution, as opposed to the respondents with a university degree. The same difference in attitude is reflected in the fact that a number of respondents with university education considered conflicts sometimes as desirable for health institutions, while none of the respondents with a high school diploma declared in this option.

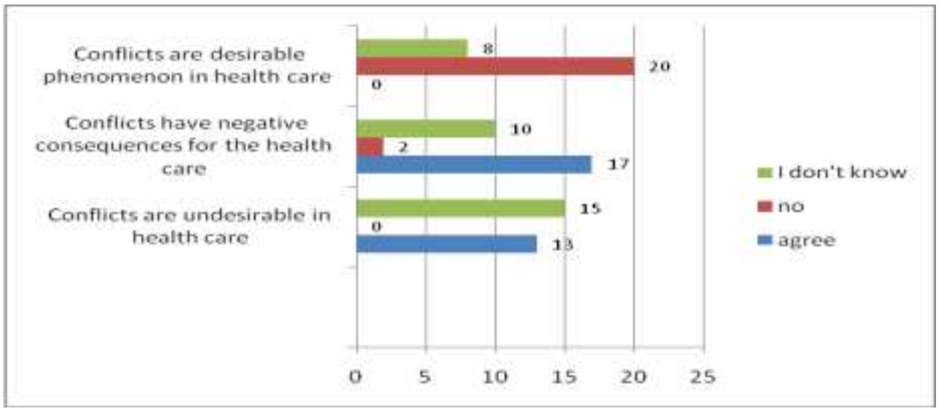

Figure 5 Respondents' Opinions on Conflict

4. CONCLUDING REMARKS AND RECOMMENDATIONS FOR FURTHER RESEARCH

Conflicts are irreversible state of personal and organizational systems and must be resolved and managed with great effort and difficulty. Identifying the nature and the event of conflict, the nature and the emergence and development of the conflict and selection of the best way of dismissal with respect to the least possible harm to people and organization are the key requirements placed before the participants in conflict.

The survey of conflict in personal and organizational levels still carry current task whose resolution can contribute to personal and organizational well-being. In order to achieve this, it is necessary to identify and categorize a clearer differentiation between the causes of the conflict, participants and their characteristics, frequency impressions, perceptions, consequences and ways to resolve and manage them. It is particularly important that employees in different levels of management are aware of all aspects in which conflicts are manifested, in order to manage them in the effective and purposeful manner, in particular in those cases where the conflicting parties are unable to accept ways to resolve them. The frequency of interpersonal and inter-group conflict requires a subtle analysis of personal and organizational values and recognition of cultural conditions of the system in which arises and develops personal, organizational and intergroup conflict.
Very often observed identical views of different management levels of the causes, consequences and indirect methods of conflict resolution indicate that employees of different levels of primary health care system are not in any way except by experience, educated for conflict management. For the realization of conflict resolution and management will be needed necessary research and systematization of their general and specific characteristics. Additional conditions that will examine updated and other issues related to various aspects of personal and organizational conflicts should be investigated. Until action or expression occurs, conflict is latent, lurking below the surface.
Looking at the developed countries as a reference case, a more team approach to health care and flexibility of resources is noticed. Since private health in Serbia begins with the application of these practices, it is clear that the change causes conflict in most cases. Negligence of employees as the cause of conflict in both groups necessarily results in conflicts. By adopting a different system of evaluation in health care institutions, employee sets new standards, both in the provision of health services, as well as in treatment of employees. Focusing on the process, not just the outcome one person desires, is key to productive conflict management. But above all, for several years now, health care experts have been issuing warnings about an impending disregard of government in expanding its role in primary health care. Health care reforms would increase government involvement in the Serbian health care system by enabling pre-employment and on-the-job training since healthcare workers need specialized skills, most of which require specific educational qualifications. Finally, by resolving financing problems in primary health care, the tensions between the opposing sides and conflict situations should be maintained at a moderate level in order that they function in harmony with one another.

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