Management of telecommunication operator services in Serbia – Case study Eastern Serbia

BILJANA STOJAN ILIC
Faculty of Management Zajecar
Megatrend University of Belgrade
Boulevard of Marshal Tolbukin 8, Belgrade
SERBIA

SAFWAN A. SALAIMEH
Dean of Information Technology Faculty,
Aqaba University of Technology
Aqaba, JORDAN

Abstract: The development of telecommunication technology in the last three or more decades has created the conditions for high quality and high speed data transmission between physically separated devices (central computers, terminals, mobile devices). Telecommunication can be defined as the electronic connection of physically (geographically) remote computers, and the telecommunication system as a component of compatible telecommunication devices connecting physically separated devices that can transmit text, image, audio and video information. The paper focuses on the choice of telecommunication providers in Serbia. It examines the attitudes of service users and what influences their choice of a particular mobile network. Consumer attitudes can influence the improvement of service management of mobile operators in Serbia. The paper represents a modest contribution to the use of telecommunication technologies to improve the existing offer on the market of mobile operators in Serbia and especially in the eastern region of the country. The city of Zajecar, the largest city in the eastern region of Serbia, is included in the study as a representative example.

Keywords: Telecommunications, Technology, Mobile Operators, Service Management, Consumers, Markets, Serbia, Eastern Serbia.

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1 Introduction

Special systems are used for the transmission of telecommunication signals or messages, which may consist of wires or be based on radio, optical or electromagnetic waves [1]. "Communication - the exchange of information - is essential both for the social life of mankind and for the organization of nature" [2]. The term telecommunication defines the field of human activity that has the task of transmitting signals, messages, words, signs, records, images and sounds or the transfer of information between two or more remote users [3]. Is it possible to "improve" the services of new technology? What else can be offered to the users of services in the field of modern telecommunication systems? Is it possible to improve the business of mobile operators in the growing global market and in what way? These are some of the questions that the author will try to answer by making a modest contribution in the part related to the management of telecommunications services. This study aims to highlight common characteristics and problems related to the attitude of consumers of mobile telecommunication technologies, using the current mobile operators in Serbia as an example. The study highlights how to improve mobile services in Serbia, i.e. how to improve service management.

2 Literature review

The word telecommunications consists of the Greek word *tele* (Greek: τηλε), which means far, and the Latin word, *communicare*, which means to share. [4]. Telecommunication systems have the following functions: Establishing a connection and transferring information between sender and receiver; determining the direction of message flow in the most efficient manner; performing the most basic information processing to ensure that the correct message reaches the correct receiver; controlling possible errors and controlling the flow of information; converting message transmission at one speed (e.g., computer speed) to the speed that a communication line can achieve [5][6]. Signals carrying different information over communication networks can be represented as analog and digital. The analog signal is represented as a continuous line so that the positive voltage is represented by a + 1 and the negative by 0 [7]. The baud rate is measured in bits per second by default. Since a digital signal is more discrete than a continuous system, it must be translated to an analog signal if you want to transmit it over an analog system [8][9]. For example, if it is necessary to transmit data over telephone lines that operate on analog signals, the conversion from digital signals to analog must be done [10]. However, the development of new technologies and innovations has primarily contributed to the emergence of new connections between people, a new modern business and the environment in which business takes place.

The modern business environment is very dynamic, unpredictable, turbulent, characterized by a shorter life cycle of products or services, by a pronounced competition on a global scale, by the transition of society from an industrial society to a society where knowledge is treated like a critical resource in business - by the volatility of the market and economic conditions [11]. Cellular mobile communications, or cellular telephony, is the technology with the fastest exponential growth. Since 1982, when the first cell phones appeared, and until today, mobile devices are used by more than 5 billion people on the planet or a little more than 70% of the world's population [12]. The constant evolution of data transmission technology has produced several generations of mobile systems, some of which are divided into subcategories. The four basic generations are 1G, whose development began in West Germany in 1972, 2G, better known as GSM (Global System Mobile Communications), 3G or UMTS (Universal Mobile Telecommunications Systems), 4G, and 5G, which is still under development and whose standard is based on needs [13]. Codecs based on different Quality of Service (QoS) requirements are used. One of the most important QoS requirements is that packets are transmitted in real time through the network. The one-way transmission time or end-to-end (ETE) packet delay and the packet delay fluctuations or jitter must be below the threshold values. [14].

2 Problem Formulation - Telecommunication Operators in Serbia

The first mobile operator in Serbia was Mobtel (short for Mobile Telecommunications), founded in April 1994 by the Serbian state-owned company PTT (Post, Telephone, Telegraph) and BK Trade, a private company from Russia. According to a survey conducted by the Regulatory Authority for Electronic Communications and Postal Services (RATEL), there are currently 8.65 million active cell phone users in Serbia, which is more than the population [16]. Today, mobile phone services are provided by three companies:

- Telecommunications Company Telekom Srbija Joint Stock Company, Belgrade; 58.11% owned by the Republic of Serbia, 20% owned by Telekom Srbija, 14.95% owned by citizens of the Republic of Serbia and 6.94% owned by current and former employees of Telekom Srbije a.d. and its predecessor.

-Telenor DOO (limited liability company) Belgrade; (until March 1, 2022 - 100% owned by "PPF TMT Bidco 1 BV", a company from the Netherlands). The ownership of the company was changed, as well as the name of the company, and Telenor was renamed Yettel (on Murch, 2022). However, in this paper, the name Telenor is used, as the investigation was conducted before the upcoming changes.

-A1 Serbia DOO Belgrade; 100% owned by Mobilkom CEE Beteiligungsverwaltungs GmbH of Austria [17]. All three operators have individual licenses for the use of radio frequencies based on public tenders (licenses) for the public mobile network and public mobile network services on a technology-neutral basis. Licenses have also been awarded to two mobile virtual operators: Globaltel and Mundio Mobile d.o.o.

The operators use GSM (2G), UMTS (3G) and LTE (4G) technology. In this paper, research is conducted for the first three mobile operators: Telekom, Telenor and A1. Operators: Globaltel and Mundio Mobile are still in their infancy and do not have a sufficient presence on the mobile communications market in Serbia.

2.1 Eastern Serbia - The city of Zajecar

The author conducted the research in the eastern part of Serbia, more precisely in the area of the city

of Zajecar. The research covered 3 smaller areas, i.e. villages belonging to the region of the town of Zajecar, including the population of Zajecar itself. Zajecar is the administrative center of Zajecar district and also one of the largest cities in Eastern Serbia. According to the last census (2011), the city had about 44,000 inhabitants [18]. In 2011, for the first time, several suburban settlements moving towards Zajecar were included in the urban settlement: Grljan, Zvezdan, Veliki Izvor. These are places that are also covered by the research. The town is located in the Zajecar valley on the Veliki Timok river. Zajecar is located between two mountain ports - Carpathians and Balkans, and this part of Serbia is classified as rural part of the country [19]. Given this geographical location of the town - the valley between the two mountains - mobile operators often face problems with the installation of appropriate equipment (relays) for mobile network coverage in the whole area. The Serbian Regulatory Authority for Electronic Communications and Postal Services conducted the benchmark of mobile networks in Serbia in 2021 (in the months of September, October and November). Then, the values of quality parameters were measured and calculated, as well as the overall result showing the best telecommunication network in Serbia [20]. According to the performance rankings of mobile networks, which include: Voice service with 40% share in the overall result; Web browsing with 22.80% share in the overall result; Data transmission services with 15% share in the overall result; YouTube with 13.20% share in the overall result; The messaging service (via WhatsApp application) with 9% share in the overall result, it was evaluated by the users that the best quality of service is provided by the mobile operator "Telekom Srbija" (with a score of 89.7 points), in second place is Telenor and in third place is A1 [21]. What this research lacked was a detailed analysis of all regions in Serbia, especially the less developed rural regions, which include the region of Eastern Serbia, the city of Zajecar.

The author decided to study the attitudes of consumers of mobile operators in the market of the eastern part of Serbia, in the city of Zajecar, because the city has a very characteristic demographic structure (mostly 45 years old), but also lower incomes (salaries) of employees. compared to other regions of the country [22]. There is a pronounced regional inequality in Serbia, and the western regions of the country are much stronger economically and socially than the eastern and southern parts of the country [23] [24].

2.1.1 Methodology

The paper applied the method of field research, since the secondary data were not sufficient to shed light on the phenomenon of the use of telecommunications providers in the Eastern part of the country. The method of interviewing consumers of mobile operators was used and for this purpose an anonymous questionnaire was prepared. A total of 241 randomly selected individuals were included in the study.

Of the seven questions, four were general in nature and related to gender, age, education level, and occupation. The last three questions of the survey were comprehensive in nature and related to the services provided by the mobile service providers. The questions were phrased as follows: a) Which of the three official mobile networks in Serbia (Telenor, Telekom and A1) do consumers use; b) On a scale of 1 to 5 (1 - not important, 2 - less important, 3 - important and not important, 4 - important, 5 - very important), respondents were asked to rate how important the following services provided by telecommunications providers are: Speed, package price; good network coverage; Internet; the possibility to buy a mobile device in installments - a cheap purchase; c)The next question was related to the level of satisfaction with your mobile operator, according to the following ratings and descriptions: 1 - Very dissatisfied; 2 - Dissatisfied; 3 - Neither (average); 4 - Satisfied; 5 - Very satisfied; d) Finally, respondents were asked to express their opinion about the improvement of the mobile network and telephone service in Serbia, using a free formulation. The statistical method of multiple logistic regression was used for data processing in the study, but also the descriptive method. Multiple logistic regression is used when the researcher models a predictive relationship between one or more independent variables and more than one binary dependent variable, in other words, logistic regression models can be useful when the dependent variable is not binary and/or the categories are not ordered or arranged [25]. The formulas for calculating multiple logistic regression are represented by the numbers 1, 2, and 3.

$$ln\frac{Pr(Yi=1)}{Pr(Yi=K)} = \beta 1 \cdot Xi(1)$$

$$ln\frac{Pr(Yi=2)}{Pr(Yi=K)} = \beta 2 \cdot Xi(2)$$

$$ln\frac{Pr(Yi=K-1)}{Pr(Yi=K)} = \beta k - 1 \cdot Xi(3)$$

Where $\mathbf{X}i$ is the vector of explanatory variables describing observation i, $\boldsymbol{\beta}k$ is a vector of weights

(or coefficient regression) corresponding to outcome k, and score ($\mathbf{X}i$, k) is the score associated with assigning observation i to category k. In discrete choice theory, where observations represent people and outcomes represent choices, the score is considered the utility with a person i choosing outcome k. The predicted outcome is the one with the highest score [26].

The aim of the research was to predict the behavior of mobile service users for three operators on the Serbian market based on the following predictors or regressors: gender, age, occupation, and education level. For this part of the research, a descriptive method was used in addition to the multiple logistic regression method.

3 Problem Solution

Of the total 241 respondents, 111 respondents were female, while 130 respondents were male. The number of people by age ranged from 18 to 70 years old - with most people being over 45 years old (183). By occupation, most respondents were retired (91), followed by employees in education, law, or another public agency (82), health care workers (22), and the fewest unemployed (15).

By education level, most respondents had a secondary or higher education degree - 185 respondents, while 43 respondents had a university degree, completed university, or had a master's degree. Only 15 respondents had completed primary education. The parameters related to the offer of operators in Eastern Serbia: Telenor, Telekom, and A1 belong to the I (first) variable, i.e., the basic research variable.

Table 1 shows how many of the respondents use the mobile operators in Eastern Serbia. 65 respondents voted for Telenor, 82 for Telekom, and 94 for A1. In preparing the analysis, the users of A1 operators (group III) were taken as the reference base (or base category) against which the other two groups were compared. Another category could also be taken for the reference group, but not because other comparisons made no sense, as most respondents voted for the A1 mobile network.

Table 1 Structure of surveyed respondents by mobile operator

		Number	Percentage
Operator	Telenor	65	27,0%
	Telekom	82	34,0%
	A1	94	39,0%
Valid		241	100,0%

Source: author's research

Since the attitudes of respondents from the eastern part of the country differ from those of respondents throughout Serbia, the author wanted to investigate the main reasons for using the mobile operator A1 - over Telenor and Telecom. The mobile operators were considered with the following parameters of the respondents: Age, Education and Prices.

Table 2 shows "Model Fitting Information" - includes a likelihood ratio chi-square test that compares the full model (i.e., that includes all predictors) to a null model (or a model that considers only the intercept) [27].

Statistical significance indicates that the full model represents a significant improvement in fit over the null model, as you can see in Table 2 [$\chi^2(16)=222.515$, $p<.001$].

Table 2 Model Fitting Information

	Model Fitting Criteria	Likelihood Ratio Tests		
	-2Log Likelihood	Chi-Square	df	Sig.
Intercept Only	527,540			
Final	305,026	222,515	16	0,000

Source: author's research

Table 3 - "Goodness of Fit" - includes the Deviance and Pearson Chi-Square tests, which are useful for determining whether a model has a good fit to the data. Non-significant test results are indicators that the model is a good fit to the data [28][29]. According to Field and Petrucci (Field and Petrucci did not always necessarily agree), the result is mixed, based on the example for social researchers of how to perform multinomial logistic regression [30].

Table 3 Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	296,764	448	0,000
Deviance	303,639	448	1,000

Source: author's research

Pearson's chi-square test indicates that the model does not fit the data well ($\chi^2(448)=296.764$, $p=0.000$), whereas the Deviance chi-square does indicate good fit ($\chi^2(448)=303.369$, $p=1.00$)

Table 4 Pseudo R-Square – analogni parametri koeficijetu determinacije

Cox and Snell	0,600
Nagelkerke	0,676
McFadden	0,421

Source: author's research

Table 4 shows pseudo R-squared values treated as rough analogs to the R-squared value in OLS (Ordinal Logistic) regression. In general, there is no clear guidance in the literature on how these values should be used or interpreted [31]. The explained variability is above 50%.

Table 5 - Likelihood Ratio Tests - presents the total contribution of all variables (regressors) with respect to the dependent variable (all operators) from the study - includes the total contribution of each independent variable in the model. Using the conventional statistical error threshold of 005% in the model, the table shows that age, school, and price are the most important predictors (regressors) in the model.

In other words, these variables are the determining factors in choosing a cellular service provider. Thus, from the perspective of mobile operators, it is possible to plan future marketing and management strategies in the market of telecommunications technology in Eastern Serbia. Other variables have no statistical significance and are therefore not considered.

Table 5 Likelihood Ratio Tests

Effect	Model Fitting Criteria	
	-2 Log-Likelihood of Reduced Model	Sig.
Intercept	330,700	0,000
Age	**454,751**	**0,000**
Job (Occupation)	307,361	0,311
Education	**324,324**	**0,000**
Speed	306,760	0,420
Price	**331,728**	**0,013**
Coverage	307,277	0,324
Internet	325,564	0,093
Purchase option	305,402	0,829

Source: author's own research

Table 6 The final result of Multiple regression analysis

Mobile Operator		B	Sig.	Exp(B)
Telenor	Intercept	10,584	0,000	
	Age	**-0,463**	**0,000**	**0,629**
	Occupation	0,234	0,498	1,264
	Education	**1,498**	**0,000**	**4,472**
	Speed	0,490	0,251	1,632
	Price	**-0,422**	**0,005**	**2,025**
	Coverage	0,787	0,154	2,197
	Internet	-,430	,528	,651
	Purchase	0,211	0,645	1,235
Telekom	Intercept	6,843	0,000	
	Age	**-0,221**	**0,000**	**0,802**
	Occupation	0,371	0,144	1,450
	Education	**0,426**	**0,097**	**1,531**
	Speed	0,408	0,216	1,504
	Price	-0,425	0,090	0,883
	Coverage	0,217	0,585	1,242
	Internet	-,342	,488	,710
	Purchase	0,215	0,543	1,240

Source: author's own research

The results from Table 6 represent comparisons between each group of respondents determined for one operator with the reference category (group III), ie the users of the mobile operator A1. In particular, the regression coefficients show which predictors - regressors (age, education, price) significantly differentiate the groups of respondents - determined users of Telenor and Telekom mobile networks, from the respondents who are determined for A1 mobile operator. The B column contains regression coefficients (expressed in the metric of log-odds). The Exp(B) column contains odds ratios [28] [29] [31].

The first set of coefficients represents comparisons between A1 users (Group III in Table 1) and those who are Telenor users (Group I in Table 1). Significant predictors (regressors) were: age, education (B = -0.463, p <.001), and price in the model. From the analysis, it can be concluded that younger people opted more for Telenor mobile operators (average age is 42; standard deviation is 11.7 compared to the range of 20 to 70). The result of 0.629 indicates that for each unit in the variable "age" - when it increases - the chances of using the mobile operator Telenor decrease and increase the chances of using the A1 mobile operator. In other words, the older the respondents (over 42 years old), the more they opt for the A1 mobile operator.

When it comes to school regressors, a positive regression coefficient is evident, which can be seen in Table 6. Respondents with higher education opted for the mobile operator Telenor, while respondents with lower education opted for mobile operator A1. In other words, almost 4.5 (4,472 from Table 6) times more likely to be more educated respondents to opt for the mobile operator Telenor (B = 1,498, p <.001).

The third significant predictor or regressor in the model was the price of services, especially to the mobile operator Telenor (B = 0.422, p <.005). Respondents gave a poor rating for the price of services of the mobile operator Telenor (slope regression parameter has a negative sign). The odds ratio of 2,025 from Table 6 indicates that for each unit of price dissatisfaction increases, the odds are reduced by two times when choosing a Telenor operator, and the same is increased for choosing an

A1 operator. In other words, the price was the deciding factor for the choice of using the mobile operator A1 in Eastern Serbia.

The situation with the mobile operator Telekom was similar to that with Telenor (except for the price, because this regressor was not significant with Telekom, ie - logically - it was in the middle, between A1 and Telenor). Thus, from the analysis presented in Table 6, it can be concluded that younger people opted for Telecom more (average age is 43; standard deviation is 11.8 compared to the range of 20 to 70). The result of 0.802 indicates that for each unit in the variable "age" - when it increases - the chances of using Telecom decrease and increase the chances of using A1 mobile operator. That is, the older the respondents (over 43 years old), the more they opted for the services of the mobile operator A1.

The regressor of school readiness also had a positive regression coefficient, in Table 6. Respondents with a higher level of education opted for the Telecom mobile operator, while respondents with a lower level of education opted for the A1 operator. That is, almost 2 (1,531 from Table 6) times more likely to be more educated respondents to opt for Telecom (B = 0.426, p <.001) than for operator A1 and vice versa, twice as likely to be less educated respondents to opt for mobile operator A1 to Telekom mobile operator.

Table 7 Classification table

	Predicted			
Observed	Telenor	Telekom	A1	Percent Correct
Telenor	52	14	0	78,8%
Telekom	12	73	9	77,7%
A1	4	9	70	84,3%
Overall Percentage	28,0%	39,5%	32,5%	**80,2%**

Source: author's research

Table 7 presents the classification of statistics, which is used to determine which group of respondents is most suitable for predicting results (representative group). The table shows that this is the group of respondents who use the mobile network of operator A1, or group III (in Table 1) - the largest percentage (80.2%).

The author points out the following observations. According to the parameters taken into consideration, the respondents estimated that the best mobile network in the Eastern part of Serbia, in the territory of the city of Zajecar - A1 is a mobile operator, while Telecom is in third place. There are several logical explanations for why the respondents from the Eastern part of Serbia are not as determined to use a mobile operator as the respondents in the entire territory of Serbia (who stated that the mobile operator Telekom is the best).

The older respondents in the territory of the city of Zajecar, in Eastern Serbia, are mostly pensioners, who following their pensions use the most favorable services, that is - for them the price is a crucial factor when choosing a mobile network. Operator A1 offers the most favorable packages and services within them, with unlimited calls to all networks and messages, which is very important for retirees. Such packages are the cheapest with the A1 operator.

The demographic structure of the city of Zajecar, with the surrounding nearby places, has more characteristics of the older population (average age of the population in the city of Zajecar - 47 years). Therefore, this result is not surprising. However, the younger population, which in the minority opted more for the other two mobile operators - Telenor (recently Yettel) and Telecom, mostly due to good network coverage. Members of the younger population travel more, and the availability of the network at all times is the most important parameter. Respondents with higher education were more in favor of using the services of mobile operators Telenor and Telekom, mostly due to the good share of the Internet within the mobile package. Namely, this group of respondents pointed out the importance of connection to the Internet, because they mostly use the services of the Internet (e-mail) when communicating.

4 Conclusion

Summarizing the results of research and attitudes of users of telecommunications operators in Eastern Serbia, the main recommendation is for mobile companies - to do good market segmentation throughout Serbia - to offer a more complete service depending on the region and attitudes of users, age, and other criteria. Asked about the degree of satisfaction of service users with the mobile operator, the results of users are far more in favor of the mobile operator A1. Out of a total of 94 (Table 1) respondents who are also users of the A1 mobile operator - as many as 92 respondents rated the services of this mobile network with a score of 5 - ie they gave the highest score to the question regarding satisfaction with the mobile network they use. Also, this group of respondents had the least objections in the last question from the survey, which referred to the way of improving the service of the mobile operator. In contrast to this group, respondents who opted for Telenor mobile operator (65 users - Table 1), in most cases were very dissatisfied with their mobile network. When asked how to improve the

service, the answers were mainly based on - reducing the price of the package, with an additional increase in the Internet tariff. Given that market segmentation takes place through rough and fine segmentation, depending on the product or service offered, for mobile operators operating in Serbia, it would be desirable to apply fine segmentation, especially when examining regional markets within the country.

Fine segmentation would represent a complex description of segments (product functions, package form, groups of mobile devices offered on the market within the package, with the possibility of purchasing in several installments). Therefore, mobile operators should pay more attention to the specialization of products - mobile packages, in several different market segments. Greater attention should also be paid by mobile operators in Serbia to the specialization of the market, in terms of meeting more diverse needs, for certain groups of consumers. This recommendation could be particularly relevant to the region of Eastern Serbia.

Product characteristics are considered to be more conducive to market segmentation than consumer characteristics. However, when the case is viewed from the point of view of mobile operators in Serbia, market segmentation should be done within the prices of mobile service packages, anticipating market potential, by defining the appropriate marketing mix for each market segment.

Analyzing the factors of competition, telecommunications mobile operators in Serbia could predict their market share in each segment, make a cost-benefit assessment, in other words, determine the "benefit" in terms of income following the company's goals, ie mobile companies.

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