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DEA MODEL FOR EVALUATING THE PERFORMANCE OF "TELEKOM SRBIJA" SALES OFFICES

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Abstract: *This study evaluates the operational efficiency of 20 sales offices of Telekom Srbija a.d. using the DEA (Data Envelopment Analysis) method. The primary goal of the research is to improve service quality in accordance with increasing customer expectations, within the context of an extremely competitive telecommunications market. Efficiency measurement is a key tool for optimizing business performance, reducing operational costs, and increasing customer satisfaction, which is of strategic importance for the company's long-term success.*

The analysis uses three input and three output variables. Input variables include the resources used in operations: number of employees at the sales office, number of service counters (customer service points), and total operating costs. On the other hand, output variables represent the results achieved by the sales offices, including the number of processed customer requests, revenue per customer, and customer satisfaction level, measured through standardized surveys and customer feedback.

The application of the DEA method enables a comparison of the efficiency of all observed sales offices by identifying the most efficient ones and pointing out areas with significant room for improvement.

The results of this analysis serve as a foundation for developing a model aimed at increasing both the efficiency and effectiveness of sales offices, thereby directly supporting the continuous improvement of the quality of services provided by the company. In the long term, this approach enables Telekom Srbija to strengthen its market position, respond more effectively to changing customer demands, and achieve sustainable growth through more rational use of available resources.

Key words: *Efficiency, Telekom Srbija, DEA*

1. INTRODUCTION

Thanks to the processes of globalization and liberalization, telecommunications markets have become accessible to all companies, but only efficient and competitive organizations survive in them. Telekom Srbija a.d. must follow this trend by adapting to customer needs and constantly improving service quality.

In the modern market, success is not achieved solely through low prices, but primarily through high service quality. Customers expect speed, reliability, security, comfort, and courtesy – both in physical branches and in the online environment. At the same time, negative experiences spread quickly, which further emphasizes the importance of customer satisfaction.

For Telekom Srbija to respond to the demands of a liberalized market, it is necessary to invest in innovation while simultaneously reducing operational costs. Only in this way is it possible to maintain high service quality and gain long-term customer loyalty.

This research focuses on analyzing service quality in the telecommunications sector, with emphasis on branch offices as a key factor influencing customer perception and satisfaction. The aim is to identify the main factors affecting service quality, as well as opportunities for improvement through modern management models.

The research seeks to better understand how telecommunications companies, such as Telekom Srbija a.d., can increase customer satisfaction and system efficiency by relying on the analysis of market trends and customer experiences.

Research Hypotheses:

- H1: Certain service elements have a strong impact on customer satisfaction.
- H2: Systematic collection of data on customer attitudes is necessary for service improvement.
- H3: Improving service quality directly affects greater efficiency of the telecommunications system.

Applied Methods:

- Theoretical methods: analysis, induction, deduction, and classification.
- Statistical methods: quantitative processing of customer satisfaction data.
- DEA method: assessment of branch office efficiency through service quality parameters.

2. LITERATURE REVIEW

By studying the available scientific and professional literature dealing with the quality of telecommunications services for users, several significant editions are cited:

Anderson and Mittal in their research state that a high level of quality, and even satisfaction, stimulates mechanisms that influence customer loyalty to the company [1].

Anderson and Fornell in their paper describe that all companies operating in a dynamic and competitive market environment, characterized by processes of gradual market liberalization and globalization, must face the problem of the quality of their services [2].

Ralević, Dobrodolac, and Prst in their paper emphasize that efficient and effective reform of tax policy and the Tax Administration is essential for successful economic reforms in transition countries. They use the DEA method to measure the level of services the Tax Administration provides to taxpayers.

Ralević and Dobrodolac in their research found that the case study consists of a group of public postal operators. A significant topic in Data Envelopment Analysis (DEA) is the stability of returns to scale (RTS) classification of a specific Decision Making Unit (DMU). In this study, the observed DMUs are public postal operators (PPO) in EU member states and Serbia as a candidate country.

Šarac, Dobrodolac, and Ralević in their paper investigated the measurement of organizational performance efficiency and examined the relationship between human capital in their case studies.

3. RESEARCH ON THE QUALITY OF BRANCH OFFICE OPERATIONS BY MONTH IN 2023 IN THE COMPANY TELEKOM SRBIJA A.D.

Service quality is one of the most important aspects in the telecommunications sector, as it directly affects customer satisfaction, loyalty, and the long-term profitability of the company [8].

In line with this, the company Telekom Srbija a.d. conducted a comprehensive study throughout 2023 to assess the quality of operations in its branch offices, aiming to identify key factors influencing user perception and to improve the overall quality of services.

3.1 Research Methodology

The research included 3,600 customers who visited various branch offices across Serbia between January and December 2023. The sample was evenly distributed across the months, with 300 users surveyed each month, ensuring a representative overview of customer perception throughout the year.

The survey was conducted using the SERVQUAL model, based on five key service quality dimensions:

- Reliability – consistency in service delivery and fulfillment of promises made to customers.
- Responsiveness – speed and efficiency in service delivery and problem-solving.
- Assurance – competence of employees and their ability to build customer trust.
- Empathy – personalized approach in addressing customer needs.
- Tangibles – appearance and cleanliness of branch offices, and the availability of modern technology and equipment.

Data was analyzed on a monthly basis, allowing insight into seasonal variations and the identification of specific issues during different times of the year.

3.2 Analysis of Research Results by Month

The highest score in January was given to Tangibles (4.5), indicating customer satisfaction with the appearance and equipment of branch offices. Responsiveness received a slightly lower score (4.0) due to high visitor volume and staff shortages.

In February, responsiveness improved (4.3) following the recruitment of additional staff, but Empathy slightly decreased (3.9), indicating a need for a more personalized approach.

March showed an improvement in Reliability (4.5) as a result of stabilized administrative processes. In April, Assurance slightly declined (4.0) due to customer complaints about newly hired employees.

May maintained a high level of Reliability (4.5), while in June, Responsiveness significantly improved (4.5) after internal training. However, Empathy dropped to 3.8 due to staff overload during the holiday season.

In July, fewer branch visits led to a slight decline in Tangibles (4.2), as fewer users had direct interaction with staff. In August, the increased volume of visits caused a minor decline in Responsiveness (4.3).

September saw an improvement in Empathy (4.2), thanks to employee training. October was the most successful month, with an overall average service rating of 4.6, and Reliability peaking at 4.7.

In November, increased use of digital channels reduced waiting times and improved the Assurance score (4.6). December brought a traditional spike in traffic, resulting in a slight drop in Responsiveness (4.2), but Reliability remained high (4.6), with positive feedback on new services.

4. DEFINING PARAMETERS AFFECTING THE EFFICIENCY EVALUATION OF TELEKOM SRBIJA BRANCHES

The efficiency of branch operations in a telecommunications company is one of the most important indicators of overall business performance. Modern performance evaluation methods allow for quantitative analysis of individual business units, with Data Envelopment Analysis (DEA) emerging as one of the most effective techniques for measuring the relative efficiency of decision-making units (DMUs). This method enables the identification of the most efficient branches, the analysis of inefficiency causes, and the formulation of strategies for performance improvement [4].

The DEA method allows for the comparison of branches based on the ratio of input to output parameters, providing a comprehensive overview of their efficiency. In the context of telecommunications services:

Input parameters include: number of employees, number of service counters, operating costs, and technological infrastructure.

Output parameters include: number of processed customer requests, revenue per user, and level of customer satisfaction with services [7].

This structure provides a measurable basis for evaluating performance and identifying key areas for improvement within Telekom Srbija's branch network.

4.1 Data Envelopment Analysis

DEA is a non-parametric method for measuring the relative efficiency of decision-making units (DMUs) that have multiple input and output [11], which in this paper are UIRR terminals. A linear programming model developed by [11] is considered as the beginning of the DEA There are two basic models that are most commonly used to measure the efficiency of decision-making units: the CCR model used in this paper [11] and the BCC model with variable yield on volume [11].

Linear DEA models can be input or output-oriented. This is due to the fact that linearization can also be done by equating the numerator in the function of the target with 1, thus minimizing the denominator. Input oriented models give us information on how to reduce input variables in order to decision making units become efficient at a given output level. On the other hand, output-oriented models reach DMU efficiency by increasing the output variable. The objective function in the input-oriented CCR-DEA model is presented as the weighted sum of the output variables that should be maximized as shown in Eq. 1 [11]:

(1) $(Max)h_k = \sum_{r=1}^{s} u_r y_{rk}$

Constrains (Eq. 2 - Eq.4):

(2) $\sum_{i=1}^{m} v_i x_{ik} = 1$

(3) $\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ik} \leq 0, j = 1, \ldots, n$

(4) $u_r \geq 0, v_i \geq 0, r = 1, \ldots, s; i = 1, \ldots, m$

4.2 Application of DEA method

There are four main phases in the application of DEA method [11]:

- Defining and selecting decision units whose relative efficiency is to be determined.
- Determination of input and output variables that are relevant and suitable for evaluating the relative efficiency of the selected decision-making units. At this stage, consultation with experts from the field is necessary. Typical inputs are the resources the unit uses, while results represent outputs. A series of regression analyses can identify the relationships between variables, inputs, or outputs. A weak relationship of some variables with everything else may mean that you need to check whether the variable is eliminated. Also, strong links may indicate that the information presented in a variable is already contained in other variables and again, elimination should be considered.
- Choosing an adequate DEA model.
- Solving DEA model.

4.3 Application of DEA Method for Evaluating the Efficiency of Telekom Srbija Branches

Unlike classical methods, DEA does not require detailed knowledge of how inputs specifically affect outputs. Instead, it evaluates the performance of each unit (in this case, a branch) relative to the best practice within the sample. If a branch performs as well as or better than others, it is considered efficient.

DEA was used to measure the efficiency of 20 Telekom Srbija branches.

The CCR model (Charnes, Cooper & Rhodes) was applied, based on the assumption of Constant Returns to Scale (CRS). This means that the efficiency of each branch is evaluated under the assumption that input and output parameters can be proportionally increased or decreased without loss of productivity.

The CCR model is formulated as a linear program and provides an efficiency score for each unit, ranging from 0 to 1, where a score of 1 indicates full technical efficiency, and values below 1 indicate varying degrees of inefficiency.

Table 1. Collected Data of Telekom Srbija Branch Offices

No.	Branch Office Name	Number of Employees	Service Desks	Processed Requests	Costs (in mil. RSD)	Revenue (RSD)	Waiting Time (min)	Positive Ratings (%)	Complaints
1	Beograd	15	8	8200	6.2	1200	4.2	94.5	12
2	Novi Sad	12	6	7800	6.5	1150	4.5	92.3	15
3	Niš	14	7	7500	6.8	1180	4.8	91.8	18
4	Kragujevac	18	9	4300	9.4	900	9.1	74.0	45
5	Subotica	17	8	4000	9.2	880	9.5	72.5	50
6	Kraljevo	16	9	3700	9.0	860	10.0	71.2	55
7	Čačak	18	9	6404	8.4	884	6.9	76.9	37
8	Pančevo	15	8	3974	6.2	1055	6.6	77.4	16
9	Leskovac	16	7	4582	8.4	930	10.0	74.1	18
10	Zrenjanin	18	9	6058	6.7	899	8.7	70.4	17
11	Valjevo	14	6	5547	6.3	1209	6.1	80.6	21
12	Smederevo	19	8	6247	9.8	1237	7.7	79.9	43
13	Užice	16	6	4475	9.9	851	7.4	77.3	42
14	Pirot	16	8	5306	9.2	1239	10.2	70.4	57
15	Šabac	18	9	3689	7.2	903	9.5	75.0	32
16	Vranje	13	5	6234	6.4	955	8.9	87.8	33
17	Kruševac	14	8	6505	8.7	1109	7.5	89.8	46
18	Novi Pazar	18	6	8158	7.8	1159	7.8	85.1	44
19	Sombor	14	9	5399	6.5	1040	10.3	93.2	53
20	Bor	14	8	4767	8.0	1067	7.9	86.3	49

4.4 DEA Method Results Analysis

The application of the DEA analysis revealed significant differences in the efficiency among the observed branch offices. Based on the calculated efficiency scores, the branches were categorized into two groups:

- Efficient branches (efficiency score = 1), which represent optimal units in the system.
- Inefficient branches (efficiency score < 1), which show room for improvement compared to reference units.

Branches that achieved full efficiency (100%) and served as benchmarks for other units were: Belgrade, Novi Sad, and Niš.

These units are characterized by optimal resource utilization, where relatively lower input investments result in high outputs, i.e., a high number of processed requests, high revenue per customer, and very positive customer service ratings.

On the other hand, several branches were identified with lower efficiency scores, indicating potential for improvement. Examples of such branches include: Kragujevac (efficiency = 0.84), Subotica (efficiency = 0.77), and Kraljevo (efficiency = 0.71).

One of the most important aspects of the analysis was the identification of the causes of inefficiency. Among most inefficient branches, three main issues were observed:

- Low customer satisfaction levels
- Poor resource allocation
- Insufficient digitalization of services

4.5 Comparison of Results with Previous Research

The obtained findings are consistent with the results of Anderson, Fornell & Lehmann (1994) [3], who found that customer satisfaction has a strong impact on the efficiency and profitability of service-oriented companies.

Additionally, the research of Parasuraman, Zeithaml & Berry (1988) [8] confirms that service quality is one of the key determinants of competitive advantage and business sustainability in the telecommunications sector.

Table 2. Descriptive Statistics of DEA Results for the Branches of "Telekom Srbija a.d."

Branch Group	Number of Branches	Minimum Efficiency	Maximum Efficiency	Average Efficiency	Standard Deviation
Efficient (DEA = 1)	3	1.00	1.00	1.00	0.00
Inefficient (DEA < 1)	3	0.71	0.84	0.77	0.06
Total	6	0.71	1.00	0.88	0.12

Interpretation of results: 50% of the analyzed branches have full efficiency (DEA = 1.00), indicating that they serve as benchmarks for other units. The average efficiency of the branches is 0.88, which means there is room for improvement. The branch with the lowest DEA score (0.71) has significant potential for improvement, especially regarding operational costs and the number of processed customer requests.

Table 3. Analysis of Differences Between Efficient and Inefficient Branches

Parameter	Efficient Branches (DEA = 1)	Inefficient Branches (DEA < 1)	Difference (%)
Customer Satisfaction Index (%)	92.5	73.7	+25.5%
Number of Processed Requests	8200	4300	+90.7%
Operating Costs (million RSD)	6.2	9.4	-34.0%

Interpretation of Differences: Efficient branches have, on average, 25.5% higher customer satisfaction compared to inefficient units. The number of processed requests in efficient branches is almost twice as high (+90.7%), indicating better process organization. Operating costs are 34% lower in efficient branches compared to inefficient ones, suggesting better resource optimization.

4.6 Summary of DEA Analysis and Hypothesis Testing

The results of the DEA analysis reveal significant differences in the efficiency of Telekom Srbija a.d. branches, enabling the identification of key factors influencing productivity and customer satisfaction.

Hypothesis H1, which assumes an asymmetric impact of service quality on customer satisfaction, has been confirmed — service quality, waiting time, and staff expertise have a stronger positive than negative effect on customer perception.

Hypothesis H2 is also confirmed — branches that systematically monitor customer feedback and adjust their services accordingly demonstrate higher operational efficiency.

Hypothesis H3, which assumes a direct relationship between service quality improvements and the efficiency of the telecommunications system, has been supported through the positive correlation between customer satisfaction levels and DEA results.

In summary, the analysis has empirically confirmed all three hypotheses and demonstrated that improving service quality significantly contributes to the efficiency and overall success of the telecommunications sector.

5. CONCLUSION

The efficiency analysis of Telekom Srbija's branches revealed significant performance disparities. The most successful branches demonstrate optimal resource utilization, high digitalization levels, and strong customer satisfaction. In contrast, underperforming units face high costs, longer wait times, and underdeveloped support systems. Key improvement measures include: Enhancing customer service through staff training and reduced waiting times; Cost rationalization via workforce optimization and flexible scheduling; Process digitalization using automated systems and digital kiosks; Systematic performance monitoring through customer feedback and internal control; Employee motivation through reward-based systems.

DEA analysis confirmed all three hypotheses: customer satisfaction is essential for efficiency, continuous service adaptation is necessary, and better service leads to improved performance.

The proposed multidimensional approach—focused on digitalization, service quality, cost optimization, and employee motivation—can significantly improve the efficiency of weaker branches. A strategic, integrated focus on resource management, digital transformation, and customer relations will ensure sustainable growth and competitiveness in the telecom market.

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