Prediction model of students' expectations and satisfaction with the quality of services provided at public Faculties in the Republic of Serbia

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Abstract. The goal of the present study was to develop a prediction model of students' expectations and satisfaction with the quality of services provided at public faculties in the Republic of Serbia. The study was conducted on a sample that included 1212 students from 13 higher education institutions of the University of Belgrade, University of Niš and University of Kragujevac. The designed questionnaire contained 34 statements related to assessing the quality of services provided by faculties, thus forming 5 independent variables. The prediction model was created using the Multilayer Perceptron (MLP). The validity of the model was assessed through the Receiver Operating Characteristic (ROC) prediction accuracy curve, which showed a high sensitivity of the model for both categories of the dependent variable. The high value of the Area Under the Curve (AUC) was 0.93 for both classification categories. This is confirmed by the high values of the AUC, which was 0.94 for the Dissatisfaction category and 0.95 for the Satisfaction category.

1. Introduction

Education is one of the foundations of a country's economic prosperity [35]. It has a very important, or key role in its socio-economic development [2]. The quality of university education in a particular country becomes a significant improvement factor in its global economy. According to Adutela et al., [3], education is the means by which individuals acquire the necessary physical and social abilities and skills needed for development. Therefore, the relevance of education for the overall development of a particular nation cannot be ignored. In addition, investing in education and human capital is essential for achieving human growth. Such investments lead to the improvement in people's quality of life, and provide social benefits for the entire society, all of which lead to an increase in people's productivity, i.e., their work. In addition, technological progress and entrepreneurship are in a mutual relationship that contributes to the growth of the literacy level of a country (nation). Additionally, globalization has led to an increase in the rate

of international students pursuing their education in different countries, leading to greater competition between nations. Many countries have adopted educational systems consisting of multiple programs that equip students in such a way that the knowledge and skills they acquire have an impact on success in the global economy [48].

One of the important goals of education is to meet the needs of students in terms of the general outcomes defined in the curriculum. The quality of university education, viewed through the prism of an educational institution, includes providing a service that meets the needs of not only students, but also academic staff, as well as other participants in the educational process. Participants of the educational process, fulfilling their usual obligations through designated activities, form a large amount of data and information, which should be collected in an appropriate manner, and then systematized and processed, so that they can be used adequately in the future. In this way, knowledge is actually generated from the collected data, through the aforementioned transformations, from which the entire academic community, as well as the society, benefits entirely [44].

However, the shortcomings of university education should also be noted, i.e. the elements that do not contribute adequately to the achievement of maximum performance at this level of education should be detected and analyzed. Looking at higher education, in many countries there is a widespread opinion that students in a final year do not have the appropriate skills for lifelong learning, nor the professional abilities needed to be successful in their professions [17]. In other words, there is a discrepancy between what employers are searching for when hiring and what students have acquired during the education. This indicates inadequate satisfaction with the quality of outcomes that universities provide. Satisfaction can be defined as the degree to which performance leads to meeting the expectations of students, as well as other partners of the faculty (companies, as well as society as a whole) [23, 33, 34]. Service users represent a control parameter of a particular institution, suggesting the extent to which universities and faculties are successful in satisfying not only needs and desires, but also in creating and providing dominant value to users. Therefore, it is very important to clearly recognize the level of expectations of users, whose goal is to create and provide appropriate value [23, 33, 34].

Satisfaction is said to represent the subjective analysis of the individual and the experience they can have. It is related to the characteristics of the service, actually, the perception of the gap between the received and expected benefits. Therefore, it is necessary to approach the organization and control of the academic and pedagogical quality of teaching with great care, as well as the infrastructure of the university, the quality of service of the administrative staff, more precisely, the services that are responsible for providing support to students in acquiring knowledge [12, 14].

Education represents the means by which individuals acquire the necessary physical and social abilities and appropriate skills needed for the development of society, and its importance for the overall development of a nation cannot be emphasized enough. Therefore, investment in education and human capital is most important for achieving economic growth. Such investments lead to an improvement in the quality of life of citizens, ensuring a social benefit for the entire society. In other words, investing in education contributes to increasing people's productivity. Moreover, technological progress and entrepreneurship are closely related to the education of the population of an observed country.

Globalization has led to a greater influx of international students studying in different countries, with an increasing rate of competition among nations. International students have the potential to yield cultural, economic and academic benefits to universities [48]. Consequently, nations are committed to providing adequate education for international students which would lead to an increase in human capital, which in turn leads to an increase in national labor productivity. In particular, student satisfaction with university services dictates the success of a country's university education. More specifically, it is important to determine whether universities are meeting the needs of their students [48].

With the advancement of technology and artificial intelligence in recent years, new opportunities have emerged in data analysis. Artificial Neuron Networks (ANN), represent a machine learning model inter-woven with a network of biological neurons representing an integral part of human brains [5, 7, 20, 59, 65].

2. Research hypotheses

The conducted research is a continuation of a study in which a prediction model of student expectations and satisfaction with the quality of services provided at public faculties in the Republic of Serbia was created. The key problem that arose as the research continued is related to the analysis of the dimensions of the created questionnaire. Based on an insight into the relevant literature that deals with the prediction of the characteristics of satisfaction in educational institutions, along with an analysis that has an impact on the implementation of teaching, with the aim of satisfying students, a theoretical framework was conceptualized for the creation of research on the functioning of the prediction model of students' expectations and satisfaction with the quality of services provided [6, 24, 31, 46, 47, 58].

In order to establish loyalty in an educational institution, it is necessary to predict student satisfaction beforehand. Satisfaction appears as a positive prediction difference between the expectations formed so far and the achieved experience with the service. User expectations are the result of understanding that the appropriate service will be provided to them in the desired way [6, 24, 31, 46, 47, 58].

Service quality is recognized as an indicator of organization or competitiveness [24, 62]. The service effect is considered a strategic weapon leading to the achievement of customer satisfaction prediction in the service industry. Organizations that offer superior quality can create a competitive advantage. For organizations to gain a competitive advantage, they need to offer superior service quality [37].

In its modern conceptualization, service quality represents a comparison between perceived customer expectations and organizational success. Consequently, private universities can use service quality that allows them to examine the level of predictors of student satisfaction, and then use this insight to modify their operations to maintain a competitive advantage in the global market [48].

Many authors [22] define educational services as "pure" services, and point to the importance of the quality of personal contacts and the important influence of the quality and behavior of professors on the perception of the quality of services by students. Based on previously conducted research [55], it is concluded that teachers' behaviors and attitudes should be the main definition of predicting students' perceptions of the quality of services provided at universities. It is observed how the personal values of students have an impact on their satisfaction, which is the result of the achieved quality and how it inevitably affects loyalty, but also the future promotion of the institution. Service research suggests that personal value systems can have a significant role in how users evaluate service quality compared to an institution [6, 23, 47].

Student satisfaction is a subjective assessment of the prediction of an individual, but also the overall experience of students, which is related to the characteristics of the service, as well as the perception of the gap that occurs between received and expected benefits. Accordingly, it is necessary to carefully organize, but also to control the pedagogical, i.e. academic quality of teaching, the infrastructure of the educational institution, the quality of services of non-teaching and teaching staff, i.e. services offered to students in learning. In order to improve the quality of services in educational institutions and achieve a higher degree of satisfaction among students, various prediction models for measuring the quality of services were applied [6, 14, 47].

Having the aforementioned in mind, one might conclude that it is necessary for educational institutions to measure the prediction of student satisfaction since students are viewed as key users. Therefore, the following research hypotheses were formulated:

Hypothesis H1: *The quality of the faculty's teaching staff will have a positive impact on the satisfaction and fulfillment of students' expectations.*

Satisfaction can also be explained as the level at which the performances lead to the fulfillment of the prediction of the expectations of students, as well as of other faculty associates. Service users, more precisely, students, constitute the control parameter of institutions in a way that shows the extent to which educational institutions are successful in satisfying needs and desires, creating and delivering inferior value to users [50].

Precise identification of the level of user expectations aims to create and deliver appropriate value [23, 47].

Thus we suggest:

Hypothesis H2: *The quality of the faculty's non-teaching staff will have a positive impact on students' opinion of the faculty and the fulfillment of students' expectations.*

Based on students' opinions, out of the eighteen proposed characteristics of a faculty, Kuk and Zaloko [9] underscore "excellent academic reputation" as the most important. Kricorian [36] focused additional attention on the academic reputation of the institution, which proved to be an extremely important element within the first factor that was singled out and called "academic". One of the more recent research studies [25] also showed that "reputation" was the most important predictive factor in the choice of a faculty by future students [6]. An investigation carried out in one part of Serbia [51] indicates that future students understand the image of the institution, based on the tradition of a particular institution, and at the same time its modernity, which is one of the key factors influencing the creation of the predicted degree of services of that particular educational institution.

Consequently, we suggest:

Hypothesis H3: *The reputation of the faculty as a higher education institution will have a positive influence on the opinion of students about the faculty and their satisfaction with studying.*

Teaching staff orientation towards students is an important feature of the quality of the relationship between the users. In order to improve relations with their users, faculties should focus attention on understanding and realizing student needs and effectively provide answers to certain prediction questions, i.e. students' dilemmas [16, 26, 32, 40, 50, 57, 64].

Hence we suggest:

Hypothesis H4: *The quality of the faculty's study programs will have a positive impact on academic performance and the fulfillment of students' expectations.*

Pertaining to the image of higher education and institutions, this element was highly ranked when ranking the prediction of decision-making among students in some of the previous studies [1, 19, 25, 29, 30, 41, 51, 56].

Some studies demonstrated [30, 41] that the image of the institution and the professor appeared as individual variables within the factors named in various ways. Within the factor called "Prominence", listed as the fourth most important [41], there are variables related to the reputation of the institution, as well as the reputation of the employees. Ivy [30] termed the aforementioned factor "Prominence", which is ranked second in terms of importance.

Thus we suggest:

Hypothesis H5: *The image of the faculty will have a positive impact on academic performance and the fulfillment of students' expectations.*

3. Method

The ANN model consists of connected nodes: an input layer, a hidden layer and an output layer, which can form one or more hidden layers that can connect next to the input and output level T. The role of the input layer is reflected in the collection of information from the outside world, but the role of the hidden layer is used in the analysis. The output layer provides class labels and, more precisely, continuous value predictions. The value obtained from the output layer is multiplied by the collection of integers, but also by the weight, while the product is added to obtain a single number. The following step consists of entering

this number into the activation function, i.e. a non-linear mathematical function whose role is to return values between zero and one (Figure 1). The following items represent the artificial neuron network [20].

The net sum of the calculated input that enters node j, while the activation function of the output itself is most often a *Sigmoid function*, which has the role of transforming the calculated input of the neuron into the activation of its output, is represented by the following formula:

$$S_i = \sum_{i=1}^{n} X_i W_{ij} \tag{1}$$

$$O_j = \frac{1}{1 + e^{Si}} \tag{2}$$

ANNs and neurons can have two modes of operation: usage mode and training mode. The training process teaches the algorithm how to predict the outcome by applying input and output information. The observed learning starts with random weights and adapts them to the task, applying descent range search methods such as back propagation. The differences between the output and the learned value, all as a function of error, are applied when starting learning [43]. For the next training set *(k1, t1), (k2, t2),..., (kk, tk)*, there are *n* inputs and an *m*-dimensional vector, which consists of ordered pairs. The output pattern is presented, while the output error for each neuron can be represented using the following equation:

$$E_j = \frac{1}{2} \left(o_j - t_j \right)^2 \tag{3}$$

While the error function can be represented as follows:

$$E_j = \frac{1}{2} \sum_{j=1}^{k} \left(o_j - t_j \right)^2 \tag{4}$$

Where o_j is the output produced when the input pattern is used; xj is the training set fed into the network and t_j represents the target value [43]. During the training mode, each weight can be changed by adding:

$$\Delta w_{ij} = -\gamma \frac{\partial E}{\partial w_{ij}} \tag{5}$$

Where γ is a constant representing the learning rate. Faster convergence and higher learning rate, while the search route can be trapped in the best case, can make convergence difficult. A neural network model can form another data set with an unknown output value and predict it automatically [7, 8, 65].

ANN include strong applications used in statistical modeling of structural equations (SEM) [65], while a group of authors [18] studied the abovementioned phenomenon using SmartPLS and SPSS software, as well as Importance and Performance Map Analysis (IPMA) to examine the influence of YouTube video content on Jordanian university students' behavioral intentions toward e-learning acceptance in Jordan. The research conducted by Yongliang [63] is based on the application of ANN in the study of the organic integration of IPE and entrepreneurship education, while Hiran and Dadhich [28] studied the application of cloud computing in higher education institutions.

3.1 Participants

The sample of respondents included 1212 students from 13 higher education institutions of the University of Belgrade, University of Niš and University of Kragujevac, who completed the anonymous questionnaire. The total sample was reduced in some applied analyses depending on the representation of

students' neutral opinions in the statements, used to form the dependent variables. Basic demographic data are given in Table 1. More than two-thirds of the entire sample consisted of female respondents (70.4%), aged 18 to 25 (91.1%) belonging to undergraduate academic studies (94.2%). Pertaining to the field of study of the respondents, more than half of the respondents (58.3%) studied in the field of social sciences and humanities, 23.8% studied technical and technological sciences, and the smallest percentage of respondents studied medical sciences and arts (1.6%).

Table 1. Participants' Demographics. Source: own study

Variables	Characteristic	N	%
Gender	Male	359	29.6
	Female	853	70.4
Age	18-25 years	1104	91.1
	26-30 years	66	5.4
	>30 years	42	3.5
Level of study	Basic academic studies	1142	94.2
	Master academic studies	52	4.3
	Doctoral studies	18	1.5
Area of study	Natural and mathematical sciences	198	16.3
	Technical and technological sciences	288	23.8
	Social and humanistic sciences	706	58.3
	Medical Sciences and Arts	20	1.6

3.2 Data collection and variables

In order to collect the necessary data, a questionnaire was used with statements and responses offered in the form of a five-point Likert scale: 1 - I completely disagree; 2 - I disagree; 3 - I have no opinion; 4 - I agree; 5 - I completely agree. The applied questionnaire was created following the instruments presented in related research conducted in institutions of higher education [21, 27, 38, 39, 53].

The questionnaire contained an introductory part in which fundamental demographic data were collected: sex, age of the respondents, level of study and field of study (Table 1). In the central part, the questionnaire included 34 statements related to the assessment of the quality of services provided by faculties with the purpose of forming 5 independent variables:

Teachers (TCR) - evaluation of the quality of the faculty's teaching staff included 10 statements related to the quality of lectures, punctuality and orderliness of teaching staff, availability of teaching staff, support and assistance to students and objectivity of evaluation.
Officials (OFC) - the assessment of the quality of the faculty's non-teaching staff included 6 statements related to the accessibility of the faculty's services, the friendliness of the staff, the professionalism of the officials, the adequacy of information provided by the faculty's services, and the appearance and hygiene of the faculty's premises.
Programs (PRG) – the assessment of the quality of the faculty's study programs included 4 statements related to the quality of the study program, the innovation and flexibility of the program, the availability of information about the study programs and the applicability of acquired knowledge.
Reputation (REP) - the assessment of the faculty's reputation included 4 statements related to the status of the faculty in society, the safety of students, the trust that employees instill in students and the fulfillment of promises given to students.
Image (IMG) - the assessment of the faculty's image included 4 statements related to the reliability and innovation of employees, contribution to society, recognition of the faculty and relationship with students.

The three dependent variables were derived from the 3 statements in the survey:

Education satisfaction - I am satisfied with the entire educational service of the faculty,
Academic satisfaction - I am satisfied with the academic work of the faculty and
Satisfied expectations - The expectations I had before entering the university are fulfilled.

3.3 Data analysis

The statistical analysis of the collected data included the condensation and transformation of the data, determination of basic descriptive statistics, reliability of the assessment of independent variables and validation of the Multilayer Perceptron - MLP [49]. Data condensation included item summation and determination of average values of 5 variables based on the measurement model. The variables obtained thus formed a set of independent variables used for the classification of respondents.

Data transformation was performed for the 3 previously described dependent variables: Education satisfaction, Academic satisfaction and Satisfied expectations. By recoding the first two codes of the scale into code 0, the **Dissatisfied** category was formed, and by recoding the last two codes into 1, the **Satisfied** category was formed. The binary variables created constituted dependent variables in further analyses. Central code 3 included students who did not have an opinion regarding the statements made, so those cases were excluded from further analyses.

Arithmetic means and standard deviations for independent variables were determined and the reliability and internal consistency of the measurements were checked, using the Rush model [52], an item analysis that determines the reliability of the separation of individuals, and by determining the Cronbach alpha [15] internal consistency coefficient of the items. The prediction of the validity of the model for assessing student satisfaction with the quality of the faculty's educational service, the academic work of the faculty and the fulfillment of expectations provided by higher education institutions was done using the **Multilayer Perceptron (MLP)**. This method represents a classifier based on feed forward artificial neural network and consists of three layers: Input Layer, Hidden Layer and Output Layer. Each layer is fully connected to the next layer in the network [4, 61].

The Input Layer contained five continuous covariates (predictor variables): Teacher (TCR), Officials (OFC), Programs (PRG), Reputation (REP) and Image (IMG). Bearing in mind that the descriptive analysis of these variables showed statistically significant deviations from the normal distribution, the **Adjusted normalized method** of rescaling [60] was applied in this analysis.

In the Hidden Layer, a **Hyperbolic tangent activation function** was applied [13, 42]. The analysis, after multiple applications of options with one and two hidden layers, was performed with one hidden layer and four units, the option that proved to be the most effective.

The Output Layer contained one of the previously described dependent variables: Education satisfaction, Academic satisfaction or Satisfied expectations, formed as binary nominal variables. In the Output Layer, a **Hyperbolic tangent activation function** [42] or a **Softmax activation function** [54] was used, depending on the efficiency of the model. The division of cases was performed by applying allocation based on random numbers with a quota of 70% for the training segment and 30% for the testing segment of the analysis.

The assessment of the validity of the model was done based on the percentage of incorrect predictions (**Percent Incorrect Predictions**) [11], which was considered good if it was less than 10%. In this sense, the NN model was tested using one or two Hidden Layers and activation functions in the architecture of the Multilayer Perception method, with the aim of obtaining the lowest percentage of wrong prediction. As part of that assessment, the precision of the assessment for each category of the dependent variable was also taken into account. Having in mind that the categories of the dependent variable were not balanced, and the number of cases in the Satisfaction category is significantly higher, the **ROC curve (Receiver operating characteristic)** method was used, which is not sensitive to the difference in the representation of the classifier, i.e., the category of the dependent variable. The assessment was made based on the appearance of the curve, where the model was assessed as successful in the case when the classifier curve was closer to the upper left corner and the ordinate, i.e. the sensitivity of the model. The final assessment

was made based on the **Area Under the Curve (AUC)** value. An outstanding model has an AUC close to 1, indicating that it has a high level of prediction. AUC value was considered excellent if it was above 0.90.

4. Results

The basic descriptive data and reliability assessment of the variables are shown in Table 2. The average values of all independent variables are above the theoretical mean value with satisfactory standard deviation values. Such average values indicate that students had a dominantly positive attitude pertaining to the quality of services provided by the faculties.

Table 2. Person separation reliability and internal consistency of items. Source: own study

Variables/Items	Mean	StD	MSE	PSR	Cronbach alfa
Teachers(TCR)	4.15	0.69	0.44	0.86	0.91
Officials (OFC)	3.93	0.87	2.10	0.70	0.88
Programs (PRG)	4.24	0.74	0.60	0.62	0.83
Reputations (REP)	4.18	0.79	0.62	0.66	0.84
Image(IMG)	3.93	0.95	0.67	0.81	0.91

StD – standard deviation; MSE - Mean square error; PSR – Person separation Reliability

The best reliability of separation of individuals was shown by the variables *Teachers*, *Image* and *Satisfaction*, above 0.80, which is considered good reliability of separation of individuals [10]. The variable *Officials* also had satisfactory separation values with a high MSE value, while the variables *Programs* and *Reputations* had slightly lower separation reliability values. The internal consistency of the items assessed by the Cronbach alpha coefficient [15] was at a satisfactory level for all analyzed variables.

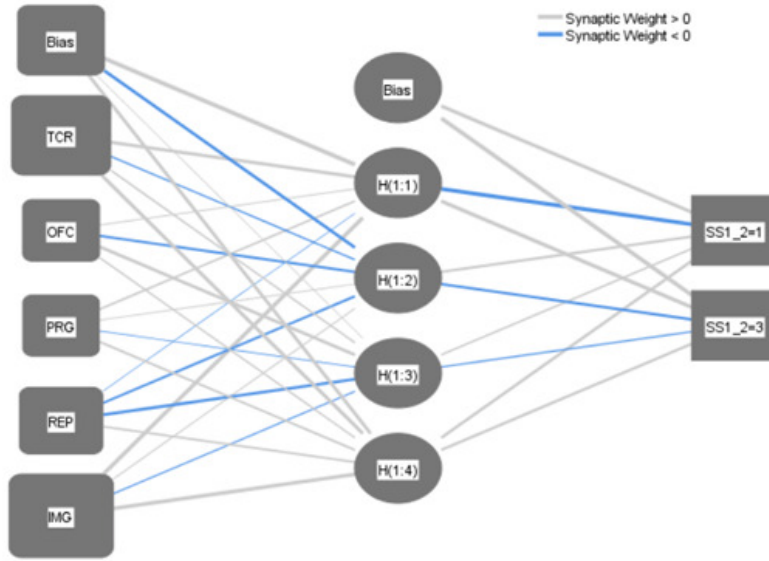### 4.1 Education satisfaction

In the Multilayer Perceptron analysis of the dependent variable *Education satisfaction*, a total of 943 cases were included, of which 664 (70.4%) cases were analyzed in the training segment, and 279 (29.6%) cases in the testing segment. In the training segment, 6.8% of wrong predictions with 31.4 Sum of Squares Error were identified, and in the testing segment, 4.7% of wrong predictions with 9.1 Sum of Squares Error were identified. The obtained classification error values are small and indicate a good predictive value of the applied model. The classification of cases based on the applied model is shown in Table 3. The overall accuracy of the classification was 95.3% and represents a high success of the classification. In the Dissatisfied category, the classification accuracy was 69.2%, while in the Satisfied category it was significantly higher, i.e. 98%.

Table 3. Classification of cases for the Education satisfaction variable. Source: own study

| Sample	Observed	Predicted		
		Dissatisfied	Satisfied	Correct
Training	Dissatisfied	51	28	64.6%
	Satisfied	17	568	97.1%
	Overall Percent	10.2%	89.8%	93.2%
Testing	Dissatisfied	18	8	69.2%
	Satisfied	5	248	98.0%
	Overall Percent	8.2%	91.8%	95.3%

Figure 1 shows the Multilayer Perceptron model for the predictor variable *Education satisfaction*. The model contained one hidden layer and 4 nodes.

Figure 1. MLP model for Education satisfaction
Dissatisfied–SS1_2=1; Satisfied–SS1_2=3

The validity of the model assessed through the Receiver operating characteristic (ROC) prediction accuracy curve shows a high sensitivity of the model for both categories of the dependent variable (Figure 2). This is also confirmed by the high value of the Area Under the Curve (AUC), which is 0.93 for both classification categories.
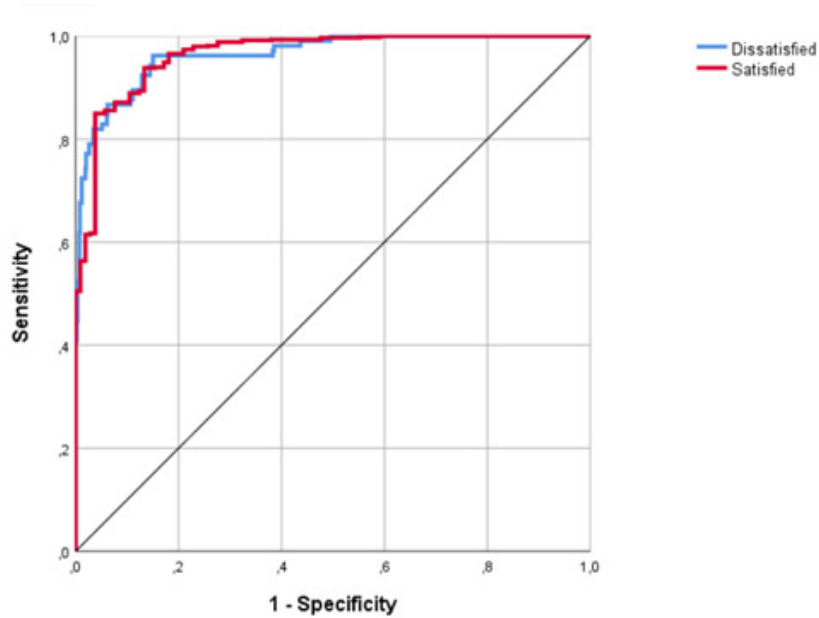
Figure 2. ROC for Education satisfaction

The analysis of the importance of independent variables in the classification of *Education satisfaction* variable categories showed that the variables *The faculty's image* with a 37.6% share and *The quality of the*

faculty's teaching staff with a 32.2% share, had the greatest importance in the prediction. The variables *The faculty's reputation* with a 14.8% share, *The quality of the faculty's study programs* with a 7.4% share and *The quality of the faculty's non-teaching staff* with an 8% share had significantly lower percentages of share.
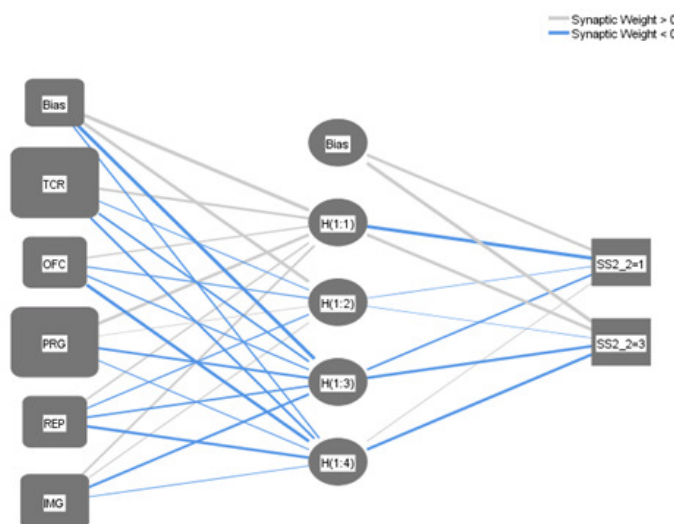
4.2 Academic satisfaction

The analysis of the dependent variable *Academic satisfaction* included a total of 946 cases. 667 (70.7%) cases were analyzed in the training segment, and 277 (29.3%) cases in the testing segment. Both in the training segment and in the testing segment, 4% of wrong predictions were identified with 18.3 and 9.6 Sum of Squares Error. The obtained value of the classification error is small and indicates a very good predictive value of the applied model.

Table 4. Classification of cases for the Academic satisfaction variable. Source: own study

| Sample	Observed	Predicted		
		Dissatisfied	Satisfied	Correct
Training	Dissatisfied	40	14	74.1%
	Satisfied	13	600	97.9%
	Overall Percent	7.9%	92.1%	96.0%
Testing	Dissatisfied	19	6	76.0%
	Satisfied	5	247	98.0%
	Overall Percent	8.7%	91.3%	96.0%

The classification of cases based on the applied model is shown in Table 4. The overall classification success rate for 96% of cases represents a high classification success rate. In the Dissatisfied category, the correct classification was 74.1%, while in the Satisfied category, it was 98%. Figure 3 shows the Multilayer Perceptron model for the *Education satisfaction* variable. The model also contained one hidden layer and 4 nodes.

Figure 3. MLP model for Academic satisfaction
Dissatisfied–SS1$_2$=1; Satisfied–SS1$_2$=3

The validity of the model assessed through the Receiver operating characteristic (ROC) prediction accuracy curve shows a high sensitivity of the model for both categories of the dependent variable (Figure 4).

This is confirmed by the high values of the Area Under the Curve (AUC), which is 0.94 for the Dissatisfaction category and 0.95 for the Satisfaction category.
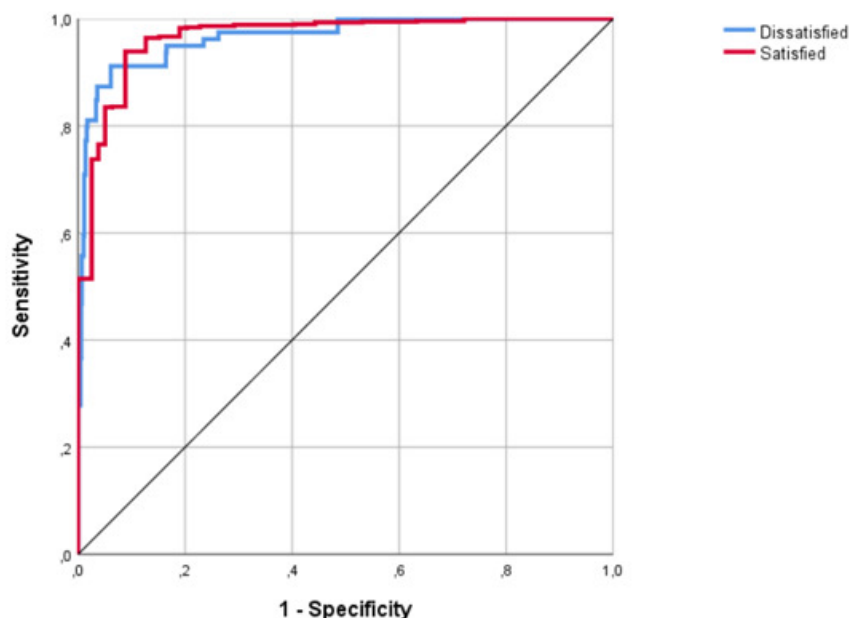
Figure 4. ROC for Academic satisfaction

The analysis of the importance of independent variables in the classification of *Academic satisfaction* variable categories showed that the variables *Teacher* with a 26.2% share and *Programs* with a 25.8% share had the greatest importance. Other variables had a lower and even contribution to the classification, *Image* 17.3%, *Reputation* 15.4% and *Officials* 15.2%.

4.3 Satisfied expectations

The analysis of the dependent variable *Satisfied* expectations included a total of 882 cases. 605 (68.8%) cases were analyzed in the training segment, and 275 (31.3%) cases in the testing segment. In the training segment, 9.3% of wrong predictions with 40.1 Sum of Squares Errors were identified, anwhile there was 8.6% of wrong predictions with 16.5 Sum of Squares Errors identified in the testing segment. The obtained value of the classification error is small and indicates a good predictive value of the applied model. The classification of cases based on the applied model is shown in Table 5.

Table 5. Classification of cases for the Satisfied expectations variable. Source: own study

| Sample	Observed	Predicted		
		Dissatisfied	Satisfied	Correct
Training	Dissatisfied	78	39	66.7%
	Satisfied	19	488	96.3%
	Overall Percent	15.5%	84.5%	90.7%
Testing	Dissatisfied	37	12	75.5%
	Satisfied	10	197	95.2%
	Overall Percent	18.4%	81.6%	91.4%

The overall accuracy of the classification was 91.4% of cases and represents a high success of the classification. In the Dissatisfied category, the correct classification was 75.5%, while in the Satisfied category it was 95.2%.

Figure 5 shows the Multilayer Perceptron model for the *Education satisfaction* variable with two Hidden layers and 7 nodes.
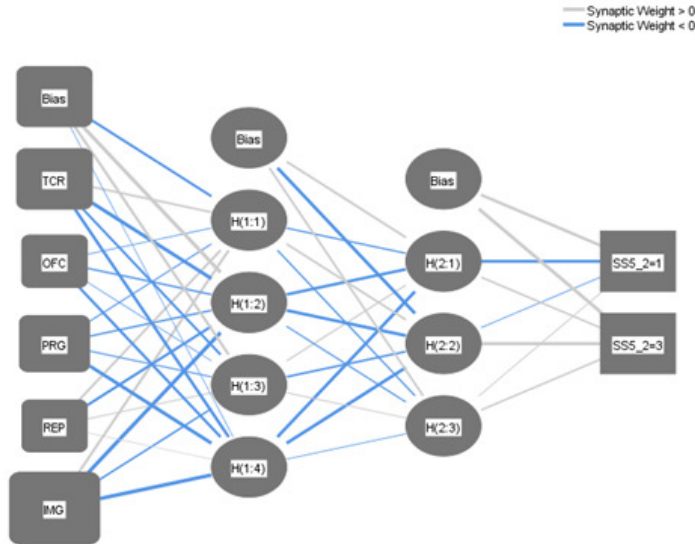
Figure 5. MLP model for Education satisfaction
Dissatisfied–SS1$_2$=1; Satisfied–SS1$_2$=3

The validity of the model, assessed through the Receiver operating characteristic (ROC) prediction accuracy curve, shows a high sensitivity of the model for both categories of the dependent variable (Figure 6). This is also confirmed by the Area Under the Curve (AUC) value, which is 0.94 for the Dissatisfaction category and 0.95 for the *Student satisfaction category*.
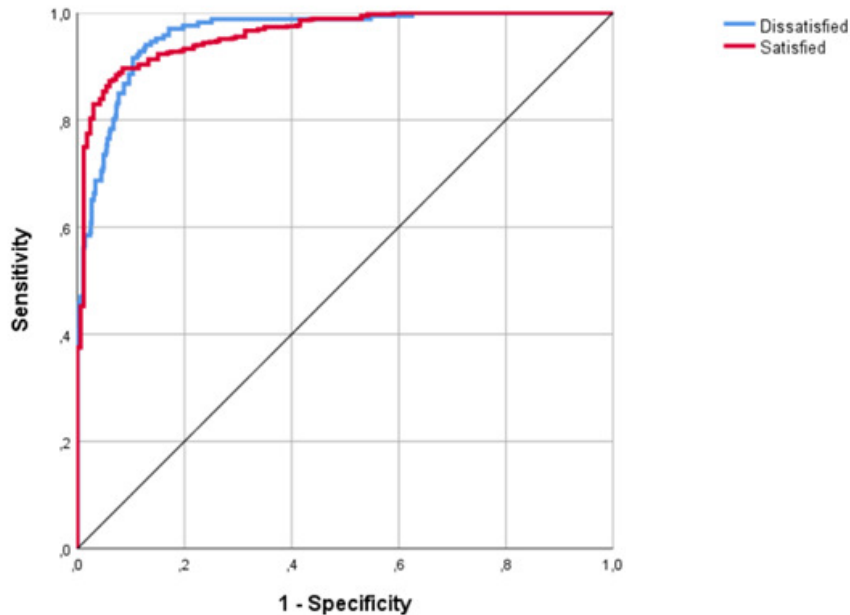
Figure 6. ROC for Satisfied expectations

The analysis of the importance of independent variables in the classification of the Satisfied expectations variable categories showed that the variables *Image* with a 45.8% share and Teacher with a 23.5% share had the greatest importance. Other variables had a significantly smaller contribution to the classification, *Programs* 15.1%, *Officials* 8.1% and *Reputation* 7.5%.

5. Discussion

The aim of the conducted research was to model the predictive factors of service quality formed based on a hypothetical model of factors for assessing the degree of predicting the quality of services at public faculties in the Republic of Serbia and the satisfaction and fulfillment of student expectations.

The designed questionnaire was conducted on a sample of 1212 respondents from 13 public universities in the Republic of Serbia. Given that the method used in the research was not standardized, but was developed for the purposes of investigation, it included the summation of items and the determination of the average values of 5 variables based on the measurement model. The variables formed this way represented a set of independent variables used for the classification of respondents.

Data condensation included item summation and determination of average values of 5 variables based on the measurement model. The variables constituted a set of independent prediction variables used to classify the respondents.

Data transformation was performed for three dependent variables: Education satisfaction, Academic satisfaction and Satisfied expectations. Multilayer Perceptron (MLP) method is based on a feed forward artificial neural network and consists of three layers: Input Layer, Hidden Layer and Output Layer. More precisely, each layer is fully connected to the next layer in the network.

The Input Layer contained five continuous predictor variables: Teacher (TCR), Officials (OFC), Programs (PRG), Reputation (REP) and Image (IMG). The best efficiency of separation of individuals was expressed by the variables *Teachers, Image* and *Satisfaction*, above 0.80, which can be considered a good reliability of separation of individuals [10]. The *Officials* variable also had satisfactory separation values with a high MSE value, while the *Programs* and *Reputations* variables had lower separation reliability values. The internal consistency of the items assessed by the Cronbach alpha coefficient [15] was at an adequate level for all analyzed variables.

When students view the reputation of teachers of a desired faculty from a higher level, their expectations will be higher compared to those who perceive the reputation to be at a low level. The tradition of the faculty provides an appropriate degree of certainty of prediction at the faculty they wish to study at, thus their opinions are formed accordingly, expecting a well-organized and elaborate system that has been working well over the years. On the other hand, future students expect and hope for a modern institution that functions in the time of prediction and the age we live in, often relying on a long-standing tradition that does not give adequate results in the long run [45, 51].

Based on the results of the conducted research, the conclusions can be drawn that **the general hypothesis can be accepted**, i.e. that the questionnaire with five implemented elements displays statistical significance in defining the perception of students about the quality of services of public universities in Serbia and their satisfaction with the services provided. Based on the acceptance of the general hypothesis and research results, it may be concluded that:

- **Hypothesis H1 is accepted:** The quality of the faculty's teaching staff has a positive effect on the satisfaction and fulfillment of students' expectations.

- **Hypothesis H2 is not accepted:** The quality of services of the non-teaching staff of a higher education institution does not have a statistically significant effect on the opinion of students about the quality of the faculty's services and the fulfillment of students' expectations.

- **Hypothesis H3 is accepted:** The reputation of the faculty as a higher education institution has a statistically significant and positive effect on the students' opinion about the quality of the faculty's services and their satisfaction with studying.

- Hypothesis H4: The quality of study programs in a higher education institution has a statistically significant and positive effect on academic performance and the fulfillment of student expectations.

- Hypothesis H5 is accepted: The image of the faculty as a higher education institution has a statistically significant and positive effect on the opinion of students about the quality of the faculty's services and the fulfillment of students' expectations.

As a final outcome of the tested hypotheses, the following can be presented. Teaching staff, student programs, reputation of the faculty and image of the faculty have a significant influence on the satisfaction and fulfillment of students' expectations. These elements represent direct factors of services provided at public faculties with which students are more or less in direct contact. On the other hand, non-teaching staff of a higher education institution does not have a statistically significant effect on the opinion of students about the quality of the faculty's services and the fulfillment of students' expectations, and it is an element with which students are not always in direct contact.Finally, from the perspective of the faculties, it is necessary to strengthen all elements that affect students expectations and their satisfaction with the quality of services provided.

6. Conclusion

The results of the conducted research are related to the model predicting satisfaction and fulfillment of students' expectations, as well as to the comparison of the concept obtained as a result of the observed and described data with the concept represented at universities in the country.

Satisfaction can be described as an important determinant of students' future behavior and of their decision to continue their education at higher levels of study or perhaps to end their education at a higher education institution. Apart from that, satisfaction is also expressed through positive word-of-mouth propaganda, which has a considerable impact on attracting potential students, thus creating a positive image of a faculty, i.e. university in the public eye.

In order to modify and improve learning and teaching, it is necessary for universities to emphasize the predictions of users, which assumes the satisfaction of their expectations. Therefore, universities should pay special attention not only to the personal values of students, but also to the analysis of the decision-making process when enrolling the faculty, bearing the delivery of service quality in mind. Determining certain satisfaction models leads to a better understanding of the decision prediction process, and points to the factors affecting students' opinions, providing universities with the opportunity to adapt their offers to market conditions and define an effective differentiation strategy more successfully.

The questionnaire implemented in this paper has displayed good measurement characteristics, which could be used for an appropriate assessment of the perceived service quality of higher education institutions in Serbia with the aforementioned correction of the item predictions.

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