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SERVICE QUALITY INDICATOR AT RIGA INTERNATIONAL COACH TERMINAL

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The level of service in „Rīgas Starptautiskā Autoosta" is studied. This enterprise provides the international, intercity and regional trips. Recent studies on the role of buses and coaches seem to confirm the already excellent safety, environmental and social record of bus and coach transport. The main attention was paid to the analyses of quality of service and its components. The theory of linear composite indicator constructing and statistical methods are used for definition of weights of aggregation function. The model was done on the basis of the questionnaire results of transport experts.

The model constructed for a scalar quality indicator, allows comparing analyzed service for the services given by other companies, to estimate influence of particular quality indicators on the overall quality estimation and to simplify monitoring of quality indicators.

Keywords: *bus terminal, quality of service, scalar indicator, weights, regression models, restrictions*

1. Introduction

The entry of Latvia in the common European market and the political integration of Latvia in the EU have forwarded qualitatively new requirements to passenger transportation – high mobility support, intermodality, passenger's comfort and rights support, and also, new requirements to interaction of transport and environment. When examining a human being and his/her needs as a central part of any system, all these requirements must be analyzed in interaction as a single whole.

"Rīgas Starptautiskā Autoosta" being a leader in the area of passenger bus transportation services in Latvia provides the international, intercity and regional trips. Recent studies on the role of buses and coaches seem to confirm the already excellent safety, environmental and social record of bus and coach transport [1]. In Latvia this mode of transport is in competition with railway (and private cars also) in Latvia that's why the quality of services are very important from the all points of view [2].

The problems of the service quality provided by a terminal have been considered by the paper's authors many times [3, 4, and 5]. The theoretical basis of the quality system in public transport might be presented in a form of a "quality loop" (Fig. 1), which components might be divided in two parts: customers-passengers and service providers-carriers. Expected Quality is the level of quality, which is required by the customer.

Targeted Quality is the level of quality that service provider or manager of mobile system is aiming to provide to the customers as a consequence of his understanding of the customer expectation. Delivered Quality is the level of quality effectively achieved in the provision of mobility services by the different components of system. Perceived Quality – the level of quality perceived by the user-customer [6].

The difference between the Expected Quality and Perceived Quality reflects a measure of the customer satisfaction. The difference between the Targeted Quality and Delivered Quality reflects problems with the service design or anything else connected with the provision of services. In our case the Perceived Quality on top level consists of two parts: the Perceived Quality, which is provided by the direct service provider (companies) and the Perceived Quality, which is provided by a terminal. In this research we pay attention to the second part the AS "Rīgas Autoosta" is responsible for. The complexity of this particular case research is connected with the fact that a customer often doesn't divide the Perceived Quality in two parts and estimates the Perceived Quality as a single whole (placing own part and carrier's part on AS "Rīgas Autoosta").

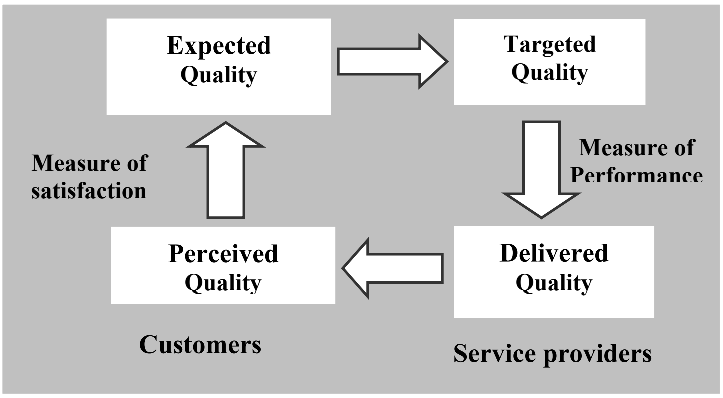

Figure 1. The parts of "Quality loop"

The main attention was paid to the analyses of Perceived quality of service and its components. When examine literature it becomes clear that it is no unique approach to measuring service quality. But, it is accepted that the quality of service is usually a function of several quality factors (attributes) and determining of each factor weight is one of the "corner-stone" of measuring quality. We took at the basis the approach that is developed in the works by D.Peña [7,8]. The theory of linear composite indicator constructing [9] and statistical methods are using for definition of weights of aggregation function.

Suppose that random sample with size denoted n from population of users involves estimates of overall quality of service – y_i, ($i = 1, \ldots, n$) and estimates of attributes (particular quality indexes), which define quality of service – x_{ij}, for k concrete attributes ($i = 1, \ldots, n$; $j = 1, \ldots, k$). Assume that these estimates are made on the basis (0–5) scale. Let the quality of service to be unknown variable, which is measured by user's estimation y_i and determined as follow

$$y_i = \beta \mathbf{x}_i + u_i \,, \tag{1}$$

where $\boldsymbol{x_i} = (x_{i1}, \ldots, x_{ik})$ – estimations of attributes, made by *i-th* user,
$\beta = (\beta_1, \ldots \beta_k)$ – vector of unknown weights,
u_i – error of measuring, which assume is normally distributed $u_i \sim N(0, \sigma_u^2)$.

A regression model assumes that overall service quality is determined by a linear combination of attribute evaluations with some unknown weights. The restrictions on a vector of weights are the next:

$$\beta_j \geq 0 \ \text{ for } j = 1, \ldots, k \ \text{ and } \sum_{j=1}^{k} \beta_j = 1 \,. \tag{2}$$

Therefore, the task is to get the estimation of the vector of unknown weights for function (1) with restrictions (2).

2. Considered Models for Weights Estimation

There were tested some variants of the weights searching in the research.

2.1. Least Squares Method for a Classical Linear Regression Model

The matrix form of the linear classical regression model is the next:

$$\boldsymbol{Y} = \boldsymbol{X\beta} + \boldsymbol{Z}, \tag{3}$$

where $\boldsymbol{X}$ is the matrix of independent variables, dimension ($n \times k$),
n is quantity of observations,
$\boldsymbol{Y}$ is the vector of dependent variable, dimension ($n \times 1$),
$\boldsymbol{Z}$ is the vector of dimension ($n \times 1$), which components $Z_1, Z_2, \ldots, Z_n$ are independent equally distributed random variables with mean zero and variance σ^2 and covariance matrix $Cov(\mathbf{Z}) = \sigma^2 \mathbf{I}_n$,
$\boldsymbol{\beta}$ is the regression model vector of parameters, dimension ($k \times 1$), which needs to be estimated.

Least Square Estimation (LSE) $\boldsymbol{\beta}$ is calculated by formula**:**

$$\widehat{\boldsymbol{\beta}} = \left(\mathbf{X}^T\mathbf{X}\right)^{-1}\mathbf{X}^T\mathbf{Y} \tag{4}$$

and gives the smallest value of function

$$f(\beta) = \sum_{i=1}^{n}\left(Y_i - \sum_{i=1}^{k}\widehat{\beta}_i x_{i,j}\right)^2 = \sum_{i=1}^{n}\left(Y_i - \widehat{\beta}x_i\right)^2, \tag{5}$$

where $\boldsymbol{x_i} = (x_{i1}, ..., x_{ik})$ is the vector-column, dimension $k \times 1$.

Because of independent variables (partial quality attributes) can correlate between each other, that's why the stepwise regression model definition procedure is going to be applied (Forward Stepwise or Backward Stepwise) [10].

2.2. A Regression Model With Constrain on Parameters' Sign (a Restricted Least Squares Problem)

It is logical to assume that the increase in an estimation of partial attribute should lead to increase in an estimation of the general attribute of quality. In this case dependence between the general estimation of quality and partial attributes should be with a positive sign. Taking this condition into account let's enter the first restriction on parameters (weights for partial attributes of quality) into model (1):

$$\beta_j \geq 0 .$$

For an estimation of regression model parameters we will take the approach for the first time used by M.S. Waterman [11]. In a basis is the same method of the least squares, but with restrictions which are realized by below-mentioned iterative algorithm:

Step 1. Column vector with unknown parameters is estimated by the classical method of the least squares $\widehat{\boldsymbol{\beta}} = \left(\mathbf{X}^T\mathbf{X}\right)^{-1}\mathbf{X}^T\mathbf{Y}$. If the received vector has negative elements, transition to the step 2, if not, then transition to the step 3.

Step 2. In case of s negative elements presence in a vector of parameters $\boldsymbol{\beta}$ ($\beta_{\text{I}} < 0$) the following updating (modification) of initial matrix **X** is made: the lines concerning negative estimations are excluded from consideration. Transformed matrix **X** dimension $(k - s) \times n$ goes on a repeated estimation of parameters, i.e. transition to the step 1 is made.

Step 3. In case of the component positivity in a vector of parameters $\boldsymbol{\beta}$ calculation of standard purpose function $f(\boldsymbol{\beta})$ in a method of the least squares which is necessary to minimize is made, by the formula (5).

Step 4 *(search of optimum value of the purpose function).* Assume that whole number of the remained positive parameters equals l. By serial zeroing (all possible combinations on one, on two, on three etc. on l remained positive parameters) and searching of all received values of the purpose function at given combinations of parameters such set is defined at which the purpose function $f(\boldsymbol{\beta})$ is minimum. Answering to the minimum value of the purpose function $f(\boldsymbol{\beta})$ the vector $\boldsymbol{\beta}$ which is not containing negative elements is the task decision.

The result of algorithm work is vector-column $\boldsymbol{\beta}$ (dimension $k \times l$), containing estimations of unknown regression model parameters only with nonnegative signs.

2.3. A Regression Model With Constrain On Parameters' Value

Let's consider other task setting, namely: algorithm of weights finding for particular quality attributes with constrain on value

$$\sum_{i=1}^{k}\beta_i = 1 .$$

Now to find coefficients $\boldsymbol{\beta} = (\beta_1, ... \beta_k)$, minimizing the function (5) providing

$$g(\beta) = \sum_{i=1}^{k}\beta_i - 1 = \beta e - 1 = 0 . \tag{6}$$

where **e** is vector-column, corresponding dimension, from ones.

Lagrange function for our problem will be

$$L(\beta,\lambda) = f(\beta) + \lambda g(\beta), \tag{7}$$

where $\lambda \geq 0$ is Lagrange coefficient.

It is necessary to minimize this function with respect to variables $\boldsymbol{\beta}$ and λ. It leads to system of the equations:

$$\frac{\partial}{\partial\beta}L(\beta,\lambda) = \frac{\partial}{\partial\beta}f(\beta) + \lambda\frac{\partial}{\partial\beta}g(\beta) = 0\,.$$

$$\frac{\partial}{\partial\beta}L(\beta,\lambda) = g(\beta) = 0\,, \tag{8}$$

The first of these equations looks like

$$\frac{\partial}{\partial\beta}L(\beta,\lambda) = -2\sum_{i=1}^{n}(Y_i - \beta x_i)x_i + \lambda e = 0\,.$$

Let's write down the equation in the matrix form

$$-2X^TY + 2X^TX\beta + \lambda e = 0\,.$$

From here let's write down expression for $\boldsymbol{\beta}$

$$\beta = (X^TX)^{-1}X^TY - \tfrac{1}{2}\lambda(X^TX)^{-1}e\,. \tag{9}$$

The Lagrange coefficient is from the second equality of system (8)

$$1 = e^T\beta = e^T(X^TX)^{-1}X^TY - \tfrac{1}{2}\lambda e^T(X^TX)^{-1}e\,.$$

From here we find

$$\lambda = 2(e^T(X^TX)^{-1}X^TY - 1)(e^T(X^TX)^{-1}e)^{-1}. \tag{10}$$

2.4. A Regression Model With Constrains On Parameters' Sign and Value

The algorithm, which is a combination of the algorithms, described in B and C is offered further. Key change consists that on step 1 the decision is searched not by a classical method of the least squares, but with use of formulas (9) and (10). Then it is applied the same procedures of an exception those vector β components which have a negative sign. Constrain on value and on a sign in this case remains.

Step 1. An estimation of a vector-column with unknown parameters β is finding by formulas (9) and (10) at which value of function (5) is minimal and the condition (6) is satisfied. If the received vector has negative elements, transition to the step 2, if not, then transition to the step 3.

Step 2. In case of *s* negative elements presence in a vector of parameters β (β_I< 0) the following updating (modification) of initial matrix **X** is made: the lines concerning negative estimations are excluded from consideration. Transformed matrix **X** dimension $(k-s) \times n$ goes on a repeated estimation of parameters, i.e. transition to the step 1 is made.

Step 3. In case of the component positivity in a vector of parameters β calculation of standard purpose function *f*(β) in a method of the least squares which is necessary to minimize is made, by the formula (5).

Step 4 *(search of optimum value of the purpose function).* Assume that whole number of the remained positive parameters equals *l*. By serial zeroing (all possible combinations on one, on two, on three etc. on *l* remained positive parameters) and searching of all received values of the purpose function at given combinations of parameters such set is defined at which the purpose function *f*(β) is minimum. Answering to the minimum value of the purpose function *f*(β) the vector β which is not containing negative elements is the task decision. The result of algorithm work is vector-column β (dimension $k \times l$), containing estimations of unknown regression model parameters only with nonnegative signs and the sum of these parameters (weights) are equal 1.

3. Numerical Results of Weight Estimation

3.1. Initial Data

The model was constructed on the basis of questionnaire results of 44 transport experts that was performed in spring 2009. This fact, that respondents are the high-qualified transport specialists, allowed as to assume that the sample is homogeny and the assumption about equal variance of residual is fulfilled. The questionnaire included 7 groups of questions concerned the following groups of quality particular attributes: accessibility (availability); information; time characteristics of service; customer service; comfort; safety; infrastructure and environment (Table 1). Totally there were 22 particular attributes of quality distributed on these 7 groups. Also the overall quality of service was evaluated. As well as particular attributes of quality the overall quality service was estimated on a scale 0–5. In total 44 questionnaires have been returned but some questions remained without the answer in three questionnaires.

Table 1. Particular Attributes of Quality

Title of chapter in questionnaire	Coding	Description of variable	Coding
1. Accessibility	**W1**	Accessibility for external participants of traffic	X1
		Accessibility for terminal passengers	X2
		Ticket booking	X3
2. Information	**W2**	General information in terminal	X4
		Information about trips in positive aspect	X5
		Information about trips in negative aspect	X6
3. Time	**W3**	Duration of trip	X7
		Punctuality	X8
		Reliability/trust	X9
		Bus time schedule	X10
4. Customer service	**W4**	Customer trust to terminal employees	X11
		Communication with customer	X12
		Requirements to employees	X13
		Physical services providing	X14
		Process of ticket booking	X15
		Services provided by bus crews during boarding/debarkation	X16
5. Comfort	**W5**	Cleanness and comfort in terminal premises and on terminal square	X17
		Additional opportunities/services providing in coach terminal	X18
6. Reliability /safety	**W6**	Protection from crimes	X19
		Protection from accidents	X20
7. Environment	**W7**	Dirtying, its prevention	X21
		Infrastructure	X22
	W8	**Overall estimation**	X23

The analysis of coordination (consistency) of questionnaire questions was made by means of Cronbach alpha coefficient:

$$\alpha = \frac{k}{k-1}\left(1 - \sum_{i=1}^{k} \frac{s_i^2}{s_{sum}^2}\right), \tag{11}$$

where k – amount of questions (in our case – particular quality attributes),

S_i^2 – variance of i question and S_{sum}^2 – variance of sum of questions.

The results of questionnaire (estimates of particular attributes of quality) have demonstrated high indices of the internal coordination. A value of Cronbach alpha coefficient is equal to 0.933 and the standardized value is 0.93. It has allowed making an assumption about reliability of results. The lowest value of correlation is between resultant estimate and variables x7 (“trip duration”) and x8 (“punctuality”).

Let's analyse the descriptive characteristics of estimates of particular attributes of quality. The lowest estimates the attributes connected with infrastructure ($\bar{x}_{22}$ = 3.035) and environment ($\bar{x}_{21}$ = 3.182) have received. It corresponds to a true situation: today the Coach Terminal is experiencing difficulties and looking for new squares for moving and further repair of the existing territory. The following low estimated attributes are „Cleanness and comfort in terminal premises and on terminal square" ($\bar{x}_{17}$ = 3.419), „Protection from crimes" ($\bar{x}_{19}$ = 3.500) and „Physical services providing" ($\bar{x}_{14}$ = 3.550). These attributes also depend directly on the state of the Coach Terminal's infrastructure. Experts have given the highest estimates to the private quality attributes of „Bus time schedule" ($\bar{x}_{10}$ = 4.409) and „Accessibility/Ticket booking" ($\bar{x}_{3}$ = 4.5) that is also explainable. The issues of accessibility (opportunity of ticket booking in the terminal ticket offices and in the Internet and via the mobile telephone) are considered by the management of the coach terminal as priority and therefore success of these attributes is obvious.

Let's investigate dependence between the particular quality attributes and the overall quality estimate given by experts. On the basis of the analysis of Kendall correlation values it is possible to make conclusions that the overall estimate of service quality in the coach terminal is correlated (connected) most with the following private criteria of quality:

- ✓ Protection from crimes (0.617)
- ✓ Cleanness and comfort in terminal premises and on terminal square (0.579)
- ✓ Additional opportunities/services providing in coach terminal (0.535)
- ✓ With attributes of quality characterizing the customer service: Customer trust to terminal employees (0.533) and Process of ticket booking (0.533)

It indicates the fact that the higher estimates are given to these attributes, the higher the overall quality estimate is.

In further research we will also consider other method of forming the independent variables for regression model, in particular: we will form 7 new variables corresponding to 7 groups of attributes (categories of questions) (Table 1, the left column). Values for each new variable (category of questions) have been received by calculation of a arithmetic mean of variables included in the composition of the given category. A reason of inputting the other set, that is the so called "clustered" variables, as the attending ones, lies in the following fact. All above mentioned models have assumed that the overall estimation and particular estimations are continuous variables. Very often variables are measured on categorical (on a discrete scale). Grouping of the initial attributes and calculation of new values on the basis of a mean arithmetic leads to a replacement of categorical variable x_{ij} by interval w_l (l = 1,..,7). In Table 2 the descriptive characteristics for new clusterized variables are presented, and in Table 3 – the lower triangle of the correlation matrix.

Table 2. Descriptive measures of the grouped variables (attributes of quality) and overall quality

	Valid N	Mean	Median	Mode	Frequency	Min	Max	Std.Dev.
W1	44	4.341	4.500	5.000	22	1.000	5.000	0.861
W2	44	4.064	4.000	4.670	13	2.000	5.000	0.678
W3	44	4.205	4.250	4.000	14	3.000	5.000	0.442
W4	44	4.031	4.170	Multiple		2.500	4.830	0.620
W5	44	3.557	4.000	4.000	18	1.000	5.000	0.916
W6	44	3.545	3.750	4.000	12	1.500	5.000	0.901
W7	44	3.119	3.000	3.000	12	1.000	5.000	0.845
W8	40	3.931	4.000	4.000	28	3.000	5.000	0.528

As it is shown in Table 2 the lowest estimates have been given by respondents to the attributes connected with infrastructure and environment (w_7), and the highest ones to Accessibility (w_1). Let's indicate important correlations between variables w_2, w_4, w_5 and w_6.

Table 3. Correlation matrix for grouped variables

	W1	W2	W3	W4	W5	W6	W7
W2	0.41						
W3	0.41	0.16					
W4	0.55	**0.74**	0.22				
W5	0.46	**0.71**	0.32	**0.72**			
W6	0.34	**0.78**	0.23	**0.75**	**0.77**		
W7	0.20	0.45	0.23	0.61	0.56	0.50	
W8	0.50	0.57	0.25	0.69	0.67	0.61	0.46

For elimination of the correlation effect between variables, it would be possible to use a method of main components for obtaining new orthogonal factors. However it would lead to a poor interpretation of the quality indicator model.

3.2. Results of Weights Estimation By Various Models

In Table 4 the results of estimating of weights on the basis of the above considered approaches for 8 various models are presented.

Table 4. Results of weights estimating

Attribute	Model A1	Model B1	Model C1	Model D1	Grouped attribute	Model A2	Model B2	Model C2	Model D2
X1	_	0.126	0.069	0.144	**1. Accessibility**	-	0.175	0.167	0.17
X2	_	_	0.134	_					
X3	0.218	0.035	0.166	_					
X4	_	0.102	0.174	0.082	**2. Information**	-	0.084	0.082	0.075
X5	_	_	-0.162	_					
X6	_	_	0.056	_					
X7	_	0.147	0.175	0.171	**3. Time**	0-337	0.255	0.232	0.235
X8	0.189	0.068	0.334	0.05					
X9	_	_	-0.217	_					
X10	_	_	-0.181	_					
X11	0.260	0.131	0.088	0.133	**4. Customer service**	0.620	0.406	0.346	0.338
X12	-	0.148	0.195	0.141					
X13	0.180	0.067	0.149	0.058					
X14	-	-	-0.011	-					
X15	-	-	-0.046	-					
X16	-	-	-0.147	-					
X17	-	-	-0.142	-	**5. Comfort**	–	0.031	0.074	0.056
X18	-	-	-0.011	_					
X19	-	0.107	0.317	0.128	**6. Reliability /safety**	–	–	-0.031	–
X20	-	_	-0.194	–					
X21	_	_	0.029	–	**7. Environment**	–	–	0.13	0.125
X22	0.103	0.137	0.225	0.093					
f(β)	5.221	4.133	2.274	4.355	f(β)	6.509	5.992	6.609	6.618
SEE2	0.366	0.349	0.322	0.353	**SEE2**	0.394	0.392	0.423	0.417
F	1024.400	564.953	304.867	625.669	**F**	2208	891.416	567.579	678.624

By ***model A1*** we indicate the classic regression model for the overall estimate of service quality as the dependent variable constructed with the help of procedure *Forward Stepwise* (SPSS package, replacing of the missed values by the mean ones). As a result of five steps an equation of regression with five significant corresponding variables has been received.

During testing of the hypothesis about insignificance, the F statistics is equal to 1024.4 (*p-level* < 0.00001), standard estimation error (SEE) is equal to .366; a model explains the dependent variable – the overall quality estimate on the level of 99%.

As to x_3 – attribute "Ticket Booking" of category "Accessibility" then, its entry is logical because a possible purchase of tickets in the ticket offices and in the Internet, and via the mobile telephone is highly estimated by customers. The significance of variable x_8 – attribute "Punctuality" of category "Time" is also logical because today a customer is exacting to a fulfilment of a time schedule and the coach terminal considers reliability of trips as a strategic task and conducts researches in this direction [5]. A significance of two other variables x_{11} – attribute "Customer trust to terminal employees" and x_{13} – attribute "Requirements to Employees" of category "Customer Service" speaks about a significance of this category of attributes. Therefore, it is possible to make a conclusion that increase of trust and conditions of services (especially, cleanness and comfort in premises) will lead to a considerable increase of the overall estimate. The last variable x_{22}, connected with the state of the Coach Terminal infrastructure also significantly influences on the overall quality estimate.

Model A2 (Table 4) – we indicate the classic regression model for the overall estimate of service quality as the dependent variable. The "grouped" variables cashiered as independent ones. An equation of regression with two significant independent variables has been received with the help of the *Stepwise* procedure. During testing of the hypothesis about insignificance the F statistics is equal to 2208.1 (*p-level* < 0.00001), standard estimation error (SEE) is equal to 0.394; a model explains the overall estimate of service quality on the level of 99%.

As it is shown in the constructed model (Table 4) the overall service quality estimate is influenced mostly by the quality of the passenger service process (w_4) – it is one of the most capacious categories including customers` trust to the terminal employees, communication with customers, help from the terminal's employees, organization of ticket booking etc. The "Time" category (w_3) including time schedule and reliability of its fulfilment is also an important category.

If to compare the results of model construction with the primary attributes and "grouped" attributes, then those entered ***model A2*** the "grouped" attributes of quality include three primary attributes, which entered ***model A1.*** Certainly, a positive character of the sign received in the ultimate equations is possible to consider being a "successful" result and with other input data it may be not like this.

For estimation of parameter of the regression model of the coach terminal services quality with restriction on signs (***model B1***) the interaction procedure has been applied described in Item 2.2. An algorithm has been realized in the MathCAD package. For the primary data (44 questionnaires and 22 private attributes) at the 1st step the results presented in Table 5 (the results coincide with the estimate of classic LSM, without a free member, in the SPSS package) have been received.

Table 5. Results of LSE-estimation at 1st step

X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
0.058	0.135	0.177	0.174	-0.147	0.027	0.153	0.304	-0.171	-0.162	0.075
X12	**X13**	**X14**	**X15**	**X16**	**X17**	**X18**	**X19**	**X20**	**X21**	**X22**
0.221	0.158	-0.024	-0.016	-0.154	-0.164	-0.028	0.342	-0.209	0.0009	0.218

The second step of algorithm has been applied twice and the received final decision contains a value of only positive weights of 10 attributes. A value of the target function corresponding to the given decision – $f(\beta) = 4.133$. With availability of 10 positive parameters there are 1024 various combinations of the alternate nulling of parameters the result of search has shown that the minimum value of the target function saves with all 10 received parameters $f(\beta) = 4.133$. In Table 4 the final results of model ***B1*** estimating have been shown**.** The attributes characterizing the process of customer service – x_{11} and x_{12}, and also the trip duration – x_4. have the strongest influence on the overall quality estimate. By the way, in total the received weights (components of vector β) are equal to 0.968. Therefore, it is possible to assume that a weight of the rest 12 components is very small. The variables entered in the model **B1** include all the variables of **model A1.** For the grouped data the given algorithm also has been applied. In Table 6 the results of estimating after step 1 has been presented.

Table 6. Results of LSM-estimating on 1st step

W1	W2	W3	W4	W5	W6	W7
0.164	0.098	0.253	0.434	0.078	-0.073	-5.4*10^-3

The second step of algorithm has been applied twice and the final decision – values of only positive weights of 5 grouped attributes (model ***B2***). With availability of 5 positive parameters there are 32 various combinations of alternate mulling of parameters. The result of search has shown that the minimum value of the target function saves with all 5 received parameters f(β) = 5.992. As it is obvious from the results of construction of ***model B2*** – grouped attributes 6 and 7 haven't entered it.

Let's use a procedure described in p.2.4 for finding weights, which values are limited by equality in amount 1. The considered algorithm has been realized in the Mathcad package. For the primary data the results submitted in Table 4 (***model C1***) have been received. As it is seen from the results, the negative value of weights relates to 9 attributes of quality, by the way, these attributes haven't entered **model A1** due to their insignificant influence on the resultant estimate or correlation with the earlier entered variables.

For the grouped attributes the given algorithm has been also applied and the results have been presented in Table 4 (***model C2***). As it is seen from the results – the negative value is just of 1 attribute – the sixth one corresponding to the „Reliability/Safety" category. It has also entered **model A2** because of the significant correlation with the earlier entered variables.

And, finally, the two-step procedure on the basis of combination of two algorithms has been applied – for decisions received with restrictions to values of parameters (***model C1*** and ***C2***) the procedure of removal of a parameter with the negative signs has been applied. The received results of estimating for models with 22 private attributes of quality (***model D1***) and the grouped attributes of quality (***model D2***) are presented in Table 4. Model ***D1*** has been received on the forth iteration and as the result of search of 512 decisions. Minimum value of the target function during the choice of 9 parameters is (f(β) = 4.355). ***Model D2*** includes 6 grouped attributes and minimum value of the target function f(β) = 6.618.

Conclusions and Discussion

As the final formula of the model for the input non-grouped data with observing all restrictions to weights it is possible to consider ***model D1***:

$$y_i^* = 0.144\,x_{1i} + 0.082\,x_{4i} + 0.171\,x_{7i} + 0.05\,x_{8i} + 0.133\,x_{11i} + 0.141\,x_{12i} + \\ + 0.058\,x_{13i} + 0.128\,x_{19i} + 0.093\,x_{22i}$$

and for the grouped data – ***model D2***:

$$y_i^* = 0.17 w_{1i} + 0.075 w_{2i} + 0.235 w_{3i} + 0.338 w_{4i} + 0.056 w_{5i} + 0.125 w_{7i},$$

For ***D1*** Standard Error of Estimate (SEE) compiles about 9% relatively a mean value of the overall estimate, for ***D2*** – a bit less than 11%.

A practical result of the given models is detecting of a significance of separate attributes of quality and their influence on the overall estimate of service quality provided by the coach terminal. It will allow the terminal's management to take more grounded measures for improvement of service quality. So, detecting the fact of the largest significance of factor w_4 corresponding to attributes of the customer service quality, once again stress a significance of measures of the staff management in the coach terminal. And, the second place according to significance x_1 – accessibility for external participants of traffic – in model ***D1*** confirms a correctness of a strategic goal of the terminal's management – to make it as a modern logistic passenger HUB with the high level of intermodality [1, 2]. Also it is confirmed from models the important role of planned reconstruction of infrastructure for improving the overall quality of service.

In a whole, the model constructed for a scalar quality indicator, allows estimating influence of particular quality indicators on the overall quality estimation and to simplify monitoring of quality indicators.

The models presented in this paper are based on a number of assumptions, which may be released later on and it will be a further development of the submitted approach.

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