Assessment of the car service services quality according to the certification system criteria

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Abstract. The Assessment of services quality is an urgent task in markets with imperfect information. Car service market refers to markets with imperfect information. Earlier, the author proposed to assess the car service quality by the voluntary services certification system criteria using the generalized principle of Edgeworth-Pareto. To implement this approach in practice, information is needed on the relative importance of the criteria, which can be obtained from regression models. The novelty of this work is the use of regression models without a constant. The information indicators analysis of the obtained models revealed the greatest importance of two of the six criteria. The information obtained is used for multicriteria assessment of the quality of the services and building a car service enterprises rating.

1. Introduction

The car was and continues to be an increased danger source on the roads. The malfunctioning technical car condition significantly increases its danger. According to the data of the Federal State Institution “Scientific Center for Road Traffic Safety of the Ministry of Internal Affairs of Russia”, the share of accidents in which vehicles' technical malfunctions were identified made up 4.1% of the registered accidents total number for 12 months of 2019. In total, 6734 such accidents were registered in the Russian Federation, the growth for the year was 8.2%. They killed 1107 people, which is 4.0% more than last year, injured 9789, an increase of 10.5% [https://media.mvd.ru/files/embed/1799170].

Ensuring good technical car condition is a car service enterprises basic task. According to the analytical agency "AUTOSTAT" in Russia, about 75 thousand enterprises are selling and servicing automobiles [https://www.autostat.ru/press-releases/40702/]. The services volume sales by car dealers amounted to 51.1 billion rubles per year, and service stations - 96.9 billion rubles per year. The market potential amounted to 162.6 billion rubles [https://www.autostat.ru/news/41082/].

Difficulties in market development, among other factors, may be associated with the uncertainty in the quality of car services. It matters to consumers. Allocate goods whose quality can be determined before their consumption, and goods whose quality can be determined as a result of their operation [1]. Workers in car service enterprises, in most cases, have more information about the problems encountered in the car and how to resolve them than the car owner. This gives rise to situations where unscrupulous employees, having misled the client, impose on him services that were not essential. Such services may not be provided, as the result of their implementation may not appear in the foreseeable future. All of the above makes it possible to classify car repair and maintenance services as “credence goods”. This term (credence goods) was introduced [2] to refer to goods whose quality determination can sometimes not be carried out even as a result of their consumption. Measuring such
products quality is associated with serious costs and is a rather complicated task requiring laborious research [3].

Problems caused by difficulties in measuring quality cannot but affect customer satisfaction and reduce trust in car service providers in general. The above allows attributing the car service services market to markets with asymmetric information about quality. Kenneth J. Arrow, George Akerlof, Joseph Eugene Stiglitz, Michael Spence, and other scholars considered this type of market in their work. Based on the writings of the above authors, we consider a simplified situation illustrating the quality uncertainty impact on market development. Suppose that D - demand in the market corresponds to S - supply. Moreover, there is a certain pe - equilibrium price for services with a qe - equilibrium services rendered quantity (Figure 1).

The demand for car service depends not only on the price (p – price), but also on the usual (expected, average) qa – services provided average quality expected by the consumer. If the expected level of quality decreases, the demand for services will decrease and, under the assumptions made, the volume (q – quantity) of the supply will decrease. To simplify, suppose a linear relationship between the ratio of benefits to costs and the level of services quality. The consumer, when choosing a service provider, has an opinion about the level of quality and does not agree to overpay, without strong evidence of a higher level of quality. Enterprises that provide quality above expected will be forced to sell their services at an equilibrium price and lose some of the profits. Ultimately, enterprises providing quality above expected will have to leave the market, which will lead to a decrease in expected quality. The process is continuously repeated, each time with a lower value of the expected quality. From the foregoing, the conclusion follows the need to improve consumer information about the car service quality level.

Significant costs in measuring the quality of the goods such as car services lead to the need to establish minimum quality standards [4]. The minimum quality in the service market is designed to provide such methods of state regulation as licensing and certification. Decree of the Government of the Russian Federation of April 21, 2001 No. 312 “On licensing of activities for the maintenance and repair of motor vehicles carried out on a commercial basis” confirmed that these activities are subject

Figure 1. The equilibrium of the market demand and supply car services.
to mandatory licensing, which implied the mandatory certification of services for maintenance and repair of automobiles. The obligatory certification was cancelled due to the entry into force of the Federal Law of the Russian Federation No. 184 FZ “On Technical Regulation” dated 12/27/2002.

Currently, voluntary car services certification is carried out by various systems subject to registration by the Federal Agency for Technical Regulation and Metrology.

This article is devoted to the problem of assessing car services quality based on the requirements of a voluntary certification system for automobile transport.

2. Literature Review
A multicriteria approach to measuring the quality of the services is used in the methods SERVQUAL [5], SERVPERF [6], INDSERV [7] and others.

A well-known approach to multicriteria evaluation is the search for Pareto-optimal solutions [8]. A multi-criteria approach to assessing the car service services quality according to a certification system criteria based on a search for Pareto-optimal criteria values sets was proposed by this article author [9]. This approach implementation has revealed that it requires additional information about the relative importance of quality criteria.

The study of the relative importance of quality criteria is a separate task. A common approach to determining relative importance is the use of expert judgment [10]. Another approach is the models’ construction establishing the relationship between a certain general quality characteristic and particular quality criteria. If the necessary statistical materials are available, one can establish the relative importance of particular criteria using regression analysis.

In the study of the relative importance of private criteria for car service quality, it was proposed to adopt a variable describing the choice of a service provider by a consumer from two groups as an independent variable: an official car dealer or an independent car service. This approach predetermined the choice of logistic regression as a method for determining the relative importance of particular criteria [11].

A similar approach was used to determine the importance of factors determining the choice of a car service provider for after-sales service of automobiles [12].

3. Methodological apparatus of the research
In the conducted studies, to assess the car service services quality, the criteria of the voluntary certification system for road transport, proposed in the works of Professor N.N. Yakunin [13]. To obtain information on the relative importance of the criteria, a logistic regression model was used [9, 11]. As a response to the model, the enterprise was classified as a motor transport enterprise (MTE) and a car service station (CSS).

To assess the prognostic ability of the obtained models, the main provisions of the ROC analysis [14] were used: sensitivity (Se), specificity (Sp), and area under the curve (AUC). These concepts are derived from the errors in classifying enterprises as one of the two types of MTE (0) or CSS (1) (Table 1).

| Type of enterprise predicted by the model | Observed enterprise type |
|-----------------------------------------|--------------------------|
| CSS type (1)                            | TP (True Positives)      |
| MTE type (0)                            | FN (False Negatives)     |

TC - truly positive cases when an enterprise of the CSS type (1) is classified as a CSS type (1);
TN - truly negative cases when an enterprise of the MTE type (0) is assigned to the MTE type (0);
FN - false-negative cases, when the enterprise of the type CSS (1) is classified as the type of MTE (0);
FP - false-positive cases when an enterprise of the MTE type (0) is assigned to the CSS type (1) (Figure 2).
Figure 2. Types of classification errors.

Sensitivity is the percentage of true positive cases:
\[ Se = \frac{TP}{TP + FN} \cdot 100\% . \]

Specificity is the percentage of truly negative cases that were correctly classified by the regression model:
\[ Sp = \frac{TN}{TN + FP} \cdot 100\% . \]

As a result of the statistical analysis [11], it was shown that to ensure high specificity and sensitivity indicators, it is sufficient to include three out of six criteria in the model. Which indicated the high importance of these criteria in identifying the type of enterprises. In these statistical models, there was a constant that hampered the semantic interpretation of the obtained models. In the present study, at the suggestion of Professor Yu.R. Vladov, a statistical analysis of the criteria was carried out according to the model of logistic regression without a constant.

4. Research Results

According to the available data, the relative humidity was analyzed using the logistic regression method. The first constructed model included all six criteria as predictors; the constant was taken equal to zero.

The model of logistic regression without a constant, which enters all the criteria, correctly classifies 46 of 53 MTEs and 28 of 35 car services.

In addition to the considered indicators of the classification properties of the model, it is necessary to remember the statistical indicators. The question was posed: is it possible to remove some of the predictors from the composition of the model and not significantly reduce the statistical significance of the model? The following methods were used for this: conditional likelihood ratio (Cond); likelihood ratio statistics calculated from maximum partial likelihood estimates (LR); statistics Wald (Wald). The exclusion of criteria from the model was carried out in two directions: Forward -FW and Backward -BW. Based on the exclusion results, seven statistically significant models were obtained. Statistical significance was estimated by the value pseudo-R-square of the Nagelkerk [15] and the significance of the Hosmer-Lemeshow statistics [16]. Characteristics of the models are summarized in Table 2.
Table 2. Characteristics of Regression Models.

| Method        | Composition   | Se    | 1-Sp | AUC    | Nagelkerke R Square | Sign. Hosmer and Lemeshow test |
|---------------|---------------|-------|------|--------|---------------------|-------------------------------|
| Enter         | K1, K2, K3, K4, K5, K6 | 0.8   | 0.132| 0.834  | 0.761               | 0.930                         |
| FW_Cond       |               |       |      |        |                     |                               |
| BW_LR         |               |       |      |        |                     |                               |
| FW_Cond       | K3, K5        | 0.65  | 0.188| 0.731  | 0.476               | 0.503                         |
| FW_LR         |               |       |      |        |                     |                               |
| FW_Wald       |               |       |      |        |                     |                               |
| BW_Wald       | K5            | 0.889 | 0.342| 0.774  | 0.256               | 0.987                         |

The values of the AUC for the obtained models are shown in Table 2. A model that includes six criteria (K1, K2, K3, K4, K5, K6) has high predictive ability, this is indicated by the high value of the AUC indicator (0.834). We will determine qualitative information about the relative importance of the criteria from the ratio of shares of the explained dispersion by each of them. Criteria K3 and K5 well divide the two types of enterprises MTE and CSS. Large values of K3 are inherent in CSS, and large values of K5 are inherent in MTE. From this, it can be argued that the most important criteria are precisely the criteria K3 and K5. Thus, it was concluded from the model that MTE-type enterprises have the best condition for the control and diagnostic, testing equipment and measuring instruments, which is evaluated by criterion K5. At the same time, CSS-type enterprises have the best state of technological equipment and tooling (K3). Models with a constant indicated the significance of criterion K2, which assesses the condition of buildings and structures [9]. Models without a constant did not reveal the significance of this criterion, but such models are easier to interpret.

The obtained information on the relative importance of the criteria K3 and K5 can be used for multicriteria assessment of the quality of services and building a rating of car service enterprises.

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