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DEVELOPMENT OF REMOTE TOOLS TO ASSESS THE EFFECTIVENESS AND QUALITY OF CAR SERVICE ENTERPRISES WORK

Abstract: *The paper is updated development problem of remote tools to assess the effectiveness and work quality of the corporate car service enterprises. This paper presents the author's methodology of activity estimation car service enterprises based on corporate information reflecting the report on the production activities of the service company. Specialized information system has been developed and implemented based on the proposed methodology. Specialized information system is the analytical tool for assessing the activities of enterprises the brand network of car service, for one of the largest national carmakers. The aim of research is development and realization of a monitoring system for certain areas of the car service work that significantly affect the quality process of the maintenance service. In addition, the paper is devoted to solving urgent issues of collection and processing of real data on warranty defects of cars.*

Keywords: *automotive industry, quality monitoring, car service enterprises activity*

1. Introduction

In recent decades the automotive industry there has been following wave of technological growth. A modern motor vehicle is not only a traditional car with an internal combustion engine, it's an electric vehicle and a car with a combined energy plant. Today the traditional cars constructions are significantly changing, which is caused by the growing demands to environmental, safety, quality and reliability (Senoz et al., 2011; Kopp et al., 2011). Mainly, the consequence of these changes is the integration electrotechnical and electronic complexes and systems to motor vehicles composition. Cars are getting harder. At the same time, automotive corporations strongly recommend performing simple operations related to maintenance and replacing consumables at certified enterprises of branded after-sales service network (Taifi and Passiante, 2011).

On the other hand, the road transport is becoming more accessible for customers under conditions of technical and technological development of the modern industries. Vehicle maintenance and repair system becomes more accessible. In a highly competitive environment, automotive companies are actively developing regional dealer networks in order products and services most consistent with the consumer environment (Gonzalez, 2015; Ostrom et al.,

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2015). Search car service enterprises in the region, service and repair vehicles under the corporate standards are becoming less burdensome from the point of view of time and from the point of view of financial costs (Onwuegbuzie et al., 2009).

Today, high-quality and reliable service of product in the operation process plays a key role in the development of the carmakers competitiveness. The effective management of the branded service network becoming increasingly important (Liu et al., 2015; Völckner et al., 2010).

If we look at the distribution geography and estimate the enterprises number of major carmakers service network, we can come to the conclusion that in the conditions of constant quantitative growth of such enterprises, to several hundreds, and sometimes thousands on the national markets of different countries, are updated the problems of establishing effective control over the activities of after-sales service network enterprises. Automakers are forced to conduct total checks of more global service markets. Total checks are carried out by own experts or experts of the foreign organizations invited under conditions of outsourcing.

At the conclusion of dealer agreements, automakers are always connected service enterprises to its corporate information systems to ensure constant communication used for reporting and operational management. However, practice shows that is not to say that information resources always work for the automaker with maximum efficiency. First of all, this concerns the issues of ensuring control over the activities of service enterprises. Today, the possibilities of informational quality control and economic efficiency of auto dealers work's are not exhausted.

It should be noted that increasing the effectiveness of control over car service enterprises activities, through corporate information systems of automakers, can not only reduce the cost of traveling expenses for auditors. Development of such systems provides a more rapid and detailed monitoring status of the most relevant issues for the automaker (Godlevsky and Yunak, 2005).

If we consider issues related to the process quality of vehicle maintenance and repair, as a key business process for the automaker and autodealers, we can conclude that many areas of work are covered by the monitoring system. Such processes, e.g.:

- delivery of spare parts for warranty and post-warranty car repairs;
- warranty service acts registration in the corporate information system;
- training and retraining of car service personnel;
- financial and economic activity of enterprises;
- providing enterprises with corporate standards, technological instructions and other regulatory documents necessary for work;
- provision of special tools and technological equipment, etc.

Automakers closely monitor all areas of dealers work. For the main enterprises, the information coming from the service network is extremely important (Kozlovskiy, 2015; Kozlovskiy and Aydarov, 2017).

However, practice shows that there are some specific work areas of the car maintenance system. Leading carmakers are only beginning to think about the need to introduce quality control in specific areas of work. And of course, today these areas of work are not covered by existing monitoring systems. Meanwhile, they are very significant from the economic point of view and significantly affect the business processes quality, both dealers and the automaker.

Specific areas of work include:

- return of defective products;
- elimination of some types of defects without the use of spare parts during warranty period;

- repeated repair to eliminate the same defects on the same cars;
- complex replacement of expensive components and aggregates on the warranty cars.

The lack of monitoring tools leads to additional costs for automakers. Deviations in the work of dealers are the reason for the unreliable evaluation of the quality of new cars in operation and reduce the efficiency of production management.

2. Review of the past research

The development of the automotive industry is inextricably linked with the development of the ensuring operational effectiveness of the industry production sector, namely service maintenance. Today the car service is an important element at ensuring the competitiveness of products and a tool of improving the customer loyalty (Hayes, 2008; Ostrom et al., 2015; Godlevsky and Yunak, 2005; Qiu, 2014).

Despite the fact that there is no direct connection between the ensuring car quality in production and the quality of service in exploitation, it is obviously that the first and the second directions definitely influence on the perceived by a consumer quality of products and services and so they form an attitude of consumer community to the brand maker (Gonzalez, 2015; Onwuegbuzie et al., 2009; Liu et al., 2015). That is why the measurement of service maintenance quality is equally important for automaker as the monitoring of the quality of production processes.

At the present time, in the course of solving problems on measuring quality of service maintenance, there has been found a spectrum of methods and techniques allowing to conduct quantitative (the service provider is estimated on a grade scale), qualitative (the quality of customer service is estimated by people responses) and comprehensive quantitative and qualitative researches – they include the above-described estimates (Völckner et al., 2010; Kozlovskiy, 2015).

The development of information and computer technologies has had a beneficial impact on improving monitoring technologies of product and service quality (Szwejczewski et al., 2015). Development and implementation of information analysis algorithms of service quality allows getting a balanced assessment of consumers reflecting the quantitative and qualitative research area of satisfaction (Fonseca et al., 2010; Pluye et al., 2009; Sabbagh et al., 2016). However, the implementation of service quality researches based on data received by corporate information systems from proprietary service network enterprises to analytical quality services of automakers enterprises about the results of the maintenance and the elimination of defects and failures of cars are not widely represented in the literature, apart from a small group of sources (Ažman and Gomišček, 2015; Dholakia et al., 2010). That is why this theme in the presented work is the main.

If we talk about the organization of control systems for the corporate network enterprises activity, the development and realization of verification systems that are conducted legally or by the method of mystery shopper are considered expedient.

The first of the selected models of inspections are a multidimensional study of the quality performance of corporate standards by dealers. Such inspections are carried out by expert groups of automakers or by expert groups of third-party consulting agencies working under contracts. The essence of legal inspections is the approval or disapproval of car service enterprises activity in all licensed areas of work and related processes:

- pre-sale preparation;
- warranty and after-warranty service and repair;
- presence and use of special tools, equipment and tooling;

- metrological support;
- standardization;
- staffing etc.

Experts conduct an analysis of the current state of organization and give an appropriate assessment (Kozlovskiy, 2015; Kozlovskiy et al., 2017; Szwejczewski et al., 2015).

Inspections by the method of mystery shopper can be carried out by expert groups of the parent company or third-party organization. The object of inspection for this method is mainly processes associated with the direct activity of the service organization with consumers. Based on the check results, the auditors prepare a report reflecting the conformity assessment of the service company activities meets the requirements of corporate standards.

Information and analytical tools of dealers activity control are operating within the corporate information systems and mainly deal with the implementation of regulated reporting procedures (meeting requirements, assessment of financial and economic activities). The responsible employees of the dealer departments fill out specialized reporting forms and the specialists of the parent company accept the reporting documents (Sabbagh et al., 2016; Pluye et al., 2009; Qiu, 2014).

3. Main research results

The importance of the process organization quality of the company service maintenance of the automotive industry products has been growing over the years. There are a lot of reasons for that. Here are the main ones:

- the alignment and a gradual value decline of the initial purchase price of different brands cars at national markets and mass segments and corresponding growing role of factor possession of price for users, which include the service indicators;
- active saturation of vehicle by electronics and automation systems which need periodic diagnostics and servicing in a proprietary network;
- the rigidity of policy measures from automakers to consumers which are associated with the mandatory maintenance of new cars in conditions of certified service;
- the impossibility of servicing and repairing cars on their own because of complication of the construction and integration of original components into the structure of vehicles which require the competence of staff and specialized tools at the enterprise.

Apart from selected aspects that affect on the importance of company service maintenance, it is also should be noted the rapidly development of electric cars, cars with combined power installations and unmanned vehicles. This is a new design-engineering level of auto industry which could not be provided without appropriate changes in the servicing system.

The experience shows that the most important in the management of activities of proprietary network, according to company standards, becomes the control of the customer service quality, and what is more, the control of providing the same high quality work at all enterprises is also the important aspect here without reference to the category or geographic location.

Control functions for service network of national automakers are traditionally realized through the organization of enterprises inspections on the requests of proprietary standards of work organization and customer service. As a rule, proprietary network of automobile corporations includes hundreds of enterprises which are located that they could provide the competitive advantages to automaker. That is why it is necessary to have a significant budget for annual coverage by inspections of a whole network.

In this case, it is not obvious that the organization of a large number of field inspections of enterprises of company car

service center is always giving the high result which is connected with the improvement of the network as a whole. As proof of this thesis, here is presented the Table 1, where are the systematized results of legal audits of enterprises of proprietary network of one of the leaders of the Russian automotive industry for the period 2012/2015. The table shows that there have been observed the same drawbacks in the different enterprises of the one proprietary network from year to year, for example, deviations in the implementation of pre-sale preparation; weaknesses in the metrological service of the enterprise; failure of existing regulations, etc. The obvious conclusion is that target audit function has been substituted for. At that time, when it is already clear that it is required to provide the system effectiveness of corrective measures, there is a growth in the number of inspections in order to identify inconsistencies. So to speak: "The checking is for checking".

That is why we offer the transition from the general concept of the annual audit to the concept of remote monitoring quality of the work with the implementation of a random checks planning system by the target indicators of the service enterprises work.

Of course, despite the remote monitoring of the activity, it is impossible to fully replace the auditing system. However, the significant reduction in the number of field verifications and providing at an acceptable level of information data flow about the quality of work of the service enterprises is real. Moreover, the tools implementation of remote monitoring of the quality creates the backgrounds for a much greater efficiency and for the possibility of adjusting the activities of service enterprises on the basis of identified deviations. The assumed concept also fits well into the current situation at the Russian market. The constant growth of competition requires the optimization of expenses on provision of the main processes from automakers. But during the economic crisis the optimization problem becomes even more critical and often leads to a reduction in the budgets of different levels.

In such situation it is obvious that for guidance of automobile corporations it is important to maintain the conditions in which the optimization of expenses will not reduce the level of control and management of all processes in general and such an important process as the customer service, in particular. Therefore, there is the necessity of development and implementing the remote tools of monitoring of service quality which reduce the load on the automaker's budget while ensuring the quality of proprietary network management on the basis of corporate information systems linking any automaker and its service. Herewith, it is supposed that level of quality of production at the enterprise of automaker in conditions of mass production is a permanent for the whole amount of produced vehicles of a certain brand with the same release date.

An electronic implementation act of presale preparation and warranty service is the source of data for calculating the monitoring indicators, where all the main information, identified defects and service operations are fixed. Indicators, that reflect the quality of service in a particular enterprise, are calculated for the reporting period (month, quarter) and determined by assessments of deviations from the appropriative overall averages all over the whole proprietary network.

Research the activities of after-sales service network enterprises complex almost always leads to the conclusion that there are some violations in the work of some of them. Violations can be immaterial. They are quickly eliminated after consulting with service development management experts. Significant or system violations are associated with organizational and technical problems, as well as with the negligence of managers working at top-level service enterprises.

Carmakers are conducting product quality monitoring. It is necessary to say that the warranty period is especially interesting for the automotive companies. During this period, design and manufacturing defects are manifested and the carmaker has a significant amount of costs for repairing cars in operation.

Table 1. Repeatability of identified deviations on the inspections results of the network enterprises during the period 2012/2015

Identified discrepancies	2012 (29 checks)		2013 (33 checks)		2014 (25 checks)		2015 (28 checks)	
	Number	% Repeatability	Number	% Repeatability	Number	% Repeatability	Number	% Repeatability
The lack of equipment and special tools	29	100	23	69	20	80	21	75
Unrealized current requirements	13	45	22	68	18	72	19	68
The elimination of defects without using spare parts	20	68	21	67	14	56	16	57
The pre-sale preparation is carried out with deviations from the technology and instructions	11	38	20	66	5	20	3	11
Metrological provision of production does not correspond to the established requirements	9	33	10	33	10	40	8	28

Let's pass to the analysis of a problem of monitoring car service enterprises activity on specific directions of work. Also it's very important to consider the decisions offered in this area. But before this, it is necessary to designate the following significant aspect. Under conditions of mass production of complex high-tech products, there is such a concept as stability of the quality. It means a constant quality level of produced cars based on system and technological decisions.

Information interaction with dealer centers is built in such a way as to help the main company to increase efficiency in identifying massive and complex defects, and to minimize the risks of the lack of information about the sharply increasing failure rates.

Usually the operating time of a car is accompanied by failures. Defective products removed during the repair of cars are returned to the carmaker for research (returned products). Some defective products are disposed of by car service companies (unreturned products). According to a dealer agreement, unreturned products must be stored in the car dealer's insulator for 3-6 months before disposal. It provides access for experts of the main enterprise, for additional research into the causes of defects.

As a rule, additional research is not mass, but research is conducted from time to time in connection with a sharp excess of the failure rate of cars. This means that there is an opportunity to conduct unreasonable

warranty repairs at the after-sales service network enterprises, which requires the carmaker to introduce additional control monitoring operations. Some results of such monitoring may indirectly indicate the presence of irregularities in the corporate network activity.

Take a look at the Figure 1 below. Figure 1 shows the dynamics of defects registration on the car service enterprises, and accompanied by the repair and return of defective products to the main company (period 2014/2015). Analysis of the diagram shows that there is a clear trend in reducing the defectiveness of cars in operation, which indicates the growth of product quality.

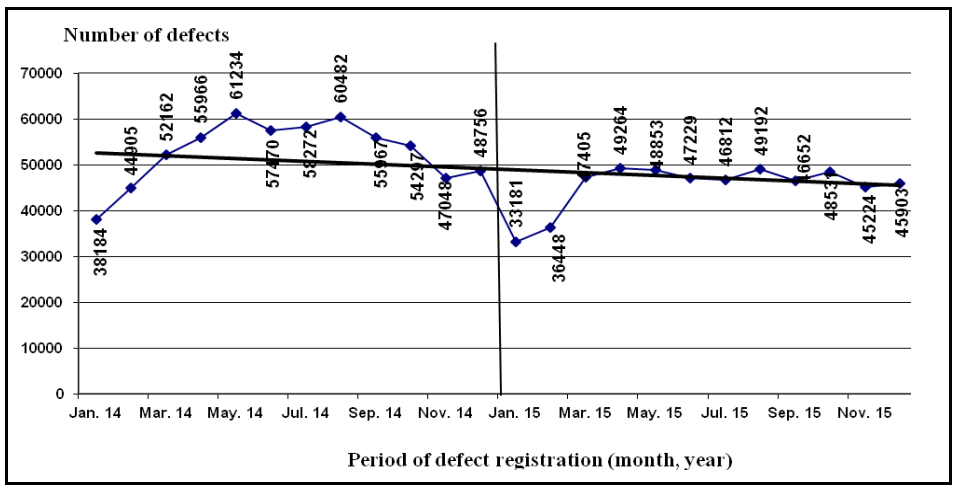

Figure 1. Diagram of returned products dynamics

Figure 2 shows a diagram reflecting the dynamics of defects registration for cars of the same carmaker, in the same period, accompanied by the repair and self-disposal of defective products. We can see a reverse trend, the defectiveness growth and reduced product quality.

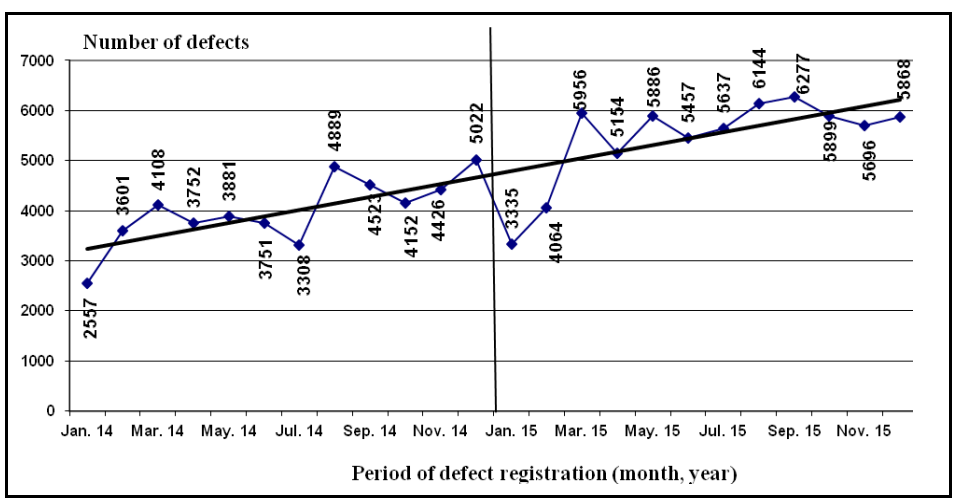

Figure 2. Diagram of unreturned products dynamics

Based on a joint analysis of diagrams presented in Figure 1 and Figure 2, it is possible to make a primary assumption about the possible presence of violations at the car service enterprises. So, suppose that an expert has a primary information about the deviations in the investigated process. In this case, it is required to conduct a more in-depth research of the problems causes and identify the main culprits.

Therefore, the next step in conducting analytical work is the analysis of the car service enterprises activity in order to identify possible deviations in work. The next analytical diagram is more specifically reveals the service problems. Figure 3 shows the distribution diagram of the relative costs level for the elimination of warranty defects that don't require the replacement of spare parts, in the context of a certain number of the car service enterprises.

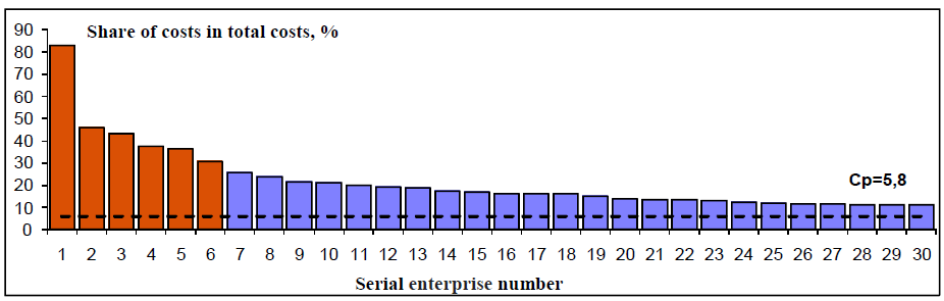

Figure 3. Distribution diagram of the relative costs level for the elimination of warranty defects that don't require the replacement of spare parts

Analysis of the diagram (Figure 3) shows that enterprises 1-6 have an extremely high level of costs to eliminate this type of warranty defects. The cost level is several times higher than the average level of 5.8. Obviously, the selected group of enterprises has problems associated with the organization of the maintenance and repair process. We list the possible causes of problems:

- insufficient professional qualification;
- low level of production culture;
- attribution of fictitious defects;
- insufficient level of quality control of the production service work by top managers.

Then the expert can conduct a research. An example of the research is illustrated in Figure 4, which shows the distribution of the average costs level for the elimination of one warranty defect, in absolute units, at the car service enterprises.

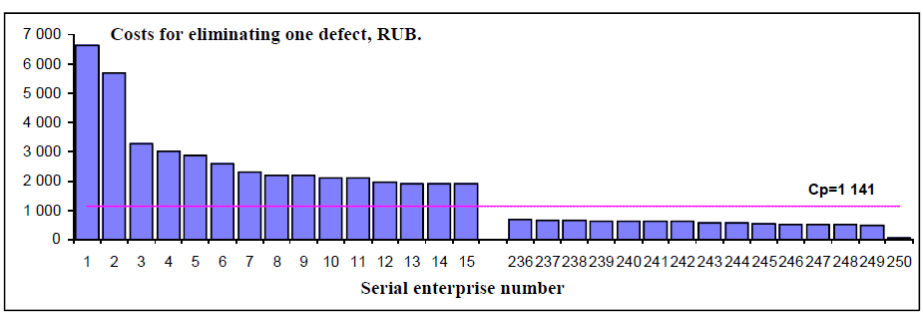

Figure 4. Distribution diagram of the average costs level for the elimination of one warranty defect

Analysis of the distribution diagram of the average costs level for eliminating typical defects (Figure 4) shows the leadership of enterprises 1–15. These enterprises have the most significant costs for the elimination of defects during the period of warranty operation of cars. Moreover, the joint analysis of Figure 3 and Figure 4 shows the same group of six enterprises. For these enterprises it is typical to conduct expensive warranty works to eliminate defects that don't require spare parts, as well as the availability of the largest average costs for eliminating one defect.

Further, we conduct the detailed monitoring of car service enterprises activity based on the costs by one car service visit during the warranty period (Figure 5).

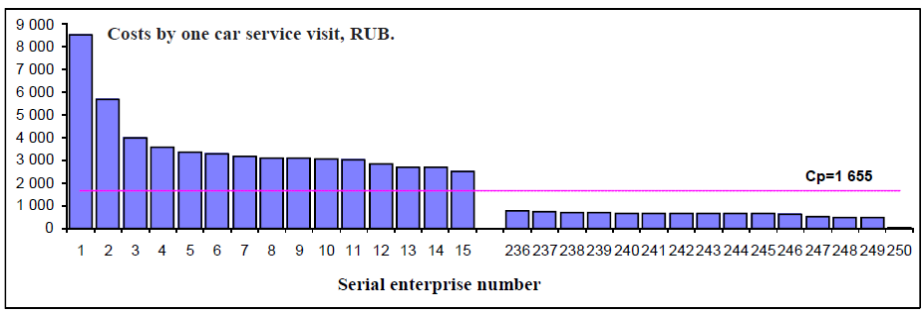

Figure 5. Distribution diagram of costs by one car service visit

Analysis of the diagram in Figure 5 allows to identify some car service enterprises. These enterprises have an extremely high costs for the elimination of defects during the warranty period. In this case, the carmaker incurs an additional financial losses due to unreasonable cars repair, conducted at these car service enterprises. And these are the same after-sales service network enterprises, identified in the analysis of Figure 3 and Figure 4.

And what about the enterprises, where the costs level for elimination of defects is below the average level over the network? For carmaker, the work of these enterprises as dangerous as the work of the first group enterprises. Most likely, the situation at the enterprises of second group is such that specialists refuse to do warranty repair, what negatively affects the operational efficiency of products and consumer satisfaction.

The question then arises. If there are no facts proving the groundlessness of carrying out repair and the costs of eliminating defects, then why check the car dealers once again? The answer to this is very simple. In the maintenance system, there are many enterprises with different classification characteristics. There are companies of the first group (category A) – these are the largest dealers, regional centers with large turnover and major sales of cars and servicing. There are companies of the second (B), the third (C) and even the fourth category. Last category companies do not have a sales quota, carry out only operations for maintenance and repair. But no matter how large the network, practice shows that violating or relaxing the rules of work with one or several auto dealers instantly leads to financial losses of the carmaker. We emphasize that the carmaker should not have illusions about partners. It is necessary finally stop turning a blind eye to the identified inconsistencies. Service quality is determined not only by the appropriate performance of the requirements and standards of repair work or maintenance. Quality of all auto dealer processes should be transparent and systemic, without exception. This quality of work is aimed at the discipline of the carmaker and dealers. It

provides confidence and the possibility of long-term joint development. The maintenance system degrades, in the opposite case. Lack of proper control, in the first place, leads to the fact that car dealers are beginning to neglect their obligations. As a consequence, in a competitive market such enterprises do not survive, losing certificate of conformity.

We offer an analytical reference as another form of control. This reference updates the questions of warranty service of specific dealer. Let us consider the approximate content of this reference.

Analysis of the enterprise No. **23** activity to eliminate **31,673** defects of the warranty service of cars during the period between **01/11/2014** and **01/11/2015** for a total cost of **RUB 28,937,681** demonstrates the need to verify the completeness and quality compliance of existing regulations, information letters, technical specifications and technological instructions:

1) For orders No. **3,740** by the amount of **RUB 2,312,547** of warranty repair without recourse to spare parts and materials;
2) For orders No. **1,797** by the amount of **RUB 1,759,856** to determine the reasons for repeated warranty repair of cars;
3) For orders No. **655** by the amount of **RUB 563,361** of pre-sale preparation;
4) For orders No. **1,851** by the amount of **RUB 1,285,864** for assessment the storage terms and availability of reclamation acts for **2,120** unreturned products;
5) For orders No. **1,232** by the amount of **RUB 1,173,512** for implementation of instruction «Reliability of information entered into orders and acts of warranty service»;
6) For orders No. **9** by the amount of **RUB 364,283** to determine the causes of numerous warranty repairs on one car.

The next element of analysis the car service enterprises activities should be a certificate of specialization in the removal of certain types of defects. Practice shows that some cases when filling out the acts of warranty service, some car service specialists often use certain codes of the defects, which indicates either insufficient level of their qualification or the presence of systemic violations related to unreasonable repair of cars and replacement of expensive components and aggregates.

Further, for the same enterprise No. 23, we present the information of the proposed analytical form (see details in Table 2).

Table 2. Determination the presence of specialization, the sign of which is the excess of more than two times the indicator of the total costs in the share of costs in Russia

Defect	Number of defects (Russia)	Number of defects (car service)	% Number of defects	Costs in Russia (RUB thousand)	Costs in car service (RUB thousand)	% Costs
1	**2**	**3**	**4**	**5**	**6**	**7**
1006033024000	7141	451	6.32%	8 134	993	12.21%
1701131096000	1937	157	8.11%	8 766	691	7.88%
3701010179002	5000	392	7.84%	7 857	634	8.06%
8118020000000	4160	248	5.96%	8 597	583	6.78%
8101012000001	3784	219	5.79%	6 018	552	9.17%

Table 2. Determination the presence of specialization, the sign of which is the excess of more than two times the indicator of the total costs in the share of costs in Russia (continued)

Defect	Number of defects (Russia)	Number of defects (car service)	% Number of defects	Costs in Russia (RUB thousand)	Costs in car service (RUB thousand)	% Costs
1701112060000	1691	126	7.45%	6 709	506	7.54%
8127200025000	4466	273	6.11%	6 311	422	6.68%
1411020000000	1268	102	8.04%	3 862	281	7.28%
1130010000000	2178	150	6.89%	2 614	182	6.97%
1003020000000	1200	111	9.25%	1 464	146	9.99%
3701010179001	1031	87	8.44%	1 588	139	8.76%
1601190067000	731	119	16.28%	713	125	17.47 %
2904185063000	3329	166	4.99%	1 749	124	7.07%
1701174060500	104	35	33.65%	356	124	34.69 %

Analysis of Table 2 shows that for the enterprise No. 23 there is a list of defects that are eliminated more often than the average over the network, i.e. there are the signs of specialization. For example, according to the first defect, the share of defects eliminated at the enterprise is 6.32% of the total indicator over the network, while the cost level, in the network costs for this defect, is 12.21%, which is quite substantial. Moreover, it should be borne in mind that spare parts are not used when eliminating a defect, in this case work is carried out using consumables. It is rather difficult to establish automated control over the expenditure of such materials. And this is not the main thing. Execution work to eliminate this defect has a significant laboriousness, and to verify the validity of repair is a difficult task. So it turns out that only with use the proposed analytical form can prove the unreasonableness of repair and withdraw from the acceptance the relevant costs incurred by automaker.

4. Conclusions

In conclusion, it should be noted that proposed remote monitoring complex of the quality of enterprises activity of service network can be formalized within the firm enterprise standard of automaker and realized in the form of a corporate information system of evaluation of activity of enterprises of service network. A list of quality indicators may vary depending on the achievements of the limit of effectiveness in the management of considered indicators and also on promising directions of service development. The monitoring results allow understanding better the occurring in the service network processes, taking into account the objective factors reflecting the actual quality of the product and subjective-reflecting the adding in the presale preparation and warranty service acts, inappropriate level of competency as an engineering staff and experts diagnosticians, low quality elimination of defects, overvalued level of costs imposed on the

automaker acceptance. In this way, level of effectiveness of control for service, which is close to maximum, is being achieved without additional expenses for planning and organizing a large number of inspections, which and to this day is typical for many major automakers.

An important aspect of this article is the development and implementation of corporate service quality monitoring system with using internal information of automakers enterprises which in the future, in conjunction with results of the research of the perceived quality service maintenance, will provide the most complete quality assessment covering the corporate environment of automaker and consumer environment.

By this means development the analytical forms of monitoring the car service enterprises activity, starting from a high level covering the entire complex of enterprises, to forms detailing certain areas of auto dealer activity, provides opportunities for implementing the additional quality control and economic efficiency of the service network

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