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# QUALITATIVE ATTRIBUTES OF SPARE PARTS FOR PASSENGER CARS AND VEHICLE SPECIFICATION AND METHOD OF ITS MAINTENANCE

ALEKSANDER LOTKO<sup>1</sup>, MAŁGORZATA LOTKO<sup>2</sup>

Kazimierz Pulaski University of Technology and Humanities in Radom

## Summary

The purpose of this paper was to study whether the formal vehicle specification and method of its maintenance differentiate the assessment of importance of qualitative attributes of spare parts for passenger cars.

The data collection method used was a survey conducted on 498 clients of car technical service centres. The identification of the differentiating attributes was performed by applying the Kruskal-Wallis and Mann-Whitney statistical tests.

The theoretic implication is the detection of qualitative attributes of spare parts, the weights of which are differentiated by vehicle specification and method of its maintenance.

The practical implication is the provision of essential recommendations for the designing and manufacturing of spare parts and communication to the clients of the utility provided by the parts.

As a result of the conducted study, it turned out that the vehicle brand differentiates all 21 studied attributes, vehicle servicing location – 18 attributes, origin of the vehicle – 13 attributes, vehicle age – 7 attributes, average annual number of technical service centre visits – 5 attributes, average annual mileage – 4 attributes and type of vehicle ownership – 1 attribute.

A novelty element in the paper is the innovative selection of the qualitative attributes of spare parts, the use of the chosen statistical researches in the studied field and detection of the differentiation of importance of these attributes.

**Keywords:** spare parts, passenger cars, quality, maintenance

<sup>1</sup> Kazimierz Pulaski University of Technology and Humanities in Radom, Faculty of Economics, 26-600 Radom, Chrobrego 31; e-mail: [aleksander.lotko@uthrad.pl](mailto:aleksander.lotko@uthrad.pl)

<sup>2</sup> Kazimierz Pulaski University of Technology and Humanities in Radom, Faculty of Economics, 26-600 Radom, Chrobrego 31; e-mail: [lotko@uthrad.pl](mailto:lotko@uthrad.pl)

## 1. Introduction

In the last years, the automotive discipline has tackled sales drops caused by the financial crisis and technological limitations, resulting from the need to protect the environment. At the same time, we observed a reduction in the cycle of development and market presence of automotive discipline products with simultaneous increase in their complexity. The issue of quality in the automotive discipline is especially important due to five premises [13]:

1. Product complexity (a car consists of several tens of thousands of parts).
2. Technological advancement of the product and its manufacturing process.
3. High series and mass scale manufacturing.
4. Configurability and modularity of the product.
5. Necessity of close co-operation within supply chains (only a small part of subassemblies, i.e. approx. 20%, is manufactured by the car manufacturer, while the rest is derived from sub-suppliers).

The maintenance of cars embraces the need to execute many servicing and repair activities, which require correct spare parts mounted as replacement for worn or damaged parts. There is a problem of selecting parts with the expected quality. It is an important and complex issue on the brink of marketing and commodity science, which may not be limited only to the criterion of price.

The purpose of this paper was to study whether the formal vehicle specification, i.e. its profile, differentiates the assessment of importance of qualitative attributes of spare parts for passenger cars. Due to the above, the following hypothesis was made:

H1: The vehicle specification and method of its maintenance differentiate the weight of qualitative attributes of spare parts for passenger cars.

The above hypothesis was verified using methods of mathematical statistics applicable in detecting differentiating factors: the Kruskal-Wallis test and the Mann-Whitney test.

## 2. Issue analysis

The conducted analysis of literature demonstrated the relevance and importance of the undertaken topic and showed the existence of a study gap. The available elaborations mainly regard the systemic frame of relations between the parts manufacturers and car manufacturers [23], supplier quality management [14], supplier quality costs [21], methods and tools used in managing quality in the automotive discipline [19], systems, standards and conditions of incorporating quality management in the automotive discipline [4], effectiveness of quality management systems [16], management of supply chains [6] or applications of quality management systems at suppliers [1]. In the specific case of quality of car parts, the analysed elaborations focused on the inspection of the quality of parts at the stage of their manufacturing and immediately after it [12], standardisation of quality testing, including reliability for parts manufacturers [2], qualitative challenges and an overview of the directions of improving the quality for parts manufacturers [17],

quality of parts in the context of recall actions [7] or the issue of logistics and packaging of automotive parts [24].

We have not encountered an elaboration which would include the results of researches regarding the classification of qualitative criteria for the selection of spare parts from the client's point of view. Due to this study gap, in this paper we have committed to compare the qualitative criteria for selecting parts, obtained by using two various multidimensional exploration techniques.

### 3. Quality of spare parts for passenger cars

In the age of globalisation, the problem of qualitative categorisation of spare parts became very important and the interest in harmonising the standards in the automotive sector has increased. Due to the above, actions taken have resulted in 1999 in the development of the international ISO/TS 16949 standard (its current version was developed in 2009), which includes harmonised requirements, based on domestic standards, but supplemented with additional elements [5].

However, for clients purchasing spare parts during their vehicle's maintenance of a bigger significance is the GVO Directive (GruppenFreistellungsVerOrdnung), the aim of which is to incorporate bigger competitiveness in the automotive sector by introducing a multi-brand approach at car dealers as well as alternative parts (substitutes). Their purpose is to constitute a competitive offer in terms of prices and quality to original parts. Poland has the Uniform Parts Quality Information System from 2005, which is the result of an arrangement between the distributors of parts and insurance companies, incorporated by the Automotive Parts Manufacturers and Suppliers Association [10].

When confronting the model of J. Żuchowski [25] with the discussed issue, it was acknowledged that the quality of spare parts for passenger cars, especially their utility value, is affected by:

- reliability – that is the fulfilment of specific requirements in any conditions and time. A passenger car is a special possession and should be in good condition to ensure safety both for the driver, passengers and other road users,
- functionality – in the case of spare parts, it means the fulfilment of a specific tasks to an expected degree (e.g. obtaining high value of delay by brake discs and pads, high tyre adhesion, good damping of irregularities by shock absorbers),
- durability – regards the time of the part's maintenance between repairs, for parts which can undergo regeneration (e.g. clutch, steering gear, motor head, some injectors),
- efficiency – regards the time of the part's operation, during which it fulfils its function in relation to the total time of its operation (e.g. shock absorbers after reaching a specific condition of wear damp irregularities in a very weak manner and can cause the body to rock, xenon lamps change the colour of the emitted light in time, tyres lose their ability to lead off water due to tread wear),
- lifetime – most parts are subject to wear, especially those parts in the suspension and braking systems and motor accessories,

- maintainability – due to economic and ecological factors, some parts, instead of recycling, can undergo regeneration for further use (e.g. clutch, steering gears, elements of suspension (beam axles), starter motors, alternators),
- modernity – fulfilment of user requirements in terms of aesthetics, use of start-of-the-art materials (aluminium, carbon fibre, ceramic elements), accomplishments in electronics (audio-visual systems, communication systems) and state-of-the-art designing accomplishments (elements of bodywork, outer lighting, interior equipment),
- safety – feature especially important due to substantial risk present in road traffic. This especially regards active safety, i.e. prevention by particular parts of the realisation of the risk (e.g. short braking distance thanks to high quality brake pads, shock absorbers and tyres, good lighting of the road in front of the vehicle, thanks to efficient lights). Furthermore, it embraces passive safety, i.e. minimisation of negative effects of road events (proper functioning of air bags, safety belt tensioners, protection by way of body crash boxes).

Aside from the aforementioned product utility features, the quality of the product's workmanship is also important. One of the most famous definitions is the proposed by T. Kotarbiński [11] product adroitness, i.e. the sum of type and workmanship quality. One of them is the degree of the product's compliance with the legal regulations and technical standards.

In the case of spare parts, it is necessary to consider that aside from the compliance with physical parameters (e.g. matching of bodywork elements), most of them is subject to certification, i.e. must have a permit for use in the country, granted by an authorised institution. Product adroitness is also affected by the quality of workmanship, which constitutes the degree of reflection of the requirements of the quality of type.

The quality of workmanship, aside from efficiency and compliance with the technical specification, may also include aesthetic values. In the case of spare parts, they can constitute secondary factors, but they must not be underestimated. The aesthetic criterion regards in fact only the visible elements of the interior equipment (special flower containers in Volkswagen New Beetle) and body elements (it would be hard to talk about clutch or shock absorber aesthetics). We can also talk about aesthetics when mentioning the product packaging, although its content is more important. In this case, most important are the protective and informative functions of the packaging.

When talking about the technical side of quality, we must also mention the quality of maintenance, which is affected, aside from technical use and wear parameters, by the form of sales and post-sales servicing (e.g. repairs and regular inspections or warranty inspections). When developing spare parts, a certain period of maintenance usefulness is assumed for them, which is most often measured using an established failure-free mileage. An essential element is the economy of utility, which embraces the economy of maintenance in terms of using technical services and economy of maintenance related to every day vehicle use.

The aspect of environmental friendliness of using spare parts is also important. Modern lifetimes of many products are shortened and the recycling of worn products becomes

a global problem. To limit the generation and disposal of wastes, the last few years brought the beginning and propagation of the process of regeneration of worn spare parts for passenger cars. Aside from the environmental aspect, this ensures savings for the users of vehicles, because regenerated parts are substantially cheaper.

## 4. Methodology of research

First, we conducted the operationalisation of the definitions in the scope of qualitative attributes of spare parts. Based on the earlier presented analysis of bibliography studies in terms of the issue of product quality [25, 11, 9, 15, 3, 18, 8, 22], in combination with the specificity of parts for passenger parts, we have selected 21 observable variables. They were numbered as follows: 1 – reliability, 2 – functionality, 3 – durability, 4 – efficiency, 5 – lifetime, 6 – maintainability, 7 – modernity, innovation, 8 – safety, 9 – degree of compliance with the design, 10 – aesthetics, style, 11 – presentation (form of offer, sales and post-sales servicing), 12 – environmental friendliness, 13 – compliance with legal regulations and standards, 14 – diligence of workmanship, 15 – warranty conditions, 16 – price, 17 – economy of installation and use (maintenance), 18 – availability, 19 – quickness of delivery, 20 – brand image and supplier reputation, 21 – packaging (aesthetics, information provided).

The values of the variables were measured on five-point scales of Osgood's semantic differential. We used the simplest version of these scales, which included two opposite adjectives at the extremes. To assess the importance of the attributes, we used a five-point scale, from 1 – insignificant to 5 – critical.

The research was conducted by way of a survey. The selection of the research population was intentional. The research embraced clients of authorised technical service stations and independent workshops. We obtained and further analysed 498 correctly filled out questionnaires. The research was conducted between 7 and 23 October 2015.

Due to the fact that the obtained breakdowns of the observable variables differ from the normal breakdown, instead of the classic ANOVA variance analysis, we used the non-parametric Kruskal-Wallis test to study the variance. In this test, the null hypothesis assumes that the samples are derived from a population with the same breakdown, whereas the alternative hypothesis states that they derive from various breakdowns. The above statement can be recorded as follows:

H<sub>0</sub>: the breakdown of the variable is the same for all codes of the grouping factor, in comparison to the alternative hypothesis:

H<sub>1</sub>: the breakdowns of the variable differ for at least two codes of the grouping factor.

The consequence of adopting hypothesis H<sub>0</sub> is the statement that the degrees of the tested factor do not have a substantial impact on the observed results. Analogously, the consequence of discarding hypothesis H<sub>0</sub> is the statement that the degrees of the tested factor have a substantial impact on the observed results. We say then that the given factor differentiates the results. We have adopted the importance degree of  $\alpha=0.05$ . We used the

functionality of the Statistica software to analyse the observed degree of importance  $p$ . To consider hypothesis  $H_0$  as lacking bases for discarding it, the value  $p$  should be higher than the set degree of importance  $\alpha$  [20]. The Kruskal-Wallis test is appropriate if there are at least three codes of the grouping variable. If there were only two codes of the grouping variable, we used the Mann-Whitney test. Here, the null hypothesis assumes the equality of the average values for both test groups, whereas the alternative hypothesis assumes that the average values differ.

## 5. Analysis of research results

We have considered 7 variables that form the profile of a car user. These variables included: (1) vehicle brand, (2) condition at the time of purchase, (3) type of ownership, (4) vehicle age, (5) average annual mileage, (6) servicing location and (7) average annual number of technical service visits.

Table 1 presents the weights of qualitative attributes in division according to vehicle brand.

The analysis of the data in table 1 demonstrates that the vehicle brand differentiates the weights of all 21 analysed qualitative attributes of spare parts. Moreover, the variances are clearly important even at a much lower  $\alpha$  than the adopted value (0.05). The data in the table was not specified in detail, taking into consideration the complexity of the table (336 cases) and it was left for the readers' own, careful interpretation. In general, taking into account the partial analyses of particular attributes and the average value of all weights of attributes, estimated for each brand, it turns out that the highest weight to the quality of spare parts is assigned by the users of FIAT, Mazda and Toyota, Mercedes-Benz and Skoda, while the lowest – by users of BMW, Citroen and Nissan. However, when taking into consideration the profiles of these brands (country of origin, market segment, image), it is hard to point out any common features.

Table 2 presents the weights of qualitative attributes in division according to vehicle condition at the time of purchase.

Table 1. Weights of qualitative attributes in division according to vehicle brand

No.	Attribute	Vehicle brand																Value <i>p</i>		
		Audi	BMW	Citroen	FIAT	Ford	Honda	Ina	Mazda	Mercedes-Benz	Nissan	Opel	Peugeot	Renault	Saab	Seat	Skoda		Toyota	Volkswagen
1	Reliability	4.04	3.67	3.38	4.62	4.21	4.00	3.76	4.21	4.65	3.50	4.24	4.11	4.09	3.40	3.95	4.54	4.44	4.43	0.001*
2	Functionality	4.00	3.67	3.25	4.45	4.20	3.86	3.68	4.07	4.24	3.33	3.88	3.44	3.88	3.40	3.90	4.24	4.24	4.14	0.004*
3	Durability	4.35	3.80	3.50	4.62	4.23	4.29	3.92	4.57	4.63	3.83	4.41	3.78	4.26	3.40	3.95	4.50	4.49	4.43	0.000*
4	Efficiency	4.35	3.47	3.50	4.54	4.11	4.21	3.96	4.43	4.54	4.00	4.05	4.00	4.09	3.80	4.19	4.50	4.44	4.36	0.001*
5	Lifetime	4.43	3.60	3.38	4.60	4.09	4.14	4.08	4.71	4.37	3.67	4.24	3.56	4.12	4.20	4.05	4.43	4.34	4.45	0.000*
6	Maintainability	4.00	2.60	3.00	4.19	3.79	3.86	3.68	4.43	3.13	2.83	3.51	3.33	3.26	4.00	3.95	3.78	4.15	3.86	0.000*
7	Modernity, innovation	3.30	2.93	2.63	3.67	3.57	3.43	3.28	4.07	3.74	4.00	3.32	2.78	2.85	2.80	3.10	3.59	3.80	3.23	0.002*
8	Safety	4.35	3.53	3.38	4.71	4.41	4.36	4.44	4.50	4.59	4.00	4.27	4.22	4.12	4.00	4.33	4.63	4.66	4.39	0.004*
9	Degree of compliance with the design	3.65	2.93	3.25	4.33	3.66	3.29	3.64	4.29	3.76	4.00	3.71	3.11	3.21	3.80	3.52	4.09	4.15	3.93	0.000*
10	Aesthetics, style	2.83	2.73	2.63	3.02	3.14	3.00	3.16	3.71	3.24	2.50	2.80	2.44	2.59	2.60	2.57	3.00	3.51	2.73	0.044*
11	Presentation (form of offer, sale and post-sale servicing)	2.96	2.53	3.00	3.76	2.91	2.93	2.88	3.36	3.33	2.50	3.24	3.00	2.68	3.00	2.52	3.33	3.83	2.86	0.000*
12	Environmental friendliness	2.83	2.67	3.00	4.02	3.00	3.21	3.20	3.86	3.35	3.17	3.59	2.89	3.06	3.40	2.86	3.11	3.71	3.05	0.000*
13	Compliance with legal regulations and standards	2.96	2.40	2.88	4.21	2.80	3.50	3.24	4.07	3.74	3.33	3.51	2.89	3.03	3.60	3.05	3.69	3.83	3.20	0.000*
14	Diligence of workmanship	4.00	3.13	3.00	4.43	3.79	4.00	4.04	4.29	4.50	3.50	4.17	3.00	3.56	4.20	4.00	4.33	4.46	4.11	0.000*
15	Warranty conditions	4.22	3.73	3.63	4.55	4.00	4.14	3.88	4.29	4.59	4.00	4.05	4.00	3.91	3.80	3.86	4.41	4.32	4.25	0.001*
16	Price	4.35	3.27	4.00	4.33	3.98	3.50	4.12	4.29	4.07	3.67	3.80	3.89	3.74	3.40	3.62	4.02	3.83	3.91	0.028*
17	Economy of installation and use (maintenance)	4.39	2.87	3.63	4.10	3.61	3.86	3.64	4.36	3.63	3.33	3.63	3.33	3.35	3.60	3.33	4.09	4.24	3.77	0.000*
18	Availability	4.04	3.40	3.63	4.24	3.79	3.93	4.00	4.07	4.22	3.33	3.88	3.44	3.79	4.20	3.52	4.13	4.12	3.98	0.013*
19	Quickness of delivery	3.74	3.40	3.25	4.26	3.82	4.14	4.00	3.93	4.24	3.33	3.88	3.56	3.56	4.60	3.19	4.17	4.15	4.09	0.000*
20	Branch image and supplier reputation	3.57	2.60	3.25	3.88	3.41	3.79	3.68	4.14	3.98	2.33	3.73	3.22	3.35	4.60	3.10	3.70	4.22	3.64	0.000*
21	Packaging (aesthetics, information)	3.09	2.53	2.88	3.43	2.52	2.64	3.00	3.14	2.63	1.83	2.71	2.78	2.44	3.60	2.19	2.80	3.46	2.77	0.003*

\* - statistically important at the level of  $\alpha=0.05$ 

Source: own work.

Table 2. Weights of qualitative attributes in division according to vehicle condition at the time of purchase

No.	Attribute	Vehicle condition at the time of purchase		Value $p$
		New	Used	
1	Reliability	4.50	4.14	0.000*
2	Functionality	4.22	3.98	0.001*
3	Durability	4.53	4.24	0.000*
4	Efficiency	4.41	4.18	0.002*
5	Lifetime	4.32	4.22	0.151
6	Maintainability	3.57	3.77	0.572
7	Modernity, innovation	3.69	3.31	0.000*
8	Safety	4.58	4.32	0.005*
9	Degree of compliance with the design	3.85	3.74	0.178
10	Aesthetics, style	3.11	2.92	0.131
11	Presentation (form of offer, sale and post-sale servicing)	3.43	2.99	0.000*
12	Environmental friendliness	3.63	3.09	0.000*
13	Compliance with legal regulations and standards	3.75	3.23	0.000*
14	Diligence of workmanship	4.32	3.96	0.000*
15	Warranty conditions	4.40	4.09	0.000*
16	Price	3.76	4.03	0.054
17	Economy of installation and use (maintenance)	3.70	3.82	0.581
18	Availability	4.01	3.93	0.184
19	Quickness of delivery	4.12	3.85	0.004*
20	Branch image and supplier reputation	3.74	3.61	0.076
21	Packaging (aesthetics, information)	3.03	2.72	0.023*

\* - statistically important at the level of  $\alpha=0.05$

Source: own work.

The analysis of the data in table 2 demonstrates that the condition at the time of purchase (new or used, i.e. deriving from the primary or secondary market) differentiates weights of 13 tested features. These include reliability, functionality, durability, efficiency, modernity (innovation), safety, presentation (form of offer, sales and post-sales servicing), environmental friendliness, compliance with legal regulations and standards, diligence of workmanship, warranty conditions, quickness of delivery and packaging (aesthetics and information provided). According to predictions, in all observed, statistically important variances, the respondents using new cars have assigned qualitative attributes with higher weights than those using vehicles deriving from the secondary market.



Table 3 presents the weights of qualitative attributes in division according to type of vehicle ownership.

Table 3. Weights of qualitative attributes in division according to vehicle ownership

No.	Attribute	Type of property		Value $p$
		Private car	Business car	
1	Reliability	4.24	4.50	0.138
2	Functionality	4.05	4.11	0.737
3	Durability	4.32	4.39	0.967
4	Efficiency	4.26	4.20	0.755
5	Lifetime	4.26	4.16	0.595
6	Maintainability	3.75	3.20	0.018*
7	Modernity, innovation	3.42	3.50	0.760
8	Safety	4.38	4.61	0.337
9	Degree of compliance with the design	3.77	3.84	0.730
10	Aesthetics, style	3.01	2.68	0.077
11	Presentation (form of offer, sale and post-sale servicing)	3.11	3.34	0.265
12	Environmental friendliness	3.24	3.52	0.107
13	Compliance with legal regulations and standards	3.37	3.64	0.156
14	Diligence of workmanship	4.07	4.09	0.831
15	Warranty conditions	4.17	4.30	0.233
16	Price	3.99	3.50	0.083
17	Economy of installation and use (maintenance)	3.81	3.45	0.178
18	Availability	3.94	4.07	0.499
19	Quickness of delivery	3.92	4.11	0.255
20	Branch image and supplier reputation	3.68	3.39	0.256
21	Packaging (aesthetics, information)	2.81	2.84	0.940

\* - statistically important at the level of  $\alpha=0.05$

Source: own work.

The analysis of the data in table 3 enables the assumption that the type of vehicle ownership substantially differentiates only 1 qualitative attribute of spare parts. It is the maintainability of the parts. The detected variance is characterised by the fact that the users of private cars have assigned higher weights to the given feature than users of business cars.

Table 4 presents the weights of qualitative attributes in division according to vehicle age.

Table 4. Weights of qualitative attributes in division according to vehicle age

No.	Attribute	Vehicle age				Value <i>p</i>
		Up to 5 years	6-10 years	11-15 years	Above 15 years	
1	Reliability	4.39	4.10	4.35	4.18	0.073
2	Functionality	4.18	4.02	3.95	3.98	0.108
3	Durability	4.42	4.21	4.40	4.29	0.184
4	Efficiency	4.32	4.14	4.33	4.27	0.361
5	Lifetime	4.28	4.13	4.42	4.29	0.340
6	Maintainability	3.49	3.76	3.91	3.84	0.088
7	Modernity, innovation	3.69	3.48	3.17	2.84	0.000*
8	Safety	4.46	4.35	4.44	4.31	0.396
9	Degree of compliance with the design	3.80	3.73	3.87	3.67	0.594
10	Aesthetics, style	3.19	3.02	2.77	2.56	0.006*
11	Presentation (form of offer, sale and post-sale servicing)	3.36	3.17	2.92	2.67	0.002*
12	Environmental friendliness	3.58	3.28	2.97	2.69	0.000*
13	Compliance with legal regulations and standards	3.56	3.41	3.22	3.13	0.066
14	Diligence of workmanship	4.16	4.03	4.03	3.98	0.209
15	Warranty conditions	4.36	4.10	4.12	3.98	0.007*
16	Price	3.74	3.97	4.27	3.84	0.002*
17	Economy of installation and use (maintenance)	3.61	3.82	4.00	3.73	0.110
18	Availability	3.95	3.93	4.05	3.87	0.791
19	Quickness of delivery	4.02	3.95	3.86	3.76	0.317
20	Branch image and supplier reputation	3.71	3.64	3.63	3.63	0.502
21	Packaging (aesthetics, information)	2.98	2.90	2.98	2.54	0.032*

\* - statistically important at the level of  $\alpha=0.05$

Source: own work.

The analysis of the data provided in the table lets us assume that vehicle age is a factor that substantially differentiates the weights of 7 attributes. These include modernity (innovation), aesthetics (style), presentation (form of offer, sales and post-sales servicing), environmental friendliness, warranty conditions, price and packaging (aesthetics and information provided). The observed variance indicates an obvious dependency. The dependency constitutes of clearly lower weights assigned to attributes in groups of users of older cars.

Table 5 presents the weights of qualitative attributes in division according to average annual vehicle mileage.

Table 5. Weights of qualitative attributes in division according to average annual vehicle mileage

No.	Attribute	Average annual vehicle mileage				Value <i>p</i>
		Up to 10 thousand km	10-20 thousand km	20-30 thousand km	Above 30 thousand km	
1	Reliability	4.42	4.19	4.42	3.82	0.055
2	Functionality	4.23	4.01	4.18	3.55	0.020*
3	Durability	4.45	4.32	4.39	3.94	0.086
4	Efficiency	4.53	4.23	4.33	3.58	0.011*
5	Lifetime	4.34	4.26	4.31	3.82	0.132
6	Maintainability	3.88	3.72	3.68	3.33	0.179
7	Modernity, innovation	3.48	3.43	3.42	3.30	0.931
8	Safety	4.53	4.44	4.38	3.91	0.050
9	Degree of compliance with the design	3.83	3.74	3.83	3.73	0.646
10	Aesthetics, style	3.08	3.00	2.98	2.70	0.567
11	Presentation (form of offer, sale and post-sale servicing)	3.11	3.16	3.17	2.82	0.462
12	Environmental friendliness	3.41	3.21	3.28	3.36	0.520
13	Compliance with legal regulations and standards	3.61	3.34	3.50	3.09	0.121
14	Diligence of workmanship	4.20	4.08	4.11	3.64	0.216
15	Warranty conditions	4.20	4.18	4.29	3.82	0.335
16	Price	3.91	3.99	4.05	3.21	0.015*
17	Economy of installation and use (maintenance)	4.03	3.76	3.81	3.30	0.052
18	Availability	4.00	3.85	4.17	3.88	0.020*
19	Quickness of delivery	3.88	3.88	4.10	3.88	0.213
20	Branch image and supplier reputation	3.83	3.59	3.79	3.21	0.127
21	Packaging (aesthetics, information)	3.05	2.80	2.77	2.70	0.519

\* - statistically important at the level of  $\alpha=0.05$

Source: own work.

The analysis of table 5 demonstrates that the average annual vehicle mileage is a factor differentiating the weights of 4 qualitative attributes of spare parts. This especially regards their functionality, efficiency, price and availability. The detected variance allows assuming that for vehicles with the lowest annual mileages the assigned weights are clearly higher than in the case of vehicles with the highest mileages. This does not however regard the last two features (price and availability) for which the clearly highest weights were assigned by users of cars from the third range of average annual mileage (20-30 thousand km). The obtained variance is therefore inconclusive in interpretation.

Table 6 presents the weights of qualitative attributes in division according to vehicle servicing location.

Table 6. Weights of qualitative attributes in division according to vehicle servicing location

No.	Attribute	Vehicle servicing location			Value <i>p</i>
		Authorised technical service station	Independent workshop	Both	
1	Reliability	4.42	4.10	4.29	0.026*
2	Functionality	4.16	3.91	4.14	0.025*
3	Durability	4.47	4.23	4.27	0.006*
4	Efficiency	4.41	4.12	4.24	0.002*
5	Lifetime	4.37	4.21	4.13	0.012*
6	Maintainability	3.66	3.70	3.78	0.722
7	Modernity, innovation	3.75	3.18	3.32	0.000*
8	Safety	4.53	4.29	4.40	0.037*
9	Degree of compliance with the design	3.93	3.73	3.57	0.005*
10	Aesthetics, style	3.18	2.80	2.99	0.009*
11	Presentation (form of offer, sale and post-sale servicing)	3.51	2.84	3.02	0.000*
12	Environmental friendliness	3.61	2.99	3.20	0.000*
13	Compliance with legal regulations and standards	3.80	3.07	3.31	0.000*
14	Diligence of workmanship	4.38	3.83	4.00	0.000*
15	Warranty conditions	4.45	4.02	4.03	0.000*
16	Price	3.97	3.95	3.87	0.954
17	Economy of installation and use (maintenance)	3.82	3.78	3.70	0.677
18	Availability	4.08	3.89	3.86	0.032*
19	Quickness of delivery	4.16	3.80	3.81	0.000*
20	Branch image and supplier reputation	4.04	3.47	3.29	0.000*
21	Packaging (aesthetics, information)	3.14	2.58	2.71	0.000*

\* - statistically important at the level of  $\alpha=0.05$

Source: own work.

The analysis of the data in table 6 demonstrates that the vehicle servicing location differentiates the weights of 18 qualitative attributes of the parts. The variance is insignificant only in the case of maintainability, price and economy of installation and use (maintenance). For the reliability, functionality, durability, efficiency and lifetime of the

parts, the interpretation of the results indicates that the highest weight is assigned to these attributes by users servicing cars in authorised technical service stations, while the lowest – by users servicing cars in authorised workshops and intermediate – by users of both. The same type of variance was detected for parts safety, aesthetics (style), presentation (form of offer, sales and post-sales servicing), environmental friendliness, compliance with legal regulations and standards, diligence of workmanship, warranty conditions, quickness of delivery and packaging (aesthetics and information provided). It is interesting to note that in the case of four attributes (degree of compliance with the design, price, availability and brand image and supplier reputation), the users using both authorised technical service stations and independent workshops have assigned lower weights than persons servicing cars only in independent workshops. Despite the above fact, in each case the users using only authorised technical service stations have assigned the highest weights to the tested attributes.

Table 7 presents the weights of qualitative attributes in division according to average annual number of technical service visits.

Table 7. Weights of qualitative attributes in division according to average annual number of technical service visits

No.	Attribute	Average annual number of technical service visits			Value <i>p</i>
		0 or 1	2 or 3	4 and more	
1	Reliability	4.30	4.23	4.26	0.325
2	Functionality	4.15	4.00	4.03	0.212
3	Durability	4.31	4.36	4.29	0.940
4	Efficiency	4.28	4.29	4.06	0.250
5	Lifetime	4.34	4.26	4.05	0.072
6	Maintainability	3.68	3.84	3.33	0.009*
7	Modernity, innovation	3.51	3.44	3.18	0.107
8	Safety	4.35	4.44	4.40	0.856
9	Degree of compliance with the design	3.85	3.82	3.49	0.018*
10	Aesthetics, style	3.02	3.02	2.76	0.190
11	Presentation (form of offer, sale and post-sale servicing)	3.13	3.20	2.92	0.229
12	Environmental friendliness	3.35	3.27	3.06	0.263
13	Compliance with legal regulations and standards	3.47	3.52	2.85	0.001*
14	Diligence of workmanship	4.15	4.08	3.86	0.078
15	Warranty conditions	4.19	4.20	4.12	0.958
16	Price	3.89	4.09	3.60	0.010*
17	Economy of installation and use (maintenance)	3.79	3.87	3.47	0.071

Table 7. Weights of qualitative attributes in division according to average annual number of technical service visits, cont.

No.	Attribute	Average annual number of technical service visits			Value <i>p</i>
		0 or 1	2 or 3	4 and more	
18	Availability	3.93	3.97	3.97	0.957
19	Quickness of delivery	3.86	3.94	4.09	0.276
20	Branch image and supplier reputation	3.73	3.76	3.15	0.004*
21	Packaging (aesthetics, information)	2.92	2.81	2.62	0.227

\* - statistically important at the level of  $\alpha=0.05$

Source: own work.

Based on the analysis of the data in table 7, we can assume that the average annual number of technical service visits differentiates 5 qualitative attributes. These include maintainability, degree of compliance with the design, compliance with legal regulations and standards, price as well as brand image and supplier reputation. The observed variance between the groups is characterised by the fact that we can clearly observe lower weights assigned to the mentioned attributes by users who visit the technical service at least 4 times a year in comparison to the two other groups, the respondents of which use the technical service no more than 3 times a year. It clear therefore that after exceeding the threshold of 4 visits at the technical service during a year, the assigned weight of the qualitative attributes of spare parts is visibly lower.

Thus, the analysis has been concluded.

## 6. Conclusions

As a result of the analysis conducted in terms of the degree in which vehicle specification and method of its maintenance differentiate the weight of qualitative attributes of spare parts for passenger cars, we reached the following conclusions:

1. In general, we have confirmed the adopted working hypothesis, according to which vehicle specification and method of its maintenance differentiate the weight of qualitative attributes of spare parts for passenger cars.
2. Vehicle brand differentiates the weights of all 21 analysed qualitative attributes of spare parts. In general, the highest weight to the quality of spare parts is assigned by the users of FIAT, Mazda and Toyota, Mercedes-Benz and Skoda, while the lowest – by users of BMW, Citroen and Nissan. However, when taking into consideration the profiles of these brands, it is hard to point out any common features.
3. The next factor in terms of variance frequency is the vehicle servicing location, which differentiates the weights of 18 qualitative attributes of the parts. In general, users

servicing cars only in authorised technical service stations have assigned higher weights to the tested attributes than owners using independent workshops or both.

4. Then, vehicle condition at the time of purchase differentiates the weights of 13 tested features. Respondents using new cars have assigned qualitative attributes with higher weights than those using vehicles deriving from the secondary market.
5. Vehicle age is a factor that substantially differentiates the weights of 7 attributes. We have observed clearly lower weights assigned to attributes in groups of users of older cars.
6. The average annual number of technical service visits differentiates 5 qualitative attributes.  
In the group of vehicles with 4 or more visits at the technical service during a year, the assigned weight of the qualitative attributes of spare parts is visibly lower than in the other two groups.
7. The average annual mileage is a factor differentiating the weights of 4 qualitative attributes of spare parts. The obtained variance is, however, inconclusive in interpretation.
8. Finally, the type of vehicle ownership substantially differentiates only 1 qualitative attribute of spare parts. Users of private cars have assigned higher weights to maintainability than users of business cars.

The next direction of the analysis assumed by the authors is the study of variance in the importance of qualitative attributes of spare parts in terms of the vehicle user's profile.

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