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Classifying passenger car users regarding their awareness towards vehicle maintenance

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Abstract

The aim of the paper was to identify consumer segments due to their awareness regarding vehicle maintenance and to determine the structure of these segments. A quantitative approach was used. The questionnaire containing 21 variables was conducted using an online survey. 235 correctly completed records were obtained. The analysis used cluster analysis. As a result, 4 consumer segments were identified. These are: (1) technically average users (35% of the sample), (2) lay users (21%), (3) cautious amateurs (9%) and (4) experts (35%). Based on the obtained results, it was found that there are consumer segments that differ in terms of awareness regarding vehicle maintenance. Proposed segmentation can form the basis for differentiating marketing strategies. Vehicle producers and workshops can create and implement them in order to optimally tailor the marketing message and its content to specific consumer groups. Contribution of the paper includes identification of consumer segments, identification of segment structures, as well as suggesting differentiating marketing strategies.

Keywords: *consumer segmentation, vehicle maintenance, car service, cluster analysis*

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Highlights

- Cluster analysis based on 21 variables and a sample of 235 individuals.
- Grouping vehicle users into 4 segments.
- Segment characteristics: (1) technically average users (35%), (2) lay users (21%), (3) cautious amateurs (9%), and (4) experts (35%).
- Forming the basis for differentiating marketing strategies.

1. Introduction

Current breakthrough on automotive market encompasses electrification, digital servitization, customer engagement, and co-creation in the automotive industry [1–3]. In these circumstances, the role of taking into account the diversity of knowledge, attitudes, and behaviours of car users regarding maintenance is emphasized [4]. However, these components of user awareness differ between user segments [5,6]. Distinguishing users segments enables both manufacturers and service providers to design tailored service architectures that foster satisfaction and long-term loyalty across the automotive market [1,7,8].

The growing technological complexity of modern cars has increased the demand for users to possess greater technical awareness and understanding of vehicle systems and its maintenance. This is essential to ensure the longest possible uptime and trouble-free operation [9]. Studies show that limited driver understanding of automation features may result in misuse and reduced safety benefits [10,11]. Moreover, the increasing digitalization of maintenance and repair processes requires drivers to possess basic awareness of service procedures, diagnostic indicators, and warranty-related obligations. Studies indicate that consumers' understanding of maintenance requirements significantly influences vehicle longevity, safety, and compliance with manufacturer recommendations [2,4]. The body of research emphasizes that maintenance-related awareness extends beyond routine servicing to include informed decision-making regarding workshop selection, use of original versus aftermarket parts,

and digital record-keeping of repairs [12,13]. The literature emphasizes the importance of driver education, transparent information systems, and human-machine interface design to support effective adaptation to vehicle technologies [14].

The efficient maintenance depends on users' adherence to established maintenance principles, while a lack of maintenance knowledge can lead to adverse outcomes [1]. Among the factors shaping the vehicle maintenance process are the users' predispositions, skills, training, and technical awareness, which collectively determine the effectiveness and safety of vehicle use [15].

Additionally, scholarly literature has long emphasized that modern markets are inherently fragmented rather than homogeneous [16,17]. They are composed of narrowly defined niches and consumer groups characterized by distinct expectations and a search for specific types of value [18]. To effectively reach and influence such groups, it is essential to identify the common traits and behavioural patterns that define each market segment. Effective marketing requires recognizing and classifying shared features within these groups [19], thereby enabling a differentiated approach to strategic communication and value delivery [18]. Segmentation allows firms to allocate marketing resources more efficiently and tailor their offerings to meet specific consumer needs [20]. Consequently, market segmentation constitutes the conceptual and practical foundation for diversified marketing strategies, facilitating the adjustment of supply structures to differentiated patterns of demand [21].

Taking all this into consideration, the research question was formulated:

Q_1: *What are the groups of passenger car users regarding their awareness towards vehicle maintenance?*

On this basis, the following working hypothesis have been posed:

H_1: *Consumers are creating groups (segments) which are homogenous regarding their awareness towards vehicle maintenance.*

Innovative application of the one of the multidimensional exploratory techniques – cluster analysis has been used as the method of the verification of the above hypothesis and the achievement of the purpose of the study.

2. The analysis of the state of the issue in literature

The issue of user awareness in the operation and maintenance of passenger vehicles has gained growing attention in recent years, reflecting the increasing complexity of automotive technologies and the shift toward automation. For example, Balassa with the team [13] emphasize that awareness of vehicle functions and safety systems varies significantly across user segments, identifying distinct groups of users differing in their understanding and trust toward advanced driver assistance systems. Similarly, Le and Circella [12] explore users' self-perceived competence and readiness to engage with automated and shared mobility solutions, noting that some groups demonstrate the high levels of technical awareness, while the other show limited understanding and low engagement. Earlier research by Wang and Zhu [4] introduced a service-oriented classification of users based on their engagement in vehicle maintenance processes, thereby framing maintenance awareness as a behavioural continuum. In a similar vein, Yildirim et al. [2] extend this approach by differentiating warranty-period service users from post-warranty independent service users, highlighting how awareness and autonomy evolve as vehicles age and warranties expire. From a managerial perspective, Tsai with colleagues [7] apply data-driven clustering to automotive customers, revealing that awareness and service loyalty are closely linked to behavioural segmentation and purchasing patterns. What is more, on the ground of technical sciences, researchers [22] are making efforts to improve the vehicle maintenance process, for example by applying machine learning-based modeling.

Recent industry analyses support and expand upon these academic findings. McKinsey [23] emphasizes that most consumers underestimate the importance of preventive maintenance and exhibit limited understanding of digital diagnostic systems, with awareness strongly correlated to education level and digital competence. Deloitte [24] highlights that trust in connected vehicle features and predictive maintenance technologies is higher among consumers with greater technological confidence and perceived data transparency. Complementarily, Standard & Poor's [25] observes a growing shift toward mixed-service models, where post-warranty vehicle owners increasingly rely on independent workshops while maintaining brand-authorized servicing for complex systems.

With rising repair costs and greater interest in independence, car owners are getting more involved in vehicle care. Recent data [26] reflects a shift from do-it-for-me (DIFM) to do-it-yourself (DIY). Conversely, another report [27] indicates a decline in the DIY segment in response to increasing vehicle complexity, accompanied by growth or stabilization in the DIFM segment. Therefore, the overall trend appears to be ambiguous.

Collectively, these studies and reports indicate that user awareness is a multidimensional construct encompassing cognitive (knowledge of vehicle systems), attitudinal/affective (trust and confidence), and behavioural (service engagement and responsibility) components. Across both academic and industry literature, a consistent pattern emerges: higher technical literacy and experience correlate with proactive maintenance and autonomous service choices. Still, the limited number of studies results in the existence of the research gap. They have primarily focused on consumer behaviors related to vehicle servicing and users' responses to the quality of repair services [28]. The literature has also addressed drivers' awareness of preventive measures and basic vehicle operation [29]. However, these analyses have most often been local in scope and limited to selected groups of respondents. Some authors have additionally highlighted the relationship between perceived vehicle quality and users' willingness to perform regular maintenance [30], whereas other studies have emphasized the insufficient level of drivers' knowledge regarding safety and basic maintenance activities [31]. Despite the growing importance of vehicle safety and reliability issues, there is still a lack of comprehensive research concerning the level of awareness among passenger car users with regard to vehicle maintenance, and many studies addressing this topic were conducted as early as the twentieth century [28,31,32]. With this paper we attempted to fill this gap.

3. Method

A quantitative approach was adopted to achieve the goal. The survey questionnaire was posted on the Ankieteo digital platform and conducted using the CAWI method between December 1-24, 2025. The sample selection was purposive in nature, targeting car users as the study population. Respondents were recruited from the database of the Ankieteo survey platform operator. The study was conducted on a nationwide scale. As a result of the empirical study, 235 correctly completed questionnaires were obtained and subjected to statistical processing. A total of 21 variables were considered. The survey questionnaire consisted of 15 variables and 6 control variables.

It was assumed that "awareness" manifests itself in 3 forms: (1) knowledge, (2) attitudes and (3) behaviours. They are defined as follows:

1. Knowledge (K) refers to the cognitive representation of information, facts, and principles about a particular area of reality that an individual acquires, stores, and applies in understanding and decision-making processes [33]. Core elements of knowledge are facts, information, understanding. In this study knowledge is reflected by 3 variables.
2. Attitudes (A) are relatively enduring organizations of beliefs, emotions, and behavioural tendencies toward a specific object, person, or phenomenon [34]. They consist of three interrelated components: the cognitive (beliefs), affective (emotions), and behavioural (action tendencies) components. There are 5 variables measuring attitudes in this study.
3. Behaviours (B) are the observable responses of an individual to internal or external stimuli, shaped by the interaction of cognitive, emotional, and social factors [35]. In social sciences, behaviours are regarded as the external manifestations of an individual's attitudes, norms, and intentions. They encompass actions, reactions and social interactions. It this study, behaviour is described by 7 variables.

The substantive variables were presented in the form of affirmative statements. Their values were recorded using five-point Likert scales, where a response of 1 indicated "strongly disagree" and a response of 5 indicated "strongly agree". A description of the variables used in the study is presented in Table 1, together with the sources which inspired for taking these variables into consideration and the types of awareness components.

The classic approach to market segmentation uses classification methods, primarily hierarchical methods [36]. Cluster analysis was used in this study. This method was introduced to modern statistics by Tryon [37] and then

developed by Cattell [38]. It includes various algorithms and methods for grouping similar objects into coherent categories [39]. It is a type of undirected exploration method, which means that all relationships and regularities are discovered based on the input data. Importantly, unlike many statistical procedures, the cluster analysis method is often used at the exploratory stage of research, when the researcher does not formulate any a priori hypotheses. This method "inherently" reveals the structure of the set of studied objects [48], cluster analysis methods can be successfully used to solve a variety of problems [19,49]. Whenever there is a need to classify a large amount of collected research data into a sensibly reduced set, these methods prove to be very useful.

Table 1. Substantive variables used in empirical research.

Var.	Affirmative sentence/description	Type	Source
P1	I am familiar with the schedule of inspections and replacement of consumable components in the vehicle.	K	[29]
P2	I respond to the vehicle's warning signals (displayed messages, illuminated indicator lights).	B	[40]
P3	I regularly perform basic maintenance activities.	B	[41]
P4	I take a proactive approach to technical maintenance.	A	[31]
P5	I use the owner's manual.	B	[42]
P6	I have knowledge of the impact of poor maintenance on vehicle safety and operating costs.	K	[41]
P7	I am aware of my own limitations in technical matters.	A	[6]
P8	I keep service and maintenance documentation.	B	[43]
P9	I am aware of the number and frequency of unplanned breakdowns that have occurred.	A	[44]
P10	I know that I am responsible for the vehicle's technical condition.	K	[45]
P11	I am able to independently assess the vehicle's technical condition.	A	[44]
P12	After detecting a fault, I take immediate action to have it resolved.	B	[40]
P13	I am involved in the selection of spare parts and service providers with an awareness of the price–quality ratio.	A	[46]
P14	I use modern technologies that support technical maintenance (applications, sensors).	B	[47]
P15	After experiencing a breakdown, I changed my behaviour regarding vehicle maintenance and repair.	B	[44]

Source: own elaboration.

Table 2. Basic statistic measures for substantive variables.

Variable /measure	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
$\bar{x}$	3.45	4.07	3.97	3.77	3.67	3.80	4.02	4.05	3.64	4.11	3.37	3.90	3.55	3.53	3.50
σ	1.30	1.11	1.10	1.05	1.15	1.05	1.04	1.06	1.13	1.04	1.16	1.13	1.23	1.20	1.19

$\bar{x}$ - average

σ - standard deviation

Source: own elaboration.

4. Identifying the segments

First, the basic descriptive statistic measures for substantive variables values obtained from the empirical study are given in Table 2.

As can be seen, the highest mean values were obtained by variables P10 - I realize that I am responsible for the vehicle's technical condition (4.11), P2 - I respond to the vehicle's warning signals (displayed messages, illuminated indicator lights (4.07) and P8 - I keep service and maintenance documentation (4.05). Therefore, vehicle users are aware of their responsibility for their technical condition, pay attention to information about this condition, and keep records of previous repairs. In turn, the lowest scores were given to variables P11- I am able to independently assess the vehicle's technical condition (3.37), P1 - I am familiar with the schedule of inspections and replacement of consumable components in the vehicle (3.45) and P15 - After experiencing a breakdown, I changed my behaviour regarding vehicle maintenance and repair (3.50). These results lead to the conclusion that user awareness of vehicle maintaining is low and, what is worse, experiencing the negative consequences of a breakdown does not lead to a change in their behaviour.

Subsequently, Table 3 presents the correlations among the substantive variables.

As shown in Table 3, the correlations between most variables can be considered moderate – ranging from 0.41 to 0.80 – and, in some cases, weak (up to 0.40). Since no strong correlations were identified between the variables, all of them were included in the model.

Then analysis was carried out by identifying consumer

segments using cluster analysis. The horizontal, hierarchical tree diagram in Figure 1 shows the obtained classification. In turn, Figure 2 shows the increase in the bond distance in the subsequent steps of the algorithm.

Table 3. Correlations among substantive variables.

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
P1	1.00	0.51	0.56	0.49	0.34	0.54	0.40	0.44	0.53	0.43	0.48	0.39	0.46	0.47	0.34
P2	0.51	1.00	0.71	0.55	0.37	0.54	0.68	0.59	0.54	0.60	0.31	0.59	0.43	0.49	0.41
P3	0.56	0.71	1.00	0.70	0.40	0.65	0.58	0.63	0.64	0.64	0.45	0.56	0.51	0.51	0.43
P4	0.49	0.55	0.70	1.00	0.54	0.64	0.48	0.58	0.58	0.56	0.53	0.50	0.55	0.53	0.49
P5	0.34	0.37	0.40	0.54	1.00	0.53	0.45	0.45	0.49	0.48	0.44	0.34	0.47	0.48	0.54
P6	0.54	0.54	0.65	0.64	0.53	1.00	0.59	0.54	0.69	0.66	0.52	0.57	0.62	0.54	0.46
P7	0.40	0.68	0.58	0.48	0.45	0.59	1.00	0.66	0.54	0.66	0.28	0.58	0.40	0.44	0.41
P8	0.44	0.59	0.63	0.58	0.45	0.54	0.66	1.00	0.49	0.60	0.29	0.57	0.39	0.37	0.49
P9	0.53	0.54	0.64	0.58	0.49	0.69	0.54	0.49	1.00	0.60	0.62	0.54	0.55	0.56	0.44
P10	0.43	0.60	0.64	0.56	0.48	0.66	0.66	0.60	0.60	1.00	0.42	0.66	0.52	0.49	0.47
P11	0.48	0.31	0.45	0.53	0.44	0.52	0.28	0.29	0.62	0.42	1.00	0.40	0.58	0.61	0.46
P12	0.39	0.59	0.56	0.50	0.34	0.57	0.58	0.57	0.54	0.66	0.40	1.00	0.57	0.44	0.44
P13	0.46	0.43	0.51	0.55	0.47	0.62	0.40	0.39	0.55	0.52	0.58	0.57	1.00	0.63	0.57
P14	0.47	0.49	0.51	0.53	0.48	0.54	0.44	0.37	0.56	0.49	0.61	0.44	0.63	1.00	0.58
P15	0.34	0.41	0.43	0.49	0.54	0.46	0.41	0.49	0.44	0.47	0.46	0.44	0.57	0.58	1.00

<=0.40 0.41-0.80 >0.80

Source: own elaboration.

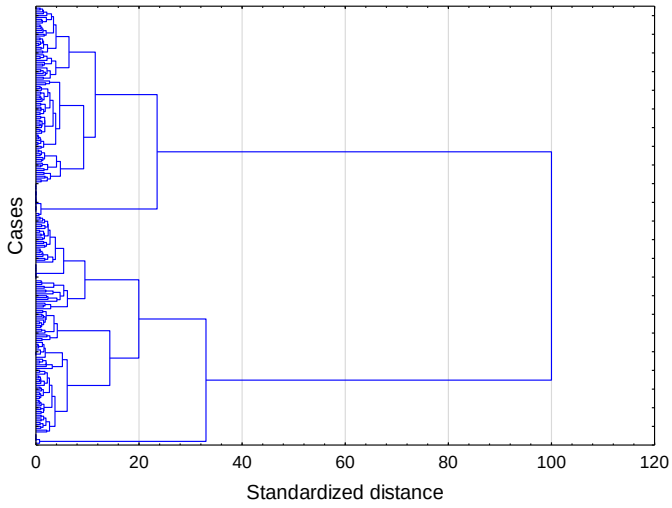

Figure 1. Identifying segments using cluster analysis.

Source: own elaboration.

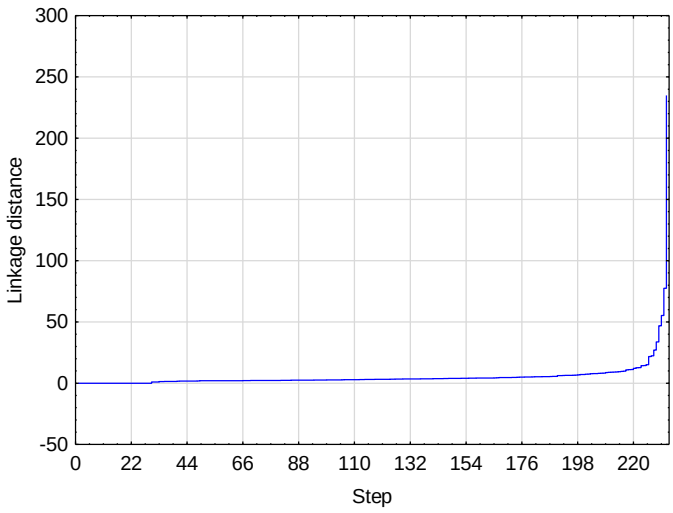

Figure 2. Linkage distance in the next steps of algorithm.

Source: own elaboration.

The analysis of Figure 1 shows that when cutting off the graph, for example, at the level of bond distance in the range of approximately 32-100, a clear increase in bond length is visible. Within this range, 2 clearly distinct clusters were obtained. However, it was concluded that such a division into 'aware' and 'unaware' users would be overly obvious and would not lead to particularly insightful cognitive conclusions. Therefore, the analysis was continued, noting that within the range of 14-20, the existence of 4 clusters was observed, accompanied by pronounced increases in linkage distances. Taking into account the reasonableness, simplicity and practical usefulness of the results, a solution with 4 clusters was adopted. In this way, the following classification was obtained:

1. Cluster 1 – groups 82 people, i.e. 35% of the respondents.
2. Cluster 2 – combines 49, or 21% of the sample.
3. Cluster 3 – includes 20, i.e. 9% of respondents.
4. Cluster 4 – groups 83 respondents, or 35% of the sample.

As an evidence of the differentiation of clusters with respect to the values of the metric variables, an analysis of variance (ANOVA) was conducted. It is summarized in Table 4.

Table 4. Results of ANOVA analysis for substantive variables.

Variable	Between-groups SS	Df	Within-groups SS	df	F	p-value
P1	184.843	3	212.934	230	66.552	0.000
P2	159.839	3	130.199	230	94.120	0.000
P3	160.077	3	120.580	230	101.782	0.000
P4	115.714	3	138.885	230	63.8760	0.000
P5	99.160	3	209.169	230	36.345	0.000
P6	139.720	3	116.433	230	92.000	0.000
P7	118.651	3	135.281	230	67.242	0.000
P8	114.564	3	145.918	230	60.193	0.000
P9	150.245	3	149.879	230	76.854	0.000
P10	121.005	3	132.534	230	69.998	0.000
P11	128.314	3	186.080	230	52.867	0.000
P12	117.570	3	178.759	230	50.4240	0.000
P13	199.194	3	154.789	230	98.660	0.000
P14	158.554	3	175.737	230	69.170	0.000
P15	118.560	3	211.939	230	42.887	0.000

Source: own elaboration.

As can be seen from the analysis of Table 4, the differentiation of the clusters can be considered statistically significant at the α=0.05 level. These identified segments provide a starting point for further considerations. Subsequently, the differences between segments concerning average values of substantive variables are presented at Figure 3.

During analysing Figure 3 one may notice that the 4 identified segments have the following characteristics.

In the case of cluster 1, the mean levels of agreement with the questionnaire statements can, in most instances, be regarded

as average. This is clearly reflected in the chart, where the profile line for all variables runs almost exactly midway between the lines plotted for clusters 2 and 4. Consequently, the level of vehicle maintenance awareness among respondents assigned to this cluster may be considered moderate. At the same time, the values of individual variables are relatively homogeneous — the empirical range of variability (defined as the difference between the maximum and minimum variable values) equals 0.82. Therefore, respondents classified in this cluster can be described as technically average users.

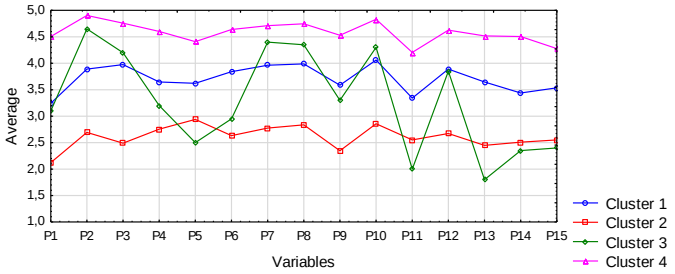

Figure 3. Average values of substantive variables for clusters

Source: own elaboration.

The distribution of mean variable values in cluster 2 indicates that in 9 cases these values represent the lowest levels of agreement with the presented statements. The course of the chart suggests that these ratings are uniformly low and relatively similar, with an empirical variability range of 0.82. This group thus comprises respondents with the lowest level of vehicle maintenance awareness, who may be characterized as lay users.

The distribution of mean variable values reported by respondents classified in cluster 3 shows a high level of agreement with statements P2, P7, P8, and P10. Accordingly, these individuals closely monitor vehicle warning messages, are aware of the limitations of their own technical knowledge, carefully store service documentation, and recognize their responsibility for the technical condition of the vehicle. At the same time, this group assigns the lowest ratings – relative to all other clusters – to variables P5, P11, and P13. This indicates infrequent use of the vehicle owner's manual, limited ability to independently assess the technical condition of the vehicle, and low involvement in the selection of service providers. Respondents in this cluster may therefore be described as cautious amateurs.

In cluster 4, the mean values of all variables are the highest among all groups, indicating a high level of agreement with the questionnaire statements. Consequently, this segment comprises respondents with the highest level of vehicle maintenance awareness, who can be characterized as experts.

In the following sections, the identified clusters will be referred to as segments, reflecting their market-oriented nature.

5. Identifying the structure of segments

Subsequently, having the profiles of the segments concerning substantive variables, their structure was broken down by control variables. Table 5 summarizes the segment structure with respect to these variables.

Table 5. Structure of segments and sample by control variables.

Variable	Category	Segment 1	Segment 2	Segment 3	Segment 4	Sample
Sex	Woman	46%	50%	85%	48%	51%
	Man	54%	50%	15%	52%	49%
Age	Younger (up to 34 years)	22%	25%	20%	17%	21%
	Middle-aged (35-54)	33%	31%	45%	38%	35%
	Older (55 and over)	46%	44%	35%	45%	44%
Length of time as a vehicle user	Beginners (up to 4 years)	25%	56%	10%	18%	28%
	Average (5-14)	34%	17%	35%	25%	27%
	Advanced (15 and over)	41%	27%	55%	57%	45%
Age of a currently used vehicle	Newer (up to 4 years)	28%	35%	15%	19%	25%
	Average (5-14)	37%	42%	50%	56%	46%
	Older (15 and over)	35%	23%	35%	25%	29%
Average annual mileage	Small (up to 9 tkm)	47%	48%	20%	31%	39%
	Average (10-29)	43%	33%	45%	49%	43%
	Big (30 and over)	10%	19%	35%	20%	18%
Place of servicing a vehicle	Authorized service center	22%	21%	20%	19%	20%
	Independent workshop	64%	56%	50%	60%	60%
	Both	14%	23%	30%	21%	20%

Source: own elaboration.

For the analysis, those characteristics were selected for which the differences between clusters are the most pronounced. As a result of the analysis of the data presented in Table 5, it was noticed that the four segments are distinguished by the following features.

Segment 1 contains a very large proportion of users who cover the shortest annual mileage (47% compared to 39% in the total sample). By contrast, this segment includes the smallest

share of users traveling the longest annual distances (10% vs. 18%). Moreover, this group comprises the largest fraction of respondents servicing their vehicles exclusively at independent workshops (64% vs. 60%). Analogously, it includes the smallest proportion of users utilizing both servicing options (14% vs. 20%).

Segment 2 groups a substantial fraction of novice car users (56% vs. 28%), while simultaneously including significantly fewer drivers with intermediate and advanced levels of experience than average (17% vs. 27%). This segment comprises the largest share of users of newer vehicles (35% vs. 25%). It also includes the highest proportion of users with the shortest annual mileage (48% vs. 39%). Furthermore, the proportion of respondents achieving medium annual mileage is the lowest in this segment (33% vs. 43%).

Segment 3 is distinctly feminized, with women accounting for 85% of the segment, compared to 51% in the total sample. It includes a relatively high proportion of middle-aged respondents (45% vs. 35%). This cluster concentrates a markedly higher-than-average share of users with advanced vehicle-use tenure (55% vs. 45%). In this cluster, the largest fractions of users of the oldest vehicles are observed (35% vs. 29%). It also contains the largest share of respondents covering the highest annual mileage (35% vs. 18%). Notably, a relatively large proportion of users utilizing both vehicle servicing options is observed (30% vs. 20%).

Segment 4 includes relatively high proportion of middle-aged car users (38% vs. 35%). It groups significantly more advanced users than average (57% vs. 45%). This segment also exhibits the largest fraction of respondents using vehicles of medium age (56% vs. 46%).

Further analysis was carried out by examining the differences in the results in terms of consumer awareness due to the 6 control variables.

So far, the two stages of cluster analysis have been completed, i.e. (1) identification of segments and (2) differentiation of their characteristics. The discovered segments were named as follows:

1. Segment 1 - technically average users.
2. Segment 2 - lay users.
3. Segment 3 - cautious amateurs.
4. Segment 4 - experts.

In general, taking into account the number, abundance and nature of the detected segments, it can be concluded that the conducted study showed a significant polarization of users awareness towards vehicle maintenance. Therefore, the research question Q_1 was answered and the working hypothesis H_1 was verified.

6. Discussion

Due to the limited number of studies classifying users exclusively in terms of technical awareness and maintenance behaviour, part of discussion is based on related research. A synthesis of its results is given in Table 6.

Table 6. Consumer segmentations towards vehicle maintenance in the literature.

Source	Segment names	Description
[13]	Conservative controllers Cautious adopters Pragmatic innovators Multitaskers/ environmentalists/ impaired drivers	Drivers differ in their level of technical awareness and acceptance of vehicle technologies, ranging from low knowledge and resistance, through cautious use, to high awareness and proactive adoption of advanced systems.
[12]	Tech mavens Life in transition Captive car-users Public/ active transport users Suburban dwellers Car enthusiasts	The identified segments vary substantially in technological awareness and readiness to understand, adopt, and manage advanced vehicle systems, which also influences maintenance-related behaviours.
[7]	Loyal customers Potential customers VIP customers Churners	Customers differ in their frequency of service visits, loyalty to authorized service centers, and engagement in after-sales maintenance activities.
[4]	High-engagement service users Moderate service users Occasional service users Low service users	This segmentation distinguishes users by intensity and regularity of vehicle servicing, reflecting varying degrees of maintenance awareness and responsibility.
[2]	Warranty-period service users Post-warranty independent service users	Vehicle owners exhibit distinct maintenance patterns, shifting from authorized service centers during the warranty period toward independent providers afterward, reflecting different levels of maintenance orientation and service-related decision-making.

Source: own elaboration.

Four user segments identified in here – technically average users, lay users, cautious amateurs, and experts – reflect distinct levels of maintenance awareness, technical competence, and behavioural engagement with vehicle care. When compared to existing segmentation frameworks [2,4,12,13], these results reveal a coherent multidimensional continuum linking users' technological attitudes, service engagement, and autonomy in vehicle management.

Respondents in segment 1 – technically average users – show moderate maintenance awareness and balanced engagement across all questionnaire dimensions. Their behavioural profile most closely matches Balassa et al.'s [13] cautious adopters – drivers who cautiously embrace technologies when they enhance safety or convenience but remain dependent on manual control and conventional habits. A comparable type appears in Le and Circella's [12] suburban dwellers, who use private cars regularly but without strong emotional or technological involvement. In terms of service behaviour, Wang and Zhu [4] classify this group as moderate service users, maintaining routine service engagement but without deeper initiative. Similarly, Yildirim et al. [2] would categorize them predominantly as warranty period service users – those who rely on authorized service centers and follow standard maintenance protocols within the warranty phase. This cluster therefore represents a moderate, compliance-oriented profile that values reliability but does not exhibit strong independence.

Segment 2 – lay users – exhibits the lowest level of maintenance awareness, technical literacy, and engagement. Their characteristics closely correspond to Balassa et al.'s [13] conservative controllers, who distrust automation and prefer fully manual operation, and Le and Circella's [12] captive car users – individuals who use cars out of necessity, not preference. From the maintenance perspective, Wang and Zhu [4] would categorize these respondents as low service users, engaging with maintenance services only when required (reactive servicing). In Yildirim et al.'s [2] terms, they correspond almost entirely to warranty period service users, who depend heavily on manufacturer service systems and show little initiative once the warranty expires. This group thus represents the least autonomous and least maintenance-conscious type of user.

Segment 3 – cautious amateurs – display a responsible attitude toward maintenance and an awareness of their own limitations. They regularly monitor warning messages, store service documentation, and take preventive action, yet rely on professionals for diagnostics and service selection. This aligns well with Balassa et al.'s [13] pragmatic innovators — users who selectively engage with technologies that serve practical or safety purposes — and with Le and Circella's [12] multitaskers/environmentalists, who combine conscientious mobility choices with reflective, risk-averse behaviour. Within the service typologies, Wang and Zhu [4] classify similar users as high-engagement service users: those who value reliability and build stable service relationships. According to Yildirim et al. [2], cautious amateurs may represent a transition from warranty period service users to post-warranty independent service users, as they begin to diversify their service choices and develop partial autonomy while maintaining reliance on professional expertise. Their behavioural pattern reflects responsible dependence rather than full independence.

The final segment – experts – demonstrates the highest maintenance awareness, self-confidence, and engagement. These users are most similar to Balassa et al.'s [13] pragmatic innovators and Le and Circella's [12] tech mavens or car enthusiasts – segments marked by high technical competence, strong engagement, and enjoyment of innovation. They display a proactive approach to diagnostics, often combining digital monitoring with self-maintenance routines. In Wang and Zhu's [4] classification, they correspond to high-engagement service users – frequent and informed service participants who actively manage maintenance quality. According to Yildirim et al. [2], experts clearly fall into the category of post-warranty independent service users: drivers who prefer trusted independent workshops or perform selected maintenance tasks themselves. Their combination of autonomy, technical skill, and self-efficacy defines the upper end of the maintenance engagement continuum.

As a comparative interpretation it can be concluded that cross the literature, a consistent behavioural gradient emerges: from dependence and reactivity to autonomy and proactive control. The four segments identified in this study align precisely with that progression, synthesizing technological, behavioural, and service-oriented perspectives.

Moreover, it is worth referring to the ambiguous findings

concerning variable P15. A review of the literature indicates that experiencing a vehicle malfunction may lead to changes in users' maintenance-related behaviors. Conlon, Devaraj, and Matta [30] demonstrated that negative experiences associated with vehicle reliability increase the propensity for regular maintenance activities. Experiencing technical problems and breakdowns was found to result in greater user caution and more frequent utilization of servicing facilities. Similar conclusions were reported by Lotko with colleagues [50], who showed that experiences related to vehicle failures and the quality of previous repairs influence subsequent user decisions regarding servicing frequency and workshop selection. Following the occurrence of malfunctions, customers more frequently declared the need for regular technical inspections and expressed stronger attachment to trusted service centers. These findings are consistent with consumer behavior theory, according to which negative experiences lead to more cautious operational decisions. Interestingly, the present study did not confirm this hypothesis, as the statement under discussion obtained the second-lowest level of respondent agreement.

7. Managerial implications

Based on the four identified segments, differentiated marketing approaches are proposed for both car manufacturers and service workshops. These recommendations align with other research. They are as follows:

1. Lay users. Manufacturers should implement educational and trust-oriented marketing, highlighting safety, reliability, and convenience. Subscription-based maintenance plans or warranty extensions can enhance user confidence and reduce decision complexity [51]. Workshops should emphasize accessibility and transparency, using reminders, simple booking systems, and loyalty incentives. The goal is to develop foundational maintenance awareness [8,52].
2. Technically average users. Manufacturers can use digital support tools (mobile apps, telematics) to strengthen proactive maintenance behaviour and reinforce brand trust [53]. Workshops should deploy customer relationship management (CRM) systems and preventive offers based on vehicle data, promoting regular, structured service visits [32,1].
3. Cautious amateurs. Manufacturers should adopt educational marketing focused on technical reasoning and long-term reliability. Access to semi-technical content and personalized reports strengthens confidence and rational engagement [51,54]. Workshops should develop hybrid trust-based models, combining user self-assessment tools with expert validation and educational advice [55].
4. Experts. Manufacturers should offer advanced data access, APIs, and technical forums supporting autonomous maintenance and performance optimization [53,56]. Workshops should move toward co-creation-based service ecosystems, providing certified parts, specialized consultation, and shared diagnostic infrastructure [55].

The proposed marketing strategies reflect the growing convergence between technological sophistication and user competence in the automotive industry. For less experienced users, the focus remains on building trust, reducing complexity, and encouraging routine maintenance behaviour. Meanwhile, segments such as cautious amateurs and experts illustrate different directions of the transformation of users into active participants in service ecosystems – a development consistent with the service-dominant logic of value co-creation [55,56]. As Beckers et al. [57] and Bustinza et al. [53] emphasize, success in digital servitization depends on aligning service innovation with the user's readiness to engage in technological and informational collaboration. Hence, understanding these segments enables both manufacturers and service providers to design tailored service architectures that foster efficiency, satisfaction, and long-term loyalty across the automotive market [8].

8. Conclusion

As a result of cluster analysis, four distinct segments were identified. These segments differ in terms of substantive variables that define vehicle operation awareness — namely, knowledge, attitudes, and behaviours — as well as in metric variables characterizing the sample's demographic and behavioural profile. The identified segments are as follows:

1. Lay users – dependent, reactive, and low-competence.
2. Technically average users – compliant and moderately

responsible.

3. Cautious amateurs – reflective, organized, yet reliant on external expertise.
4. Experts – self-sufficient, technically skilled, and autonomous.

When compared to existing segmentation frameworks [2,4,12,13], these results reveal a coherent multidimensional continuum linking users' technological attitudes, service engagement, and autonomy in vehicle management.

The identification of these segments provides a foundation for differentiating the marketing strategies applied by car manufacturers and workshop networks. Depending on the segment, manufacturers should adopt the following strategies (the number in brackets is the segment number): (1) digital tools and telematics-based support, (2) simplified, safety-based communication; maintenance subscriptions, (3) educational and reliability-focused engagement, and (4) advanced data access and technical communities. Workshops, in turn, should consider implementing (1) CRM personalization and preventive maintenance, (2) transparency, convenience, loyalty programs, (3) hybrid trust-based advisory model, and (4) co-creation, consultation, certified parts.

It may be expected that the presented results, both cognitive and utilitarian in nature, will contribute to structuring the body of knowledge within the examined domain and enhance the effectiveness of marketing strategies, thereby fostering greater satisfaction among vehicle users [8].

9. Research limitations

Like any research, this one is limited by various methodological and practical factors. First, there is the test. It is numerous, but the study was carried out only using the CAWI method, so it is not entirely representative. Likewise, the number of questionnaire items is quite limited. Moreover, the selection of variables for the questionnaire, however based on literature, was discretionary.

10. Directions for future research

Particularly interesting direction for developing the analysis presented here may be e.g. examining consumer attitudes towards the vehicle maintenance and repair services implying their loyalty and retention [54]. Future studies could also focus on segmenting vehicle owners based on maintenance behaviours and technical awareness to better predict shifts between authorized and independent service providers [2].

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