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Automotive Service Quality Investigation Using a Grey-DEMATEL Model

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Abstract: In today's fast-challenging business environment, automobile manufacturers are required to supply customers with high-quality vehicles at competitive prices. However, existing research on factors influencing service quality lacks a detailed and systematic understanding, and there is no consensus study on causal relationship and measuring the weights of service quality factors in the automotive manufacturing industry. This study provides an integrated technique for evaluating the automotive service quality in the context of VinFast-the Vietnamese leading brand. First, the Grey Theory System (GTS) is utilized to estimate the subjective views of the decision maker (DM) and overcome incomplete and vague decision information. Then, a Decision-Making Trial and Evaluation Laboratory approach integrated with GTS (Grey-DEMATEL) is proposed not only to define the cause-effect factors but also to quantify the causal relationship of proposed criteria, which is based on comprehensive analyses of the current service quality literature and experts' opinions, as well as to capture the criteria weights. The results show that the weights of main criteria can be sorted as follow: Tangibility > Reliability > Assurance > Pricing > Empathy > Responsiveness. Among the proposed sub-criteria, Pricing is the top concern compared to other dimensions, making it a prerequisite for VinFast. The causal relationships of VinFast's service quality are discovered by the Grey-DEMATEL technique. The findings also indicated a rising need for VinFast to focus on Empathy. Furthermore, the proposed model might be used as a decision support tool to contribute to the literature on service quality, provide recommendations for future study, and assist managers in improving service quality more efficiently.

Keywords: MCDM; grey theory; DEMATEL; SERVQUAL; automobile industry

1 Introduction

The automotive industry is becoming an economic driver in many countries, which is still booming, because of the rising transport demand in developing nations, a massive number of vehicles manufactured year after year [1]. Despite an increasingly competitive automotive market across the Association of South East Asian Nations (ASEAN) region, Vietnam has expressed its intention to

aggressively develop its own domestic auto sector. Among the primary reasons for this ambition is that the automotive industry has the ability to generate thousands of jobs and a robust system of supporting businesses. Additionally, Vietnamese automakers like as VinFast have begun exporting their first automobile models, indicating a bright future for cars exported from Vietnam [2]. Therefore, this "spearhead industry" of the country has been provided with numerous incentives and experienced certain challenges.

This sector's policies consist of four main categories: investment policy, protectionist policy, supporting industry, and tax policy [3]. Regarding the investment policy, automobile production is listed among the business line eligible for investment incentives. This allows the manufacturing companies to a lower rate (10%), reduction or exemption of corporate income tax for a certain period (up to 50% reduction in 9 years), or throughout the project execution regarding the specific types of automobiles. A three-year exemption for land rentals, a five-year exemption from the day of import tax on products purchased as fixed assets, on raw materials, and supplies are also applied in the automobile manufacturing industry. For the protectionist policy, Vietnam followed a reduction schedule under World Trade Organization (WTO) commitments to reduce the import tariff on completely built-up (CBU) cars from 90% to around 70% from 2007 to 2015. However, since 2018 under ASEAN Free Trade Area (AFTA) commitments, the import tariffs on CBU between ASEAN countries were all eliminated [3]. Without such protection measures, VinFast and other local manufacturers have confronted stiff competition from CBU imports from ASEAN countries. Regarding the supporting industry policies, noting that local suppliers in Vietnam fell behind other ASEAN nations, the government provides several incentives to encourage local manufacturers. Some of the key incentives are access to government funding for the cost of 75% of technological transfer, up to 50% of production for trial products, funding for human training, reduction of corporate income tax, a zero tariff on imports of auto parts, and further access to investment credit. However, Vietnam has imposed high taxes and fees on cars, which are in sum double to triple the car's original price and contribute to the market's limited size. These taxes and fees include a special consumption tax from 40% to 150% depending on cylinder capacity, a 10% value-added tax (VAT), a 12% registration fee, a 10% license plates registration fee, and other minor fees.

Among Vietnamese car assemblers, the success of VinFast company over the past three years in the domestic market is supported by incentive tax policies supporting the industry, Vietnamese people's patriotism, and most importantly, VinFast's service quality. Although the vehicle assembling and manufacturing industry has been developing in Vietnam for decades, it still falls far behind in citizen's awareness and operating spectrum compared to developed countries in the world. The Vietnamese market is disorganized because of the lack of a massive manufacturing scale and the absence of supply chain management. Now the Vietnamese automobile industry has been confronting with worldwide standards of service quality.

After examining the characteristics and existing circumstances of the Vietnamese market, numerous scholars have been conducting relevant studies on quality assessment in various service fields, using different research methods such as statistics, case study, conceptual and literature review. The relationship between the service quality dimensions of VinFast is so complex. Moreover, there is no consensus research on service quality dimensions. Although recent research shows the widespread application of qualitative analysis, there is a dearth of multi-criteria decision-making (MCDM) analysis of the Vietnamese vehicle business. However, such a successful case in the Vietnamese automobile industry, VinFast's service quality has not yet been investigated. For this reason, studying the critical factors of VinFast's service quality to help improve VinFast's sales service towards increasing sales output and revenues is of great necessity. This study's main motivation is to analyze the influencing factors

of service quality, including Tangibility, Assurance, Reliability, Responsiveness, Empathy, and Pricing, which has not been empirically investigated earlier in the Vietnamese automobile sector. To the author' knowledge, this study proposes the first hybrid MCDM model of Grey Theory and Decision-Making Trial and Evaluation Laboratory (Grey-DEMATEL) to evaluate VinFast's service quality for several objectives.

This research highlights some contributions: (i) Identify critical service quality dimensions in the automotive sector from the literature review followed by discussions with industrial and academic experts; (ii) Propose a framework to analyze service quality in the Vietnamese automotive industry using the grey DEMATEL tool; (iii) Explain and identify the causal relationships of service quality factors for the Vietnamese automotive manufacturers in the case of VinFast; (iv) Validate these cause-effect factors through feedback from industrial and academic experts. The obtained results are then compared with the existing literature.

2 Literature Review

2.1 Service Quality Models

The implementation of service quality management has continuously been perceived as a conducive factor in maintaining competitive advantage, excellence, success, stability, and growth among dealers in the automobile manufacturing industry. Service receivers are beneficiaries from a range of service options, which has driven a rise in customer expectations, consequently led to fierce competition in the industry [4]. In an attempt to retain existing ones, attract potential customers, and compete with peer companies, car dealers prioritize improving service quality towards satisfying customers' expectations to posit in a densely populated market. The study of customer satisfaction has gathered a substantial amount of attention in academic and business circles. As studied by many scholars [5–7], customer satisfaction is undoubtedly a hotly debated topic in both the academic and business context. Service quality is among the essential indications of customer satisfaction. However, owing to service quality's unquantifiable characteristics [8–11], it is hard to measure it without a conceptualized framework. For this reason, dating back 36 years ago, initiated a theory, which discusses the multi-dimensionality of service quality. The theory of service quality model (SERVQUAL) indicates a linkage between customers' expectations and their perceived performance, including five dimensions: Tangibility, Reliability, Responsiveness, Assurance, and Empathy. Even though being criticized by academicians for the inadequate assessment of service quality, failure to keep up with dynamic changes in expectations [12], and unstable measuring method due to customer heterogeneity [13], the SERVQUAL framework appears to be a popularly used measure of an organization's service quality in its wholeness [8]. SERVQUAL model has been broadly applied in the marketing research domain and various industries. For instance, Augustyn et al. [14] inherited the SERVQUAL model to investigate the correlated relationship between service quality and satisfaction. As indicated by [15], Mauritius customer's satisfaction of public service conveyed by a public department was verified using the SERVQUAL approach. Recently, Luke et al. [16] analyzed the quality of alternative state-owned public transportation modes in South Africa by the SERVQUAL. When it comes to applying the SERVQUAL approach to explore gaps between customers' satisfaction and the quality of services provided in Iskandar Malaysia's logistics industry, Roslan et al. [17] identified positive gaps between customers' expectations and perception towards Iskandar's logistics sector. On the other hand, a fuzzy SERVQUAL model was proposed by [18] to evaluate a Taiwanese airline company's service quality, which then discovered that airline passengers perceive assurance and reliability dimensions as the top considerations, while Tangibility being the least important service dimension. Moreover,

Liu et al. [19] also applied SERVQUAL to discover a big gap between service expectations and perceived performance in the tangibility aspect in China's registration and verification industry. Likewise, Chaichinarat et al. [20] empirically examined the automotive industry's service quality in Thailand. By referring to preceding studies about the SERVQUAL model, they identified positive weight for all five SERVQUAL components. When Farshianabbasi et al. [21] used an integrated SERVQUAL model to assess after-sales service efficiency, they discovered a considerable gap between customers' perceptions and expectations for service characteristics. Besides, Ko et al. [22] specified drawbacks in Taiwanese Nursing Homes. Based on the results, information and communication technology (ICT) technologies were proposed to alleviate such shortcomings. Kafere et al. [23] offered better blood services at the Zimbabwe National Blood Service Centre in that employee's code of conduct, compensations, and attitude against work must be improved to convey better services to blood donors. The utilization of the SERVQUAL model might vary across different service sectors. Also, this characteristic is significant in the same industry due to customers' heterogeneity in the service evaluation process [13]. It is notable that, in the implementation steps of improving service quality, the five SERVQUAL items are flexibly utilized case by case. They proved the effective use of a refined SERVQUAL model by excluding customer heterogeneity and service types from the original SERVQUAL components. It is assumed that SERVQUAL five-point scale is unable to represent customers' psychometric dimensions, and therefore, adopting a five-item scale across service sectors is unnecessary. Their work's empirical inference suggested two grand attributes: tangibles and intangibles than the original five components. In the management of quality in service companies, the two permanent components are supported by different cost structures between the physical and human resources. This should be noted that tangibles are related to the physical environment, while non-tangibles closely link to human resources.

2.2 MCDM in Service Quality Assessment

Despite its widespread use, the SERVQUAL paradigm has specific shortfalls, and its philosophical basis and empirical operationalization have been argued in the research sector. Also, there are real disadvantages of questioning respondents both before and after using the service; this is the so-called distance measure. To be more precise, the SERVQUAL scale is an essential but inadequate quality measure in the automotive industry, with clear implications for future research. The automotive industry is one of the main actors in developed and developing countries in today's dynamic world economy. MCDM methods, such as sampling, prioritizing, ranking, or choosing a range of alternatives, are by far the most practiced and implemented in a wide range of decision situations. MCDM may be implemented where evaluation needs various variables that cannot easily be translated into observable units, and many conflicting parameters are likely to influence the assessment. The service industry is filled with intangible, perishable, inseparable, and varied items, making it even more challenging to quantify service quality. Most of the approaches for determining service quality use the statistics approach to explore the historical data-based research paper. In the past, service quality was most often measured by using the 5–7 point-Likert Scales. To the best of our knowledge, the Grey System Theory (GTS) has recently been applied to operational research [24,25]. Nonetheless, it is rarely used in the field of service quality [26]. For instance, satisfied, reasonable, unsatisfied, and lingual statements are regarded as excellent representations of an opinion or judgement in practice. On the basis of these features, it appears that the GTS might be used to determine the structure of decision makers' decisions by contrasting the overall complexity of commonly used terms for subjective human assessment. Numerous scholars have used the SERVQUAL model to evaluate the quality of service in a variety of contexts, including as banking [27], retailing [28], supply chain [29]. Although numerous researchers

employ MCDM methods in a variety of domains, only a few apply SERVQUAL model in conjunction with the MCDM technique to examine automotive service quality problems. This study attempts to apply the Grey based approach to empirically examine service quality in an automotive context to provide VinFast's service quality supervisors, industry experts, and scholars to determine customers' needs, demands and ultimately achieve customer satisfaction. Therefore, this study integrates the GTS and MCDM model-based SERVQUAL to improve the comprehensiveness and reasonableness of analyzing service quality. Consequently, this study aims to address the quality assessment of automotive services by applying the Grey-DEMATEL, which combined qualitative and quantitative methodologies. The Grey-DEMATEL model is applied to obtain the cause-effect relationship and weighting of the proposed criteria.

3 Research Methodology

3.1 Basic Definitions of Grey System Theory

Professor Deng firstly elaborated on a Grey System Theory (GTS) in 1989 because of incomplete information, unquantifiable information, and partial ignorance. The grey theory is commonly applied to solve problems in an uncertain environment. This research presents grey numbers, grey sets in the grey theory [24]. The grey theory can be utilized with any imprecise decision-making process. The grey values can be translated into numbers by converting fuzzy values into crisp scores (CFCS) [30].

Definition 1: A grey system is a set of grey numbers and grey variables, all of which feature varying degrees of uncertainty. The grey number Xg is presented with an upper bound (X_g^u) and lower bound (X_g^l) and anonymous distribution information (Tab. 1):

$$X_g = \left[X_g^l, X_g^u\right] = \left[x' \in X | X_g^l < x' < X_g^u\right] \tag{1}$$

Table 1: Linguistic grey assessment

Values	Linguistic assessment	$[\otimes X_{ij}^{lp}, \otimes X_{ij}^{up}]$
0	No influence	(0, 0)
1	Very low influence	(0, 1)
2	Low influence	(1, 2)
3	Hight influence	(2, 3)
4	Very hight influence	(3, 4)

Definition 2: Grey number operation is characterized as a set of intervals rather than a set of real numbers. This analysis applied to the basic operating laws of grey numbers. The following Eqs. (2)–(5) are the basic mathematical operations implemented in the theory of grey numbers:

$$X_{g1} + X_{g2} = \left[X_{g1}^l + X_{g2}^l, X_{g1}^u + X_{g2}^u\right] \tag{2}$$

$$X_{g1} - X_{g2} = \left[X_{g1}^l - X_{g2}^u, X_{g1}^u - X_{g2}^l\right] \tag{3}$$

$$X_{g1} \times X_{g2} = \left[\min \left(X_{g1}^l \times X_{g2}^l, X_{g1}^l \times X_{g2}^u, X_{g1}^u \times X_{g2}^l, X_{g1}^u \times X_{g2}^u \right), \max \left(X_{g1}^l \times X_{g2}^l, X_{g1}^l \times X_{g2}^u, X_{g1}^u \right. \right.$$
$$\left. \left. \times X_{g2}^l, X_{g1}^u \times X_{g2}^u \right) \right] \tag{4}$$

$$X_{g1} \div X_{g2} = \left[X_{g1}^l, X_{g2}^u \right] \times \left[\frac{1}{X_{g2}^l}, \frac{1}{X_{g2}^u} \right] \tag{5}$$

Definition 3: For the two grey numbers $X_{g1} = \left[X_{g1}^l, X_{g1}^u \right]$ and $X_{g2} = \left[X_{g2}^l, X_{g2}^u \right]$, the possible degree of $X_{g1} \leq X_{g2}$ can be shown as follow:

$$P\left\{ X_{g1} \leq X_{g2} \right\} = \left[\max(0, G^* - \max\left(0, X_{g1}^u - X_{g2}^l \right) \right] / G^* \tag{6}$$

where $G^* = G\left(X_{g1} \right) + G\left(X_{g2} \right)$, the positive relationship between (X_{g1}) and (X_{g2}) is identified as follow:

If $X_{g1}^l = X_{g2}^l$ and $X_{g1}^u = X_{g2}^u$, that $X_{g1} = X_{g2}$ then $P\left\{ X_{g1} \leq X_{g2} \right\} = 0.5$

If $X_{g2}^l > X_{g1}^u$ that $X_{g2} > X_{g1}$, then $P\left\{ X_{g1} \leq X_{g2} \right\} = 1$

If $X_{g2}^u = X_{g1}^l$ and $X_{g1}^u > X_{g2}^u$, that $X_{g2} < X_{g2}$ then $P\left\{ X_{g1} \leq X_{g2} \right\} = 0$

If there is an intercrossing part in them when $P\left\{ X_{g1} \leq X_{g2} \right\} > 0.5$; that is $X_{g2} > X_{g1}$.

Where $P\left\{ X_{g1} \leq X_{g2} \right\} < 0.5$, that is that $X_{g2} < X_{g1}$.

X is represented with a set *of* $\mu_{G(x)}^l$ *and* $\mu_{G(x)}^u$: $X \rightarrow [0, 1]$; G as grey universal set X with $\mu_{G(x)}^u$ and $\mu_{G(x)}^l$; with the top and bottom limit of the G membership function. Equation $\mu_{G(x)}^u \geq \mu_{G(x)}^l$. The number of grey $\otimes X_{ij}^p$ for P decision; $\otimes .X_{ij}^p = \left[\otimes X_{ij}^{lp}, \otimes X_{ij}^{up} \right]$; criterion i will affect criterion j.

3.2 Proposed Models of Grey-DEMATEL

The DEMATEL approach was constructed by Battelle Memorial Institute of the Geneva Research Center [31]. The advantages of this technique are useful in evaluating the role of the independent criteria involved and describing the degree of impact and interrelationships between the criteria considered and alternatives. Therefore, the Grey-DEMATEL approach is explained as following steps:

Step 1: Considering influencing factors from experts' opinions and then constructing a direct-relation matrix.

Step 2: A number of K experts evaluate criteria (Ci) with i = 1, 2, 3, n in terms of pairwise relations using a linguistic scale. Five-level of the assessments are defined in Tab. 1.

Normalizing the lower bound and upper bound with the grey values by the following Eq. (7)

Normalization:

$$\Delta_{Min}^{Max} = Max_j \otimes X_{ij}^{lp} - Min_j \otimes X_{ij}^p \tag{7}$$

$$\otimes \tilde{x}_{ij}^p = \left(\otimes X_{ij}^{lp} - Min_j \otimes X_{ij}^p \right) / \Delta_{Min}^{Max}$$

$$\otimes \tilde{x}_{ij}^p = \left(\otimes X_{ij}^{up} - Min_j \otimes X_{ij}^p \right) / \Delta_{Min}^{Max}$$

Computing the total normalized crisp value using Eq. (8):

$$Y_{ij}^p = \frac{\left(\otimes X_{ij}^{lp}(1 - \otimes X_{ij}^{lp}) + \left(\otimes X_{ij}^{up} \times \otimes X_{ij}^p \right) \right)}{1 - \otimes X_{ij}^p + \otimes X_{ij}^p} \tag{8}$$

Calculating the final crisp values by Eq. (9):

$$Z_{ij}^p = Min_j \otimes X_{ij}^p + Y_{ij}^p \Delta_{Min}^{Max} \tag{9}$$

Hence, k direct-relation grey matrices (Z1, Z2, ... Zk) are extracted by taking the average grey direct relation matrix, Eq. (10):

$$Z_{ij}^p = Min_j \otimes X_{ij}^p + Y_{ij}^p \Delta_{Min}^{Max} \tag{10}$$

Step 3: The normalized matrix S is obtained by Eqs. (11) and (12)

$$K = \frac{1}{MAX_{1 \leq i \leq n} \ \Sigma_{j=1}^n a_{ij}} \tag{11}$$

$$S = K \times T \tag{12}$$

Step 4: (Di) is denoted with the sum of rows, and (Ri) is computed by the sum of columns, respectively:

$$D_i = [\sum_{j=1}^n m_{ij}] n \ x1 \tag{13}$$

$$R_i = [\sum_{i=1}^n m_{ij}] 1 \ x \ n \tag{14}$$

Step 5: Creating the value of $(R_i + D_i)$, $(R_i - D_i)$. The influencing factors can then be shown in the causal relationship diagram.

Step 6: Structural relationships occur between the analyzed elements, and it is a premise for the use of Grey-DEMATEL in the weighting of criteria. We determine criteria weights using the results of Grey-DEMATEL with Eqs. (15) and (16).

$$W_i = \sqrt{(R_i + D_i)^2 + (R_i - D_i)^2} \tag{15}$$

$$W_i^{nor} = W_i / \sum_{i=1}^n W_i \tag{16}$$

where W_i^{nor} are normalized weights

4 Case Study

VinFast, Vietnam's first fully integrated automobile manufacturer, plans to transition to all-electric vehicle production by late 2022. VinFast is betting heavily on the US market, where it plans to compete against major manufacturers and startups by delivering affordable electric sport utility vehicle (SUVs) and a battery leasing scheme [32]. Although numerous academics have constructed service quality studies, and different scales have already been developed to measure and investigate service quality, the existing research has been described as fragmented. Therefore, a comprehensive framework is needed to identify the critical dimensions of the automotive industry's service quality. After combining and synthesizing the existing literature of service quality, perceived service quality,

and practical consideration, this study proposes a set of critical factors for VinFast's service quality, consisting of VinFast's and customers' dimensions' perspectives based on expert opinions. In this study, four Vietnamese experts (three senior managers with at least an master degree, 10-year experience working in the automotive, and one professor from a famous university with numerous researches in Marketing/Sales) have been selected and interviewed. The proposed model comprises six main criteria and 65 sub-criteria. The explanation of these dimensions is explained in appendix Tab. A1

4.1 Results of Cause-Effect Relationships

Encountering a complex decision problem, where factors might affect the others and are affected by the others, is inevitable. It is not the case because of the interdependence of factors; improving one factor might improve the whole system. Accordingly, it is of necessity to identify cause and effect factors upon the whole system's improvement. This proposed model offers an ordinal perspective on initial considerations and further consideration of them in the future stage. For urgent resource allocation, therefore, influencing factors should be prioritized. After that, effect factors are generally serious issues at later stages and can be addressed. Under this circumstance, cause-effect factors should be established simultaneously. The relationships among evaluation factors are visualized on a causal relationship diagram in Tab. 2, which could be obtained using the dataset of $(R_i + D_i)$ and $(R_i - D_i)$. Judging by the values of $(R_i - D_i)$, it is noteworthy that causal factors with negative values should be categorized into effect criteria, which implies being heavily influenced by cause criteria. Since negative weights identify the effect group, the cause group on the other side is determined by positive values.

Table 2: SERVQUAL criteria results

Di		Ri		Di + Ri		Di-Ri		Crisp Di + Ri	Crisp Di-Ri	Criteria
0.323	2.354	1.037	4.031	1.360	6.385	−3.709	1.316	3.872	−1.196	(C1)
0.768	3.397	0.438	2.622	1.206	6.019	−1.854	2.959	3.613	**0.553**	(C2)
0.935	3.791	0.237	2.156	1.173	5.946	−1.220	3.553	3.560	**1.167**	(C3)
0.652	3.130	0.435	2.622	1.087	5.752	−1.970	2.695	3.419	**0.362**	(C4)
0.452	2.658	0.708	3.258	1.159	5.917	−2.806	1.951	3.538	−0.428	(C5)
0.443	2.640	0.718	3.281	1.161	5.921	−2.837	1.923	3.541	−0.457	(C6)

Regarding the results from Tab. 2 and Fig. 1, cause-factors including (C3), (C2), and (C4), are demonstrated over the horizontal axis, while effect-factors (C1), (C5) and (C6) are located on the opposite end. The illustration shows that (C3), (C2) and (C4), are the most influential criteria, affecting (C6), (C5) and (C1). Consequently, much attention should be paid forth to improve (C3), (C2), and (C4); the following are later considerations for (C6) (C5), and (C1).

Concerning the causal relationship diagram based on Tab. 3 for (C1). The cause-group in Fig. 1 consists of (C11), (C13), (C14), (C110), (C113), (C114), (C115), (C116), (C117), (C118), (C120). Effect-factors are (C118), (C111), and (C18). In contrast, the mentioned cause-factors, except for (C11), cause minimal impact on the overall Tangibility. The results indicated that there is a rising need for VinFast to focus on (C11), (C118), (C111), (C18), (C114). The better the Formal dress code, the more detailed Organizational chart information and genuine auto components, in conjunction with Certification, the better the Tangibility dimension.
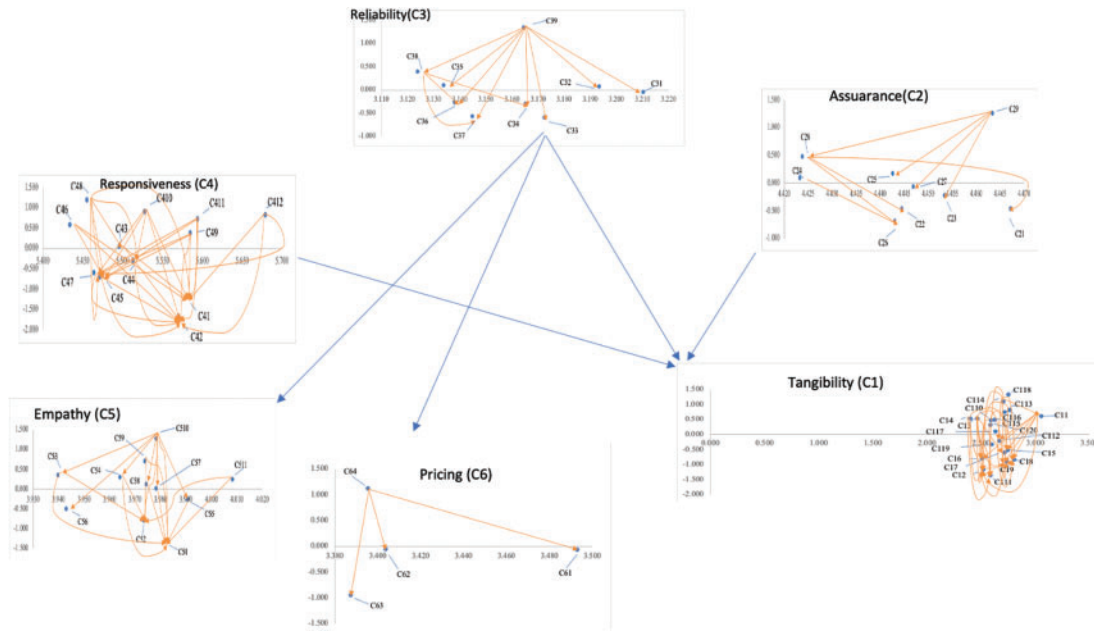
Figure 1: Causal relationship diagram for SERVQUAL criteria

Table 3: Tangibility's sub-criteria results

Di		Ri		Di + Ri		Di-Ri		Crisp Di + Ri	Crisp Di-Ri	Criteria
0.983	2.675	0.559	1.899	1.542	4.574	−0.916	2.115	3.058	**0.600**	(C11)
0.163	1.173	1.002	2.709	1.165	3.881	−2.545	0.171	2.523	−1.187	(C12)
0.748	2.244	0.379	1.569	1.127	3.813	−0.821	1.865	2.470	**0.522**	(C13)
0.720	2.192	0.361	1.537	1.081	3.729	−0.817	1.831	2.405	**0.507**	(C14)
0.470	1.734	0.854	2.439	1.324	4.174	−1.970	0.880	2.749	−0.545	(C15)
0.291	1.407	0.867	2.463	1.158	3.870	−2.173	0.540	2.514	−0.816	(C16)
0.434	1.670	0.870	2.467	1.304	4.137	−2.033	0.800	2.720	−0.616	(C17)
0.384	1.578	0.982	2.673	1.366	4.251	−2.289	0.595	2.809	−0.847	(C18)
0.334	1.485	0.983	2.675	1.317	4.160	−2.341	0.502	2.739	−0.919	(C19)
0.768	2.281	0.447	1.694	1.216	3.975	−0.925	1.834	2.596	**0.454**	(C110)
0.120	1.094	1.093	2.875	1.213	3.969	−2.755	0.002	2.591	−1.377	(C111)
0.555	1.890	0.717	2.188	1.272	4.078	−1.634	1.173	2.675	−0.230	(C112)
0.952	2.619	0.386	1.581	1.339	4.200	−0.629	2.233	2.769	**0.802**	(C113)
1.031	2.762	0.266	1.362	1.297	4.124	−0.331	2.496	2.711	**1.082**	(C114)
0.792	2.324	0.452	1.702	1.244	4.026	−0.910	1.872	2.635	**0.481**	(C115)
0.912	2.545	0.394	1.595	1.306	4.140	−0.683	2.151	2.723	**0.734**	(C116)
0.654	2.073	0.591	1.957	1.245	4.030	−1.303	1.482	2.637	**0.090**	(C117)
1.128	2.939	0.202	1.245	1.330	4.184	−0.117	2.737	2.757	**1.310**	(C118)
0.489	1.770	0.731	2.213	1.219	3.983	−1.724	1.039	2.601	−0.343	(C119)
0.712	2.177	0.501	1.792	1.212	3.969	−1.080	1.677	2.591	**0.298**	(C120)

Tab. 4 and Fig. 1 show that the cause sub-criteria are (C29), (C28), (C25), (C24), while the effect group includes (C26), (C22), (C21), (C3), (C7). Among these relationships, the most prominent cause-factor would be (C29) since most sub-criteria are affected by (C29). Therefore, service users are more concerned about VinFast's capability to fulfil promised service quality.

Table 4: Assurance's sub-criteria results

Di		Ri		Di + Ri		Di-Ri		Crisp Di + Ri	Crisp Di-Ri	Criteria
0.738	3.262	1.016	3.919	1.754	7.180	−3.181	2.245	4.467	−0.468	(C21)
0.731	3.246	1.010	3.903	1.740	7.149	−3.173	2.236	4.445	−0.468	(C22)
0.803	3.416	0.942	3.745	1.746	7.161	−2.942	2.474	4.454	−0.234	(C23)
0.887	3.614	0.840	3.505	1.727	7.120	−2.618	2.774	4.423	**0.078**	(C24)
0.916	3.683	0.823	3.463	1.739	7.146	−2.547	2.860	4.443	**0.156**	(C25)
0.661	3.081	1.079	4.066	1.739	7.147	−3.405	2.002	4.443	−0.702	(C26)
0.848	3.522	0.894	3.631	1.742	7.152	−2.783	2.628	4.447	−0.078	(C27)
1.003	3.8819	0.724	3.232	1.727	7.120	−2.229	3.164	4.424	**0.468**	(C28)
1.247	4.464	0.504	2.712	1.752	7.175	−1.464	3.959	4.463	**1.248**	(C29)

The cause-factors are identified in Tab. 5, as follows: (C39), (C38), (C35), (C32), while the remaining factors are classified into effect group with negative net effect values. As can be seen from Fig. 1, (C39) and (C38) are the most significant cause sub-dimensions because these two factors unilaterally affect the others.

Table 5: Reliability's sub-criteria results

Di		Ri		Di + Ri		Di-Ri		Crisp Di + Ri	Crisp Di-Ri	Criteria
0.720	2.433	0.760	2.508	1.480	4.941	−1.788	1.673	3.210	−0.057	(C31)
0.754	2.497	0.715	2.422	1.468	4.919	−1.668	1.783	3.194	**0.057**	(C32)
0.520	2.046	0.934	2.845	1.454	4.891	−2.325	1.112	3.173	−0.607	(C33)
0.617	2.234	0.831	2.648	1.448	4.882	−2.031	1.403	3.165	−0.314	(C34)
0.743	2.477	0.685	2.364	1.427	4.841	−1.621	1.792	3.134	**0.085**	(C35)
0.617	2.234	0.813	2.613	1.430	4.847	−1.996	1.421	3.138	−0.287	(C36)
0.520	2.048	0.914	2.807	1.434	4.856	−2.287	1.134	3.145	−0.576	(C37)
0.838	2.661	0.582	2.167	1.420	4.828	−1.329	2.079	3.124	**0.375**	(C38)
1.176	3.313	0.272	1.568	1.448	4.881	−0.392	3.041	3.165	**1.324**	(C39)

Similarly, for Responsiveness aspect as shown in Tab. 6 and Fig. 1, (C43), (C46), (C48), (C410), (C411), and (C412) are classified as cause-criteria. Meanwhile, the remainder composes of negative effect-criteria: (C42), (C41), (C45), (C47), and (C44). As a consequence, cause-criteria should be the priorities, followed by effect criteria at later stages.

Table 6: Responsiveness' sub-criteria results

Di		Ri		Di + Ri		Di-Ri		Crisp Di + Ri	Crisp Di-Ri	Criteria
0.645	3.734	1.281	5.502	1.926	9.236	−4.857	2.453	5.581	−1.202	(C41)
0.511	3.359	1.410	5.862	1.920	9.221	−5.351	1.949	5.571	−1.701	(C42)
0.951	4.586	0.929	4.526	1.880	9.111	−3.574	3.656	5.496	**0.041**	(C43)
0.861	4.336	1.029	4.802	1.890	9.137	−3.940	3.307	5.514	−0.317	(C44)
0.746	4.014	1.122	5.062	1.868	9.076	−4.317	2.892	5.472	−0.712	(C45)
1.074	4.929	0.773	4.091	1.847	9.021	−3.017	4.156	5.434	0.570	(C46)
0.771	4.085	1.093	4.980	1.863	9.066	−4.209	2.993	5.465	−0.608	(C47)
1.238	5.386	0.620	3.667	1.859	9.053	−2.429	4.766	5.456	**1.168**	(C48)
1.057	4.880	0.871	4.362	1.928	9.242	−3.305	4.009	5.585	**0.352**	(C49)
1.183	5.230	0.715	3.928	1.898	9.158	−2.746	4.514	5.528	**0.884**	(C410)
1.155	5.151	0.779	4.105	1.933	9.256	−2.951	4.372	5.595	**0.711**	(C411)
1.205	5.289	0.774	4.091	1.979	9.380	−2.887	4.515	5.679	**0.814**	(C412)

Out of 11 Empathy's sub-dimensions, the cause-group accounts for the majority with seven factors including: (C510), (C59), (C511), (C57), (C58), (C54), and (C53), while the other factors are subjected to the effect-group as shown in Tab. 7 and Fig. 1. In terms of the cause-effect relationship for Pricing's sub-criteria as shown in Tab. 8 and Fig. 1, (C64) appears as an influencing factor on other factors comprising (C63), (C61), and (C62).

Table 7: Empathy's sub-criteria results

Di		Ri		Di + Ri		Di-Ri		Crisp Di + Ri	Crisp Di-Ri	Criteria
0.408	2.248	1.231	4.076	1.640	6.324	−3.668	1.017	3.982	−1.326	(C51)
0.567	2.600	1.068	3.712	1.634	6.312	−3.146	1.532	3.973	−0.807	(C52)
0.914	3.372	0.699	2.895	1.613	6.267	−1.981	2.673	3.940	**0.346**	(C53)
0.904	3.349	0.725	2.951	1.629	6.300	−2.047	2.624	3.964	**0.288**	(C54)
0.733	2.969	0.912	3.367	1.646	6.336	−2.634	2.057	3.991	−0.288	(C55)
0.646	2.778	0.969	3.493	1.615	6.271	−2.847	1.809	3.943	−0.519	(C56)
0.819	3.160	0.819	3.159	1.638	6.319	−2.341	2.341	3.978	**0.000**	(C57)
0.853	3.236	0.782	3.078	1.635	6.314	−2.224	2.455	3.975	**0.115**	(C58)
1.032	3.634	0.603	2.680	1.635	6.313	−1.647	3.031	3.974	**0.692**	(C59)
1.212	4.034	0.425	2.285	1.638	6.319	−1.073	3.609	3.978	**1.268**	(C510)
0.900	3.339	0.757	3.021	1.657	6.360	−2.121	2.582	4.008	**0.230**	(C511)

Table 8: Pricing's sub-criteria results

Di		Ri		Di + Ri		Di-Ri		Crisp Di + Ri	Crisp Di-Ri	Criteria
0.744	2.675	0.794	2.773	1.538	5.449	−2.030	1.881	3.493	−0.074	(C61)
0.712	2.619	0.762	2.715	1.474	5.334	−2.003	1.857	3.404	−0.073	(C62)
0.404	2.021	1.058	3.292	1.462	5.313	−2.889	0.962	3.388	−0.963	(C63)
1.111	3.395	0.357	1.929	1.468	5.324	−0.818	3.038	3.396	**1.110**	(C64)

4.2 Results of Criteria Weights and Rankings

For VinFast's ranking of main concepts, weight values pointed out that Tangibility > Reliability > Assurance are under customers' scrutiny, whilst service users are putting backward Pricing > Empathy > Responsiveness in Tab. 9. The results are confirmed by [33], whose research revealed the role of Reliability, and Assurance for the correlation involving service quality dimensions and customer satisfaction. Alternatively, the results are consistent with the findings from a study by [34], which recognized Responsiveness as an integrated element of the service delivery in the health care system.

Table 9: Global results

Criteria	W_concept	Rank concept	Sub-criteria	W_local	Local ranking	W_global	Global ranking
(C1)	0.1840	1	(C11)	0.056	**1**	0.0103	46
			(C12)	0.050	11	0.0093	56
			(C13)	0.046	19	0.0084	**64**
			(C14)	0.044	20	0.0082	**65**
			(C15)	0.051	9	0.0093	54
			(C16)	0.048	14	0.0088	59
			(C17)	0.050	10	0.0093	55
			(C18)	0.053	4	0.0097	49
			(C19)	0.052	6	0.0096	51
			(C110)	0.048	16	0.0087	61
			(C111)	0.053	**3**	0.0097	48
			(C112)	0.048	12	0.0089	57
			(C113)	0.052	7	0.0096	52
			(C114)	0.053	5	0.0097	50
			(C115)	0.048	13	0.0089	58
			(C116)	0.051	8	0.0094	53
			(C117)	0.048	15	0.0088	60
			(C118)	0.055	**2**	0.0101	47
			(C119)	0.047	17	0.0087	62
			(C120)	0.047	18	0.0087	63

(Continued)

Table 9: Continued

Criteria	W_concept	Rank concept	Sub-criteria	W_local	Local ranking	W_global	Global ranking
(C2)	0.1659	3	(C21)	0.1114	**3**	0.0185	15
			(C22)	0.1108	4	0.0184	17
			(C23)	0.1106	5	0.0184	18
			(C24)	0.1097	9	0.0182	22
			(C25)	0.1103	8	0.0183	21
			(C26)	0.1116	**2**	0.0185	14
			(C27)	0.1103	7	0.0183	20
			(C28)	0.1103	6	0.0183	19
			(C29)	0.1149	**1**	0.0191	6
(C3)	0.1701	2	(C31)	0.1112	**3**	0.0189	8
			(C32)	0.1106	5	0.0188	10
			(C33)	0.1119	**2**	0.0190	7
			C (C34)	0.1102	6	0.0187	11
			(C35)	0.1086	9	0.0185	16
			(C36)	0.1091	7	0.0186	12
			(C37)	0.1107	4	0.0188	9
			(C38)	0.1090	8	0.0185	13
			(C39)	0.1188	**1**	0.0202	5
(C4)	0.1561	6	(C41)	0.0850	**3**	0.0133	36
			(C42)	0.0867	**1**	0.0135	34
			(C43)	0.0818	11	0.0128	44
			(C44)	0.0822	8	0.0128	41
			(C45)	0.0821	9	0.0128	42
			(C46)	0.0813	12	0.0127	45
			(C47)	0.0818	10	0.0128	43
			(C48)	0.0830	7	0.0130	40
			(C49)	0.0833	6	0.0130	39
			(C410)	0.0833	5	0.0130	38
			(C411)	0.0839	4	0.0131	37
			(C412)	0.0854	**2**	0.0133	35
(C5)	0.1618	5	(C51)	0.0947	**1**	0.0153	23
			(C52)	0.0914	**3**	0.0148	25
			(C53)	0.0892	11	0.0144	33
			(C54)	0.0896	10	0.0145	32
			(C55)	0.0902	6	0.0146	28
			(C56)	0.0897	8	0.0145	30
			(C57)	0.0897	7	0.0145	29
			(C58)	0.0897	9	0.0145	31
			(C59)	0.0910	4	0.0147	26
			(C510)	0.0942	**2**	0.0152	24

(Continued)

Table 9: Continued

Criteria	W_concept	Rank concept	Sub-criteria	W_local	Local ranking	W_global	Global ranking
			(C511)	0.0906	5	0.0147	27
(C6)	0.1621	4	(C61)	0.2497	3	0.0405	**3**
			(C62)	0.2433	4	0.0394	**4**
			(C63)	0.2517	2	0.0408	**2**
			(C64)	0.2553	**1**	0.0414	**1**

Regarding local rankings of Tangibility's sub-criteria, (C11), (C118), and (C111) are ranked the highest. Meanwhile, (C29), (C26), and (C21) are the top three of Assurance's sub-criteria. Ranked by the local weights, it is inferred that (C39), (C33), and (C31) should be prioritized. When discussing the rankings of Responsiveness' sub-criteria, it was evident that allocating resources for (C42), (C412), and (C41) is more urgent. On the other hand, (C51), (C510), and (C52) critically serve as the foundational attributes for VinFast's Empathy; settling down these problems would help set the stepping stone for improving the rest of Empathy's dimensions. Finally, the top sub-criterion of Pricing is (C64). It means that most customers concern about the reasonable price of service. Along with global weights and rankings (Tab. 9), VinFast's board of management would prioritize factors for development based on the level of contribution. The highest weight scores indicated that VinFast's Pricing sub-dimensions are the top 4 of global rankings, which demonstrates its importance amongst other enablers and shows that advancements toward improving these factors should be considered. However, Chang et al. [35] pointed out Assurance's sub-criteria and Empathy's sub-criteria as essential indicators of service quality in Taiwan's automobile industry. Alongside manufacturing vehicles powered by fossil energy, VinFast is targeting to develop a sustainable ecosystem including electric vehicles, which was inspired by Tesla. The research of [36] also highlighted the automobile industry's substantial contribution to sustainable development on a global scale through electrification and decarbonization schemes. Meanwhile, environmental regulations influence R&D projects, automotive companies need to contemplate sustainability [37]. As a result, VinFast's investments in electrification are appropriate in corresponding to changes.

5 Conclusions and Implications

5.1 Conclusions

This study conducted a comprehensive model of Grey-DEMATEL to investigate the influencing factors for VinFast's service quality in Vietnam's automotive industry. Basing on a "deep" and" wide" literature review and expert interviews, the proposed dimensions and sub-dimensions are indicated for VinFast's service quality supervisors, senior managers. These criteria were analyzed through Grey-DEMATEL, and it provides better support for decision makers to get helpful results with less information. This study was completed with the assistance of a proposed model with its application in a leading automotive manufacturer through feedbacks from their industrial managers and one academic expert. The findings of this research framework could be applied to help high-level managers and practitioners better design more and more effective managerial strategies in service quality. Regarding the decisive dimension of (C1) Tangibility, Tangibility's most significant causal factor is (C11) Genuine with the highest weight at 0.057. The results imply that VinFast's customers are more concerned about genuine products and (C11) Genuine. Regarding the (C2) Assurance dimension, global weight

values indicated that (C29) Service quality, (C26) Safety, (C21) Professionalism, and (C22) Detail work explanation is far more critical in comparison with other groups' factors. Dealing with the (C3) Reliability, the most crucial driver of VinFast's Reliability is (C39) Billing with a weight of 0.119. Based on the global weighting results of (C4) Responsiveness, (C412) Compatible staff is remarked as the most significant sub-criterion, and this criterion is a key point in maintaining responsiveness in particular and overall VinFast's service quality in general. The main driver of the (C5) Empathy is (C51) Courtesy criterion. This study implied that customers show more concerns over (C6) Pricing dimensions of VinFast. Compared to other sub-dimensions, Pricing's sub-dimensions are far more important in terms of global weight values, with (C64) Reasonable prices being the second most important on global weight rankings.

5.2 Implications

As the Vietnamese automotive manufacturing industry develops rapidly, accumulating a substantial market share is challenging due to fierce competition. In this sense, retaining customer satisfaction through the implementation of service quality should be supported by diverse factors. First, from the macroeconomic viewpoint, the government's policies supporting the industry plays an essential role in protecting the national automobile production. Upon the industry's development, continuously issuing incentive regulations could help stimulate domestic producers to engage in the industry, eventually laying a firm foundation for the sector's future development. Business owners, both existing entities and potential ones need to proactively take measures in response to the regulations to advance further. The linkages between business and government have been investigated in a case study by [38], which commented that there is a bidirectional lobbying situation between the automobile industry and the local state government of Michigan. As the decisive point for successes, it is suggested that there should be appropriate applications of the government's policies. Besides, a study conducted in China about government intervention and the automobile industry concluded that government intervention through Gross domestic product (GDP) incentive might possibly induce tax avoidance for enterprises. The study's findings have strengthened the thesis that government intervention into business activities stimulates preferential treatment. Second, in an increasingly demanding market, where automobile makers are caught up in intense competition, conformity in industrial and environmental standards is inadequate to move companies fast forward. Service innovation requiring applications of cutting–edge technologies, in conjunction with Research and Development (R&D) activities that often appear in new services, new products, and new business models, could create competitive edges for companies. For this reason, as studied by [39], adopting a data mining process in managing customer data, customer repair data helps improve the quality of the problem-solving system in the automobile industry. A data mining protocol lying in the core of a customer-based problem-solving tool is a creative way to improve VinFast's service quality.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

Data Availability Statement: The dataset is available online via the following link: https://data.mendeley.com/drafts/10.17632/j77skr7yc3.1 (accessed on 29 April 2022).

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Appendix:

Table A1: Proposed criteria

Criteria	Sub-criteria	Explanation
Tangibility (C1): refers to the physical presence of facilities, equipment, and personnel (Peitzika et al., 2020) [40]	Genuine (C11)	The service quality shows genuine auto parts
	Clear identity of employee (C12)	Employee positions and titles are well-defined
	Customer scheduling management (C13)	There is a customer appointment scheduling
	Confirmation of service scheduling (C14)	Customers are alerted to the service schedule
	Product information (C15)	The service center is committed to supplying customers with product information and brochures
	Available product information (C16)	Product information is prominently displayed in the waiting room and on the internet.
	Available technical information (C17)	Technical information is available in the customer lounge
	Organizational chart information (C18)	The service center organizational chart is displayed with staff details
	Service center location information (C19)	The location of the service center is clearly marked on the entrance and the paths.
	Industry standards equipment (C110)	Equipment and tools used are industry standards
	Formal dress code (C111)	The service center staff are well-dressed.
	Beautiful decoration (C112)	The service center is very attractive and well decorated
	Registration (C113)	Registration facility
	Parking (C114)	Parking area

(Continued)

Table A1: Continued

Criteria	Sub-criteria	Explanation
	Replacement (C115)	Replacement car
	Updated equipment (C116)	Up to date Equipment
	Waiting lounge (C117)	Comfortable waiting lounge
	Certification (C118)	Certificated quality standard
	Checklist (C119)	Checklist of repairs carried out
	Cleaning services (C120)	Car cleaning services after services
Assurance (C2): implies knowledge and courtesy of employees and the ability to inspire trustworthiness and confidence. (van Iwaarden et al., 2003) [41]	Professionalism (C21)	The service team is well-versed in all of their expertise.
	Detail work explanation (C22)	Service workers shall clarify in depth the work that needs to be performed.
	Carefulness (C23)	Service workers pay close attention to detail and follow-up work.
	Accuracy (C24)	Service staff give accurate information to customers
	Warranty (C25)	There is an explicit warranty on customer service maintenance
	Safety (C26)	Feel safe in transactions
	Extra repairs (C27)	Contacts customers if extra repairs are needed
	Adequacy (C28)	Adequate support from the producer
	Service quality (C29)	The quality of service meets the initial deal
Reliability (C3): is defined as the competence to convey a promised service task reliably and accurately (Chaichinarat et al., 2018) [20]	Accessories (C31)	Original accessories
	Modern management (C32)	Uses modern management and repairing system

(Continued)

Table A1: Continued

Criteria	Sub-criteria	Explanation
	Sufficient information (C33)	The service staff provided customers with estimates about how long they will be and how much they will cost.
	Capability (C34)	Service staff are capable of providing customers the service required
	First-time correctness (C35)	Service is done the first time correctly
	Punctuality (C36)	Fix car within the promised time
	Data storage (C37)	Customer service records are stored and secured
	Maintenance checklist (C38)	Customer service maintenance checklists are accurately followed
	Billing (C39)	Customer billing is accurate and reasonable
Responsiveness (C4): is identified as the willingness to help customers and provide prompt service (Buttle, 1996) [12]	Verification (C41)	Customer service staff welcome the customer quickly and check what needs to be done.
	Quick responses (C42)	Service staff are quick and responsive
	Enthusiasm (C43)	Service staff enjoy their work and are willing to serve customers.
	Respect (C44)	Service staff appreciate their customers and welcome them quickly.
	Appointment (C45)	The request does not need to be reiterated after an appointment has been made.
	Problem-solving skills (C46)	Service staff can quickly resolve problems
	Customer maintenance information (C47)	The service staff maintains a customer service worksheet.
	Vehicle maintenance information (C48)	Precise and reliable information on vehicle maintenance can be given to customers

(Continued)

Table A1: Continued

Criteria	Sub-criteria	Explanation
	Sufficient staff (C49)	The service facility has sufficient numbers of service staff
	Additional work (C410)	If more work needs to be done, the workers will be able to provide the customer with the necessary details.
	Phone responses (C411)	Service staff responds quickly and in-depth to your telephone.
	Compatibility (C412)	Compatible staff
Empathy (C5): refers to access, communication, and customer understanding (Peitzika et al., 2020) [40]	Equality (C51)	All consumers are equally provided for by the service personnel
	Customer focus (C52)	Service staff focus on each customer
	Sympathy (C53)	Service workers are polite and understanding to any client
	Careful staff (C54)	Service personnel tracks and conduct repairs according to the demands of the customer.
	After-sales records (C55)	The service center maintains after-sales service records
	After-sales calls (C56)	Customer support center makes a 2–3 days after the service has been delivered
	Friendliness (C57)	Customer service staff are friendly and behave like friends
	Offerings (C58)	Offering gifts and promotions
	Operating hours (C59)	Convenient operating hours
	Customer benefits (C510)	Considering the best benefits for customers
	Courtesy (C511)	Polite in answering customer's inquiries

(Continued)

Table A1: Continued

Criteria	Sub-criteria	Explanation
Pricing (C6): Is defined as theways that a company decides price and payment method make the convenience and satisfaction for customers (van Zanten et al., 2016) [42]	Service charge (C61)	Reasonable service charge
	Payment terms (C62)	Payment options
	Promotion (C63)	Promotion campaigns
	Reasonable prices (C64)	Reasonable prices for accessories