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DETERMINING CRITERIA AND EVALUATING SUPPLIERS PERFORMANCE IN AUTOMOTIVE SPARE PART SECTOR*

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Abstract

Parts of the automobiles should be renewed after a certain time and distance of usage. Considering that automobiles are indispensable elements of everyday life, the renewal process has significant cost to the users. Criteria, effecting the performances of relationship between spare part retailers and their suppliers, are revealed via this study. Using these criteria, performance of suppliers is evaluated with Grey Relational Analysis (GRA). It is seen that suitable price, return convenience and discount rate are more important than the other criteria.

Keywords: Spare part, Supply chain, Grey Relational Analysis

OTOMOTİV YEDEK PARÇA TEDARİK ZİNCİRİNDE ÖNEMLİ KRİTERLERİN BELİRLENMESİ VE TOPTANCILARIN PERFORMANSLARININ DEĞERLENDİRİLMESİ

Özet

Otomobillerde kullanılan parçaların belli bir kullanım veya süreden sonra değiştirilmesi gerekmektedir. Günlük yaşantımızın önemli bir parçası olan otomobillerin yenileme maliyetleri yüksek olmaktadır. Çalışmada otomobil yenileme pazarında yer alan toptancılar ile perakendecilerin ticari ilişkilerinde önemli olan kriterler ortaya konmuştur. Bu kriterler kullanılarak toptancıların performansları Gri İlişkisel Analiz (GİA) ile değerlendirilmiştir. En önemli kriterler de fiyat uygunluğu, iade kolaylığı ve ıskonto oranı olarak belirlenmiştir**.**

Anahtar Kelimeler: *Yedek parça, Tedarik zinciri, Gri İlişkisel Analiz*

Introduction

It is not possible to see the trace of a single business in all stages of a product from its raw material form to the arrival to a customer. Businesses are suppliers of other businesses in today's commercial atmosphere where specialization has a significant advantage for competition.

Businesses may control their performances by running their own inner functions in harmony. However, controlling the performances of businesses forming the supply chain may not be on their own hand. Supply chain performance depends on the performance of the relationship between the businesses forming the supply chain. Therefore, it is necessary to establish important criteria in relations of businesses. Establishing these criteria and measuring the performances of businesses according to these criteria are necessary for the supply chain to operate effectively and productively.

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Automotive sector is an important sector for the economies of developed countries. Turkey, which is among the developing countries, also has been working in order to increase its share in this sector. Many brands manufacture in Turkey due to Turkey's close position to Europe and other markets and its labour cost and quality. Many spare parts of these brands are also supplied by these suppliers operating in our country. Turkey has important potentials for vehicle spare parts. In addition, due to this potential for these spare parts Turkey also works in order to generate a domestic brand by government.

Spare parts used in the production of automobiles should be replaced after a certain distance of use or after a while. This replacement process can be done by authorized services of the brands or rather by special services operating in small industrial sites. While authorized services use original spare parts of the automobiles in replacement, special services may use original or equivalent spare parts at vehicle owner's pleasure. Labour costs of authorized services are higher compared to special services. Also it is possible to find the original spare parts at a more affordable price in special services.

There are 15 315 224 vehicles in Turkey as of the beginning of 2016. 16 % of them are between 1-3 ages and 19 % of them are between 4-6 ages. Vehicle parking age average of Turkey is 12. In vehicle replacement market while authorized services are used heavily by the vehicle at the age of 3 or less, there is a competition for special services in the vehicles between 3-5 ages and special services are used heavily in vehicles over 5 ages. While users prefer using authorized services due to the warranty period of their new vehicles or other reasons, they go to special services over years due to the costs (KPMG, 2016).

Special services supply the parts that are going to be replaced in replacement operations from the spare part retailers operating in small industrial sites again. Spare parts need to be obtained as soon as possible so that the operations of the vehicles which come to special services for replacement and repairs can be fulfilled in a short time. This is important for both the workers in special services not to waste time by waiting and for the vehicle owners to get their vehicles in a short time.

There are many models of many brands in the markets. Spare parts of these vehicles vary according to the features such as brand, model, engine type and model year. Thus, these spare part sellers vary according to the size of cities that they operate in. While there are businesses having the spare parts of only one brand in big cities, the businesses keeping the spare parts of brand groups according to the countries' origins or the businesses keeping the most wanted spare parts of all vehicles operate in smaller cities. When the difficulty of stocking the spare parts of such various vehicles is considered, the necessity to establish important criteria for spare part retailers in their relations with their suppliers occurs.

The purpose of this study is to establish important criteria for spare part retailers in their relations with their suppliers by adapting them according to the criteria in former studies and evaluate the performances of suppliers according to these criteria.

1. Supply chain management and its processes

Supply chain which is a concept defined in order to coordinate the coordinative studies of businesses with each other effectively and productively consists of methods and transactions which realize the processes that raw materials are semi-manufactured and manufactured and delivered to customers in accordance with the costumer needs by creating added value (Cesur, 2010; Korkmaz, 2013). This network consisting of suppliers, producers and consumers provided to focus on conducting the works in business process and infrastructure support in adaptation of the benefits of scale economy to the management. (Chen, 2003). It provides the coordination of information and financial flow between

businesses and business functions (Stadtler and Kilger, 2008). By applying supply chain method businesses whose main objective is customer satisfaction and exact competition get benefits such as an increase in productivity and performance, cost advantage, a decrease in net business capital needs, reduction in stock management costs, a decrease in waste capacity stocks, a decrease in flexibility, product cycle time, progress in order fulfillment rates, success in demand estimation, a decrease in logistics costs and customer complaints (Eleren, 2008).

Eight business processes explained by Global Supply Chain Forum provide the supply chain to work healthily and the access between functional departments of businesses such as marketing, research and development, financing, production, purchase and logistics and other business departments (Croxton et al, 2001). In Costumer Relations Management activities are carried out in order to create healthy and long term relations with current customers. Therefore, customers feel themselves special and business loyalty is provided (Demir and Kırdar, 2000). Determining replacement needs on time and realizing the necessary processes, being in industry-leading position in various activities and adding value to customers are the tasks of Customer Service Management process. (Çiçek, 2006). Demand management which emerges as a new dimension in customer interface aims to work in syncronized with customer demands and business resources (Rexhausen et al, 2012). The process which is complicated because it is carried out between functional departments and starts with the receipt of customer demands and ends with the delivery of the final product to the customer is the Order Processing Period. (Lin and Shaw, 1998). In Manufacturing Flow Process the product is manufactured according to the needs of the market. Determining the transactions to be done in interaction with suppliers, categorizing the suppliers in relevant segments, determining the relation level, activities for generating suitable product and service contracts for suppliers are conducted in Supplier Relations management process (Croxton et al, 2001). In Product Development Process it is aimed that the product would be sold well and provide good profits and it would be compatible with customer needs (Mital et al, 2014). Although Return Management is not regarded sufficiently by companies, it is important for maintaining customer relations at a certain level and, most importantly, for getting feedback for product development (Derman, 2006).

2. Factors affecting the performance of supply chain

In some organizations ambiguity, the level of complexity and environmental dynamics are considered stable but they may vary according to the perception of members. While some individuals may tolerate ambiguity and uncertainty, some of them may not accept it (Duncan, 1972). Internal and external factors such as customers who affect the activities of a company, suppliers, rivals, developments in technology, laws and government policies, market trends, social and economic trends are called as business environment. It is not easy to measure the effects of these environmental functions, but they should be analyzed as much as possible and benefits and costs should be tried to be shared levelly to the chain members (Bourgeois, 1980; Lamming and Hampson, 1996).

Throughout the supply chain use of Information Technologies (IT) is a significant factor which affects the performance and chain members encourage and even force each other to adopt them more (Lai et al., 2006). While investing on these technologies, human factor may sometimes be ignored. Selecting and educating right people for right tasks will create a success story for the members of other organizations and it will increase their loyalty to the chain (Fawcett et al, 2008).

New and radical needs that arise due to joinings in the supply chain, a change in the institutional strategy and so on require new designs to be made or changes in design (Kurt, 2011). Ensuring the supply chain flow in a healthy manner is also necessary to avoid

problems with stocks. Disruptions in flow sometimes cause stock costs due to high stocks and sometimes cause some problems such as not responding to customer demands due to stock shortage (Sevimli, 2007).

3. Criteria used for evaluating the supply chain performance

First study in which the required criteria for selecting the supplier were presented is G.W Dickson's study published in 1966. Dickson identified 23 criteria for supplier selection in his study that he carried out by addressing a survey to purchasing officers and managers of 273 companies in USA and Canada who were members of National Purchasing Manager Association. Weber et, al. stated that the order of importance of the criteria had changed due to quality guidelines, advanced computer communication and increasing technical competences in their studies that they analyzed the studies for supplier selection from Dickson's study to 1991.

Table 3.1. The criteria used by Weber and Dickson and their rankings

Weber's ranking	Dickson's ranking	Criteria	Number of articles mentioned
1	6	Price	61
2	2	Delivery	44
3	1	Quality	40
4	5	Production facilities and capacity	23
5	20	Geographical location	16
6	7	Technical capability	15
7	13	Management and organization	10
8	11	Reputation and position in industry	8
9	8	Financial position	7
10	3	Performance history	7
11	15	Repair service	7
12	16	Attitude	6
13	18	Packaging ability	3
14	14	Operating controls	3
15	22	Training aids	2
16	9	Procedural compliance	2
17	19	Labor relations record	2
18	10	Communication system	2
19	23	Reciprocal arrangement	2
20	17	Impression	2
21	12	Desire for business	1
22	21	Amount of past business	1
23	4	Warranties and claim policies	0

Source: Weber et, al (1991)

Tayyar and Arslan analyzed 5 main studies used for supplier selection in their study that they published in 2013. They included the criteria used for supplier selection and the usage frequency of these criteria in the table that they prepared to help subsequent studies.

Tablo 3.2. Criteria used for supplier selection and usage rates

Kriterler	1966-1990(74)	1990-2001(36)	2000-2011(46)	2000-2008(78)
	Weber et, al	Cheragi et, al	Thiruchelvam et, al	Ho et, al
Quality	54%	79%	80%	87%
Delivery	60%	77%	78%	82%
Performance history	10%	10%	22%	
Warranties and claim policies	1%	0%	11%	
Production facilities and capacity	31%	26%	44%	50%
Price	82%	67%	80%	81%
Technical capability	20%	28%	52%	32%
Financial position	10%	18%	37%	30%
Procedural compliance	3%	5%	0%	
Communication system	3%	10%	15%	
Reputation and position in industry	11%	3%	17%	19%
Desire for business	1%	0%	4%	
Management and organization	14%	18%	48%	32%
Operating control	4%	0%	0%	
Repair service	10%	28%	24%	45%
Attitude	8%	13%	13%	
Impression	3%	5%	9%	
Packaging ability	3%	0%	9%	
Labour relations record	2%	3%	13%	4%
Geographic location	16%	5%	26%	
Amount of past business	1%	0%	4%	
Training aids	2%	0%	0%	
Reciprocal arrangements	2%	5%	0%	
Reliability		NEW	24%	
Consistency		NEW		
Inventory cost		NEW		
Culture		NEW		
Flexibility		NEW	41%	23%
Quality standards		NEW		

Process improvement		NEW	26%	
Product development		NEW	41%	31%
Environmental and social responsibility *			20%	4%
Occupational health and Safety		NEW	9%	4%
Integrity		NEW	11%	
Professionalism		NEW	9%	
Just in time production		NEW	11%	
Commitment *			20%	
Economical situation *			2%	
Long-term relationship		NEW	9%	
Political situation *			4%	
Risk			%	4%

*The new criteria added to literature by Thiruchelvam and Tokey(2011)

Source: Tayyar and Arslan, 2013.

4. Evaluating the performance of supply chain in automotive spare part sector

What is aimed in the relations of automotive spare part retailers with their suppliers is to establish criteria and evaluate the performance of suppliers according to these criteria. For this purpose, first of all, face-to-face interviews were held with 10 major spare parts retailers operating in Manisa and Usak. At the end of the interviews 40 businesses that are the suppliers of these retailers were determined. 5 expert views were taken to establish important criteria in the relations of spare part retailers with their suppliers. These experts have an average of 25 years of experience in spare part sector. 20 criteria were determined in accordance with the expert views.

First survey was prepared with the obtained information. This survey consists of two parts. In the first part the determined criteria were listed. 5 point likert scale was utilized in order to identify the significance levels of survey criteria. Participants were asked to express the criteria importance with one of the options of “I absolutely agree”, “ I agree”, “I’m neutral”, “I disagree”, “I absolutely disagree”. In the second part names of 40 supplier businesses were written and 3 point likert scale was utilized in order to identify the working frequency of retailers with their suppliers. They were asked to express the working frequency with supplier business by choosing one of the options of “always”, “sometimes”, “never”. Prepared survey was applied to 25 businesses through face-to-face surb-vey method. By taking the arithmetic average of the points of the criteria in the survey their order of importance was created. In the same way, companies were ranked according to their working frequency.

According to the results of the first survey, the most important 10 criteria and most worked 12 suppliers were determined and a second survey was established. In the second survey participants were asked to evaluate each of the businesses according to the determined criteria. 5 point likert scale was used in the evaluation. Again data were obtained as a result of the survey applied by face-to-face survey method to the same 25 businesses. By taking the average of the obtained data points of each business were obtained according to each

criterion. In addition, the scores of the first 10 criteria from the first survey were used as the weight scores of the criteria.

Multiple Criteria Decision Making Techniques can be used because they include multiple criteria and alternatives in evaluating supplier performance. Among the used methods there are some methods such as AHP, ANP, TOPSİS, ELECTRE, GİA and MAUT.

Grey Relational Analysis (GRA) was used in this study. GRA was suggested in 1982 by Professor Julong Deng. While in Grey Theory missing or unknown information is regarded as grey, the measurement of the change in relationship between two factors or systems in time is called as grey relationship. In order to identify the direction of the change in similarities and differences between these two factors and systems in time Grey Relational Analysis is used. (Feng and Wang, 2000). Using grey relational analysis, simple and understandable analysis based on the original data is made. This method is one of the best among the methods used by managers who need to make decisions under the influence of various factors in the business environment so that they make these decisions in the most appropriate way (Wu, 2002).

The steps for Grey Relational Analysis are as follows (Wu, 2002);

Step 1. *Preparation of data set and creation of Decision Matrix*

To be $i = 1, 2, \ldots, m$ and $j = 1,2,\ldots,n$

χ_i Showing alternatives and $\chi_i(j)$ represents the value that alternatives take for each criterion. The decision matrix X is constructed as shown below.

$$X_i = \begin{bmatrix} \chi_1(1) & \chi_1(2) & \cdots & \chi_1(n) \\ \chi_2(1) & \chi_2(2) & \cdots & \chi_2(n) \\ \cdots & \cdots & \ddots & \cdots \\ \chi_m(1) & \chi_m(2) & \cdots & \chi_m(n) \end{bmatrix} \quad (1)$$

Step 2. *Creation of Reference Series and Comparison Matrix*

Reference series to be compared in decision problem determined as;

$$\chi_0 = (\chi_0(j)) \quad j = 1,2,\ldots,n \quad (2)$$

Here $\chi_0(j)$ represents the best value within the normalized values of the j criteria. The reference series is added to the first line of the decision matrix and the comparison matrix is obtained.

Step 3. *Normalization of the Decision Matrix and creation of the Normalization Matrix*

There are three different states for normalization.

Utility Situation: If it is thought that the value which is bigger than the series value is better;

$$\chi_i^*(j) = \frac{x_i(j) - \min_j x_i(j)}{\max_j x_i(j) - \min_j x_i(j)} \quad (3)$$

Cost Situation: If it is thought that the value smaller than the serial values is better;

$$x_i^*(j) = \frac{\max_j x_i(j) - x_i(j)}{\max_j x_i(j) - \min_j x_i(j)} \quad (4)$$

Optimal Situation: If a best value is specified for the series values;

$$x_i^*(j) = \frac{\left| x_i(j) - x_{0b}(j) \right|}{\max_j x_i(j) - x_{0b}(j)} \quad (5)$$

Here, $x_{0b}(j)$ is the value of j. criteria and $\max_j x_i(j) \geq x_{0b}(j) \geq \min_j x_i(j)$

The normalized matrix is shown as follows..

$$X_i^* = \begin{bmatrix} x_1^*(1) & x_1^*(2) & \cdots & x_1^*(n) \\ x_2^*(1) & x_2^*(2) & \cdots & x_2^*(n) \\ \cdots & \cdots & \ddots & \cdots \\ x_m^*(1) & x_m^*(2) & \cdots & x_m^*(n) \end{bmatrix} \quad (6)$$

Step 4. Establishment of the Absolute Value Table

$\Delta_{0i}(j)$ shows the absolute difference between x_0^* and x_i^* at point ;

$$\Delta_{0i}(j) = \left| x_0^*(j) - x_i^*(j) \right| = \begin{bmatrix} \Delta_{01}(1) & \Delta_{01}(2) & \cdots & \Delta_{01}(n) \\ \Delta_{02}(1) & \Delta_{02}(2) & \cdots & \Delta_{02}(n) \\ \cdots & \cdots & \ddots & \cdots \\ \Delta_{0m}(1) & \Delta_{0m}(2) & \cdots & \Delta_{0m}(n) \end{bmatrix} \quad (7)$$

Step 5. Creation of Grey Relational Coefficient Matrix

The grey relational coefficient $\gamma_{0i}(j)$ is calculated by the following procedure;

$$\gamma_{0i}(j) = \frac{\Delta_{\min} + \varsigma \Delta_{\max}}{\Delta_{0i}(j) + \varsigma \Delta_{\max}} \quad (8)$$

Here, $\Delta_{\max} = \max_i \max_j \Delta_{0i}(j)$, $\Delta_{\min} = \min_i \min_j \Delta_{0i}(j)$ and $\xi \in [0,1]$

Adım 6. *Calculation of Grey Relational Degrees;*

Grey scale is calculated as shown below;

$$\Gamma_{0i} = \sum_{j=1}^{n} \left[W_i(j) \times \gamma_{0i}(j) \right] \quad (9)$$

Here, Γ_{0i} represents the best performing alternative among the highest value alternatives.

Performance evaluation was conducted with Grey Relational Analysis using the data consisting of retailer information participated in the survey to evaluate wholesaler performances. While "1" was used as the indicator of the best performance, "5" was used as

the indicator of the worst performance in used 5 point Likert scale. Microsoft Excel spread sheet program was utilized in decision-making and problem solving due to the simplicity of the calculations and the usefulness of the problem.

The steps for implementing Grey Relational Analysis in supply chain performance evaluation are shown below.

Step 1. 10 Criteria that will influence our 12 alternatives have been identified. The values of the alternatives according to the criteria are shown in table 1.

The criterion score of the wholesaler was determined by taking the arithmetic average of the values that each wholesale business operator received from the survey respondents according to that criterion.

Here, it is desirable that each alternative has a minimum value because it indicates that the performance of taking small values according to the criteria is good.

Table 5.1. The values of the alternatives according to the criteria

	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**
	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min
	The prices of the products are affordable	Products are guaranteed	Provides return convenience for defective products	Promote new products	Product stock is sufficient	Product shipment every day	The discount rate is good	Ordering system is useful	Having product variety	Send orders completely
A1	2,000	2,000	1,875	3,125	2,250	2,625	2,375	1,875	1,875	2,625
A2	2,143	2,429	2,429	2,429	2,429	2,000	2,143	1,857	2,000	2,429
A3	2,375	1,875	2,250	3,000	2,125	2,375	2,250	1,875	2,125	2,250
A4	1,333	1,667	1,667	2,167	1,167	1,333	1,500	1,667	1,333	1,667
A5	2,625	3,625	3,750	3,125	3,000	3,375	2,625	2,500	3,250	3,500
A6	2,000	2,286	2,571	2,429	2,000	2,429	2,000	1,571	1,714	1,857
A7	2,250	3,250	2,750	3,000	2,625	2,875	2,500	2,250	2,500	2,750
A8	2,125	1,444	1,333	1,444	1,889	1,667	1,778	1,667	1,889	2,000
A9	2,000	1,750	1,750	2,125	2,250	2,250	2,000	1,625	2,000	2,125
A10	2,333	2,167	2,000	2,667	2,167	2,667	2,000	1,833	2,667	2,500
A11	1,857	1,857	1,714	2,286	2,000	2,000	1,857	1,857	2,000	2,000
A12	1,700	3,200	3,900	2,100	2,300	2,625	1,875	2,375	2,375	2,625

Step 2. Preparation of reference serie and comparison matrix

For each criteria, the best value was determined and reference serie is established.

Table 5.2. Reference series and comparison matrix

	Min	Min	Min	Min	Min	Min	Min	Min	Min	Min
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**
Reference	1,333	1,444	1,333	1,444	1,167	1,333	1,500	1,571	1,333	1,667
A1	2,000	2,000	1,875	3,125	2,250	2,625	2,375	1,875	1,875	2,625
A2	2,143	2,429	2,429	2,429	2,429	2,000	2,143	1,857	2,000	2,429
A3	2,375	1,875	2,250	3,000	2,125	2,375	2,250	1,875	2,125	2,250
A4	1,333	1,667	1,667	2,167	1,167	1,333	1,500	1,667	1,333	1,667
A5	2,625	3,625	3,750	3,125	3,000	3,375	2,625	2,500	3,250	3,500
A6	2,000	2,286	2,571	2,429	2,000	2,429	2,000	1,571	1,714	1,857
A7	2,250	3,250	2,750	3,000	2,625	2,875	2,500	2,250	2,500	2,750
A8	2,125	1,444	1,333	1,444	1,889	1,667	1,778	1,667	1,889	2,000
A9	2,000	1,750	1,750	2,125	2,250	2,250	2,000	1,625	2,000	2,125
A10	2,333	2,167	2,000	2,667	2,167	2,667	2,000	1,833	2,667	2,500
A11	1,857	1,857	1,714	2,286	2,000	2,000	1,857	1,857	2,000	2,000
A12	1,700	3,200	3,900	2,100	2,300	2,625	1,875	2,375	2,375	2,625

Step 3. *Normalization of the decision matrix and creation of the normalization matrix*

Normalization is done to make the alternatives comparable. Since the criteria value is requested to be minimum, formula 3 which expresses the cost state is used.

Table 5.3. Result of normalization

	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**
Reference	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
A1	0,484	0,745	0,789	0,000	0,409	0,367	0,222	0,673	0,717	0,477
A2	0,373	0,549	0,573	0,414	0,312	0,673	0,429	0,692	0,652	0,584
A3	0,194	0,803	0,643	0,074	0,477	0,490	0,333	0,673	0,587	0,682
A4	1,000	0,898	0,870	0,570	1,000	1,000	1,000	0,897	1,000	1,000
A5	0,000	0,000	0,058	0,000	0,000	0,000	0,000	0,000	0,000	0,000
A6	0,484	0,614	0,518	0,414	0,545	0,464	0,556	1,000	0,801	0,896
A7	0,290	0,172	0,448	0,074	0,205	0,245	0,111	0,269	0,391	0,409
A8	0,387	1,000	1,000	1,000	0,606	0,837	0,753	0,897	0,710	0,818
A9	0,484	0,860	0,838	0,595	0,409	0,551	0,556	0,942	0,652	0,750
A10	0,226	0,669	0,740	0,273	0,455	0,347	0,556	0,718	0,304	0,545
A11	0,594	0,811	0,852	0,499	0,545	0,673	0,683	0,692	0,652	0,818
A12	0,716	0,195	0,000	0,610	0,382	0,367	0,667	0,135	0,457	0,477

Step 4. Establishment of the Absolute Value Table

The distances of the normalized alternate values with the normalized reference series are calculated using the formula 7.

Table 5.4. Absolute Value Table

	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10
A1	0,516	0,255	0,211	1,000	0,591	0,633	0,778	0,327	0,283	0,523
A2	0,627	0,451	0,427	0,586	0,688	0,327	0,571	0,308	0,348	0,416
A3	0,806	0,197	0,357	0,926	0,523	0,510	0,667	0,327	0,413	0,318
A4	0,000	0,102	0,130	0,430	0,000	0,000	0,000	0,103	0,000	0,000
A5	1,000	1,000	0,942	1,000	1,000	1,000	1,000	1,000	1,000	1,000
A6	0,516	0,386	0,482	0,586	0,455	0,536	0,444	0,000	0,199	0,104
A7	0,710	0,828	0,552	0,926	0,795	0,755	0,889	0,731	0,609	0,591
A8	0,613	0,000	0,000	0,000	0,394	0,163	0,247	0,103	0,290	0,182
A9	0,516	0,140	0,162	0,405	0,591	0,449	0,444	0,058	0,348	0,250
A10	0,774	0,331	0,260	0,727	0,545	0,653	0,444	0,282	0,696	0,455
A11	0,406	0,189	0,148	0,501	0,455	0,327	0,317	0,308	0,348	0,182
A12	0,284	0,805	1,000	0,390	0,618	0,633	0,333	0,865	0,543	0,523

Step 5. Creation of Grey Relational Coefficient Matrix

Values of $\Delta_{max} = 1,000$ and $\Delta_{min} = 0,000$ were determined by using the values in the absolute value table. We used $\zeta = 0,5$. Grey relational coefficient matrix is formed by using formula 8.

Table 5.5. Matrix of Grey Relational Coefficients

	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10
A1	0,492	0,662	0,703	0,333	0,458	0,441	0,391	0,605	0,639	0,489
A2	0,444	0,526	0,540	0,461	0,421	0,605	0,467	0,619	0,590	0,546
A3	0,383	0,717	0,583	0,351	0,489	0,495	0,429	0,605	0,548	0,611
A4	1,000	0,831	0,794	0,538	1,000	1,000	1,000	0,830	1,000	1,000
A5	0,333	0,333	0,347	0,333	0,333	0,333	0,333	0,333	0,333	0,333
A6	0,492	0,564	0,509	0,461	0,524	0,482	0,529	1,000	0,716	0,828
A7	0,413	0,376	0,475	0,351	0,386	0,398	0,360	0,406	0,451	0,458
A8	0,449	1,000	1,000	1,000	0,559	0,754	0,669	0,830	0,633	0,733
A9	0,492	0,781	0,755	0,553	0,458	0,527	0,529	0,897	0,590	0,667
A10	0,392	0,602	0,658	0,407	0,478	0,434	0,529	0,639	0,418	0,524
A11	0,552	0,725	0,771	0,500	0,524	0,605	0,612	0,619	0,590	0,733
A12	0,638	0,383	0,333	0,562	0,447	0,441	0,600	0,366	0,479	0,489

Step 6. Calculation of Grey Relational Degrees

The weight values of the criteria for the calculation of the grey relational analysis ratings are given in table 3.6. Here, w_i represents the weight coefficient of criteria and $\sum w_i = 1$

Table 5.6. Weight Coefficients of Criteria

	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**
w_i	0,105	0,099	0,105	0,097	0,097	0,095	0,101	0,105	0,099	0,095

Sum of the values formed by multiplying the criterial weights by grey relational coefficients and the grey relational ratios were obtained using the formula 9. Rank of each alternative was determined by ranking these values from small to large.

Table 5.7. Grey Relational Degrees and ranking of alternatives

	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**K7**	**K8**	**K9**	**K10**	Γ_{0i}	Rank
A1	0,492	0,662	0,703	0,333	0,458	0,441	0,391	0,605	0,639	0,489	0,524	6
A2	0,444	0,526	0,540	0,461	0,421	0,605	0,467	0,619	0,590	0,546	0,522	7
A3	0,383	0,717	0,583	0,351	0,489	0,495	0,429	0,605	0,548	0,611	0,521	8
A4	1,000	0,831	0,794	0,538	1,000	1,000	1,000	0,830	1,000	1,000	0,899	1
A5	0,333	0,333	0,347	0,333	0,333	0,333	0,333	0,333	0,333	0,333	0,335	12
A6	0,492	0,564	0,509	0,461	0,524	0,482	0,529	1,000	0,716	0,828	0,612	5
A7	0,413	0,376	0,475	0,351	0,386	0,398	0,360	0,406	0,451	0,458	0,408	11
A8	0,449	1,000	1,000	1,000	0,559	0,754	0,669	0,830	0,633	0,733	0,763	2
A9	0,492	0,781	0,755	0,553	0,458	0,527	0,529	0,897	0,590	0,667	0,627	3
A10	0,392	0,602	0,658	0,407	0,478	0,434	0,529	0,639	0,418	0,524	0,510	9
A11	0,552	0,725	0,771	0,500	0,524	0,605	0,612	0,619	0,590	0,733	0,624	4
A12	0,638	0,383	0,333	0,562	0,447	0,441	0,600	0,366	0,479	0,489	0,474	10

As a result of evaluating the scores obtained by the wholesalers with the criteria of grey relational analysis, it was found out that the performance of A4 business was the best. It is also seen that A8 business is in the second rank in evaluation. It can be said that performance of these two businesses is rather better than other businesses. Performance values of A1, A3 and A2 businesses are very close to each other. Performances of A7 and A5 businesses are rather lower than other businesses and they are in the last two position as their performance values.

Conclusion

The criteria which are considered important in other sectors with supply chain were adapted to automotive sector with a significant economic size and presented as an example for the businesses operating in the sector so that they increase their performances.

Although significant value differences were observed between the criteria in previous studies, it was observed in this study that criteria had weight values close to each other. Here, it is observed that the criteria of manufacturing business and retail business have different weight values.

One of the 10 criteria included in the first survey of the study but less important than the others is the criterion "It is important that the products are domestic products". The fact that there has not been an automobile brand that can be considered as domestic in the sector yet and the awareness of domestic spare part brands is not at an adequate level appears to be the reasons that this criterion is not considered important. The criterion “It is important that products are Chinese origin” is not considered as important due to quality and branding problems. The criterion “It is important that products are original” is not considered as important because original products are qualified but their prices are high and function of original products are fulfilled by more affordable equivalent products. Domestic, Chinese and Taiwanese products which function as original products exist in the spare parts sector in great amount.

By considering that the values such as trust and experience are important in commercial activities the criterion “Commercial background of supplier is important” was used. However, it is not considered as important because some businesses which are in the sector for long years could not follow the innovations and the businesses that can be seen as new in the sector have more competitive manners. By considering that spare part retailers have limited stocks and suppliers always need the products in their stockrooms the criterion “Stockroom distance of the supplier is important” was used, but the advances in logistic sector and delivery of the order to the desired destination in a very short time by cargo or distribution network are the factor of the decrease in the importance of this criterion.

Competition among suppliers is experienced in the automotive spare part sector. The criterion “Delay interest offered by supplier is important” was used by considering that it was one of the advantage that suppliers utilized in order to be one step ahead in this competition. However, since retailers sale by cash or credit cards this criterion is not considered as important. The criterion “It is important that supplier business has a corporate structure” is not considered as important because imitation of businesses each other gets easier with the developing technology and there are similarities in business structures. One of the advantages that suppliers offer in order to be prefered is promotions. For that reason, the criterion “Promotions offered by supplier is important” was used and it was found out that the importance of promotions was low because costs stood out due to the severe competition in the sector.

The criterion “ It is important that prices are affordable” are found out to be one of the most important criteria. It is known that consumers care about the costs in studied sector. Here, the price that the consumers pay and the quality of the product that they purchase are the determiners of customer satisfaction. It is observed that almost each supplier have an order system. However, some retailers are observed to prefer ordering the sales representatives by hand or order by telephone. The criterion “ Practicability of supplier order system is important” is among important criteria due to the mentioned reasons. Also the criterion “It is important for the supplier to ensure the return of defective products” is among the most

important criteria. Although it is stated that products are guaranteed, suppliers often rise difficulties under the pretext of user error. Some suppliers can also provide the convenience of return by prioritizing customer's satisfaction, even if it is a user error.

Suppliers can apply discount rates according to the annual product capacity of retailers themselves. When the costs are considered, the discount rate offered by the supplier is regarded as important.

Paid product is expected to provide the expected benefit. Product change or payment return due to unhealthy product function is considered as important for the trust to the retailer. When it is considered that there are vehicles with various brand and model in the market, the importance of the variety of spare parts of suppliers in their stockrooms occurs. Although stocks of retailers are limited, stock variety of suppliers is important because they can supply products from suppliers in a short time. Suppliers also choose to specialize. Some have only rubber, rubber band, and plastic raw materials in stock, while others have only spare parts for electrical parts. In the sector, it is also seen that there are suppliers who have stock of spare parts according to automobile brand and brand origin.

Businesses involved in the study are rather interested in substitute products. With laws applied in Turkey substitute products can be put on the market 3 years after the original products are put on the market. Retailers think that it is important that they are informed about the original and substitute products released in the market. It appears that the fact that the decrease in the stocks are substituted on time or special orders from the final consumers arrive completely and on time is related with keeping the retailer stocks at a sufficient level. In addition, retailers say it is important to deliver every day because they do not want to wait for orders. Complete and on time delivery of the requested products ensures the retailer to build up a reputation in the eye of final customer and also the supplier to build up a reputation in the eye of the retailer.

The businesses in automotive spare part sector as suppliers need to be aware of each criterion in order to increase their performances. In addition, the fact that they can provide substitute products to retailers in original quality will increase the demand of final customers to these retailers. It is necessary to work for brand awareness especially in products of Chinese origin, considering that consumers maintain an attitude towards products originating from countries with low brand awareness. An increase in exchange rates also provides an opportunity for domestic products.

Performance of the relationship between retailers and suppliers can be evaluated in subsequent studies by using different methods. In addition, performances of these retailers and suppliers operating in automotive spare part sector can be evaluated according to only one vehicle brand, country of origin or stocking spare parts of all brands.

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