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# An analytic hierarchy process approach with a novel framework for luxury car selection

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**Abstract**

The luxury car industry is one of the world's fastest growing sectors in many years. Each improvement on a car has a strategic meaning for our daily life and makes more competition in the strategic management. It is important to evaluate consumer preferences that provide attributes that make consumer decision-making easier. This paper researches consumer preferences of luxury car features using an analytic hierarchy process (AHP). Initially the most important key factors which influencing the choosing the car brands were identified. Then these factors have been evaluated by the experienced car sale representatives. At the evaluation procedure, the AHP was applied to determine the relative weights of evaluation criteria. This paper results have carried that flexibility and then brand image are the customers' most important criteria for car selection. The findings of the study provide useful insight in the luxury car brand consumer preferences for future strategy decision making procedures.

## 1. Introduction

Nowadays the most important aspect in designing to develop a hundred percent domestic car brand became one of the most important macro economical goals in Turkey. However, because of the dramatic changes in traditional infrastructure of the automotive industry and fierce competitive environment, that kind of a strategic decision has to be given very carefully by examining all aspects of the situation. The new vehicle design process has to continue parallel to the needs and demands of the market. Understanding customer requirements and incorporating them into the conceptual vehicle design is the

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first step of automotive products development. Indeed, the main criteria here are not only design and production of one sole product, but also meeting all expectations and requirements of the customer.

Since the beginning of 2000s, the mid-priced automotive owners look for the additional features that luxury cars offer. For this reason, the success key in today's automotive sector comes from offering high service and product quality in appropriate price ranges. The customers expect from the chosen "model" to meet their performance, security, brand image, economic cost, sale and after sale service quality criteria at least in certain level during a purchasing decision (Aghdaie, 2011).

The goal of this research is the Comparative Analysis of affecting factors on purchasing domestic luxury cars by using Analytic Hierarch Process (AHP) technique, in Turkish market. The type of this paper is descriptive-cognition and the related information for this scope has been collected from questionnaire designed by researchers. Statistical society of present study includes car's buyers in Istanbul city. The result indicate that the most important criteria for this study, includes the customized product flexibility, brand image, and after sale services quality.

With this research, the aim is to examine and analytically evaluate different luxury car features in respect to consumer preferences. The analysis of the collected data using AHP technique will be the best method to use regarding to our research question. The criteria will be analyzed comparatively in pairs based on AHP technique to determine relatively perceived the most important criteria from the customer side.  With the help of this exploratory study, the findings related to the newly developed (novel) strategies for the entrance to Turkish passenger car brand will be obtained.

The reminder of the paper is presented as follows: The related studies are examined and evaluation framework is presented in the literature section. Section 3 introduces the AHP method theory and implementation on this study step by step. Section 4 explains the data gathering procedures and shows the computing criteria results. Finally, at the conclusion section the findings of this study discussed for practical and academic implications.

## 2. Literature Background

The importance of supplier relationship cannot be omitted for an automotive industry which has been formed of a lot of components assembling. For this reason, in the literature it is seen that the studies related to the automotive industry are focused on buyer-supplier relationships in general. In these studies, "supplier selection" and "supply chain collaboration" subjects are investigated from different point of views (Calabrese ,2000; Lee, 2009; Vonderembse, 1999). Similar to those, researches in Turkey also figure out the high competitiveness of Turkish supplier firms (Gules *et al*., 1997; Wasti *et al*., 2006).

Another research subject of academic studies investigating automotive industry is the comparison of car models in the market. These studies investigate car models using some research methods like analytic hierarchy process (Gungor and Isler, 2005), fuzzy promethee (Balli *et al*., 2007), data envelopment analysis (Yilmaz and Karakadilar, 2010) based on tangible "technical and economic" criteria. However, that kind of academic works disregards customer satisfaction. Indeed, it can be mentioned that in the literature there is no many research influencing customer preferences.

In Bottani' (2006) work, using a fuzzy quality function deployment (QFD) method, customers ranked the relative  importance sequence of each service factor from the most important to the lowest one like; 1) reliability; capability to deliver orders within the due date, 2) assurance and flexibility; capability to modify orders in terms of due date and quantity when required, 3) information technology; despite the

very high cost for implementation; it makes possible to improve the most important service factors, such as delivery accuracy and reliability.  In Lai's (2006) work, found that reliability in e-business seems to have the most influence on user satisfaction. Moreover, ease of use and user-friendliness of information technology criteria are found critical for overall user satisfaction.

In the literature, "quality" concept has been searched in various dimensions. For ex; Murthy and Kumar (2000) defined "quality" under 3 different sub-dimensions as (i) quality of performance, (ii) quality of conformance, and (iii) quality of service (providing the promised service accurately). In this study, the concept of "after sales service support" for automotive sector has been analyzed based on the idea that the car owner will be able to profit from the product in the long-term. Even though this study covers the facts like "after sales service" user training, documentation, maintenance and repair, warranty (Goffin, 1999), especially "parts and maintenance support" dimension has taken into consideration.

Reliability refers to the perceived, permanency, and durability of the product from the customer side (Kumar, 2000). Reliability also refers time responsiveness and order delivery within the due date. In this context "after sales service support and product reliability" are both interrelated concepts. For this reason, both of them are complementarily analyzed.

Technology is another important factor that influences customer preferences in automotive industry. Technology factor is a critical issue in car users' purchasing decisions not only regarding to based on environmental sensitivity but also usage comfort ability. For this reason, apart from luxury or moderate segmentation, during the innovation stage of research and development all customer expectations related to the technological performance have to be defined as taken into consideration; a serious attention has to be paid (Thomke and Hippel , 2002).

Brand image is another factor that influences car owners' purchasing decisions. Beside, the perceived brand image level has an important role on both the market performance of the product (Roth, 1995) and also product life cycle strategy (Park *et al.*, 1986) that will be defined by automotive producers. For this reason, brand image will be analyzed as one of the factors which influence customers purchasing decisions.

Flexibility refers the variety in car models offered to different customer types and the accomplishment of the required changes that the customer wishes. This kind of product customization applications takes priority in automotive sector being one of the important selection criteria (Waller *et al*., 2000). For this reason, automotive brands meet customer demand with the help of their flexible product variety (Tsai *et al*., 2008).

Performance means the accomplishment of the transaction of purchasing duties at the quickest and correct way by car dealer and car delivery at the shortest time. In this study, "speed of delivery" criterion has been used to evaluate the dealership performance (Gunasekaran *et al*., 2004).

Price becomes the main reference criteria in a purchasing decision since the customer evaluates his/her buying power regarding to the product price (Lehtonen, 2001). Beside, customers also evaluate other car brands with different price ranges offering different price range alternatives to obtain the best purchasing deal. The buying process contains the following phases; need recognition, information search, and evaluation of alternatives, purchase decision and post-purchase behavior (Etzel *et al*., 1997). In order to avoid post-purchase cognitive dissonance after the sale, the customer must be satisfied with the purchasing that has been made after making the comparison with other alternatives in the market. For this reason, "price" has been searched as a final concept that influences customer decision in this study.

The authors pointed out seven criteria that would be important for the customers and defined them under Table 1 in this paper.

Table 1. Preferences definitions

| Criteria | Definition |
|---|---|
| *Quality* | After-sales service quality such as parts and maintenance support (Goffin, 1999; Murthy and Kumar, 2000; Balli *et al*., 2007; Yousefi and Hadi-Venceh, 2010). |
| *Reliability* | The reliability of the products produced by that brand (Murthy and Kumar, 2000; Gungor and Isler, 2005; Kim *et al*., 2011). |
| *Technology* | The technology, comfortability and environmental (social) responsibility level offered by that brand (Thomke and Hippel, 2002; Gungor and Isler, 2005; Kim *et al*., 2011). |
| *Brand image* | Brand perception of the car (Roth, 1995; Park *et al*., 1986; Gungor and Isler, 2005; Kim *et al*., 2011). |
| *Flexibility* | Customization varieties of the required brand model and its delivery time or order accessibility, or accessibility (Waller *et al*., 2000; Tsai *et al*., 2004; Balli *et al*., 2007; Yilmaz and Karakadilar, 2010;). |
| *Performance* | The quality and reliability of the required (brand) model delivery time (Gunasekaran *et al*., 2004; Gungor and Isler, 2005; Balli *et al*., 2007; Yilmaz and Karakadilar, 2010;). |
| *Price* | The price appropriateness of that brand when compared with those of other alternative brand models at the same market segmentation (Etzel *et al*., 1997; Lehtonen, 2001; Yilmaz and Karakadilar, 2010; Yousefi and Hadi-Venceh; 2010*)*. |

### 3. Methodology

AHP is a decision making process which provides comprehensive structure to combine the intuitive rational and irrational values with a pairwise comparison approach (Saaty, 20089). The AHP has been widely used across many industrial applications such as quality management, and strategic planning and policy making (Yousefi and Hadi-Venceh, 2010; Nepal *et al*., 2010; Byun, 2001).

Saaty (2005) summarizes major steps of AHP
(1) State the problem;
(2) Broaden the objectives of the problem by considering all actors, objectives, and outcomes;
(3) Identify the criteria and/or sub-criteria;
(4) Structure the problem hierarchically by considering the goal, criteria, sub-criteria, and a set of alternatives;
(5) Construct a set of pairwise comparison matrices;
The matrix can be defined by

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \qquad [1]$$

where n is the order of matrix.

Then the consistency property in the pairwise comparison is examined by the procedure as following

   a-   Build the normalized pariwise comparison matrix $A_1$

$$A_1 = \begin{bmatrix} a_{11}' & a_{12}' & \cdots & a_{1n}' \\ a_{21}' & a_{22}' & \cdots & a_{2n}' \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1}' & a_{n2}' & \cdots & a_{nn}' \end{bmatrix},$$ [2]

and $a_{ij}' = \dfrac{a_{ij}}{\sum\limits_{i=1}^{n} a_{ij}}$ for $i, j = 1, 2,\ldots, n$, [3]

    b- Calculate the eigenvalue and the eigenvector.

$$w = \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix}, \text{ and } w_i = \dfrac{\sum\limits_{i=1}^{n} a_{ij}'}{n} \text{ for } i = 1, 2,\ldots, n,$$ [4]

$$w' = Aw = \begin{bmatrix} w_1' \\ w_2' \\ \vdots \\ w_n' \end{bmatrix},$$ [5]

$$\text{and } \lambda_{\max} = \frac{1}{n}\left( \frac{w_1'}{w_1} + \frac{w_2'}{w_2} + \cdots + \frac{w_n'}{w_n} \right),$$ [6]

where $w$ is the eigen vetor, $w_i$ is the eigen value of criterion I, and $\lambda_{max}$ is the largest eigen value of the pairwise comparison matrix.

(6) Perform computations to find CI is the consistency index, CR is the consistency ratio, λmax is the largest eigenvalue of the pairwise comparison matrix, n is the matrix order, and RI is radom index. Table 2 shows a set of recommended RI values presented by Saaty (2005).

Table 2 Random index

| N | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|
| RI | 0 | 0.52 | 0.89 | 1.11 | 1.25 | 1.35 | 1.40 | 1.45 | 1.49 |

where *CI=($\lambda_{max}$-n)/(n-1)* and *CR=CI/RI* [7]

(7) When CR values are > 0.10 for a matrix larger than 4x4, it indicates an inconsistent judgment. Decision makers should revise the original values in the pairwise comparison matrix. Use the normalized values to make decisions if CR is satisfactory with the value less than 0.10.

Although the study applied group decision process that approach consider aggregating the opinions from a group of people. The aggregation of individual judgments by the arithmetic mean method is applied.

## 4. Data and Results

Seven major criteria summarized in Table 1 are used in this case study. A questionnaire consisting of all strategic factors, criteria of the level of the AHP model is designed and is used to collect the pairwise

comparison judgments from all evaluation team members. This approach is found to be very useful in collecting data. The pairwise comparison judgments are made with respect to attributes of one level of hierarchy given the attribute of the next higher level of hierarchy, starting from the level of strategic factors down to the level of criteria. The survey was conducted to seven qualified and at least 10 years experienced auto dealer executive officers located in Istanbul-Turkey and were invited to fill out the AHP-based questionnaire. Valid questionnaires have been received. Respondents were asked the question "Which dimension/criterion should be emphasized when selecting luxury car?". A Saaty's scale ranging from 1–9 scale was utilized to gauge answers, where, 1 denoted "equal importance", 3 represented "moderate importance", 5 was "strong importance", 7 denoted "very strong importance", and 9 was "extreme importance" (Saaty, 2005). The even numbers represented intermediate importance levels. We then elaborated Saaty scales for each criterion that was to be evaluated.

In our case, for each criterion, we define Saaty scales which do not use all the values that can be used for ranking, and which propose larger value intervals between situations in order to insist on the importance of differences between them. Each Saaty scale is thus very different from one to another and corresponds to the specific case and reality of each criterion. Once the AHP framework entirely built then calculations are to be made. First, matrices must be calculated thanks to the pair-wise comparison of all the criteria. Matrix A shows the comparison matrix for comparing dimension in level 2 in terms of their contribution to achieving the primary objective. After each element has been compared, a paired comparison matrix (A) is formed as;

$$
A = \begin{bmatrix}
1 & 0.8776 & 2.2397 & 1.1325 & 0.6225 & 1.0278 & 0.5941 \\
1.1395 & 1 & 1.3567 & 0.9987 & 0.6884 & 0.6842 & 0,6899 \\
0.4465 & 0.7371 & 1 & 2.0221 & 1.5246 & 0.9584 & 0.7436 \\
0.8830 & 1.0013 & 0.4945 & 1 & 3.4512 & 1.7896 & 1.1426 \\
1.6064 & 1.4526 & 0.6559 & 0.2897 & 1 & 3.4562 & 2.2158 \\
0.9729 & 1.4616 & 1.0434 & 0.5588 & 0.2893 & 1 & 1.5698 \\
1.6832 & 1.4495 & 1.3448 & 0.8752 & 0.4513 & 0.6370 & 1
\end{bmatrix}
$$

The normalized weights of quality, reliability, technology, brand image, flexibility, performance, and price, are 0.0867, 0.0514, 0.0741, 0.3163, 0.3481, 0.0386, and 0.0846 respectively, with CR = 0.0168 which is less than 0.10. Based on the priority of these seven criteria are flexibility, brand image, quality, price, technology, reliability, and performance, where flexibility is an essentially important criterion with a weight of 0.3481. The results indicate that flexibility and brand image take an important role on auto dealer's decision perception. All evaluators who assigned pairwise comparison judgments appear to be satisfied with the final selection of the luxury car. Also, the managers of the concerned departments were happy with the application of the proposed AHP model. To overcome the problems of assessing pairwise comparison judgments, the evaluators were first trained on AHP principles and assessment techniques. Gaining the support and commitment to evaluation team from senior and middle management would also encourage the continued application of the proposed model. Thus, we can conclude that the use of the proposed AHP model can help facilitating the decision making and significantly understanding the strategic issues.

### 5. Conclusion

The results of this work will, subject to the propositions being tested, make an important contribution in terms of confirming (or otherwise) the impact that purchasing practice has on firm performance when there is strategic alignment between purchasing practices and business unit strategy. It will also separate a series of purchasing practices that are more aligned with different strategic model, thus allowing for a more sensitive configuration of strategies by purchasing practitioners. It provides the impetus for a detailed investigation of the different archetypes from a purchasing practices perspective, which will be undertaken using case-based research. This will support more in-depth research about the processes of strategizing in purchasing, and the impact it has on the relative financial and operational performance of the business. This methodology allowed us to have a deeper understanding of the problem and to follow a systematic approach to evaluate the potential alternatives and helped us. It allowed us to take into account the preferences, the personal judgment and experience of the various factors involved in the study.

This study has several implications for luxury car consumers who intend to evaluate criteria to build a decision making system. The main contribution of the paper is the AHP evaluation results. This proess provides a useful guideline as a structured and logical means of synthesizing judgements for evaluating appropriate decision tools for a car dealer. The second implication is the functionalities of the luxury car preferences in the process. Based on a comprehensive review, the features of luxury car evaluation criteria have been examined and identified. These give an overview structure for customers without much knowledge. Such companies can better understand the evaluation criteria in term of the functions in the luxury car preferences. Thirdly, decision-makers can compare different scenarios and possibilities with respect to appropriate criteria through the AHP. Thus, these decision-makers can examine the strengths and weaknesses of each criterion. Finally, AHP methodology would be applied in strategic management issues for decision making in a multi-criteria context.

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