

**DETERMINANTS OF QUALITY AND PRODUCTIVITY IN AUTOMOBILE
SERVICES: MADM APPROACHES AND EMPIRICAL ANALYSIS**

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SERVICES: MADM APPROACHES AND EMPIRICAL ANALYSIS

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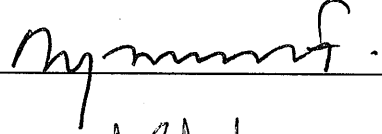
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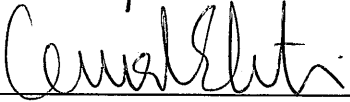
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ABSTRACT

Determinants of Quality and Productivity in Automobile Services: MADM

Approaches and Empirical Analysis

Quality and productivity are two important concepts for all businesses including automobile services. This research study is a PhD dissertation at Boğaziçi University and has the goal of examining the determinants of quality and productivity in automobile services by Multi Attribute Decision Making and empirical analysis. Thus it includes three separate parts all of which are associated with the automobile sector. The first part of the study aims to measure productivity in automobile aftersales business whereas the second part looks for a scale to measure the service quality in automobile aftersales, and the last part uses this AutoServQual scale to compare automobile brands in Turkey. A literature review of related theories done in all parts includes Multi Attribute Decision Making Theory in the first part, Service Quality Measurement Methods in the second part, and the Turkish Automotive Industry in the last part. Data Envelopment Analysis is selected to compare automobile aftersales services at stations of a specified brand in Turkey. In the second part, ServQual scale is selected for adaption to the automobile services by the name of AutoServQual using studies of focus groups, item generation and pilot survey; this new scale is now available for use in international studies in the area of automobile services. The last part of the study compares different automobile brands by using the results of a recently generated AutoServQual scale to find out the strong and weak sides of automobile aftersales services in Turkey with the use of SPSS and AMOS software.

ÖZET

Otomobil Hizmetlerinde Kalite ve Verimlilik Belirleyicileri:

ÇKKV Yaklaşımları ve Ampirik Analizler

Kalite ve verimlilik otomobil servisleri de dâhil bütün işletmeler için önemli unsurların önde gelenleridir. Bu araştırma otomobil servislerinde kalite ve verimliliği belirleyen unsurları Çok Kriterli Karar Verme (ÇKKV) yöntemleri ve deneye dayalı (ampirik) analizlerle incelemek üzere hazırlanmıştır. Bu bağlamda üç ayrı bölümden oluşan bu çalışmanın tüm bölümleri otomotiv sektörüyle ilişkili ve birbirleriyle de ilintilidir. İlk bölümde otomobil servislerinde verimlilik ölçümü, ikinci bölümde otomobil servislerinde kalite ölçümü için kullanılacak anket olan AutoServQual'ın oluşturulması ve son bölümde de bu ölçek kullanılarak Türkiye pazarında hizmet veren otomobil markalarının durumunun ölçülmesi amaçlanmıştır. Literatür taraması her bölümde ilgili teoriler üzerine olacak şekilde, ilk bölümde çok kriterli karar verme yöntemleri üzerine ikinci bölümde hizmet kalitesi üzerine ve üçüncü bölümde de Türk otomotiv endüstrisi üzerine yapılmıştır. İlk bölümde Veri Zarflama Analizi, ikinci bölümde ServQual hizmet kalitesi ölçeği ve üçüncü bölümde de yeni oluşturulan AutoServQual ölçeği kullanılarak SPSS ve AMOS yazılımlarından da faydalanılarak yapılan analizlerle otomotiv sektöründe kalite ve üretkenlik konusunda literatüre katkı sağlanmıştır. Bu çalışma ile odak gruplar, faktör analizleri ve ampirik çalışmalarla ortaya çıkarılan AutoServQual ölçeği tüm dünyada otomotiv hizmetlerinde kullanılmaya hazır hale getirilmiştir. Ayrıca, yapılan analizlerle Türk otomotiv pazarında markaların satış sonrasındaki güçlü ve zayıf yönlerine de ışık tutulmuştur.

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CHAPTER 1

INTRODUCTION

This part of the study examines productivity in automobile aftersales. The sample in this part of the study includes dealers of one of the best-selling automobile brands in Turkey, and the analysis includes the results of an investigation into the service stations of this brand. Multi attribute decision-making models are used to analyze the productivity of these dealers. Data Envelopment Analysis is one of the most popular multi attribute decision-making methods that has several applications reported in the literature about various services. Banks and hotels are usually evaluated by Data Envelopment Analysis and this part of the study is the first to use comparison in the area of automobile aftersales services.

Multiple criteria decision making (MCDM) or multi attribute decision making are used interchangeably in the literature. Business life is full of decisions and these decisions determine the quality of the remaining life. This reasoning is also valid for companies and businesses. These tools are mostly used for studies about making decisions according to multiple but often conflicting criteria.

The oldest studies of multi attribute decision-making problems start with Churchman et al. (1957). In MADM or MCDM, the purpose of the analysis is to find the best solution by using criteria of effectiveness, that evaluate different weights, and different dimensions as well as different directions of optimization (Dzemyda et al., 2007; Zavadskas and Vilutiene, 2006; Kaklauskas et al., 2006; Zavadskas and Viteikiene, 2007; Kendall, 1970) multiple criteria decision analysis (MCDA) or multiple criteria decision making (MCDM) is an area of operations research which

examines multiple criteria in decision-making environments. In this part of our study these methods are briefly explained and the relations between our research areas and these methods are explained.

Studies in the literature on the validity of the MADM theory cover a broad area. On the other hand, sensitivity analysis is a fundamental concept for the effective use and implementation of quantitative decision models (Dantzig, 1963). To understand MADM methods better, a detailed description of quantity and quality concepts must be included. Both qualitative and quantitative data are included in Multi Attribute Decision Making literature. These subjects are all examined in this part of our study in order to show the importance of these methods. The method selected should be in accordance with the type of data available. As we will show in detail, the Gap Theory and its applications are important areas of both qualitative and quantitative analysis.

Furthermore, the operations research literature provides many examples for the comparison of multi attribute decision-making methods. Analysts are studying real life cases or real life formulated problems and presented them to a particular group of people (Stratford and Lockett, 1987; Karni 1990; Stewart, 1992; Goicoechea 1992; Bouyssou and Roy, 1986; Daellenbach and Buchanan, 1987; Stillwell 1987; Hobbs, 1986; Belton, 1986; Hauschildt & Gemunden, 1985; Sarin and Currim, 1984). Moreover, the Multi Attribute Decision Making literature shows examples of different classifications by different authors. Triantaphyllou et al. (1998) state that every method has its own characteristics. They also show that many ways are available for the classification of the multi attribute decision-making methods which are explained in this part of our study.

The concept of efficiency has been around probably from the day human kind first inhabited the hunting grounds of the ancient African continent. The usual definition of efficiency is the ratio of an output to an input. More sophisticated definitions of efficiency are also introduced in the literature (Avkiran, 2006). Literature developments about the Data Envelopment Analysis also include studies of efficiency and productivity.

This study explains and uses Data Envelopment Analysis (DEA), which has a long history, as mentioned in many studies in the literature. Production theory is the base for analysis of performance. Mainly firms aim to employ inputs for producing outputs with an incentive which is regarded as maximizing profits. Technically inefficient firms were seen to be unable to increase the level of outputs by a smaller increase in the level of inputs. Data Envelopment Analysis makes no assumption about a particular production type.

Thus, the efficiency of the service stations can also be measured based on past performance. As mentioned above, Data Envelopment Analysis measures the efficiency of DMUs (Decision-making Units) by comparison to other similar DMUs. Our study compares the efficiency of various service stations.

The first part of our study starts with a brief introduction. Multi Attribute Decision Making concept is investigated in the next chapter. Chapter 2 starts with analyzing MADM Theory, which comes from decision making. The next step is the explanation of some important MADM methods in terms of their validity and sensitivity. Here, the concepts of Qualitative and Quantitative Variables need to be studied. Lastly, the comparison and classification of MADM methods in the

literature is explained. Chapter 3 is about Data Envelopment Analysis, which starts with the key advantages and key limitations.

Then important points in the determination of decision-making units are explained, followed by explanations of the concepts of efficiency and productivity. In the Services sector and DEA, the connection between the method and our study is explained and the chapter ends with the formulation steps of Data Envelopment Analysis. Chapter 4 is about the aftersales productivity in Turkey and analyzes the automotive industry in Turkey and automotive aftersales services procedures. Chapter 5 describes the research design and methodology of this part of the study, where the data preparation and DEA implementation steps are explained. The last chapter of this part is Chapter 6, where the results are reported and further recommendations are made.

CHAPTER 2

MULTI ATTRIBUTE DECISION MAKING

Multi Attribute Decision Making (MADM), is regarded as discrete, and usually has limited, pre-specified alternatives that require intra- and inter-construct comparisons which involve explicit or implicit tradeoffs (Zanakis, 1997). This chapter starts with the MADM Theory and goes on to consider Decision Making Steps. Then an explanation of some important MADM methods is given and both validity and sensitivity analysis of MADM methods are studied. A comparison and classification of multi attribute decision-making methods is explained in this chapter, and qualitative and quantitative variables are also treated in this chapter. We start with the MADM theory.

2.1 MADM theory

Models for multi attribute decision making and multiple criteria decision making are mainly evaluated together in the literature. Multiple criteria decision making (MCDM) is used for the studies about making decisions by multiple but usually conflicting criteria. Continuous and discrete are the two main categories for MCDM problems. This categorization depends on the domain of alternatives classified by Hwang and Yoon (1981) as:

- A. Multiple Attribute Decision Making (MADM), which is regarded as discrete, and has usually limited, pre-specified alternatives, that require intra and inter-

construct comparisons, which involve explicit or implicit tradeoffs (Zanakis, 1997); and

- B. Multiple Objective Decision Making (MODM), which is regarded as continuous. Here, the values of decision variables are determined from an integer or continuous domain that has large or sometimes infinite number of choices for better satisfying the decision-making priorities, preferences or constraints. Multi attribute decision-making models are also used to combine good Multi Objective Decision Making solutions that are based on decision-making priorities (Kok, 1986; Kok and Lootsma, 1985).

Our study focuses on a multi attribute decision making method which can be used in a finite choice or selection examination. The name Multi Criteria Decision Making is mostly used in the literature for indicating multi attribute decision making but it is also used for multi objective decision making models. To get rid of any misunderstanding this study uses the term Multi Attribute Decision Making to refer to a discrete multi criteria decision making concept.

The oldest studies of multi attribute decision-making problems start with Churchman et al. (1957) using a simple additive weighting model. Then academicians, including decision theorists and operational researchers, introduced many methods to describe how a decision-making authority makes its choice.

Stewart (1992) and Zanakis et al. (1995) are other researchers that studied DEA and conducted surveys for multi criteria decision-making models, and give detailed analysis in their studies. To better understand the work of the MADM or MCDM, analyzing the decision-making processes from the literature is a prerequisite.

2.2 Decision making

Life is full of decisions and these decisions determine the quality of the remaining life. This logic is also valid for companies and businesses. Here, the steps taken by a decision maker are identified, and the theory of decision making is explained. The preferences and values of a decision maker (DM) determine his/her identifying and choosing the best of the possible alternative decisions. When we talk about a decision-making situation we assume that there is more than one alternative to be selected.

Understanding and evaluating all alternatives is very important for arriving at the best solution. Making a decision assumes that we have alternative choices to be evaluated, and in such a case, we want not only to identify as many of those alternatives as possible, but also to select the alternative which best fits our goals, objectives, desires, values, and so on (Harris, 1980).

Furthermore, Baker et al. (2001), state that decision making has to begin by identification of the decision maker(s) and stakeholder(s) related to the decision, and this should reduce potential disagreement about the problem criteria, requirements, goals and definition.

Based on studies in the literature, Fülöp (2005) divides the decision-making procedure into eight steps, which can be explained as follows:

- Step 1. Problem Definition

The first step questions the effectiveness of the problem definition. This step is important because other steps are built on the base of this first step. All seven forthcoming steps work on the problem which is defined here. To express the main

goal in a clear statement in less than two sentences constitutes better analysis.

Agreement of all related parties is a requirement for successful problem definition.

- **Step 2. Determination of the Requirements**

Determination of the requirements imposes the conditions which have to be met by the solution. Mathematically explained, these requirements are the constraints which should be met for an optimal solution. Requirements may include decision-making model determination. For example, the type of evaluation used for other steps should be explained in this step. The importance of subjective evaluation is considered in this step.

- **Step 3. Establishing the Goals**

This step determines the objective function. In other words, here, the decision-making authority has to decide on the broad conclusion that should be reached after all the steps are done. This is a general situation where the goal may be a combination of more than one problem.

- **Step 4. Identification of the Alternatives**

Each particular alternative offers a different solution in decision-making procedures. Thus, objective identification of all alternatives is an important step in a successful decision-making process. Here, the issue is to define all possible alternatives before going on to the next step because these alternatives will be used in the following steps, and the variability or the solution potential is determined by the quality of alternative identification.

- **Step 5. Defining the Decision Criteria**

Discrimination among the alternatives is made by definition of the decision criteria. This criteria definition should be parallel with the goals defined in previous steps.

Grouping related criteria for a simpler decision-making process is also possible.

Furthermore, the word “attribute” is also used in place of “criterion” in the literature.

Independency of the decision criteria is also required.

- Step 6. Selecting an appropriate decision-making tool

The tool used for decision making is very important in terms of its assumptions and reliability. The recommendation for this step is mainly to select a decision-making tool which better meets the requirements of the decision makers.

- Step 7. Evaluating Alternatives

Objective assessment of the criteria is needed for a qualified alternative evaluation step. The scale of measurement should be well understood and based on commonly accepted methods. Subjective evaluation is also a model for alternative evaluation, which should have been justified in previous steps.

- Step 8. Validating Solutions

The solution has to be fully related to the problem defined. It also has to be validated by the requirements and goals defined in previous decision-making steps.

Misapplication of the decision-making tool and/or mathematical miscalculation might occur, so the result should be double-checked by the decision-making authority.

Howard (1966) is the pioneer in decision-making analysis. Also Keeney and Raiffa (1976) have interesting views on decision-making theory and steps. Zavadskas (2008) states the main steps of multiple attribute decision making. The study advises the establishment of system evaluation criteria which compare the capabilities of the system to the goals and suggests the development of alternative solutions for reaching the goals.

Next, evaluation of the alternatives is needed in terms of criteria, and the application of a normative MADM method by accepting one optimal alternative is required.

Unless the ultimate solution is accepted, to turn back and gather fresh information before going on to the next iteration of MADM optimization is advisable. MADM is a branch of a general class of Operations Research (OR). This area deals with decision problems by evaluating the restrictions and goals.

2.3 Explanation of some important MADM methods

In MADM or MCDM, the purpose of the analysis is to find the best solution by using effectiveness criteria that evaluate different weights and different dimensions as well as different directions of optimization (Dzemyda et al., 2007; Zavadskas & Vilutiene, 2006; Kaklauskas et al., 2006; Zavadskas & Viteikiene, 2007; Kendall, 1970).

Applying different normalization methods may sometimes result in normalization of the discrete attribute values (Ginevicius, 2008; Turskis, 2008; Zavadskas, 2003). The goal of the analysis can be different (Ginevicius, 2008; Kaklauskas et al., 2007; Filatovas & Petkus, 2008; Bregar et al., 2008; Dzemyda & Petkus, 2001).

According to Roy (1986), the problem may be:

- choice – selection of the best alternative,
- ranking – putting in order beginning with the best and ending with the worst,
- sorting – arranging the best alternatives from a provided list.

As mentioned above, multi attribute decision-making models do not show only one exact solution to the problems. Comparison of the alternatives is the

determinant of decision making. On the other hand, when we have conflicting alternatives, then, as a decision-making authority, we have to think about ambiguous and/or imprecise data that may be possible in such types of problem.

The type of data is one of the determining issues in selecting the best method, together with the characteristics of the Decision Makers (DMs), another important issue in selecting the best method. Zadeh (1965) introduced fuzzy sets for making an extension to the known characteristics of sets. This introduction has been used in many Multi Criteria Decision Making methods and solves fuzzy problems that include COPRAS (Complex Proportional Assessment), VIKOR (ViseKriterijuska Optimizacija I Komoromisno Resenje) and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution). Fuzzy TOPSIS is the name used for fuzzy adapted TOPSIS method. The same definitions also hold for VIKOR and COPRAS.

Multiple Criteria Decision Analysis (MCDA) or Multiple Criteria Decision Making (MCDM) is an area of operations research which examines multiple criteria in decision-making environments. We face many decisions in our daily life, including private or business-related issues. With regard to our core subject, when a car is to be taken to a service station, cost, location, and customer satisfaction are some of the main criteria to be considered. We cannot say that the cheapest service is always the most reliable and convenient one.

According to Moghaddam et al., (2011), in designing a successful MADM method we first have to characterize the methods. Then it will be possible to design an appropriate method with regard to the conditions of the problem. MADM methods are classified into two groups, namely elementary and advanced. A qualitative approach is used in elementary methods whereas a quantitative approach is used in

advanced decision making. A quantitative approach will be explained in a separate section, but in brief, it uses mathematical operations much more than a qualitative approach. In a qualitative approach the basis of the analysis is more subjective.

Polatidis et al. (2006) introduce their prerequisites for the MADM methods and their justification. These prerequisites are the following:

- Elicitation of weight,
- Use of critical threshold values,
- Integration of comparability,
- Quantitative and qualitative information,
- Rigidity,
- Having a group decision-making mindset,
- Presentation by graphs,
- Ease of use,
- Use of sensitivity analysis,
- Use of different criteria and alternatives,
- Consensus reaching,
- Looking for procedures,
- Looking for intangible views,
- Part compensation,
- Use of hierarchy of scale,
- Use of r parameters that have concrete meaning,
- Consideration of learning dimension,
- Acknowledgement of temporal aspects.

Furthermore, Guitouni and Martel (1998) define important guidelines for choosing the appropriate multiple attribute decision-making model:

- Finding a method compatible with decision makers' way of thinking,
- Finding a method compatible with defined problem,
- Finding a method compatible with decision makers' expectations,
- Finding a method compatible with respect to degree of compensation,
- Finding a method compatible with the assumptions of the problem, and
- Finding a compatible decision support software system.

Deason (1984) describes a set of precepts for criteria problems, while Gershon (1984) defines 27 attributes to choose the best method. These attributes classified according to four criteria:

- Non-mandatory binary,
- Mandatory binary,
- Application dependent, and
- Technique dependent.

Furthermore, multi attribute decision-making models are compared by Tecle (1988), based on a distance metric and the 49 characteristics are divided into four groups using the description of:

- Decision maker or analyst,
- Techniques,
- Problem, and
- Solution obtained.

Tecle (1988) is a good reference for the classification of MADM models. Sixteen multi attribute decision-making methods are evaluated with respect to 24

characteristics and 70 MADM methods are also reviewed. According to Peeters and De Keyser (1996) other attributes for the design of a reliable approach are:

- Availability of software,
- Finding meaningful parameters,
- Understanding,
- Ease of use,
- Rigidity,
- Degree of determinacy of the decision makers,
- Motivation to support group decision making.

2.4 Validity analysis of MADM methods

Studies for the validity of the MADM theory cover a broad area in the literature. This part of the study reveals the works which are examined in the literature in terms of integrating and comparing the validity of different models of multi attribute decision making methods. The first detailed study comes from Denponton et al. (1983), who construct a comprehensive catalogue including a variety of MADM methods. Validity ensures that the model is compatible with the choices and completely reflects the importance level of the user-specified criteria (Hobbs et al., 1992).

Validity is addressed as the key criterion for finding the most appropriate method from multi attribute decision-making models but no objective and absolute standard for validity can be found because choices may be contradictory when they are articulated by different strategies (Zanakis, 1997). Researchers always measure validity after checking for the degree of a method in predicting the unaided decisions

that are to be taken without considering whether the judgments made fit the model (Sarin & Currim, 1984; Waid & Schoemaker, 1982).

Furthermore, the operations researchers and decision scientists question the capability of these criteria by analyzing complex business problems which may cause users to be inconsistent by adopting less rational heuristics. The literature on decision making includes an inverted U shaped relationship between the amount of information provided and the efficiency of the decision made (Hauschildt & Gemunden, 1985; Kok, 1986).

2.5 Sensitivity analysis of MADM methods

Sensitivity analysis is a fundamental concept for the effective use and implementation of quantitative decision models (Dantzig, 1963). MADM models include some subjective values. There are many uncertainties, including judgmental criteria and weights determination. Final ranking of the solution is directly affected by these subjective determinations. Sensitivity issue becomes important here. When the weight of a single input is changed, this may affect the overall solution and ranking.

Multi attribute decision-making models include simple linear programming functions, thus graphical software tools can be used for sensitivity analysis (Selly & Forman, 2001). Stability regions and intervals are also mentioned by Mareschal (1988). These define some simple cases involving changing one or more inputs to affect the output results. They also introduce an LP model, which finds the minimum modification of weights for ranking a particular choice first.

The purpose of using a sensitivity analysis in a multi criteria decision-making method is to understand when the output is reached by changing input data to the new values. As mentioned above, sensitivity analysis is needed in MADM studies and the literature shows many examples of this analysis.

Evans (1984) examined an LP type sensitivity analysis of decision-making theory which included only states of nature and one set of alternatives. Insua (1990) is another study that mentions its importance in multi attribute decision making analysis. Analytic Hierarchy Process (AHP) was studied in terms of sensitivity analysis by Masuda (1990).

Furthermore, Sanchez and Triantaphyllou (1997) introduced a new approach in sensitivity analysis for the important multi attribute decision-making methods. They analyzed the effects of changing a single parameter in the final ranking of the alternatives.

Rapcsák and Mészáros (1996) analyzed the change of scores and weights of the criteria at the same time and questioned the sensitivity of MADM methods.

As explained above, sensitivity analysis in multi attribute decision-making studies is very important because these MADM problems change and it is very difficult to quantify these problems. So the decision maker always needs to check the accuracy of the data first in order to rank the alternatives.

2.6 Qualitative vs. quantitative variables

To understand MADM methods better, a detailed description of the quantity and quality concepts must be included first. We define a variable quantitative when it is

measurable by a reliable unit. Thus, the value of this variable is not subjective. It is independent of the opinion of an expert. An example related with our study is the physical capacity of a car service.

On the other hand, we define a variable as qualitative when there is no way of defining a reliable and objective unit to measure it. Different people may have different ideas about qualitative variables. Researchers include these variables in their study on the assumption that they are measured by these experts. A relevant example can be the degree of problematic issues that emerge from using a difficult software system in an automobile service station.

Decision-making studies are full of cases where researchers try to transform the qualitative variables into quantitative ones by using indicators. Of course, sometimes there is no other way except by using the qualitative variables as they are. Assume the capacity of service station X is 400 vehicles per month and the capacity of service station Y is 300 vehicles per month. Measurement tells us that the vehicle capacity of service station X is 100 vehicles more than service station Y.

On the other hand, suppose that, as a result of using software X, personnel become more tired than those using software Y, which is much easier to use. Nobody would say that using software X instead of using software Y would be more difficult

Both qualitative and quantitative data are included in multi attribute decision making literature. The method selection should be in accordance with the type of data available.

As will be analyzed, the Gap Theory and its applications are important areas of both qualitative and quantitative analysis. It is obvious that information gap is a

result when we analyze data which is based on ratios. We have qualitative data in some studies and quantitative data in others.

Moreover, different methods should be selected according to the data we have. Moghaddan (2011) recommends the selection of multi attribute decision-making methods according to the data on hand. The author states that a researcher should use analytic hierarchy process to calculate the value of each alternative when data is only qualitative and PROMETHEE II when the data includes only quantitative variables.

Therefore, if the data includes both quantitative and qualitative variables, the recommendation is to use analytic hierarchy process for the qualitative parts of the study and PROMETHEE II for the quantitative parts of the study and then to combine the analysis.

In sum, a variable has two defining characteristics. It may be qualitative or quantitative. Examples of qualitative variables include the variables that are not subjective. For example, the class of a car or the exterior color of a car is an example of a categorical or qualitative variable.

On the other hand, numeric variables are mostly quantitative. They can be measured again to give the same results, such as the car sales figures in a certain city or the car sales percentage growth in years.

For the MADM methods, the selection of the method is determined by the decision makers, according to the characteristics of the variables in terms of being qualitative or quantitative.

2.7 Comparisons of MADM methods

The literature shows many examples for comparison of multi attribute decision-making methods. Analysts study real life cases or real life simulations of problems presented to a particular group of people (Stratford & Lockett, 1987; Karni 1990; Stewart, 1992; Goicoechea 1992; Bouyssou & Roy, 1986; Daellenbach & Buchanan, 1987; Stillwell 1987; Hobbs, 1986; Belton, 1986; Gemunden & Hauschildt, 1985; Sarin & Currim 1984).

The best comparison for Multi Attribute Decision Making can be done by using such field experiments. They show the effect of subjective decision-making and information- processing, if designed appropriately.

Quality, robustness, trustworthiness, and perceived simplicity are different dimensions which are used for comparison in the literature.

Moreover Zanakis (1997) lists the following disadvantages and limitations for field studies;

- A. The limited range of problems studied,
- B. The limited sample size,
- C. Use of students as research subjects rather than real-life decision makers,
- D. The way information is elicited which affects the results more than the proposed model (Olson et al., 1995),
- E. The learning effect bias when different methods are employed sequentially (Kok, 1986),

F. The high sensitivity resulting from the subjective perspective of the researcher to the method used (Hobbs, 1992) whereas there is no significant effect on rankings from the method selections of the decision-maker (Goicoechea, 1992),

G. No obvious answer for questions like:

- i. Which types of problem require these methods?
- ii. What are the advantages or disadvantages of one method over another?
- iii. Does the result of a decision change when using different methods?

To overcome these limitations researchers recommend the use of simulation. Nevertheless, human idiosyncrasies cannot be captured by simulation studies, so without field studies, simulation alone cannot reach adequate conclusions. Solomon (1997) compares different types of analytic hierarchy process with the use of simulation studies.

Our study uses Data Envelopment Analysis (DEA) for decision making, which is examined in the following chapters. Here, we will try to explain other important and popular MADM methods in the literature. One of the many MADM methods comparison studies available, Zanakis et al., (1997) compares the five methods given below. All five models were used for solving the same problem.

- A. (SAW) Simple Additive Weighting,
- B. (MEW) Multiplicative Exponent Weighting,
- C. (AHP) Analytic Hierarchy Process,
- D. (ELECTRE) Elimination and Choice Translating Reality, and
- E. (TOPSIS) Technique for Preference by Similarity to the Ideal Solution.

These five models are determined by looking at their use in the literature. They show different approaches when solving multi attribute decision-making

problems and are widely used and popular methods. The simplicity of the Simple Additive Weighting method is its main advantage (Zanakis, 1995; Hobbs, 1992). Multiplicative Exponent Weighting is more attractive theoretically than Simple Additive Weighting. TOPSIS is not used widely and is an exception in this list but is included because it has a very different approach to problem solving and is very easy to understand.

The highest relative closeness is the criterion to determine the best model. The ELECTRE method is more widely used in Europe than in the US. It uses a discordance and concordance index for each pair of alternatives and elicits data from the decision maker. In their simulation experiments, Zanakis et al., (1997) set these threshold values as the average of each index in each pair of alternatives, as suggested by Hwang and Yoon (1981).

As we know and will explain in a detailed format, AHP is a complicated technique for analyzing and organizing structured decisions through the use of psychology and mathematics. This methodology was introduced by Thomas L. Saaty in the 1970s and has been refined and studied since then. Geometric scales are attached over the original AHP scale of Saaty, because of their larger value span and transitivity. These are found in many physical situations, resulting in more robust selections (Legrady et al., 1984).

Many multi criteria decision making models have been studied in the literature, but little is known about their relative merits in similar problems. Surveys of Multi Criteria Decision Matrix research status point to the need of more validation studies, and choice of aggregation procedures based on problem characteristics, as well as simple, understandable, and usable approaches for solving multi criteria

decision making and multi attribute utility theory problems (Stewart, 1992; Dyer et al., 1992). The models analyzed by Zanakis et al., (1997) are criticized by field studies in other papers. Olson et al. (1995) uses a single problem to examine how a group of students used and compared software implementing MAUT, SAW, and AHP, by a procedure of ordinal tradeoffs with additive value function whose parameters are not explicitly determined.

Furthermore, since the 1970s, multi criteria decision making has become a popular research area, according to Köksalan (2011). We can find several multi criteria decision making related organizations, which include the International Society on Multi-criteria Decision Making. On the other hand, multi criteria decision making provides information to many fields:

- Information systems,
- Software engineering,
- Computer technology,
- Economics,
- Behavioral decision theory,
- Mathematics.

This is a different classification for multi criteria decision making problems and models. MCDM evaluation problem mainly consists of a finite number of alternatives, known before analysis starts. Every unique alternative is represented by its own performance under multiple criteria. The solution may be determined to be finding a set of good alternatives or finding the best alternative for a decision-maker.

Classifying or sorting the alternatives is the area of multi attribute decision making. Preference-ordered classes are emerging in sorting studies whereas non-

ordered sets of assigned alternatives are determined in classifying studies.

Triantaphyllou (2000) studies some of the multi criteria decision making methods in this category in a comparative manner.

In summary, MADM or MCDM is an important area which includes an enormous number of methodologies under its umbrella. The following multi criteria decision making methods also available under the same umbrella are presented by specialized software for decision-making theory (Weistroffer, 2005); (McGinley, 2012):

- WSM - Weighted Sum Model,
- WPM - Weighted Product Model,
- VE - Value Engineering,
- VA - Value Analysis,
- SIR - Superiority and Inferiority Ranking method,
- SMAA - Stochastic Multi-criteria Acceptability Analysis,
- RM - Rembrandt Method,
- PAPRIKA - Potentially All Pairwise Rankings of All Possible Alternatives,
- NSFDSS - Nonstructural Fuzzy Decision Support System,
- NATA - New Approach to Appraisal,
- MAVT – Multi Attribute Value Theory,
- MAGIX – Multi Attribute Global Inference of Quality,
- MACBETH - Measuring Attractiveness by a Categorical Based Evaluation Technique,
- IPV - Inner Product of Vectors,
- GRA - Grey Relational Analysis,

- GP - Goal Programming,
- ER - Evidential Reasoning approach,
- DRSA - Dominance-based Rough Set Approach,
- DEX - Decision Expert,
- CBA - Choosing By Advantages,
- COMET - Characteristic Objects Method,
- BWM - Best Worst Method,
- ANP - Analytic Network Process,
- AIRM - Aggregated Indices Randomization Method,

Despite the wide diversity of multi attribute decision-making methods, most of them have certain common aspects (Hwang & Chen, 1992). These aspects include the goals, the criteria, and the notions of alternatives as described next

(Triantaphyllou et al., 1998):

a. Goals

These are the general aim of the multi attribute decision making processes that are examined and specified by an alternative definition and evaluation.

b. Alternatives:

These are all the possible ways a decision maker might select to reach the ultimate goal. Usually there is a finite, alternative choice set. They are ranked, prioritized and screened for better evaluation. The important point is the selection of the best alternative.

c. Multiple attributes:

Multi attribute decision making or, in other words, multi criteria decision making has several criteria as can be understood from its name. These criteria are also referred to

as attributes, which are the different dimensions to view the alternatives. There may be conflicts between these attributes, which will be explained in the coming subject.

d. Conflict among attributes:

In the theory of decision there is a selection process, so these decisions are a requirement in case of conflict. Different attributes may include conflict between them.

e. Incommensurable units:

Variables should not be the same in manner in determining the units of measure.

Multi attribute decision-making models are difficult to solve because of having very different attributes to consider.

f. Decision weights:

Some of the multi attribute decision-making models require the attributes to have been assigned weights of importance. This is another complexity of MADM studies.

g. Decision matrix:

Matrices are used for easier representation of the models. Multi Attribute Decision Matrix problems are also shown in a decision matrix.

To summarize: among different models the terms criterion and attribute are used interchangeably in all types of studies. Another interchangeable terminology is also valid for MADM and MCDM. Multi attribute decision making and multi criteria decision making always mean the same in the literature. Now, it is time to explain the classifications of these MADM techniques by different studies from the literature of operations research.

2.8 Classifications of MADM methods

As we explained in the previous section, the literature of Operations Management (OM) and/or Operations Research (OR) contains many available multi attribute decision-making methods. MADM literature shows examples of different classifications by different authors.

Triantaphyllou et al. (1998) state that every method has its own characteristics and gives information on many ways that are available for classification of multi attribute decision-making methods. Classification according to the data type used is the most popular way, of which there are two types in the literature. Stochastic, fuzzy and deterministic types are the main categories noted for MADM methods (Hwang & Chen, 1992).

Different combinations of these methods are also available. The number of decision-making authorities involved is another way of classifying multi attribute decision-making methods. There are group decision maker and single decision maker MADM methods available.

Single decision maker multi attribute decision-making methods are examined by Triantaphyllou et al. (1998). Hwang and Chen (1992) examine single decision maker MADM methods by classifying the methods according to information type. They examine TOPSIS, WPM, AHP, revised AHP and WSM methods which are generally used today. The common characteristics for all MADM methods include the use of numeric techniques for determining the DMs to use to select the best alternative among a discrete set.

Furthermore, Fülöp (2005) uses the classification of MADM, which has two categories, including the Outranking and Multi Attribute Utility Theory (MAUT) category. Aggregation of different criteria into a specific function that has to be maximized is the basis of MAUT family methods.

Here, the researchers examine the mathematical restrictions of the aggregation process. The MAUT theory allows complete compensation between criteria, in other words, loss of any criterion can be compensated for by the gain of any other (Raiffa & Keeney, 1976).

Roy (1986), on the other hand, introduces the category of outranking. The main idea is very simple: to alternate X by outranking Y when on the main part of the criteria X performs at least as well as Y. This is called concordance condition, but when the worst performance is still at an acceptable level on another criterion, then this is called a no discordance condition. Apart from the Multi Attribute Utility Theory family, a partial ranking of an outranking method may not directly guarantee the best alternative (Fülöp, 2005).

As explained above, Figueira (2004) and Triantaphyllou (2000) use the category of outranking MADM methods in their studies. The main outranking multi attribute decision-making methods include ELECTRE and PROMETHEE. The data availability assumption is very similar to the Multi Attribute Utility Theory, where both families require the use of the same decision table and they assume the criteria and alternatives to be specified.

Figueira (2004) and Vincke (1992) introduced popular outranking methods. The present study explains the two outranking methods which are used in a high portion of MADM studies.

Another category is elementary approaches, which do not require a computational support, and thus are very simple. These methods are for the models that have very few alternatives and criteria, and also for a single decision maker (Linkov et al., 2004).

Lexicographic methods, conjunctive and disjunctive methods, maximin and maximax models, and pros and cons analysis are the popular elementary MADM methods (Fülöp, 2005).

1. Lexicographic method

The attributes are ranked in order of importance in this method. The most important criterion score is examined and the alternative with the highest performance is chosen (Linkov et al., 2004).

2. Conjunctive and disjunctive methods

In this method, rather than the highest performance, highest satisfaction is required. Minimal performance concept is valid for the conjunctive method whereas the disjunctive method requires an alternative to exceed the predetermined threshold level on at least one criterion.

3. Maximin and maximax methods

In the maximin method, when the score of the weakest attribute is highest, then that alternative is preferred. The limitation of this method is that it is only used when all attributes can be compared (Linkov et al. 2004).

4. Pros and cons analysis

In this method, the pros and cons are compared for each and every alternative. Preference is given to the specific alternative that has the strongest pros and weakest

cons. This method is very easy to implement because it does not require advanced mathematics skills (Baker et al. 2001).

On the other hand, MAUT methods include the Simple Multi Attribute Rating Technique (SMART), Generalized Means, TOPSIS, Analytic Hierarchy Process, and Outranking Methods which include (I) the ELECTRE method and (II) the PROMETHEE method.

A. Simple Multi Attribute Rating Technique (SMART)

The simplest model of the MAUT method is the Simple Multi Attribute Rating Technique (SMART). The ranking value of alternative A is obtained simply as the weighted algebraic mean of the utility values associated with it. Besides the above simple explanation, Edwards (1977) proposed a simple method to assess weights for each of the criteria to reflect its relative importance to the decision. Barrett and Barron (1996) also give detailed explanations about Simple Multi Attribute Rating Techniques and further techniques.

B. Generalized means

In a decision problem, the vector X plays the role of aggregation, taking into account the performance scores for every criterion with the given weight. Mészáros and Rapcsák (1996) introduced an entropy optimization problem to find the vector X of best fit.

By introducing another entropy optimization problem, based on another measure of fitting, the weighted algebraic means (used also in SMART and additive linear models) were obtained as the best fitting ranking values (Mészáros & Rapcsák, 1996).

C. The TOPSIS method

Yoon and Hwang (1981) introduced the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method. The basic concept of this method is that the selected alternative should be the shortest distance from the ideal solution and the farthest distance from the negative ideal solution in a geometrical sense. The TOPSIS method is implemented by using the following steps. (Shu et al., 1998):

- a. Normalized decision matrix is constructed,
- b. Weighted normalized decision matrix is constructed,
- c. Ideal and the negative-ideal solutions are determined,
- d. Separation measure is calculated,
- e. Relative closeness to the ideal solution is calculated,
- f. Preference order is ranked.

D. The Analytic Hierarchy Process (AHP)

As mentioned before, Saaty (1980) introduced the Analytic Hierarchy Process (AHP). Converting judgmental assessments of relative importance to a set of overall scores or weights is the basis of the Analytic Hierarchy Process, which is one of the more popular MADM methods that is widely applied.

The methodology of AHP is based on pairwise comparisons of the following type: How important is criterion A relative to criterion B? Questions of this type are used to establish the weights for criteria and similar questions are furthermore to be answered to assess the performance scores for alternatives on the judgmental criteria (Fülöp, 2005). The same issue was also studied by Fülöp (2005) and explains the AHP steps in detail.

- a. Deriving the weights of the criteria.

The responses can use the following nine-point scale expressing the intensity of the preference for one criterion versus another.

1= Equal importance or preference.

3= Moderate importance or preference of one over another.

5= Strong or essential importance or preference.

7= Very strong or demonstrated importance or preference.

9= Extreme importance or preference.

- b. Estimate the set of weights that are most consistent with the relativities expressed in the comparison matrix.

Matrix algebra is the base of Saaty's (1980) original Analytic Hierarchy Process model, which computes the weights and uses them like the elements in the eigenvector, which is related to the matrix eigenvalue maximum. Consistency and prioritization theories criticized the eigenvalue method and many other techniques have been developed.

A high ratio of operations management researcher have introduced a number of concerns about the Analytic Hierarchy Process, which includes the weakness in terms of the questionable theoretical foundation of the rigid 1-9 scale and the potential internal inconsistency.

Thus, the phenomenon of rank reversal arises when a new alternative is introduced. However, attempts at deriving similar methods which retain the strong sides of Analytic Hierarchy Process avoid some of these criticisms.

E. The ELECTRE methods

Elimination and Choice Translating Reality is abbreviated in the literature as ELECTRE. ELECTRE I is assumed to be the easiest method inside the ELECTRE family. Discordance and concordance indices are used in all ELECTRE methods (Fülöp, 2005). Assume a set of alternatives where none of them are outranked but each one outranks at least one other alternative. Promising alternatives are assumed to be contained in this set for the decision problem. The size of the set can be changed by changing the threshold levels interactively. A partial ranking set is constructed and used in ELECTRE I to choose a set of promising alternatives.

Ranking the alternatives is the aim for using ELECTRE II, whereas ELECTRE III establishes an outranking degree. This last method is the most sophisticated method because it shows an outranking comparison between two alternatives.

Figueira (2004) explains many details about the ELECTRE family, which includes further members. According to Lootsma (1990), on the other hand, the best application of ELECTRE method is done by using the following steps when making research:

- a. Decision matrix should be normalized,
- b. Normalized decision matrix should be weighted,
- c. Discordance and concordance sets should be determined,
- d. Discordance and concordance matrices should be constructed,
- e. Discordance and concordance dominance should be determined,
- f. Aggregate dominance matrix should be determined,
- g. Less favorable alternatives should be eliminated.

F. The PROMETHEE methods

Vincke and Brans (1985) introduced the PROMETHEE method, which is based on decision tables. A better performance coming from a higher score assumption is made in PROMETHEE models. The PROMETHEE II can be defined by a degree in normalized form. Another popular member of this family is PROMETHEE V, where optimization under constraints is considered. This is a typical area of Operations Research. When there is a set of constraints, finding an optimal solution for several alternatives is an extension of PROMETHEE V over PROMETHEE II (Fülöp, 2005). A brief review of PROMETHEE methods is given in a study by Brans and Mareschal (1994).

CHAPTER 3

DATA ENVELOPMENT ANALYSIS

Data Envelopment Analysis (DEA) has a long history, as mentioned in many studies in the literature. Production theory is the basis for analysis of performance. Mainly, the aim of firms is to employ inputs for producing outputs with an incentive which is regarded as maximizing profits. Technically inefficient firms cannot increase the level of outputs by a smaller increase in the level of inputs.

Farrell (1957) provides a deconstruction of inefficiency in two parts, namely technical and allocative. Observed input prices are given. Allocative efficiency can be defined as the relative cost minimizing mix of inputs. Multiple outputs and decreased returns to scale concepts are also studied, and a formula for handling a single output in the case of constant returns to scale is provided in the same study.

An extended approach as a linear program allows increasing returns to scale (Fieldhouse, 1962). There are many formulas provided in the literature for technical efficiency measurement which is regarded as being mainly consistent with the method of our study which compares different service stations, namely, data envelopment analysis (DEA). Fare et al. (1994) also provide examples of the theoretical foundations of efficiency measurement.

DEA Literature includes many studies about various sides of Data Envelopment Analysis. For a historical and mathematical background, Sarafoglu and Forsund (2002) are the articles to refer to, along with the study by Farrell (1957), which laid the foundation for DEA. For the seminal DEA Theory, milestone papers are the studies by Charnes, Rhodes and Cooper (1978) for the CCR Model and

Banker, and by Charnes and Cooper (1984) for the BCC Model. These studies are influential seminal papers that enhanced DEA's scope by introducing variable returns to scale measurement.

On the other hand, Banker and Morey (1986) examine the efficiency analysis for exogenously fixed inputs and outputs. The use of categorical variables in Data Envelopment Analysis is also explained in Banker, and Morey (1986). Furthermore, the paper that introduced multipliers into DEA is Thompson et al. (1986). There are also important books that account for the details of DEA, the studies and explanations of which are used in this study (Cooper et al., 2000; Thanassoulis, 2001; Zhu, 2003; Cooper et al., 2004; Norman and Stoker, 1991; and Avkiran, 2006). Other studies include Cook, Kress and Seiford (1993; 1996) which first showed how DEA could be extended to treat ordinal data and were illustrated with applications to the adoption of a new technology and an R&D project selection, respectively.

As mentioned in previous parts of this study, The Multi-Attribute Decision Making (MADM) literature contains extensive discussions on the use of imprecise data, including data known only in the form of upper and lower boundaries. Sage and White (1984) and Park and Kim (1999) discuss various forms of imprecise data that can occur in practice.

Similar situations can occur in the context of DEA because of structural similarities between MADM and DEA (Belton & Vickers 1993), Stewart (1996), Bouyssou (1999)). Cooper (2006) states a precise characterization that relates goal programming models from MADM to DEA. Furthermore, Belton and Stewart (1999) give examples for differences in usage. To deal with all aspects of such imprecise data that can appear in DEA, Cooper, Park and Yu (1999) proposed a body of

concepts and methods that goes by the name of IDEA (Imprecise Data Envelopment Analysis).

Data Envelopment Analysis (DEA) was originally used to investigate the relative efficiency of non-profit organizations, following which it was quickly adopted by profit-making organizations. Application of DEA can be found in such diverse settings as financial institutions, hospitals, the US Air Force, airports, schools and courts (Lewin, Morey & Cook 1982; Charnes et al. 1985; Thanassoulis, Dyson & Foster 1987; Sherman & Ladino 1995; Carrico et al. 1997; Gillen & Lall, 1997). Charnes et al. (1994) present a discussion of DEA theory and productivity models in a variety of industries. A *Fortune* magazine article provides managers with an easy-to-read introduction to DEA (Melao, 2005).

3.1 Key advantages

When determining the efficient units, no predetermined structure is defined. In other words, Data Envelopment Analysis makes no assumption about a particular production type. Thus, the efficiency of the service stations can also be measured on the basis of past performance.

As mentioned above, Data Envelopment Analysis measures the efficiency of DMUs (Decision Making Unit) by comparing it to other similar DMUs. It gives the inefficiency score by comparing a particular DMU by using a similar efficient DMU. Thus, we can summarize the important advantages of Data Envelopment Analysis according to Avkiran (2006) as:

1. Multiple inputs and multiple outputs can be analyzed simultaneously.

2. DMUs are benchmarked against actual performance rather than against a theoretical benchmark that may not be achievable.
3. Inefficiencies are identified and potential improvements prescribed accordingly.
4. Reference set membership provides a peer group whose operations can be emulated by the inefficient DMU.
5. DEA accommodates inputs and outputs that cannot be easily converted to dollars.
6. Management can nominate the inputs and outputs in the model free of any theoretical production function.
7. Inputs that are beyond managerial control and the influence of external factors can be accounted for as part of DEA (but with mixed success!).
8. DEA can provide more insight than traditional ratio analysis.
9. DEA can be an effective decision-making tool in directing the attention of management to areas that can be improved.

3.2 Key limitations

Data Envelopment Analysis makes the assumption that the data is free of measurement error and as a result it becomes more sensitive to measurement error than other parametric techniques. That is, the integrity of data used in DEA must be secured before results can be interpreted with confidence. Another important issue here is that in DEA analysis, the DMUs, which are regarded as efficient, are only efficient when compared to others in that particular sample.

Thus, it is always possible to find a more efficient unit outside the sample, and this efficiency may be higher than the best practice of the DMU in the sample. The efficiency frontier is highly dependent on the number and characteristics of the sample. Therefore, the important disadvantages of Data Envelopment Analysis according to Avkiran (2006) are:

- A. DEA is sensitive to measurement error and outliers.
- B. DEA does not provide a measure of absolute efficiency but scores represent a relative measure within the sample. Two different samples cannot be directly compared.
- C. A sample size that is small compared to the product of number of inputs and outputs will cause DEA to report most DMUs as efficient.

Finally, an application checklist to use before making DEA analysis is presented for the benefit of those who are keen to implement DEA (Avkiran, 2006):

1. Determine the decision-making unit to be studied. How large is the sample size?
2. Identify the outputs which are critical to the success of the decision-making unit.
3. Identify the inputs that support the key business drivers of your studied area.

Here, a process analysis may help the researcher.

4. Are the data on key inputs/outputs collected in a consistent and regular manner?
5. Do you have a particular angle such as, service volume, service quality, overall efficiency, and so on from which you would like to examine the efficiency details of the units?.
6. Is input minimization or output maximization the main objective?
7. Is there any evidence of VRS (variable returns to scale) in the units analyzed?
8. Are DEA calculations ready to start so that the efficient and inefficient units can be determined?

3.3 Determination of DMUs

In previous parts, we explained decision-making theory. However, when any decision-making problem is faced by an economic agent (for example, a producer or a consumer), then it has three basic features. Productivity, efficiency, and Data Envelopment analysis subjects are explained by the Indira Gandhi Institute of Development Research (IGIDR), which is an advanced research institute established and fully funded by the Reserve Bank of India.

Thus, in this part of our study, publications and examples from this Institute are also used as a resource to better explain these concepts. Determination of decision-making units has generally three steps. The first of the three is that there are variables, the values of which are chosen by the researcher. These are the decision or choice variables of the Data Envelopment Analysis problem. Second, there are the restrictions which are defined as a set of feasible values from which to choose. Finally, there is a criterion function, which assigns independent figures to the outcomes from alternative decisions. In the example of a production decision, the decision-making authority is the producer. The quantities of output to be produced are the choice variables as well as the quantities of input used. For better analysis, a logical input /output combination has to be determined. The feasibility of producing the output products from the determined inputs is an important factor.

DEA can be used to measure the technical efficiency of the decision-making units (DMUs) studied. Technical efficiency can be defined as the successful implementation of a production plan. Most publications using DEA to measure efficiency of the DMUs are found in journals of operations research (OR) or

management science (MS): Sherman & Ladino 1995, Nash & Karwat 1996, Schaffnit, Rosen & Paradi 1997, Lovell & Pastor 1997, Camanho & Dyson 1999, Cook & Hababou 2001, Portela, Thanassoulis & Simpson 2004, Camanho & Dyson 2005.

The DEA method has also been used in performance analysis of bank branches. Some recent examples are Favero and Papi (1995), Wheelock and Wilson (1995), Miller and Noulas (1996), Resti (1997), Avkiran (2000), Chen (2004) and Hauner (2005). It is feasible to apply DEA to a small sample size (Evanoff & Israilevich 1991).

Nevertheless, unless we work with a sample size larger than the product of the number of inputs and the number of outputs, the analysis loses discriminatory power. That is, the majority of the units appear efficient with only a few units benefiting from potential improvements analysis.

Another rule of thumb is to select a sample size at least three times the sum of the number of inputs and outputs. Yet a third rule of thumb can be dubbed as the one-third rule, where you accept the sample size if the number of efficient DMUs does not exceed one-third of the sample. Furthermore, data on inputs and outputs should be collected in a common time frame in order to arrive at meaningful conclusions (Sherman & Gold 1985).

Seiford and Thrall (1990) explain the above issue of dimensionality as follows: as the number of factors (inputs and outputs) increases, the ability to discriminate between the DMUs decreases; for example, given enough factors, all (or most) of the DMUs are rated efficient. This is not a flaw in the methodology but

rather a direct result of the dimensionality of the input/output space relative to n , the number of DMUs (observations).

We should also note the potential problems with the DEA method. For example, DEA assumes data to be free of measurement error or noise (Mester, 1996). This could in turn give rise to unreliable findings unless we are certain of the integrity of the data.

Currently, addressing the measurement error in DEA is a topic of research under the heading of Stochastic DEA (SDEA) (Avkiran, 2006). Recent examples in this area include Li (1998), Sengupta (2000), and Post (2001). Under traditional DEA, it is particularly important to scrutinize the data for outliers and errors in data entry before running DEA (Morey, Capettini & Dittman 1985).

3.4 Efficiency and productivity

The concept of efficiency has probably been around from the day humankind first inhabited the hunting grounds of the ancient African continent. When our ancestors went on communal hunting trips, they quickly discovered that by combining their resources (inputs) they could kill a larger number of animals (outputs) than they otherwise would by hunting as individuals.

Thus, collaboration amongst our ancestors led to more efficient use of resources such as manpower (labor) and hunting tools (capital investment). At its most elementary level, we can define efficiency as doing things the right way.

However, a more scientific definition would be along the lines of maximizing a desired outcome with given resources. The usual definition of efficiency is the ratio

of output to input. More sophisticated definitions of efficiency are also introduced in the literature (Avkiran, 2006). Clearly, the word “relative” implies a comparison.

The task on hand is to identify the desired outcomes and the corresponding outputs from the type of unit investigated (e.g. universities, real estate agents, etc.) and determine the resources (inputs) needed to generate the desired outputs. Once this output/input identification is completed, we then proceed to analyze how the inputs interact to produce the outputs for each unit in the group investigated.

In the process, we aim to pinpoint inefficiencies in allocation and conversion of resources to outputs. The common measure of relative efficiency can be stated as the ratio of weighted sum of outputs to weighted sum of inputs. Where this ratio equals one (or 100%), we refer to that organization as an efficient unit. One of the objectives of relative efficiency analysis is to recognize the efficient (smart) configuration of resources that can produce the desired outcomes. Effectively, this efficient configuration (and there may be more than one) becomes a focus for benchmarking activities.

According to Miller (1984), acceptance of productivity management can be enhanced by linking improvements to profits. To profit from productivity improvements, management needs measurement procedures for monitoring productivity performance and identifying improvement opportunities. These procedures must clearly link the company’s overall productivity performance to changes in its profits (Avkiran, 2006).

Developments in the literature on Data Envelopment Analysis also include studies of efficiency and productivity. Forsund and Sarafoglou (2002) state important considerations about DEA and productivity concepts. Lewin, Charnes, Cooper, and

Seiford (1994) also explain the primal and dual specifications, along with a number of extensions of the basic CCR model.

The CCR model of Data Envelopment Analysis (DEA) is introduced by Charnes, Cooper, and Rhodes (1978) to examine the issue of efficiency measurement of decision-making units (DMUs) by multiple outputs and multiple inputs. They also define the chronology of the development of the literature for the seminal CCR through a flow chart.

In the absence of relative efficiency analysis, many economic decisions based on performance indices such as deposits per staff (in a bank branch example) or student enrollments per academic staff (in a university example) may be too simplistic and misleading.

In the case of profit-making organizations, even the highly respected accounting profitability measures may not adequately reflect the success of management. That is, a unit appearing as profitable may simply be benefiting from a favorable environment. To address such contingencies, the best approach is to try and measure environmental factors and compare the results of efficiency analysis with that of a profitability analysis. Serious deviations in findings should be carefully investigated (Avkiran, 2006).

Another source of improvement in efficiency is technological progress. Technological progress represents an outward shift of the efficient frontier due to technological advancement and it should be distinguished from gains in technical efficiency represented by DMUs moving towards the frontier. On the other hand, allocative efficiency is defined as the effective choice of inputs. Logically, we should ask about allocative efficiency when technical efficiency has been achieved.

Data Envelopment Analysis (DEA) has been adapted to measure allocative efficiency in a number of studies. Examples of allocative data envelopment analysis (ADEA) include Banker and Maindiratta (1988), Morey et al. (1992), Morey et al. (1995) and Sengupta (1998). The difference between efficiency and productivity will also be explained in the forthcoming chapters by using formulas.

3.5 Services sector and DEA

Existing measures such as productivity ratios, and time and motion studies borrowed from manufacturing are insufficient to capture the interaction between multiple service variables. Productivity ratios examine one pair of output/inputs at a time, and time and motion studies are only suitable for organizations with inputs and outputs that lend themselves to easy measurement. Yet other measures of productivity in the service sector such as number of customers served or sales per employee hour do not incorporate customer service quality.

Complexities of productivity measurement in services mean there is a need to go beyond accounting and ratio measures or regression analysis. Ultimately, the choice of outputs must reflect the objectives and service mix of the organization and the inputs must be traceable to these outputs (Avkiran, 2006). Productivity analysis becomes useful when the output/input levels change in response to decisions taken by management. This is where we can introduce data envelopment analysis as a method that can measure productivity in complicated situations and calculate potential improvements.

As most industries within the service sector come to terms with maturing markets, profitability will increasingly be sourced from higher productivity. Nevertheless, in the service sector, the extent to which we can replace people by machines is limited (Mill 1989). This underscores the importance of efficient or productive employees. Today, the service sector happens to be the largest employer (Harker 1995). For example, in Australia the service sector represented 78.8% of the GDP in 2002, with an average annual growth of 3.9% from 1985 to 2002, which is the second highest rate after mining (DCITA, 2005).

The employment shift to services was well recognized as far back as the 1980s, when it was attributed to a lagging productivity growth in services and a rapid growth in demand for services (Elfring 1989). The developed economies in particular are dominated by service industries that are often less productive than the manufacturing industries. This relationship implies an overall fall in economic productivity unless the service industries continue to make a special effort to raise the efficiency of their operations. DEA provides an invaluable opportunity to identify the inefficiencies in the service units and devise improvements (Avkiran, 2006).

Under the DEA technique, no particular structure is superimposed on the data in identifying the efficient units (Burley 1995; Mester 1996). Instead, a best-practice structure is empirically constructed by putting the inputs and outputs through linear programming. The significance of this feature of DEA is that it can become a valuable tool in benchmarking. It also means that units with different configurations of inputs and outputs can be recognized as efficient in implementation of the production process.

DEA determines the inefficiency in a particular unit by comparing it to efficient units of similar configuration. This contrasts with the operation of parametric techniques such as Cobb-Douglas functions where a particular measure of inefficiency is associated with statistical averages that may or may not be applicable to that unit's composition. It should be noted that those units identified as efficient are only efficient in relation to other units in the same sample.

It is conceivable for a unit outside the sample to attain higher efficiency than the best practice unit in the sample. In other words, an efficient unit does not necessarily generate the maximum feasible output for a given level of input (Miller & Noulas, 1996).

DEA labels a unit as either efficient or inefficient compared to its reference set. The reference set of a unit consists of efficient units most similar to that unit in their levels of inputs and outputs (Avkiran, 2006).

The physical inputs and outputs are particularly conducive to productivity analysis, whereas less tangible variables such as customer service quality in the service organizations complicates the measurement process. While this can be a disincentive for attempting productivity analysis in the service sector, the larger number of homogenous service units compensates for this disadvantage.

The requirement for service in real time introduces further difficulty in productivity analysis in the service sector (McLaughlin & Coffey, 1990). That is, demand for service needs to be met at the moment it arises. For example, when a hotel is asked to provide a room for the night, the organization must be able to deliver at that moment.

A reply such as “we will have a vacancy in three working days” will clearly be unacceptable to the customer. On the other hand, when you order a new car from your local dealer, you might be happy to wait for six months before delivery (Avkiran, 2006). This shows the variety of the customer expectations in terms of different services.

3.6 DEA formulation

For the formulation part, we will go through production because of the difficulty and variety in the services sector. Despite being the base of our study, production analysis will be given in the formulation sub-section, which can also be applied to for the calculations of the service studies. To produce means to transform inputs into outputs.

The objective of any production facility is to create value by producing the demanded outputs by minimum use of inputs. This brings up the concept of efficient resource utilization for the production firms.

These firms then have the goal of producing as much output as possible by using as little input as possible or to produce the same quantity of outputs by using fewer inputs. These are productivity and efficiency concepts which are defined in previous parts of this study.

For better understanding how DEA is used, we first have to see productivity in a simple system which includes only one input and one output.

We may suppose that entity A uses x_A units as the input x to produce y_A units as the output y .

On the other hand, entity B produces output y_B from input x_B . Then the average productivities of the two entities are:

$$AP_A = \frac{y_A}{x_A} \text{ for entity } A$$

And,

$$AP_B = \frac{y_B}{x_B} \text{ for entity } B.$$

If $AP_A > AP_B$ it is concluded that entity A has higher productivity level than entity B . The productivity index of entity A relative to entity B can also be calculated as

$$\Pi_{A,B} = \frac{AP_A}{AP_B} = \frac{y_A / x_A}{y_B / x_B}.$$

If this index which shows productivity is more than 1, then it is concluded that entity A is more productive than entity B . Values higher than one mean higher productivity for entity A relative to entity B .

Assume that $(x^A, y^A) = (16, 3)$ and $(x^B, y^B) = (64, 7)$,

$$AP_A = \frac{3}{16} \text{ and } AP_B = \frac{7}{64}.$$

Thus,

$$\Pi_{A,B} = \frac{12}{7} = 1.7.$$

This example therefore shows that entity A is 1.7 times more productive than entity B .

Here, in single input/single output case, knowledge of technology is not needed in measuring either the relative or absolute productivity of an entity. Nevertheless, a comparison between the entities is needed and is provided by the productivity index.

Supposing that the technology is known, then the production function is developed as:

$$y = f(x).$$

So $y_A^* = f(x_A)$ is the maximum level of producible output from the input x_A .

Also $y_B^* = f(x_B)$ is the maximum level of output which can be produced from x_B .

The technical efficiency for an entity can be measured by the comparison of its maximum producible quantity from its given input, and its actual output.

That is called *output oriented* measure of efficiency. For entity A , the formula for output oriented technical efficiency is:

$$TE_O^A = \frac{y_A}{y_A^*} \leq 1.$$

Likewise, for entity B ,

$$TE_O^B = \frac{y_B}{y_B^*} \leq 1.$$

The level of maximum producible output produced from input x_A is y_A^* . Then the average productivity of entity A is:

$$AP_A^* = \frac{y_A^*}{x_A},$$

while the productivity at the observed input-output level is

$$AP_A = \frac{y_A}{x_A} .$$

So the alternative characterization for its output oriented technical efficiency would be:

$$TE_O^A = \frac{y_A}{y_A^*} = \frac{y_A / x_A}{y_A^* / x_A} = \frac{AP_A}{AP_A^*} .$$

Similarly,

$$AP_B^* = \frac{y_B^*}{x_B}$$

and

$$TE_O^B = \frac{AP_B}{AP_B^*} .$$

Furthermore, the technical efficiency of an entity is the level of its productivity index relative to a hypothetical entity that is producing the maximum output level possible by the equal input quantity which the related entity has been using.

So

$$TE_O^A = \Pi_{A,A^*}$$

And,

$$TE_O^B = \Pi_{B,B^*} .$$

In the formulas above, the input level x is measured along the horizontal axis and the output level y by the vertical axis. The points of P_A and P_B show the bundles of input and output of entities A and B . The slope of OP_A measures the average productivity of A and the average productivity of B is equal to the slope of the line OP_B .

These are feasible points because the input and output combinations of both entities are actually observed.

The point P_A^* shows the maximum output level y_A^* that can be produced from the input quantity x_A . This point is needed in determining the efficiency of A . The same abbreviation logic is kept for entity B . The location of the P_A^* and P_B^* depends on the parameters and the functional form of the production frontier $f(x)$.

For entity A ,

$$TE_O^A = \frac{y_A}{y_A^*} = \frac{P_A x_A}{P_A^* x_A} = \frac{\text{slope of } OP_A}{\text{slope of } OP_A^*}.$$

Similarly, for entity B ,

$$TE_O^B = \frac{y_B}{y_B^*} = \frac{P_B x_B}{P_B^* x_B} = \frac{\text{slope of } OP_B}{\text{slope of } OP_B^*}.$$

Output oriented approach is used in this formula in which the output level is expanded until the frontier is reached.

On the other hand, with an input-oriented approach as shown above, input levels are reduced by small quantities by leaving the output level unchanged until the frontier is reached.

The point p_A^* is the input-oriented projection on to the frontier, where the input level is x_A^* and the output produced from this input is y_A .

The same abbreviation logic is kept for entity B .

Formulas for input-oriented technical efficiency of both entities are shown:

$$TE_I^A = \frac{x_A^*}{x_A} \leq 1$$

And,

$$TE_I^B = \frac{x_B^*}{x_B} \leq 1 .$$

As before,

$$TE_I^A = \frac{\text{slope of } OP_A}{\text{slope of } Op_A^*} = \Pi_{A,A^*}$$

And,

$$TE_I^B = \frac{\text{slope of } OP_B}{\text{slope of } Op_B^*} = \Pi_{B,B^*} .$$

Moreover, the importance of output augmentation and input conservation determines the appropriate measure to be the output or input oriented measure.

Only in constant returns to scale (CRS) will both input oriented and output oriented results of technical efficiency of an entity be indifferent.

Assuming (x_0, y_0) to be the observed input-output combination, then x_0^* is the minimum input quantity that can produce y_0 .

On the other hand, y_0^* is the maximum producible output from x_0 . As a result, both technically efficient points lying on the frontier are (x_0, y_0^*) and (x_0^*, y_0) . This equation is needed for technical efficiency measures of the input- and output-oriented studies to be equal,

$$\frac{x_0^*}{x_0} = \frac{y_0}{y_0^*}.$$

This is equivalent to:

$$\frac{y_0}{x_0^*} = \frac{y_0^*}{x_0}.$$

Which shows that the average productivity of two independent points on the frontier is the same? In other words, we can conclude that constant returns to scale (CRS) are present. Before elaborating on CRS, information about a case in which an entity may be more efficient without being more productive than another entity must be explained. Assume that:

$$f(x) = \sqrt{x}.$$

So,

$$y_A^* = \sqrt{16} = 4 \quad \text{and} \quad y_B^* = \sqrt{64} = 8.$$

Thus,

$$TE_O^A = \frac{y_A}{y_A^*} = \frac{3}{4}$$

$$TE_O^B = \frac{y_B}{y_B^*} = \frac{7}{8}.$$

Obviously, entity B is more efficient than entity A . Also,

$$AP_A = \frac{y_A}{x_A} = \frac{3}{16} > \frac{y_B}{x_B} = \frac{7}{64} = AP_B.$$

This formula is also true. So without being more efficient, entity A is more productive than B .

We assume that, rather than output y_A , output y_A^* is produced rather than y_A from input x_A . Thus, both TE_O^A and TE_I^A are equal to unity. By the same logic, TE_O^B and TE_I^B also will be unity. Whereas,

$$AP_A^* = \frac{y_A^*}{x_A} > \frac{y_B^*}{x_B} = AP_B^*.$$

Thus, without being more efficient, entity A is more productive than entity B . Then the case of constant returns to scale is considered, where the CRS frontier becomes a ray on the origin for a single-output, single-input technology. So the production function becomes

$$f(x) = kx, \quad k > 0.$$

Through the frontier, the average productivity has been the constant k .

As explained above,

$$TE_O^A = \frac{y_A}{y_A^*} = \frac{\text{slope of } OP_A}{\text{slope of } OP_A^*}$$

And,

$$TE_I^A = \frac{\bar{x}_A}{x_A} = \frac{\text{slope of } OP_A^{**}}{\text{slope of } OP_A}.$$

Similarly,

$$TE_O^B = \frac{y_B}{y_B^*} = \frac{\text{slope of } OP_B}{\text{slope of } OP_B^*}.$$

And,

$$TE_I^B = \frac{\bar{x}_B}{x_B} = \frac{\text{slope of } OP_B^{**}}{\text{slope of } OP_B}.$$

Nevertheless, the points P_A^{**} , P_A^* , P_B^{**} , and P_B^* are all on the same ray through the origin. Hence,

$$TE_O^A = TE_I^A \text{ and } TE_O^B = TE_I^B.$$

In other words, technical efficiency of the output and input oriented measures are just the same. Besides,

$$\frac{TE_O^A}{TE_O^B} = \frac{AP_A / AP_A^*}{AP_B / AP_B^*} = \frac{AP_A}{AP_B} \cdot \frac{AP_A^*}{AP_B^*}.$$

Nevertheless, in the case of CRS, $AP_A^* = AP_B^*$. While constant returns to scale are exhibited for the technology, then

$$\Pi_{A,B} = \frac{AP_A}{AP_B} = \frac{TE_O^A}{TE_O^B} = \frac{TE_I^A}{TE_I^B}.$$

Furthermore, only under CRS is greater efficiency always implied by higher productivity.

When we get out of our simplified system of single output and single input, the average productivity concept breaks down. Average productivity cannot be explained in the systems of more than one input and/or output.

We suppose that to produce the level of output, y_A , x_{1A} of input 1 and x_{2A} of input 2 are used by entity A . A similar abbreviation is also generated for entity B . Here, there are two independent formulas for average productivities:

$$AP_A^1 = \frac{y_A}{x_{1A}}, \quad AP_A^2 = \frac{y_A}{x_{2A}} \text{ for entity } A$$

And,

$$AP_B^1 = \frac{y_B}{x_{1B}}, \quad AP_B^2 = \frac{y_B}{x_{2B}} \text{ for entity } B.$$

Obviously it is not appropriate to assume entity B as less productive than entity A whenever AP_B^1 is smaller than AP_A^1 because there is a possibility that at the same time AP_B^2 is smaller than AP_A^2 .

The average productivity of an entity depends on the combination of all inputs, so it would be wrong to measure the productivity of an entity by a single input and rely on that analysis.

When your model includes multiple-input but single-output, then an aggregation of the individual inputs is needed which will result as a composite input. The same logic is also valid for the outputs; a composite output is needed for better analysis.

We assume r_1 and r_2 to show the prices of two inputs. Thus,

$$X_A = r_1 x_{1A} + r_2 x_{2A}$$

and

$$X_B = r_1 x_{1B} + r_2 x_{2B}$$

These figures show the total quantities of inputs for A and B . Then,

$$AP_A = \frac{y_A}{X_A} = \frac{y_A}{r_1 x_{1A} + r_2 x_{2A}}$$

$$AP_B = \frac{y_B}{X_B} = \frac{y_B}{r_1 x_{1B} + r_2 x_{2B}}.$$

On the other hand, it is obvious that the input costs of the two entities are represented as aggregate input bundles. So an entity's average productivity level is related to its level of average cost (AC),

$$AP_A = \frac{1}{AC_A} \text{ and } AP_B = \frac{1}{AC_B}.$$

Here, we assume y_1 and y_2 are the two outputs produced by each entity. q_1 and q_2 are the prices of outputs respectively. Thus, the measurements of aggregate outputs for the two entities are;

$$Y_A = q_1 y_{1A} + q_2 y_{2A} \text{ for entity } A$$

$$Y_B = q_1 y_{1B} + q_2 y_{2B} \text{ for entity } B.$$

$$AP_A = \frac{Y_A}{X_A} = \frac{q_1 y_{1A} + q_2 y_{2A}}{r_1 x_{1A} + r_2 x_{2A}}$$

$$AP_B = \frac{Y_B}{X_B} = \frac{q_1 y_{1B} + q_2 y_{2B}}{r_1 x_{1B} + r_2 x_{2B}}$$

So an entity's average productivity is its rate of return on outlay.

Then suppose a multiple-input and single-output production technology. CRS is also assumed.

Let $x_A = (x_{1A}, x_{2A}, \dots, x_{nA})$ be the input bundle of entity A and y_A the level of output of entity A . Suppose also that

$$y = f(x)$$

Is the production function which shows the level of maximum output (y^*) that can be produced by using the input bundle x . So the technical efficiency value for entity A can be calculated as:

$$TE^A = \frac{y_A}{y_A^*} = \frac{y_A}{f(x_A)}.$$

But under CRS, $f(x) = \sum_{i=1}^n f_i x_i$, where, $f_i \equiv \frac{\partial f(x)}{\partial x_i}$.

So it is easy to formulate the calculation of aggregate input quantity:

$$X_A = \sum_{i=1}^n f_i(x_A) x_{iA}.$$

Furthermore,

$$AP_A = \frac{y_A}{X_A} = \frac{y_A}{f(x_A)}.$$

Moreover, the calculation for producing output y_B from the input bundle x_B , for entity B is:

$$AP_B = \frac{y_B}{X_B} = \frac{y_B}{f(x_B)}.$$

In CRS, as explained above, the productivity index of entity B which can be calculated relative to entity A comes from the ratio of their technical efficiency levels, respectively. So

$$r_i = q f_i; \quad (i = 1, 2, \dots, n),$$

While the r_i shows the price for input, i and q show the price for output. Thus,

$$AP_A = \frac{q y_A}{\sum_{i=1}^n r_i x_{iA}} = \frac{TR_A}{TC_A},$$

where TR_A shows the total revenue of entity A , and TC_A shows the total cost of entity A . The same abbreviations are used for entity B .

$$AP_B = \frac{q y_B}{\sum_{i=1}^n r_i x_{iB}} = \frac{TR_B}{TC_B}.$$

The formulation found here is the *return to the dollar* criterion proposed by Goergescu-Roegen (1951). In DEA, a benchmark technology from the observed input-output bundles of the entities is constructed in the sample. For this, the following general assumptions have to be made, without specifying any functional form for the production technology.

Assumptions:

- Feasible combinations of inputs and outputs are used.
- Convex production possibility set is used.
- Freely disposable inputs.
- Freely disposable outputs.

Whenever (x, y) is assumed to be feasible, then for any $k \geq 0$, (kx, ky) is also assumed to be feasible. Furthermore, by the observed input and output quantities, given the assumptions (A1-A5), the production possibility set or the technology set can be defined as:

$$T^C = \{ (x, y) : x \geq \sum_{j=1}^N \mu_j x^j; y \leq \sum_{j=1}^N \mu_j y^j; \mu_j \geq 0; (j=1, 2, \dots, N) \}.$$

Here, we use C for indicating the technology which assumes constant returns to scale.

Here, we consider technical efficiency of entity t which produces output y^t by using the input bundle x^t . The aim is to determine the maximum output (y^*) that can be produced by using this input bundle x^t . We assume ϕ^* being the maximum of ϕ such that $(x^t, \phi y^t)$ is included in the technology set. Thus, $y^* = \phi^* y^t$ and the technical efficiency of entity t by assuming output-oriented model is:

$$TE_o^t = TE_o(x^t, y^t) = \frac{y^t}{y^*} = \frac{1}{\phi^*}.$$

Output-oriented technical efficiency is formulated by the linear programming (LP) in the following section. The technical efficiency of when we assume input oriented model for entity t is θ^* where:

$$\theta^* = \min \theta : (\theta x^t, y^t) \in T^C.$$

by $(x^t, \phi^* y^t) \in T^C$. So, $(k x^t, k \phi^* y^t) \in T^C$.

Supposing $k = \frac{1}{\phi^*}$, we find $(\frac{1}{\phi^*} x^t, y^t) \in T^C$.

Precisely, by assuming CRS, $\theta^* = \frac{1}{\phi^*}$. That is, the technical efficiency

measures of both output and input oriented models are identical in this case.

Data Envelopment Analysis (DEA) is introduced by Charnes, Cooper, and Rhodes (1978) to examine the issue of efficiency measurement of decision-making units (DMUs) by multiple outputs and multiple inputs.

The study used the concept of decision-making units (DMUs) to analyze service agencies such as courts, hospitals, and schools that use measurable inputs to produce measurable outputs. In this study, we regard a DMU as synonymous with an automobile aftersales entity.

We assume there are N entities which use n inputs to produce m outputs. The input bundle of entity t is $x^t = (x_{1t}, x_{2t}, \dots, x_{nt})$ and the output bundle is $y^t = (y_{1t}, y_{2t}, \dots, y_{mt})$. As explained above, aggregation of outputs and inputs is needed to measure average productivity. Nevertheless there are no prices available for measurement so shadow prices for outputs and inputs are used. $u^t = (u_{1t}, u_{2t}, \dots, u_{nt})$ is defined for the shadow price vector of inputs and $v^t = (v_{1t}, v_{2t}, \dots, v_{mt})$ is defined for the shadow price vector of outputs. Using these vectors we calculate the measurement for average productivity of entity t as:

$$AP_t = \frac{\sum_{r=1}^m v_{rt} y_{rt}}{\sum_{i=1}^n u_{it} x_{it}} = \frac{v^{t'} y^t}{u^{t'} x^t}.$$

Here, the vectors of shadow prices are used for aggregation. Thus, we also ensure that $AP_t \leq 1$ for each entity t . Thus, the modified calculations are formulated as follows:

$$AP_j = \frac{v^t y^j}{u^t x^j} = \frac{\sum_{r=1}^m v_r y_{rj}}{\sum_{i=1}^n u_i x_{ij}} \leq 1; (j=1, 2, \dots, t, \dots, N);$$

$$u_{it} \geq 0; (i=1, 2, \dots, n); \quad v_{rt} \geq 0; (r=1, 2, \dots, m) .$$

Between many vectors of shadow price, (u^t, v^t) which satisfy those restrictions, the one that maximizes AP_t is chosen, as defined above.

The simplest solution here is to multiply the objective function (AP_t) by a non-negative scale factor $k (>0)$. Thus, suppose;

$$w_{it} = k u_{it} (i=1, 2, \dots, n)$$

and,

$$p_{rt} = k v_{rt} (r=1, 2, \dots, m) .$$

Thus, the optimization problem is

$$\begin{aligned} & \max \frac{p^t y^t}{w^t x^t} \\ & \text{s.t. } \frac{p^t y^j}{w^t x^j} \leq 1, (j=1, 2, \dots, N); \\ & p^t \geq 0; w^t \geq 0. \end{aligned}$$

Now, set

$$k \equiv \frac{1}{\sum_{i=1}^n u_{it} x_{it}}.$$

so $w^t x^t = 1$ such that the formula becomes:

$$\begin{aligned} & \max \sum_{r=1}^m p_r y_r \\ \text{s.t. } & \sum_{r=1}^m p_r y_{rj} - \sum_{i=1}^n w_{it} x_{ij} \leq 0; \quad (j=1, 2, \dots, t, \dots, N); \\ & \sum_{i=1}^n w_{it} x_{it} = 1; \\ & p_r \geq 0; \quad (r=1, 2, \dots, m); \\ & w_{it} \geq 0; \quad (i=1, 2, \dots, n). \end{aligned}$$

This becomes a linear programming (LP) problem that can be solved by using different software alternatives such as the simplex method.

Lastly, we assume constant returns to scale, thus the correspondence of efficient production becomes

$$F(x, y) = 0$$

And, this is homogeneous of degree zero.

So,

$$\sum_i \frac{\partial F}{\partial x_i} x_i + \sum_j \frac{\partial F}{\partial y_j} y_j = 0.$$

Thus, the profit imputed of the entity is zero, when shadow prices are derived from the technology.

For every entity including entity t , which is the one under consideration, this constraint is applied.

Finally, the maximum level of the aggregate output Y_t , which is unity by implying that:

$$\Pi_t = \frac{Y_t}{Y_t^*} = Y_t = p^t \cdot y^t$$

so this LP problem yields an output oriented technical efficiency measurement of entity t .

To better understand the solution, we formulize a two output, and two input case by assuming $y^t = (y_{1t}, y_{2t})$ and $x^t = (x_{1t}, x_{2t})$.

So the LP problem can be formulated as:

$$\begin{aligned} & \max \quad p_{1t} y_{1t} + p_{2t} y_{2t} \\ & \text{s.t.} \quad p_{1t} y_{11} + p_{2t} y_{21} - w_{1t} x_{11} - w_{2t} x_{21} \leq 0; \\ & \quad p_{1t} y_{12} + p_{2t} y_{22} - w_{1t} x_{21} - w_{2t} x_{22} \leq 0; \\ & \quad \dots \dots \dots \\ & \quad p_{1t} y_{1t} + p_{2t} y_{2t} - w_{1t} x_{1t} - w_{2t} x_{2t} \leq 0; \\ & \quad \dots \dots \dots \\ & \quad p_{1t} y_{1N} + p_{2t} y_{2N} - w_{1t} x_{1N} - w_{2t} x_{2N} \leq 0; \\ & \quad w_{1t} x_{1t} + w_{2t} x_{2t} = 1; \\ & \quad p_{1t}, p_{2t}, w_{1t}, w_{2t} \geq 0. \end{aligned}$$

The dual of this LP problem is:

$$\min \theta$$

$$\text{s.t. } \lambda_1 y_{11} + \lambda_2 y_{12} + \dots + \lambda_t y_{1t} + \dots + \lambda_N y_{1N} \geq y_{1t};$$

$$\lambda_1 y_{21} + \lambda_2 y_{22} + \dots + \lambda_t y_{2t} + \dots + \lambda_N y_{2N} \geq y_{2t};$$

$$\theta x_{1t} - \lambda_1 x_{11} - \lambda_2 x_{12} - \dots - \lambda_t x_{1t} - \dots - \lambda_N x_{1N} \geq 0;$$

$$\theta x_{2t} - \lambda_1 x_{21} - \lambda_2 x_{22} - \dots - \lambda_t x_{2t} - \dots - \lambda_N x_{2N} \geq 0;$$

$$\theta \text{ free, } \lambda_j \geq 0, (j=1, 2, \dots, N).$$

Definition of $\phi = \frac{1}{\theta}$ and $\mu_j = \frac{\lambda_j}{\theta}$ is needed. Therefore to minimize θ is equal to

maximize ϕ . We redefine the variables and then the LP problem becomes

$$\max \phi$$

$$\text{s.t. } \sum_{j=1}^N \mu_j y_{1j} \geq \phi y_{1t};$$

$$\sum_{j=1}^N \mu_j y_{2j} = \phi y_{2t};$$

$$\sum_{j=1}^N \mu_j x_{1j} < x_{1t};$$

$$\sum_{j=1}^N \mu_j x_{2j} \leq x_{2t};$$

$$\phi \text{ free; } \mu_j \geq 0; (j=1, 2, \dots, N).$$

As a result, obviously, $\frac{1}{\phi^*}$ result is equivalent to θ^* which comes from the

previous formula. In conclusion, θ^* equals $p^* y^t$ by standard duality results.

There are also many studies in the literature which use a two-stage or three-stage Data Envelopment Analysis. Liu and Ciu (2014) give a brief summary of these

theories. The two-stage and three-stage DEA studies are mainly applied to the banking sector. Peter Wanke (2014) used a two-stage DEA process to measure efficiency in the Brazilian banking sector.

Rho and An (2007) studied a two stage DEA model by considering slacks of outputs and inputs. They use banking industry data to compare the results with the two-stage DEA models before them. In 2007 Ying (2011) introduced the network DEA method to evaluate the efficiency of sub processes for different railway transport entities to provide some advice on the efficiency of those entities.

The DEA methods of two stage models examine consistent estimators of the impact of contextual variables on productivity, which is not a prerequisite for the contextual variables to be distributed independently of each other.

CHAPTER 4

AUTOMOBILE AFTERSALES PRODUCTIVITY IN TURKEY

This chapter examines the productivity in automobile aftersales in Turkey by a deep introduction of automobile aftersales services procedures and the industry realities in Turkey. A history of the sector in Turkey is also provided in this chapter.

4.1 Automotive industry in Turkey

The basic aim of economic policy is to use available resources in the most effective way and maximize social welfare. In realizing this aim, criteria such as efficiency and effectiveness are very important. For underdeveloped and/or developing economies, especially, increasing efficiency by depending on the effective use of resources is one of the main problems in terms of the competitiveness of the economic decision makers. After the 1990s, due to the liberalization trend, the globalization process, which gained momentum in almost every area, increased the importance of the usage of available resources in an efficient and effective way.

When considering problems from the perspective of firms, which are also economic decision-making units that try to achieve the ultimate purpose of profit maximization and/or cost minimization, the importance of efficiency and effectiveness is increasing every day. Companies aim to decrease costs depending on intermediate purposes so as to maximize production by cost minimization (Coban, 2007).

Considered from the sectorial point of view, it can be said that the automotive industry is one of the most important sectors in which the impact of globalization is

seen. Therefore the automotive industry is considered a prototype of all globalized products. The automobile may be considered representative of the automotive industry and, as a global product, its place in human life consistently changes. At first it was a curiosity; with time it became a passion and today it has become almost an essential consumer good.

The World Trade Organization describes the automotive industry as an example of a sector which represents the future of globalization. The automotive industry has various functions such as contributing to technological development, providing employment, and creating added value as well as being a source to gain currency in foreign trade. From this perspective, the Turkish automotive industry, which has a history of only about 60 years, has gained its status as the leading sector of the economy.

Furthermore, the structure and perspectives of the automotive industry completely changed with the Customs Union process. Therefore, when making a structural analysis of the Turkish automotive industry, it is important to show its economic performance.

Since the end of the 18th century, Western countries began to produce self-propelled vehicles, without any extra power source. Thus, these countries have nearly 200 years of experience in the automotive industry, whereas the Turkish automotive industry is just now a nearly 70-year-old story. The Turkish automotive industry could respond to demand until the 1990s in only a limited way, but in the 1990s, the production capacities increased. However, only the assembly plants of other countries' automobile brands emerged in Turkey. These plants are still importing the parts of the cars and producing the cars mostly by imported spare parts. The Turkish automotive

industry needs to decrease the import rate of these production facilities and develop and produce its native-born car in the future (Coban, 2007).

In the period after the Second World War, initiatives for the automotive industry in Turkey gained velocity. In 1954, in Istanbul's Tuzla district, a Turkish-Willis Jeep factory was established in order to supply the jeep and truck needs of the Turkish army. In Ankara another factory was established which was the first tractor assembly plant of Turkey. These factories can be listed as the first milestones in the Turkish automotive industry. This period was an era of limited resources after the war; thus production facilities were established to revive the power of the Turkish army and the capacity of Turkish agricultural. Thus the most important sector in the automotive industry is automobile production.

In Turkey, the first attempt to import cars came from the Koc Trading Company setting up the Ford Motor General Office in Turkey. In 1956, the Koc Trading Company gained the status of Dealer /Assembler for the Ford Motor Company, which gave it the right of a joint-production with Ford Motor US. Depending on this concession, Istanbul Ford-Otosan was established in 1959. This assembly plant began to operate with a daily production capacity of eight trucks and four passenger automobiles (Bilgin, 1999).

Another attempt in the automobile field came in 1961 by direct order of the President, Cemal Gürsel, who ordered the engineers of that time to produce a Turkish car. The Eskisehir State Railways factory was used for this purpose and a car prototype named Devrim was produced in that factory. The Devrim adventure collapsed because of an unsuccessful trial phase. We know that only four prototypes were produced and

the development of a wholly Turkish-produced car has remained limited since that period.

Another attempt was made by the Uzel Company in 1962, which established a tractor plant by license from the M. Ferguson Tractor Company and started producing tractors there. Then, in 1954, production began in the same area of the tractor plant under the name of Turkish Uzel Tractor Company. This is a reflection of the predominant place of agriculture in the automotive industry and in Turkey's economy during that period. In 1964, the enacting of amended regulations governing assembly and manufacture were intended to accelerate the Turkish automotive industry. This effort resulted in the first really Turkish automobile, the Anadol, which went into production in 1966. Initially, the Anadol was sold for 263 Republican Gold coins and production continued until the 1980s.

Tofaş was founded in 1968 by a partnership between the Koc Trading Company and the Italian company Fiat. Tofas has the distinction of being the first car factory in the automotive industry in Turkey. Then, in 1969, the Oyak Group and the French company Renault took the joint investment decision to produce cars in Turkey. Both companies set up their factories in 1971 in Bursa and started car production there. Both factories are still working in Bursa with increased capacities. There are also many more automotive and related supply industries located in Bursa because of these first investments. In this context, Tofaş and Oyak-Renault have made a significant contribution to the development of the automotive industry in Turkey (Coban, 2007).

Because of the continuation of import substitution policies until 1980, the companies operating in the Turkish automotive industry continued their production activities only for the domestic market. After this period, liberal policies adopted by

the government were intended to open the way for the automotive industry in Turkey to compete internationally in terms of quality and price.

In other words, the Turkish automotive industry was preparing itself for international competition by using modern technology and taking economic advantage of the scale of production. However, despite the stabilization of the industry at that time, due to the effect of high customs duties and tariffs production did not increase. Nevertheless, with the reduction of protectionist policies in the 1990s, significant developments have occurred in the Turkish automotive industry. Depending on the changes in economic policy and the rapidly increasing demand in the automotive industry, foreign companies operating in Turkey turned to new searches with their domestic partners.

Furthermore, Far East Asian companies also started several initiatives to establish production plants in Turkey. In 1994, Toyota, Hyundai and Honda, received permission to produce cars and made their investment decisions. Of these newcomers, Toyota began production in 1994, while Hyundai and Honda began production in 1997. Together with the addition of the production of these new brands, under the Customs Union enacted in 1996, the Turkish automotive industry began to experience more intense levels of competition. With the impact of globalization, since the year 2000 companies operating in the automobile sector, such as Toyota, Renault and Fiat, all of which already had production facilities in Turkey, have incorporated global axis development projects through their Turkish partners.

In particular, these global firms, through modernization processes in their production facilities in Turkey, have started to produce automobiles in Turkey and export their products to the world market. Operating in the trucks and buses sector, the

export-oriented companies Mercedes-Benz and MAN are the main actors. Thus, their plants in Turkey were chosen as the production base in accordance with their global strategy. In addition, since 1998 BMC Trucks Company has developed research and development activities in Turkey and have started exporting to the EU market from Turkey. All these developments signal an increase in the competitiveness of the Turkish automotive industry over time.

The generally unstable structure of the Turkish economy and the experience of continuous economic crises have negatively affected the automotive industry in Turkey. Therefore, achieving stability within Turkey's economy is very important in terms of improving the competitiveness of the Turkish automotive industry in the future. The literature shows that levels of productivity by firms operating in the Turkish Automotive Industry change from year to year. In particular, it decreases in economic crisis periods (Coban, 2007).

4.2 Automobile aftersales services procedures

Aftersales business is a detailed, longitudinal relationship between customers and car brands. Here, the car brand part includes the producer, the distributor, the dealer and the personnel at the service station; the customer part includes the owner and user of the car, and the passengers. Many examples are seen in service stations where customers come and say that their car is making an abnormal noise. The strange point is that generally this abnormal voice is not heard by anybody else travelling in that car.

There are also complaints that the service staff has to solve which are due the customer or their relatives' or friends' misunderstanding of the car's properties which

may be regarded as a breakdown by them. On the other hand, aftersales relationships are not limited to the service station; the production firm or the distributor firms also affect this relationship by their rules and regulations. Here, the service station is only the “bumper” between the customers and these firms.

Furthermore, aftersales procedures for automobiles are very detailed compared to sales. Basically, sales deal with the varieties of the car, the task of convincing the customer to buy and effecting payment. The process is short, sometimes less than one day in Turkey. There are, however, situations where these negotiations take months. Nevertheless, aftersales business starts with buying a car and continues until the customer sells that car. Today, the main aim of the automotive manufacturers is to create lifetime customers through successful service operations encouraging the customer to select the same brand for his/her next car. It is not easy to create a lifetime customer.

Service stations have to begin by examining the after sales business models which are applied in the market nowadays. These include having the capacity to refresh the landscape of the automotive service business in order to be successful in the near future. The new aftersales business models are becoming a threat to the traditional automobile service strategies, but they can also be an important growth motivator for the firms which are able to include them in their active strategies. Thus, it is a hard job to have happy customers without failing in the procedures of detailed aftersales business.

The customer is expected to come and visit the authorized aftersales station of the producer company to take advantage of the manufacturers’ warranties. So, unless an accident or breakdown happens, all customers are expected to visit the service

stations for the purpose of maintenance. In Turkey, every car sold has to visit the authorized service station at least once a year within a period determined by varying mileage limits.

The main job of the service station is maintenance, and their next job is repairing the car in cases of accident or breakdown. Irrespective of the purpose of the visit, on each visit to the service station each car undergoes a detailed examination by an expert. A form filled in by the expert is the reference point for the accurate reception and delivery of the car. This form exempts the service from being responsible for scratches or dents which happened before the service process began. The same form is also filled out on delivery, which puts the responsibility on the service station for faults that differ from those on the initial forms.

Nearly all brands in Turkey use work order forms for recording the service process. These forms are in different formats for different brands. When the expertise appraisal is finished, then customer requests and complaints are recorded on the work order form, and the customer leaves the car at the service station. The service station then schedules the process in line with the existing job organization. Generally, the customers visit the service stations by appointment and this appointment makes the organization easier for the management. Then the car is taken to the related workshop where the maintenance or repair will be done.

It is economically a burden for the service stations to have each and every spare part in their inventory, so they get the spare parts ready before the appointment. In general, there is an inventory of maintenance parts and spare parts are ordered as needed for repairs. Then the maintenance and/or repair process is ready to start. Staff at the service station are trained according to the expertise, procedures and control of the

distributor, so a customer expects a reliable service quality in authorized service stations. The efficiency of the service stations will be examined in the following section.

After the service process, when the car is ready, it is time to call the customer back. In Turkey, service stations generally provide a replacement vehicle for use while your car is under repair. So the customer brings back the replacement vehicle and receives his/her own car in return. If the work done is a process to be paid by the customer, an invoice is prepared and payment is collected before delivery of the car. The procedure continues if the car is repaired under warranty or repairs are paid for by the insurance company. If under warranty, the parts removed are sent to the distributor with a detailed form including an explanation of the fault and details of the repair.

These forms are examined by the distributor and, if accepted, payment is made to the service station and outstanding accounts are settled. On the other hand, when payment will be made by an insurance firm, then the insurance firm sends an authorized expert to decide which parts should be changed and which parts should be repaired. She/he is fully entitled to negotiate with the service station and decide on the price of the repair.

After the inspection, the required forms are sent to the expert to be examined and, if accepted, the insurance firm makes the payment to the service station. Because of these difficult procedures, service stations in Turkey face the possible financial burden of not receiving payments for repairs under warranty from the distributor and from the insurance firm. The ratio of uncollected payments is included as a financial cost in automobile service stations in Turkey.

Delivery is the last step in terms of aftersales procedures. We also examine in another part of this study the factor of qualified and clean delivery, which is one of the most important expectations of aftersales customers. Each and every automotive brand in Turkey has its own customer satisfaction indexes, but every brand includes qualified and clean delivery in their surveys. There are some brands that also give a home car-delivery service to the customers. Generally this service is provided for owners of luxury cars.

There is increasing pressure on authorized aftersales service providers in Turkey because of new legislative changes, growing competition, and growing customer requirements. This creates a shift towards unauthorized multi-brand service stations which gain cost advantages in servicing multiple brands.

Service stations which apply for authorization face a very rocky road because of the strict requirements of the distributor firms. These strict requirements should not be unlimited in long-term collaboration between the distributor firms and service stations because at the end of the day, the authorized service stations are also profit-oriented organizations which face efficiency and productivity problems. These will be analyzed in this study.

Lastly, another important issue directly related to the automotive aftersales business is the efficient management of spare parts supply chain operations. The automotive spare parts sector is also discussed in other sections of this study, whereas the important point here is to show that the efficiency of spare parts distribution quickens the service operations and increases customer satisfaction.

Automotive brands are very knowledgeable about the factors which increase customer satisfaction; thus, they develop new logistics and information systems to

keep their spare parts distribution. Some brands select outsourcing their supply chain operations to increase customer satisfaction. Inventory management procedures or incentives of the distributors determine the average stock level of their dealers in Turkey. Some brands prefer high-inventory dealers and require minimum inventory levels whereas other brands reward dealers who are effective in spare parts management without maintaining a large stock in hand.

CHAPTER 5

RESEARCH DESIGN AND METHODOLOGY

As explained in the previous sections, Avkiran (2006) has an application checklist as presented above for the benefit of researchers who are implementing Data Envelopment Analysis. In this part of our study, before going on to these steps, it will be useful to analyze the prerequisites of data preparation in Data Envelopment Analysis. Afterwards, we will also go over the eight steps explained in that study.

5.1 Data preparation for DEA

Selection of inputs and outputs and the number of DMUs is one of the difficulties in developing a productivity model and preparing data. In this brief summary, we will use the Avkiran (2006) studies that do not focus on the managerial aspects for the determination of inputs and outputs, but focus more on the computational and data aspects of the variable selection process. When faced with extra-large data sets, you may try to decrease the size by deleting the correlated input and/or output factors. When some mathematical programming software is used to make the DEA analysis scaling issues may be faced.

Problems which result from an imbalance in the execution of the software may be erroneously rounded off. Here the best solution is to make sure that the data sets are at the same or similar magnitude. This will decrease much of the imbalance in the data sets. In other words, normalizing of the data is needed.

The first job is to calculate the mean of the data set specifically for each input and output. Then the next step is to divide each input and/or output by the calculated specific factor mean.

Zero values or negative numbers are other problematic issues. The data set may include negative numbers or zero values which affect the calculation in DEA software because the basic DEA models cannot complete the analysis with data sets that include negative numbers.

All variables should be non-negative for better analysis. In other words, before the Data Envelopment Analysis start, the researcher should be sure that all numbers are positive (non-negative and also non-zero). This rule is known as the positivity requirement of DEA.

A model developed by Charnes, Cooper and Thrall (1991) performs analysis with cases that are problematic in terms of this requirement. One known solution is to add a sufficiently large positive constant number to all inputs and outputs to make them positive. Bowlin (1998), on the other hand, suggests increasing the negative numbers or zero values by a number smaller in magnitude than the other input and output values in the data set.

These types of solutions might overcome some of the difficulties of this requirement, whereas the results may also change because of this adjustment process used by researchers. This problem, known as translation variance, is seen in some ratio-based DEA models which are regarded as translation-variant.

The starting point for adjustment should be to eliminate negative and/or zero values in the data sets. Another way may be to set up the data so that the smaller values are better. In such a data set for a given output fewer resources are needed,

and the output can be determined in terms of bigger being better. Here, both adjustments need to be completed before the analysis for the results to make sense to the management. It is a hard job to get rid of translation or data scaling errors. Bowlin (1998) recommends the substitution for variables when errors are very small and if they are an output variable.

Another issue is missing data. Missing data is an important problem in DEA analysis as it is in every statistical analysis. Akkucuk (2006) makes statements about calculations by missing data. Usually, DMUs which lack information about input or output are eliminated. However, this process questions the strength of the efficiency frontier, which is developed by the remaining data. Researchers present different recommendations including the idea that getting a “best estimate” is an alternative from a managerial perspective, but this is a very subjective solution. Expected value calculation is regarded as a better alternative by the DEA researchers.

The last issue in the preparation of data is assigning weights to the data before the analysis. DEA mathematics assigns weights to inputs and outputs of a DMU in assessing its efficiency relative to the performance of others in the sample. It is this mechanism that makes DEA a powerful benchmarking tool where weights can be regarded as the values or prices of inputs and outputs.

However, the process has some limiting technical and managerial assumptions. For example, the linearity assumption may not hold when we consider that the value of additional output might decrease, suggesting a nonlinear function. Yet in practice, nonlinear functions are regarded as difficult to follow and the additional insight gained marginal.

Another potential weights-related problem is assigning zero or a very small weight to an input or output that essentially removes it from the analysis. This contradicts the selection of inputs and outputs based on their managerial importance in the first place.

Use of weight restrictions is a well-established practice that secures the presence of all the variables in the assessment. In assigning weights, we also need to pay attention to preserving the presumed interaction and rationale between inputs and outputs. Careful assignment of weights can be used to reflect managerial objectives as well.

However, imposing weight restrictions reduces the degree of freedom in the analysis, as well as making a direct comparison with non-weighted DEA impossible (Avkiran, 2006). Data preparation in the present study is achieved according to the circumstances explained above.

In our study, data preparation started by a detailed literature review. The studies exploring the quality and efficiency in automobile aftersales stations and also exploring other studies are mentioned in different parts of our study. Here, our focus is about the input and output selection process first.

Our inputs are regarded as the properties of the facility, properties of the employees, and business potentials in the literature. On the other hand, our outputs are the outputs which are used in many DEA studies, including economic and quality outcomes. Then we will explain our data preparation steps. Literature review for several inputs and outputs related to our study is provided in Table 1.

Table 1. Inputs and Outputs of Services Sector in Literature

Inputs and Outputs Literature		
INPUTS		
1. Properties of the Facility		
a.	Service capacity	Doutt, 1984; Bucklin, 1978
b.	Size of firm	Ingene, 1982; Lusch & Moon, 1984
		Stoops & Ratchford, 1988
2. Properties of the Employees		
a.	Number of Employees	Bucklin, 1978; Piling et al., 1995; Yoo et al., 1997
b.	Education	Good, 1984
c.	Attitudes	Bush et al., 1990; Podsakoff et al., 1993
d.	Job training level & Motivation	Bush et al., 1990; Serpkenci & Lusch, 1990
e.	Attitudes	Bush et al., 1990; Podsakoff et al., 1993
f.	Wage rate	Bucklin, 1978
g.	Hours worked	Bucklin, 1978; Doutt, 1984
		Stoops & Ratchford, 1988
3. Performance Indicators		
a.	Competitive conditions	Goldman, 1992; Ingene, 1984
		Henson, Yoo & Piling, , 1995
b.	Business Potential	Ingene, 1984
OUTPUTS		
1. Economic Related Outcomes		
a.	Gross Sales	Serpkeni & Lusch, 1990; Bucklin, 1978
		Stoops & Ratchford, 1988
b.	Gross Profit	Bucklin, 1978; Doutt, 1984
		Kendrick & Creamer, 1965
c.	Gross margin	Ingene & Lusch, 1979; Ingene, 1984,
2. Quality Related Outcomes		
a.	Service Quality	Parasuraman, Zeithaml & Berry, 1994
b.	Customer Satisfaction	Serpkeni & Lusch 1990

Moreover, data preparation steps continue with focus groups after the literature review. The distinguishing feature of focus groups is the explicit use of group interaction to produce data and insight that would be less accessible without

the interaction found in a group (Morgan, 1997). Focus groups generate greater depth of information on an issue than a general count of single opinions gleaned from a survey (Carson et al., 2001).

As a result, a focus group was our selection as a starting point. Business professionals and operations research experts, including the author and the advisor, meet to evaluate the proper input/output selection for this study. The records of the focus group were examined and the period of surveys by open-ended questions started. The face-to-face surveys were conducted by business professionals in the distributors and managers of automobile aftersales service stations all over the country.

After the determination of the inputs and outputs, the adventure of data collection started. First, we had meetings with the workers of the distributor firm in order to gathering the required data.

Some of the data was taken from their records. Other data from some service stations needed to be refreshed, and it was time for the journey to visit those service stations. In our contacts with the service stations, we also needed their permission for us to analyzed their business in our study. Here, nearly 15% of the service stations declined to participate in our study.

After a long update and permission process, we had reached the useful data for our study, which included 76 service stations with a gross sales figure of over 140 million TL. This huge data set was ready for the researchers to use but we made a double-check by obtaining the approval of the seven regional managers of our examined brand whose success came from joint endeavours between the dealers and their brand.

The data preparation process for the Data Envelopment Analysis of our study is as explained. Now, let us come to the implementation steps and the results.

5.2 DEA implementation steps

As explained above, Avkiran (2006) has an application checklist presented above for the benefit of those who are keen to implement DEA. This part of our study goes over these steps:

1. Define the decision-making units to be studied. How many of these units are there?

Our study aims to determine and measure the productivity levels of different automobile aftersales stations in Turkey. Here, we collect data from different service stations from all regions of Turkey. Homogeneity is the main determinant in terms of DMU determination. DMUs are assumed to share a similar production technology; for example, undertaking similar activities and producing comparable products/services. Under the heading of homogeneity other assumptions include similar resources being available to all DMUs and operating in similar environments. When any of these homogeneity assumptions are violated, DEA results cannot be interpreted with confidence.

When the assumption that similar resources are available to all DMUs appears to be violated, we can work around this problem by costing the resources. Dealing with the potential problem of different operational environments is more difficult and this is still an area of DEA under development. However, there is no violation like that here because we measure only the service stations of the same brand with each other.

Here, DMUs are servicing the same models of cars, and the distributor firms' regulations, obligations and procedures are totally the same.

It is obvious that the selection and the quantity of inputs and outputs, and the sample size of DMUs determine the degree of discrimination that exists between efficient and inefficient units. In the literature, we usually see two considerations: the first is to include as many DMUs as possible to increase the probability of high performance with a larger sample size, which will be a result of a more efficient frontier; the second one, conflicting with the first, states that the homogeneity of the data set may decrease, which shows that some exogenous factors of no interest to the researcher may affect the research results (Golany and Roll 1989). Another support to this conflicting idea is the need for high technological programs to analyze larger data sets.

As we will justify in the related parts of our analysis, there are many important rules of thumb for determining the number of inputs and outputs and the number of DMUs. Boussofiane, Dyson and Thanassoulis (1991) state that to obtain a better discriminatory power out of the both CCR and BCC models, the lower level for the sample size of DMUs should be the multiple of the number of inputs and the number of outputs. This reasoning is a result of the increased flexibility in the selection of variable weights which are assigned to the input and the output values in the step of determining the efficiency of each DMU.

Therefore, when a DMU attempts to be efficient it may be the result of assigning all of its weight to a single input or output. The DMU having the highest ratio of one for output to input will assign all its weight to those specific inputs and outputs in

order to appear efficient. The number of such possible dummy inputs is the product of the number of inputs and outputs.

For example, let's assume that there are three inputs and five outputs: the minimum total number of DMUs should be 15 for a sufficient discriminatory power to exist in the Data Envelopment model. Golany and Roll (1989) established a rule which states that the number of units should be at least twice the number of inputs and outputs considered. On the other hand, Bowlin (1998) states that for an efficient examination we need to have three times the number of DMUs as there are input and output variables.

Furthermore, Dyson et al. (2001) advise a total of twice the product of the number of input and output variables. For example, in a model with an input of three inputs and five outputs, Golany and Roll recommend using 30 DMUs, while Bowlin recommends 24 DMUs. As a result, it is obvious that these minimum requirements should be considered as a prerequisite before constructing the basic productivity model. We have data from 76 automobile aftersales service stations in Turkey, which is more than the minimum number required in the literature.

In brief, many DEA models assume inputs and outputs to be isotonic where higher inputs reduce efficiency and higher outputs increase efficiency. In terms of the measurement scale, DEA normally assumes data to be generated on an interval scale which does not have a zero point but has equal intervals. The choice of inputs and outputs assumes that resources used in the DMUs, activity levels, and impacts of the environment have been captured by a set of variables common to DMUs in the sample.

In practice, there is a limit to satisfying these assumptions because as the number of variables rise, DEA loses discrimination by reporting mostly 100% efficient DMUs. Therefore, it is essential to devise a parsimonious productivity model that will discriminate between efficient and inefficient DMUs. Three rules of thumb can be used here when sample size is selected and these, to be examined at the end of the analysis, are as follows:

- a. greater than twice the product of inputs and outputs,
 - b. greater than three times the sum of the number of inputs and outputs,
 - c. a trial and error approach where the researcher is satisfied with a sample size in which not more than one third of the DMUs are seen as efficient.
2. Identify the business drivers (outputs) critical to success of the decision-making unit.

In the design of a relative efficiency model, as in any statistical model, the choice of variables needs to be justified. In academic papers, the standard procedure is to review the literature before proposing an improvement to the previous attempts at solving the problem on hand. In a managerial application the primary concern is to choose those variables that will represent the analysis desired by management. Clearly, this requires an intimate knowledge of the industry.

The desired analysis depends partly on the definition of the DMU to be studied (Avkiran, 2006). In our study, through the detailed literature review and meetings with the business authorities, four outputs were selected from many alternatives, gross sales of mechanics, gross sales of body and paint, complaint rate (1-c), and the results of Customer Satisfaction Index scores were determined as outputs by the committee. In literature, gross sales is included in nearly all sectors and by the

addition of sector-specific critical success factors, which are low complaints and high satisfaction in terms of the automobile aftersales sector.

3. Identifying the key resources (inputs) that support the key business drivers. Here, a process analysis can provide direction.

As advised by the DEA book of Avkiran (2006), inputs were identified by process analysis. The principal advantage of DEA is that management can determine the inputs and outputs in light of the desired analysis. Nevertheless, this should not be construed as an open invitation to design haphazard models. While we have the freedom to choose variables that reflect a difference in managerial focus, a more useful analysis can be attempted if we identify the business drivers critical to the success of the DMU under investigation. This involves identifying performance variables (outputs) that represent the strategies and objectives in place in the DMU.

Once the outputs were determined, we then identified the inputs that could be said to manifest themselves as outputs. Gillen and Lall (1997) recommend a more simplistic approach when it is not easy to distinguish inputs from outputs. They suggest that we consider desirable outcomes as outputs and less preferred factors as inputs.

A less obvious advantage of DEA is that it allows inputs to be categorized as either controllable (by management) or uncontrollable. This provides an additional level of analysis where performance can be interpreted in the context of uncontrollable environmental conditions (Banker & Morey 1986a; Epstein & Henderson 1989). The inputs in this study were assumed to be controllable. In a real life analysis, failure to account for environmental factors is bound to confound the DEA results and lead to unreliable economic decisions.

There are at least two main approaches to incorporating uncontrollable or non-discretionary inputs in DEA. As part of the single stage adjustment, the uncontrollable input can be included in DEA in such a manner that it does not actually enter the calculation of the efficiency score for DMUs. This approach suffers from inflated efficiency scores as more constraints enter the linear program (SCRCSSP 1997). We used the data of 76 automobile aftersales service stations in Turkey and the inputs determined after several analyses were the following: the covered area of the service station, the number of employees working in the service station and annual number of car visits to that service station.

The physical properties and number of employees are generally used in most of the DEA analysis in several sectors together with the inputs that reflect the potential of the DMUs. Specifically, in the automobile service sector, the stations' monthly or yearly total number of car visits signals the potential for each car service (DMU). These inputs were decided by the combined analysis of expert opinions and the literature review.

4. Is data on the key outputs/inputs collected in a regular and consistent manner?

Data Envelopment Analysis was selected mainly because of its several advantages, including the ease with which multiple inputs and multiple outputs can be analyzed simultaneously. This is an advantage to the researcher in terms of data collection, but here the important point is the quality and consistency of the data. In our study, all inputs and outputs are based on numerical and precise data collected in a regular and consistent manner.

Our study uses the data from an automobile brand in Turkey which has been the leading brand for three years in terms of customer satisfaction in automobile

aftersales services. This data was gathered from the records of the distributor firm and double-checked by personal interviews with the dealers' managers. In authorized service stations, the requirements of the distributors are many and very strict, so every detail is examined and recorded.

Our inputs were the covered area of the service station, the number of employees working in the service station and the annual number of times a car came to that service station, data which is controllable and recorded by the information systems of both distributor and dealer. Our outputs, as mentioned above, were the gross sales of mechanics, gross sales of body and paint, complaint rate (1-c), and the results of Customer Satisfaction Index scores, which are controllable and recorded by both distributors and service stations. All dealers in this study were using the same standards, including the physical resources and software systems which ensured the consistency of the input/output data collection.

5. Is there a particular angle that you would like to analyze the units' efficiency? For example, service volume, service quality, overall efficiency, and so on.

Here, our aim was to measure the general productivity of service stations and determine the stations that work to maximum efficiency (have a result of one in DEA analysis). When you have a specific purpose, as mentioned in the question above, a common practice is to run DEA where all the inputs are treated as controllable and then regressed as the emerging efficiency scores on non-discretionary inputs, often using Tobit regression. A useful practice before embarking on either of these approaches is to regress the inputs on outputs in an effort to find out the direction and strength of the relationships.

Another way to determine an appropriate number of variables is to compare the product of outputs and inputs with the sample size. That is, all other things being equal, the smaller the product of outputs and inputs compared to the sample size, the better the discrimination between efficient and inefficient DMUs. Such a process is not needed in our study.

6. Are you interested in output maximization or input minimization as the main objective?

In DEA, there are three key analysis options, namely, the method of optimization, assumptions on the nature of returns to scale for the DMUs, and weight restrictions on variables. Frontier Analyst refers to the first two of these options as optimization mode and scaling mode.

Optimization mode can either be input minimization or output maximization. This option refers to the choice of objective function in the linear program behind DEA (the CCR Model). Under input minimization, the analyst is concerned with maintaining at least the same level of outputs while minimizing inputs. This option may be particularly attractive to the analyst when cost reduction strategies are in place or downsizing is planned.

The alternative, output maximization, is defined as maximizing the level of outputs for given inputs. Output maximization is particularly appropriate when the management is interested in raising productivity without necessarily reducing resource usage. For example, where the strategy has been to expand market share, the relative efficiency of the DMUs is best investigated under output maximization. As mentioned here, this study aims to expand the relative efficiency of the DMUs; thus, output maximization objective is used in the analysis.

7. Is there any evidence of variable returns to scale in the units to be analyzed?

Regarding the scaling mode, once again we have to choose from one of two options, namely, constant returns to scale (CRS) and variable returns to scale (VRS). CRS is found in most DEA published in 1980s. Strictly speaking, CRS is only appropriate when the majority of DMUs in the sample are operating at the most productive scale size (MPSS); at MPSS (Banker 1984), a DMU's production of outputs is maximized per unit of inputs. With this option we assume that outputs change in direct proportion to the change in inputs regardless of the size of the DMU. In a homogenous group of DMUs, this is likely to be the case, but what happens when we are investigating the efficiency of a group composed of DMUs with a large variation in scale of operations? CRS, which assumes that efficiency of the DMU is not influenced by the scale of its operations, becomes an incorrect assumption.

In a large sample with large variations in the size of the DMUs, we first needed to examine the relationship between efficiency scores and size. VRS assumes that changing inputs will not result in a proportional change in outputs. That is, as a DMU becomes larger, its efficiency either falls or rises. The DEA published since 1990 has shifted to VRS (Coelli, Rao & Battese 2005). This is not a surprising change since variable returns to scale is a better reflection of actual observations made in the commercial world. Thus, CCR is selected because of its high sample size and homogeneity.

8. Run the DEA calculations and determine the efficient and inefficient units.

The Data Envelopment Analysis calculations were done and the efficient and/or inefficient units were determined. The next chapter describes the results of our analysis.

CHAPTER 6

ANALYSIS RESULTS

In our study, we accessed the data of 76 service stations of one of the market-leader automobile brands in Turkey. These stations are located in different parts of the country and classified into seven different regions by brand distributor firm. The division of the distributor firm is a base for the analysis.

As mentioned above, a detailed literature review and meetings with the business authorities obtained the following inputs: the covered area of the service station, the number of employees working in the service station and yearly number of car visits to that service station.

On the other hand, the four outputs were the gross sales of mechanics, gross sales of body parts and paint, complaint rate (1-c), and the results of Customer Satisfaction Index scores. We ran the DEA calculations with the help of Microsoft Excel DEA solver, and the results are given in Table 2.

Table 2. DEA Results

DEA Results – General							
No	Code	Result	Region	No	Code	Result	Region
1	DEAL1	1	REG3	39	DEAL39	0.966	REG1
2	DEAL2	0.935	REG4	40	DEAL40	1	REG2
3	DEAL3	0.901	REG7	41	DEAL41	0.739	REG7
4	DEAL4	0.776	REG4	42	DEAL42	0.998	REG6
5	DEAL5	0.973	REG7	43	DEAL43	1	REG6
6	DEAL6	0.709	REG5	44	DEAL44	0.98	REG2
7	DEAL7	0.857	REG5	45	DEAL45	0.878	REG6
8	DEAL8	0.853	REG1	46	DEAL46	0.947	REG4
9	DEAL9	1	REG4	47	DEAL47	0.759	REG2
10	DEAL10	0.865	REG1	48	DEAL48	0.911	REG5
11	DEAL11	0.938	REG5	49	DEAL49	1	REG6
12	DEAL12	0.889	REG5	50	DEAL50	0.977	REG6
13	DEAL13	0.909	REG3	51	DEAL51	0.849	REG7
14	DEAL14	0.93	REG7	52	DEAL52	0.971	REG6
15	DEAL15	0.945	REG7	53	DEAL53	0.899	REG2
16	DEAL16	1	REG3	54	DEAL54	0.738	REG1
17	DEAL17	1	REG3	55	DEAL55	1	REG1
18	DEAL18	0.816	REG3	56	DEAL56	0.797	REG3
19	DEAL19	0.816	REG6	57	DEAL57	0.866	REG6
20	DEAL20	1	REG6	58	DEAL58	1	REG1
21	DEAL21	0.777	REG2	59	DEAL59	0.789	REG5
22	DEAL22	0.895	REG5	60	DEAL60	0.945	REG1
23	DEAL23	0.889	REG3	61	DEAL61	0.977	REG2
24	DEAL24	0.843	REG6	62	DEAL62	1	REG2
25	DEAL25	0.774	REG7	63	DEAL63	0.791	REG4
26	DEAL26	0.981	REG3	64	DEAL64	0.782	REG5
27	DEAL27	0.953	REG5	65	DEAL65	1	REG4
28	DEAL28	0.941	REG5	66	DEAL66	0.886	REG3
29	DEAL29	0.872	REG5	67	DEAL67	0.992	REG4
30	DEAL30	1	REG2	68	DEAL68	0.88	REG1
31	DEAL31	1	REG1	69	DEAL69	0.961	REG4
32	DEAL32	0.796	REG3	70	DEAL70	0.982	REG7
33	DEAL33	1	REG1	71	DEAL71	0.953	REG3
34	DEAL34	0.765	REG4	72	DEAL72	0.944	REG2
35	DEAL35	1	REG1	73	DEAL73	0.98	REG3
36	DEAL36	0.838	REG5	74	DEAL74	0.91	REG7
37	DEAL37	0.962	REG2	75	DEAL75	0.94	REG4
38	DEAL38	0.997	REG2	76	DEAL76	0.956	REG3

Of the 76 DMUs, 16 service stations have a score of one which means that they are working efficiently. Results from other stations vary from 0.998 to 0.709. When we examine the DMUs that have an efficiency score of 1, we see that they are generally located in big cities. Thus, to work efficiently, an automobile service station should appeal to a high number of customers.

There are also exceptions that have efficient results because of their success in working with fewer personnel or smaller service areas. The important point here is that, all automotive brands have minimum requirements for both the closed area and the number of employees at a service station. The success comes from good organization of the staff or the working area.

We also show the rankings according to the region classification. We have a minimum result of 0.709, which may show the success of this brand in terms of dealers' location determination. To open a service station where there is no potential may cause bankruptcy to the entrepreneur firm, which also harms the brand image of the distributor firm. In other words, a minimum result signals the minimum survival efficiency limit for automobile aftersales service stations.

Turkey has seven geographic regions which are used as bases by the management of different companies. Automotive companies in Turkey differentiate the regions slightly from their geographical boundaries because of the potential differences in regions. Generally, their zoned areas include more cities in the north and east of Turkey, and fewer cities in the west and south of the country. This is a reflection of the population density, which directly affects the potential of car sales and aftersales service stations. The regions of the brand examined are also given. Table 3, 4, 5, 6, 7, 8, 9 shows the results by regions.

Table 3. DEA Results of Region 1

DEA Results of Region 1			
1	1	REG1	DEAL31
2	1	REG1	DEAL33
3	1	REG1	DEAL35
4	1	REG1	DEAL55
5	1	REG1	DEAL58
6	0.966	REG1	DEAL39
7	0.945	REG1	DEAL60
8	0.88	REG1	DEAL68
9	0.865	REG1	DEAL10
10	0.853	REG1	DEAL8
11	0.738	REG1	DEAL54

Region 1 includes Thrace and the European part of Istanbul. In other words, the area of Turkey which is inside Europe. Here, we examine five aftersales service stations that have a score of 1, which shows that they are efficient DMUs. The average efficiency score for region 1 is 0.931 and this region had a minimum score of 0.738.

When we look at the efficient DMUs, a common point is that they are all in Istanbul, which again shows the advantage of high potential for an aftersales service station. This may be shown as a result of the economics of scope, which is an advantage for DMUs that are located in big cities.

Table 4. DEA Results of Region 2

DEA Results of Region 2			
1	1	REG2	DEAL30
2	1	REG2	DEAL40
3	1	REG2	DEAL62
4	0.997	REG2	DEAL38
5	0.98	REG2	DEAL44
6	0.977	REG2	DEAL61
7	0.962	REG2	DEAL37
8	0.944	REG2	DEAL72
9	0.899	REG2	DEAL53
10	0.777	REG2	DEAL21
11	0.759	REG2	DEAL47

Region 2 includes the service stations that are located on the Asian side of Istanbul and the Marmara region, where there has been a great increase in population in recent years. Here, there are three DMUs that have an efficiency score of 1, and there are also many DMUs that have very high scores. Of the three service stations, two are located in Istanbul and one is located in Kocaeli.

The average efficiency score for region 2 is 0.935 and this region has a minimum score of 0.759. The high population density in the region is reflected in the efficiency scores.

Table 5. DEA Results of Region 3

DEA Results of Region 3			
1	1	REG3	DEAL1
2	1	REG3	DEAL16
3	1	REG3	DEAL17
4	0.981	REG3	DEAL26
5	0.98	REG3	DEAL73
6	0.956	REG3	DEAL76
7	0.953	REG3	DEAL71
8	0.909	REG3	DEAL13
9	0.889	REG3	DEAL23
10	0.886	REG3	DEAL66
11	0.816	REG3	DEAL18
12	0.797	REG3	DEAL56
13	0.796	REG3	DEAL32

Region 3 includes two geographic zones of Turkey, the Aegean and Mediterranean cities. We have a high return rate from this region. Here, there are three service stations that have a maximum efficiency score of 1. When we examine the data, we see that one of them has the highest efficiency score because of the high potential of the city where it is located. The other two service stations, however, are working efficiently in cities which do not have a high density of population. Their success comes from good organization of the staff and working areas. The average of the efficiency scores in Region 3 is 0.920 with a minimum of 0.796.

Table 6. DEA Results of Region 4

DEA Results of Region 4			
1	1	REG4	DEAL9
2	1	REG4	DEAL65
3	0.992	REG4	DEAL67
4	0.961	REG4	DEAL69
5	0.947	REG4	DEAL46
6	0.94	REG4	DEAL75
7	0.935	REG4	DEAL2
8	0.791	REG4	DEAL63
9	0.776	REG4	DEAL4
10	0.765	REG4	DEAL34

Region 4 includes cities located in Central Anatolia . Here, we accessed the data of ten service stations and they have an average efficiency of 0.910 with a minimum of 0.765.

There are two service stations in this region that have the maximum efficiency score. One of them is located in the capital city of Turkey, and dominates the potential in Ankara, whereas the other one shows a successful efficiency rate in a city that has a moderate population.

Table 7. DEA Results of Region 5

DEA Results of Region 5			
1	0.953	REG5	DEAL27
2	0.941	REG5	DEAL28
3	0.938	REG5	DEAL11
4	0.911	REG5	DEAL48
5	0.895	REG5	DEAL22
6	0.889	REG5	DEAL12
7	0.872	REG5	DEAL29
8	0.857	REG5	DEAL7
9	0.838	REG5	DEAL36
10	0.789	REG5	DEAL59
11	0.782	REG5	DEAL64
12	0.709	REG5	DEAL6

Region 5 includes service stations that are located in South Anatolia. We accessed the data of 12 DMUs from this region and they have an average efficiency score of 0.864, with a minimum of 0.709. The minimum for this region is also the minimum of Turkey. No service station in this region has a score of 1, which may be the result of the population characteristics of this region.

Southern Anatolia is a tourism region and the variation of the potential changes throughout the year; in other words, seasonal fluctuation is the main problem for the companies in this region. The DMUs in Region 5 has to have large covered working areas in their high season, which had a negative effect on their

efficiency score. Here, we see the seasonal disadvantage of some automobile aftersales service stations.

Table 8. DEA Results of Region 6

DEA Results of Region 6			
1	1	REG6	DEAL20
2	1	REG6	DEAL49
3	0.998	REG6	DEAL42
4	0.977	REG6	DEAL50
5	0.971	REG6	DEAL52
6	0.878	REG6	DEAL45
7	0.866	REG6	DEAL57
8	0.843	REG6	DEAL24
9	0.816	REG6	DEAL19

Region 6 includes the service stations located in North Anatolia. This region is also called the Black Sea Region. We accessed the data of nine service stations from this region, which shows an average of 0.927 and a minimum of 0.816.

There are two service stations in this region that gained the highest efficiency score. DEAL49 is located in one of the biggest cities in Northern Anatolia and profits from the advantage of high potential.

On the other hand, DEAL20 profits from being the only service station in a very big area which includes four or five small cities.

Table 9. DEA Results of Region 7

DEA Results of Region 7			
1	1	REG7	DEAL43
2	0.982	REG7	DEAL70
3	0.973	REG7	DEAL5
4	0.945	REG7	DEAL15
5	0.93	REG7	DEAL14
6	0.91	REG7	DEAL74
7	0.901	REG7	DEAL3
8	0.849	REG7	DEAL51
9	0.774	REG7	DEAL25
10	0.739	REG7	DEAL41

Region 7 is our last region, which includes the cities located in East Anatolia. We accessed the data of ten service stations in this region and the efficiency average of this region is 0.900 with a minimum of 0.739.

There is only one service station in this region that has an efficiency score of one. This service station, which is located in one of the biggest cities of Turkey, and it has the advantage of high aftersales potential.

We will also show the average and minimum efficiency scores of the regions in Table 10.

Table 10. Regional Statistics

Regional Statistics				
Region	# of SS	# of '1'	Avg.	Min.
REG1	11	5	0.9315	0.738
REG2	11	3	0.9359	0.759
REG3	13	3	0.9202	0.796
REG4	10	2	0.9107	0.765
REG5	12	0	0.8645	0.709
REG6	9	2	0.9276	0.816
REG7	10	1	0.9003	0.739
Total	76	16		
Average	10.86	2.29	0.9130	0.7603

When examined regionally, there are 16 efficient DMUs in our study, mainly located in the big cities of Turkey. Region 1 has five DMUs that are working efficiently whereas Region 5 has none. The average number of Service Stations (SS) that we analyzed in each region is more than ten, which is a high number that shows the characteristics of each region.

The average efficiency score of Turkey is higher than 90%, which is a result of strict rules and regulations of the distributor firm when selecting a location for opening a service station. On average, there are 2.29 service stations that are working efficiently in each region.

The rule of thumb about sample size which we explained above is that the results must be considered in order to decide about a convenient sample size. Remember

that Avkiran (2006) states that unless we work with a large enough sample size, the analysis loses discriminatory power. That is, the majority of the units appear fully efficient, with only a few units benefiting from potential improvements analysis. So for reliable DEA analysis, these rules should be considered after the analysis.

- Rule-of-thumb 1: Select a sample size preferably larger than the product of number of inputs and number of outputs. Table 11 shows the calculations.

Table 11. Sample Size Rule 1

Rule-of-Thumb 1	
a. Number of Inputs	3
b. Number of Outputs	4
Product of a and b	12
Sample size in our study	76

- Rule-of-thumb 2: Another acceptable approach is to select a sample size at least three times the sum of the number of inputs and outputs. Table 12 shows the calculations.

Table 12. Sample Size Rule 2

Rule-of-Thumb 2	
a. Number of Inputs	3
b. Number of Outputs	4
Three times of the sum	21
Sample size in our study	76

- Rule-of-thumb 3: a.k.a. “one-third rule” where sample size is accepted if the number of fully efficient DMUs does not exceed one third of the sample.

Table 13 shows the calculations.

Table 13. Sample Size Rule 3

Rule-of-Thumb 3	
Number of fully efficient DMUs	16
Three times of the (a)	48
Sample size in our study	76

As seen above, the sample size in our study exceeds all three factors. For the first rule, the minimum sample size for our study should be $(3*4)=12$, whereas it is more than five times the sample size; for the second rule, the minimum sample size of our study should be $[3*(3+4)] = 21$, whereas we have more than three times the required sample size; and for the last rule, the minimum sample size is $(16*3)=48$ and we have more than the required minimum sample size, which the main determinant for discriminatory power of Data Envelopment Analysis in this study.

This study evaluated the data of 76 automobile aftersales service stations of a popular automotive brand in Turkey by Data Envelopment Analysis and classified them according to their efficiency results. There are seven regions of the studied automobile firm, which is taken as the basis to detailed classification of results which are reported by DEA. Further studies should enlarge the data collected in this study by including other automobile brands and making a cross-brand Data Envelopment Analysis for evaluating the efficiency of different brands in Turkey. Another study to follow on from our research may be to compare the same brand's dealers in another

country it serves and to make a comparison between different countries.

Furthermore, to analyze the same data by any other MADM method is also a brief idea for further research.

The managers at Turkish automobile aftersales business may wish to group the service stations into various classes or clusters for administering different programs, depending on their needs. Cluster analysis is a technique that can be used on the same dataset (or with additional variables), which can help in this end. The main purpose of cluster analysis is to group similar objects into clusters. Within the clusters, the researchers seek to maximize similarity and at the same time to minimize similarity between the clusters.

Cluster analysis has many applications in business and economics. In market segmentation, the consumers can be classified into groups so that similar market offerings may be targeted towards them. In economics, socio-economic indicators may be used as input to cluster analysis so as to classify countries. The dealers or the service shops for these brands can be classified by the input data or output data that was used for DEA analysis in this dissertation. Again the choice of variables and the number of clusters to choose and to interpret these clusters are interesting further research areas that can be explored in the automotive industry as well as other industries.

Apart from grouping the dealers according to similarity, other statistical techniques such as Multidimensional Scaling (MDS) can be used for visualizing the objects on a map of required dimensionality. One way to prepare such visual perceptual maps is by using Multidimensional Scaling (MDS) technique. MDS is the name given to a broad range of methods and techniques and is incorporated in

various widely available computer packages (such as ALSCAL and PROXSCAL) (Akkucuk, 2011a; 2009; 2006). This technique has previously been applied in the literature in terms of mapping countries based on global competitiveness index data, (Akküçük, 2011b; 2014), perceptual maps of universities in Turkey (Akkucuk & Küçükkancabaş, 2007), perceptual maps of automobile brands (Akkucuk, 2011a), mapping US Supreme Court judges based on their decisions (Akkucuk, Carroll & France, 2013) and a very similar application on patent mapping using OECD data for the year 2008 (Akkucuk, 2011a).

CHAPTER 7

MEASURING QUALITY IN AUTOMOBILE AFTERSALES

This part of the study aimed to generate a survey to measure the service quality in automobile aftersales services. The roadmap for this survey generation process started by examining the service quality measurement scales in literature and then continued by the adaptation process of ServQual over automobile aftersales customers. Each and every step in the survey generation processes is explained in detail in this part of our study.

There are many sector-adapted service quality scales but there is not a density in terms of scale generation on automobile aftersales found in the literature. Thus, this study will be a milestone in the area of service quality in automobile aftersales services. The survey generated from this study will be for the use of the automobile aftersales sector.

ServQual is the most popular scale and is intensively used in many service quality measurement problems in the literature. The ServQual scale consists of 22 items which are used by many academicians to measure the service quality in a variety of industries, such as acute care hospitals, tire retailing, business school placement centers, dental services (Carman, 1990), restaurants (Lee & Hing, 1995), the health sector (Youssef, Nel & Bovaird, 1996), holiday resorts (Tribe & Snaith, 1998), internet websites (van Iwaarden et al., 2003), tourism (Khan, 2003), banking (Cui et al., 2003), airlines, (Gilbert & Wong, 2003) and the car service sector (Bouman & van der Wiele, 1992), the latter of which is the main focus of this study. ServQual and other important service measurement surveys including ServPerf, The

B&W (Bouman & van der Wiele) Model, Customer Satisfaction Index and Expectancy-Disconfirmation Framework are examined in Chapter 8.

Companies need to monitor the needs and satisfaction levels of the customers continuously in order to make informed decisions about their operations at the level of manufacturing facility, distribution network or service network. Measuring satisfaction for complicated products like cars or electronics requires detailed questionnaires. For services, detailed questionnaires have long been used in pioneering work resulting in the SERVQUAL scale.

Today's global customers, who generally live in countries that are members of regional trading associations such as the EU and NAFTA, demand very high quality and value, which need to be satisfied by the companies offering the products or services. The customers not only demand high quality products but also require excellence in billing, shipping and after sales service (Akkucuk, 2008). It is also worthwhile to note that quality management is not only related to marketing and operations functions but is also related to corporate governance for multinational companies (Akkucuk, 2009).

Quality and efficiency are the two bases of this study in terms of automobile aftersales services. For the quality part, which is the subject of this section, ServQual was selected because of its superiority to any other quality measurement scales. Despite the criticisms of ServQual, it was still the best option for our study because the use of the ServQual model in assorted industries has the advantage of being the choice in the service sector literature. This study intends to base its research on this scale, which was originated by Parasuraman, Zeithaml and Berry (1988) (PZB) and developed by Cronin and Taylor (1992).

The former study suggests that service quality is a measure of the difference between customers' expectations and perceptions, whereas the latter suggests that only the perception is important when measuring the level of service quality.

In this study, because of its aims to measure the level of service quality and develop a survey that can be used in further studies, as Cronin and Taylor (1992) advised, the perception side of ServQual was examined and modified by various steps to reach an AutoServQual scale. Chapter 9 explains the steps, including focus group interviews, item generation process, and content and reliability analysis.

The Research methodology chapter, Chapter 10, aims to explain the steps which follow the steps in Chapter 9. These steps are sampling method and scale design selection, survey preparation steps and the tests of the pilot survey. Each and every item for all dimensions was evaluated by many criteria as part of an elimination process. Factor analysis was used to develop AutoServQual from the global ServQual scale. The reliability and validity analysis of the scale statements are also explained in related parts of Research Methodology chapter.

Lastly, Chapter 11 defines and examines the updated version of AutoServQual survey questions, which will be used in the next part of this study to measure the service quality level of different car brands in Turkey. Besides these items, adjustments in demographic questions of the updated AutoServQual, which is also explained in Chapter 11. As explained above, next chapter continues with the literature review of service quality measurement scales.

CHAPTER 8

LITERATURE REVIEW

The review of the literature on the service quality construct and the methods evaluated for measuring service quality are explained in this chapter under the headings of ServQual and Other Important Measurement Scales. AutoServQual will also be a new scale for measuring service quality in automobile aftersales services.

8.1 ServQual

ServQual is a name which originated from the combination of the first letters of Service Quality. In this scale, service quality is determined by the discrepancy between a customer's expectations of a service offered and the same customer's perceptions of the service he/she received, by asking the customer questions about both his/her perceptions and expectations (Parasuraman et al., 1988).

ServQual measure is differentiated from satisfaction because it uses the term "perceived" in place of the actual service "received." ServQual is a valid, reliable and applicable survey for the services sector and it is ready for the use of the companies and organizations that work in the services sector.

Modifying the scale helps to monitor the developments in the determinants of service quality, clustering customers according to their expectations, and detecting the importance of various factors for a specific category of services.

8.1.1 Origin

Measuring quality in the services is more difficult than measuring production, so the importance of ServQual is mainly a result of its capability to measure the quality of the services provided. Results are determined by customer perception, so the customers and providers of a service may differ in terms of their perceived level of the quality of the services. The Gap theory, which will be explained, is valid when there is such a gap between the perception of a company and that of the customer.

Companies may think that they are providing high quality service but the customers may think the opposite; this signals a gap between the opinions of the customers and those of the company (Brown, 1993). There are many studies in the literature that state that the level of service quality of a company can be determined by the gap between the two perceptions.

Service Quality (SQ) is not directly related to customer retention (Sasser & Reichheld, 1990), customer satisfaction (Drew & Bolton, 1991; Boulding, 1993), profitability (Gale & Buzzell, 1987; Rust & Zahorik, 1992), costs (Crosby, 1979), or word of mouth. It is shown in the literature as a motivator for better long-term financial performance. ServQual is the most popular survey in the literature for measuring service quality. Alternatives are explained in the forthcoming paragraphs, but neither of these alternatives is used as much as ServQual.

The ServQual scale asks 22 questions on five dimensions. The dimensions will be explained later but let us identify them now with examples from the automobile sector:

Tangibles (physical cues): This dimension includes physical cues as having up-to-date equipment, facilities being visually appealing, employees being well-dressed, and conformity of the appearance with the services provided.

Reliability (promised service): As other service providers do, dealers also give their customers promises related to this dimension of their services, including being dependable, sympathetic and reassuring, and keeping records accurately.

Responsiveness (willingness to serve): This dimension includes providing prompt services, telling the customers the exact time that the service will be carried out, and a willingness on the part of the employees to help and respond to customer requests.

Assurance (confidence or trust): At service stations, this dimension requires that customers have confidence in the transactions and trust the employees of the service provider. The employees' politeness and success are also measured in this dimension.

Empathy (importance and convenience): The last dimension concerns giving personal attention, understanding what the customer's needs are, and having convenient operating hours for all customers.

The literature has many examples of developed versions of the ServQual applied in various industries. In their study evaluating customer perceptions for service quality, Hill and Alexander (2000) used ServQual to determine what constitutes reliable and effective business (Akkucuk & Teuman, 2016). Heung et al., (2000) state that ServQual should be used in every service quality measurement study because it achieves a status of research validity.

Weitz and Wensley (2002) consider another advantage of ServQual. They state that this method signals to the companies the perceptions and needs of the customers apart from measuring the quality. Peters and Pikkemaat (2006) evaluate ServQual as having the purpose of identifying the gap between customer perceptions and expectations. Lastly, Fedoroff (2009) explains the importance of employee opinions with respect to customer expectations.

Service quality is an important key to success in the automobile business, and ServQual has become an important technique to assess and manage service quality (Buttle, 1996). After its introduction by Parasuraman, Zeithaml and Berry (PZB) (1985), this scale was developed by the same researchers for the next eight years.

As explained above, this scale is used by many academicians to measure service quality in a variety of industries, including acute care hospitals, tire retailing, business school placement centers, dental services (Carman, 1999), restaurants (Lee & Hing, 1995), the health sector (Youssef, Nel & Bovaird, 1996), holiday resorts (Tribe & Snaith, 1998), internet websites (van Iwaarden et al., 2003), tourism (Khan, 2003), banking (Cui et al., 2003), airlines, (Gilbert & Wong, 2003) and car services (Bouman & van der Wiele, 1992), the latter of which is the sector which will be explained later.

8.1.2 Definition

The quality concept is first studied in academic sources in the meaning of quality of production. Service Quality is a new issue which can be evaluated as a follow-up of the term “manufacturing quality”. In the early 1950s, Deming, Juran and Feigenbaum emphasized the importance of quality in manufacturing. Others, like

Crosby (1979), contributed to the understanding of quality; thus their works contained several quantitative and statistical techniques, concentrating on the philosophy of quality, particularly as it relates to management (Bicheno, 1994).

Zeithaml (1990) states that most of the literature on quality is devoted to examining the production of goods and, as a result, there is much less information on service quality. This predominance is a result of the ways in which services are different from goods: the way they are produced, consumed and evaluated are all totally different. These differences are mainly perishability, inseparability, heterogeneity and intangibility (Parasuraman, 1985; Zeithaml, 1985). These differences are explained as follows:

Perishability: Services are performances; they cannot be stored as an inventory for future use (Zeithaml, 1985). There are important differences between goods and services, and Parasuraman (1985) states that the literature about goods quality is insufficient for understanding service quality.

Inseparability: Consumption and production of many services are inseparable. The consumer is usually involved during the delivery of the services (Gronroos, 1978; Carman et al., 1980; Parasuraman, 1985).

Heterogeneity: Service performance is not the same everywhere and often differs from one producer to another, from one customer to another, and also from one day to another (Parasuraman, 1985).

Intangibility: Services are not objects; they are performances. Therefore they cannot be verified, tested, inventoried, measured or counted like products to assure quality before they are sold (Chase, 1978; Gronroos, 1978; Carman & Langeard, 1980; Parasuraman, 1985).

Furthermore, Shostack (1997) brought service marketing into prominence as a discipline and stated more differences than these four explained. Their study highlighted the way for further research about services and service quality. Before the development of the ServQual scale, there were other studies investigating the meaning of service quality such as that of Weitz and Wensley (2002), which counted the following studies as examples of such preliminary works: Sasser et al. (1978), Gronroos (1982), Lehtinen et al. (1982), Lewis et al. (1983).

On the other hand, there were also discussions about quality, satisfaction, and attitude regarding the expectations of the customers. The definition of the perceived quality is simply the direction and degree of the discrepancy between expectation and perception in the Expectancy-Disconfirmation Theory perspective, which is regarded as the basis of ServQual and will be explained in the following sections. Expectations are interpreted as the wants and/or desires of the consumer.

As mentioned above, a well-known and generally accepted multi-item scale to measure consumer perceptions for service quality is ServQual, which was introduced by Parasuraman, Zeithaml, and Berry (1988). There are many definitions of service quality in the literature, one of which is meeting the requirements and needs of the customer (Lewis, 1993). On the other hand, Gronroos (1984) defines service quality as a comparative evaluation outcome.

Moreover, the above authors are not the first group of researchers to adopt comparative definitions to define service quality. Howard and Sheth (1969) and Oliver (1981) defined service quality in a similar manner in the service quality literature.

In more recent years, notions such as providing better service than the customer expects (Lewis, 1989) have become popular. The same study also explains that service quality is mainly determined by consumer perceptions, each of which is unique and may be idiosyncratic, end-of-the-day, emotional, or irrational.

There is no strict overall definition of service quality, but what the customers think has to be accepted as reality (Lewis, 1989). PZB (1990) and many authors in the literature base service quality on the customers' thoughts and make different definitions.

In conclusion, although the wording for all these definitions is different, they center around the same logic of comparing the services delivered to what the customers expect.

On the other hand, some authors consider this definition of service quality as stemming from a comparison of performance and expectation perceptions. They argue that service quality should be derived only from the perceptions of performance (Cronin & Taylor, 1992).

More precisely, there are other definitions in the literature. These studies base service quality on the definition stated unambiguously in Parasuraman et al. (1988), that is, that service quality is viewed as the direction and degree of discrepancy between consumers' perceptions and expectations.

To better understand this definition, the terms expectations and perceptions and the gaps between them must be understood, and these will be explained in the next sections.

8.1.3 Gap Theory

In addition to the previous explanations, to better understand the definition of service quality, the gap theory, which is based on the terms “expectations” and “perceptions,” which are explained in this section. Parasuraman et al. (1988) define expectations as wants and/or desires of customers. Other researchers have different views when defining expectations. For example, Teas (1993) argues that the above definition is vague and believes that customers might use one of the following six interpretations when asked about expectations: importance attributed to service, forecast performance, equitable performance, deserved performance, ideal performance, or minimum tolerable performance.

Parasuraman et al. (1994) responded to objections by redefining expectations as what customers feel a service provider would be offering, rather than what they should offer, and the latter is a measure of the normative expectation. Of these different definitions suggested by various authors, the original interpretation of expectations with respect to service quality is used in this report.

The present study views expectation as the desires and wants of customers, which is understood as what customers feel a service provider would be offering rather than what should be offered. With the definitions of expectation presented, one must also consider factors that may influence the customers' expectations. PZB indicate that there are four factors that may influence customers' expectations: external communications, past experience, personal needs and word of mouth communication.

The definition of perception is found more rarely in the literature, however. It is accepted as being customers' opinions on the performance of the company

according to the services being provided, according to Parasuraman et al. (1988), and this is the meaning that is used in this research. Boulding (1993) states that customers refresh their perceptions and expectations during the service process.

Therefore, service quality measurements, which base their theory on the perceptions and expectations of the customer, face rapid changes at the time of the service. Parasuraman (1985) introduced the gap theory before the introduction of ServQual. The gap model examines service quality in five steps which will be explained later. The main assumption behind the model is that the four gaps that affect the perception of a customer occur on the side of the service provider.

Thus, marketing and operations managers have to focus on the aforementioned four gaps in order to control gap 5 (overall gap about service quality level), which is the focal point of the model. The difference between perceptions and expectations is examined under several conditions which are referred to as gaps, which are outlined by Yan & McLaren (2010) as follows:

- The first gap is the inconsistency between the expectations of the customers and the perception of the management about these expectations (GAP 1).
- The second gap is the inconsistency between the perceptions of the management on the expectations of the customers and service quality specifications (GAP 2).
- The third gap signals the inconsistency between specifications of service-quality and actual delivery of the service (GAP 3).
- The fourth gap is about the inconsistency between the actual delivery of the service and what is promised and/or told to customers (GAP 4).

- The fifth and most important gap deals with the inconsistency between the services expected by the customers and the service delivered. Gap 5 shows the additive result of the previous four gaps (GAP 5).

In their studies, PZB conducted focus groups and a series of face-to-face interviews with executives and managers of various companies in the United States of America. Some of these managers belonged to the repair and maintenance industry (Zeithaml et al., 1990), which is directly related to our study.

During these interviews, PZB discovered four major gaps pertaining to executives' assessments of service quality within their companies. The existence of these four gaps results in customers not receiving the services they expected (Gap 5).

The fluctuation on the outcome of the level of service quality is not simply a variation due to customers; it is also affected by the individuals that are involved in providing the services. Therefore, understanding the factors that lead these gaps is important. These gaps will be discussed in the following pages. In order to better understand the dimensions of the ServQual, each of the other four gaps and the fifth gap are discussed separately in this section.

- Gap 1: The first gap is the inconsistency between the expectations of the customers and the perception of the management about these expectations.

Zeithaml et al. (1990) attempt to measure Gap 1 by applying the ServQual scale to both customers and managers. They state that when the difference between the scores is high, then this shows a bigger Gap 1, which is explained above. The managers' perception of customer expectations may differ from the actual needs and wants of the customers. To understand what customers expect is the first step for delivering qualified service. Factors that contribute to this gap include insufficient

marketing research of customers' expectations, inadequate usage of the findings of marketing research and a lack of communication between customers and management and between management and contact employees. PZB recommend better market research, more interaction with customers and the elimination of management levels in order to close this gap (Zeithaml et al. 1990).

- Gap 2: The second gap is the inconsistency between the perceptions of the management concerning the expectations of the customers and service quality specifications.

Although management presumes it is fully aware of customers' expectations, the reality may be different. Inadequate task standardization of and commitment to service quality, an absence of goal setting and a lack of perception of feasibility may cause this gap (Zeithaml, 1990). PZB suggest the following solutions to management to reduce the size of Gap 2:

- (1) increased commitment to service quality and constant and visible expression of their commitment to the employees,
- (2) receptiveness to different and possibly better ways of doing business,
- (3) openness to innovation,
- (4) standardization of routine transactions, and
- (5) setting appropriate service quality goals that are challenging but realistic.

- Gap 3: The third gap signals the inconsistency between specifications of service quality and the actual delivery of the service.

This gap is caused by a difference between actual service delivered and service quality specifications.

Thus, the situation is simply that employees are unable to or unwilling to perform what is required of them. A high level of service quality does not depend only on recognizing and establishing the customer's desired standards; it also depends on the employees' willingness and ability to perform at a specific level.

Zeithaml et al. (1990) have identified seven key conceptual factors that may contribute to Gap 3, which are:

- (1) low level of teamwork,
- (2) low level of perceived control on the employees' side,
- (3) poor supervisory control system,
- (4) low level of technology job fit,
- (5) low level of employee job fit,
- (6) role conflict,
- (7) role ambiguity.

To reduce this gap, employees need specific and frequent communication with supervisors and managers about what they are expected to do. In addition, employees need to know how well they are performing compared to the standards and expectations that management sets for them. Finally, employees need to feel confident and competent in their jobs. This is done by training them in the skills needed to satisfy customers (Zeithaml et al., 1990).

- Gap 4: The fourth gap is about the inconsistency between actual delivery of the service and what is promised to and/or told to customers.

The fourth gap arises when promises do not match the actual service delivery. Two key conceptual factors have been identified which might contribute to Gap 4 (Zeithaml et al., 1990):

- (1) Low level of horizontal communication among departments, including human resources, marketing and operations management,
- (2) propensity to over-promise in communication.

These problems can be eliminated by increasing communication between operations, marketing and human resources departments. In addition, companies must develop appropriate and effective communications with their customers (Zeithaml et al., 1990). The fifth gap is an overall figure that comes from the previous four gaps.

- Gap 5: The fifth gap deals with the inconsistency between expected services of the customers and the delivered service.

Gap 5 shows the additive result of the previous four gaps. This result is the theoretical base for the ServQual studies. The existence of any of these four gaps will impact negatively on the level of service quality.

8.1.4 Dimensions

Zeithaml et al. (1990) identify dimensions that are important to customers when evaluating service qualities. These dimensions are identified during a series of in-depth interviews as well as focused group discussions with firms in four different service industries, one of which relates to repair and maintenance, which is the focus of our study. These first but old dimensions are: (Parasuraman et al., 1985)

Tangibles: This dimension includes the appearance of the physical facilities, equipment, personnel and communication materials.

Reliability: This dimension includes the ability to perform the promised service dependably and accurately.

Responsiveness: This dimension includes the willingness to help customers and provide prompt service.

Competence: This dimension includes possession of the skills and knowledge required to perform the service.

Courtesy: This dimension includes the politeness, respect, consideration and friendliness of contact personnel.

Credibility: This dimension includes the trustworthiness, credibility and honesty of the service provider.

Security: This dimension includes freedom from danger, risk or doubt.

Access: This dimension includes approachability and ease of contact.

Communication: This dimension includes keeping customers informed in language they can understand and listening to them.

Understanding the customer: This dimension includes making the effort to get to know customers and their needs.

Customer expectation of these dimensions may be affected by several factors, according to Zeithaml (1990). These factors are: past experience, external

communications from the service provider, word of mouth communication, and personal needs of the customer. Due to the overlap between dimensions found during further analysis (PZB, 1988), these components are summarized in five dimensions. These are tangibles, reliability, responsiveness, assurance and empathy. The tangibles, reliability and responsiveness dimensions remain distinct but the remaining seven components are integrated into two aggregate dimensions: assurance and empathy.

Tangibles, Reliability, Responsiveness, Assurance and Empathy are the five dimensions which are described by Zeithaml et al. (1990).

PZB claim that the above-mentioned five dimensions are applicable across a broad spectrum of service industries when the subject is to measure the service quality level (PZB, 1988), including the automobile services, which is the focus of our study. A number of dimensions across different industries have been variously determined by different authors.

Carman (1990) found six dimensions in the tire service industry, seven dimensions in a business school placement center, and five dimensions in dental services, whereas Bouman and van der Wiele (1992) found three dimensions in car servicing, which will be discussed later in the related section in this chapter.

Although Parasuraman et al. (1988) originally mentioned that this scale was designed for different applications across a broad spectrum of services; they also declared that it could be used as a base for further research. This scale has been adapted in many studies to suit new contexts. This is the starting point of our study, about a regenerated survey on automobile servicing which was not adopted before in the literature. For these reasons, PZB's five dimensions are evaluated academically

in this study. The steps for survey generation will be explained in detail in the related parts of this study.

8.2 Other important measurement scales

ServQual is the most studied scale in terms of service quality, but there are also other scales that are used for the same purpose. Other scales including ServPerf, The Bouman and van der Wiele Model (B&W model), Customer Satisfaction Index (CSI) and Expectancy-Disconfirmation (E-D) Theory that are explained in this section.

8.2.1 ServPerf

In the literature the most popular service quality measurement scale after ServQual is ServPerf. Cronin and Taylor (1992) introduced the ServPerf scale in opposition to the researchers who were studying using the ServQual scale. They questioned the conceptual basis of the ServQual scale and stated that ServQual was being confused directly with the concept of service satisfaction. The expectation (E) component of ServQual is not used in this new scale; and the performance (P) component is used alone. This new scale is referred to as the ServPerf scale in the literature. There are many studies which have adopted its dimensions and items.

On the other hand, besides the theoretical arguments, the creators of the ServPerf provided empirical evidence across four industries. They used data from fast food, dry cleaning, pest control and banks to prove the capabilities of their new performance-only instrument. ServPerf is derived from the performance component of the original ServQual scale and thus includes 22 items. This single-item scale

explains variance better (Cronin & Taylor, 1992). Another advantage of this new scale is that it decreases the number of questions and the time for filling in the questionnaire. This signals the popularity of this scale with several authors in the literature: Woodruff, Cadotte & Jenkins, 1983; Mazis, Antola & Klippel, 1975; Hartline & Ferrell, 1996; Gotlieb, Grewal & Brown, 1994; Churchill & Surprenant, 1982; Boulding et al., 1993; Bolton & Drew, 1991; Babakus & Boller, 1992.

Moreover, an important issue here is the way the founders of ServQual considered this popular scale. Even Zeithaml observed in a study that their results were directly influenced only by perception (Boulding et al., 1993), which is regarded as a positive criticism of the ServPerf.

The ServPerf versus ServQual debate is ongoing in the literature. Recently, many members of both groups consider one method more suitable than the other.

8.2.2 The Bouman and van der Wiele Model (B & W model)

There are many application of ServQual scale in the literature, but Bouman and van der Wiele (1992) studied automobile services sector, which is directly related to our study. They developed an instrument to measure the level of service quality in the motor industry in the Netherlands.

Their model is based on the disconfirmation theory where the individual compares his or her experience with a particular set of expectations. Their instrument consists of 48 items; and each item has two seven-point Likert scales (on both sides of each item). One scale is for the respondents to enter their expectation scores and the other is for their perception scores. Their model measures service quality using three factors: customer kindness, tangibles, and faith.

As mentioned earlier, there are many revisions of ServQual in the literature. Bouman and van der Wiele's (1992) research also made revisions to the original ServQual instrument. They suggest that a possible reason for the deviating dimensions is given by the far less rigorous analyses done in their research.

As mentioned above, Bouman and van der Wiele (1992) used many analyses and found three factors (customer kindness, tangibles and faith) which consist of 48 items spreading over the five ServQual dimensions to measure service quality in the car service industry. Their scope of the measure was the car service industry in the Netherlands.

8.2.3 Customer satisfaction index

Another often-used measure in many sectors, including automobile services, is the customer satisfaction index (CSI). Each and every automotive brand has its own customer satisfaction index to measure the satisfaction level of their customers. The customer satisfaction index is an instrument which examines a number of items related to the service provided by the organization; the customers are required to rate each of the items according to their encounter with the services provided (perceptions only).

The number and the type of questions may vary between organizations. Each of them is pre-weighted by the organization instead of the customers. Customer satisfaction has an important effect on repurchase in the new car retail market. The overall performance of the dealers is examined by using these scores and, according to these results, many criteria are determined by the manufacturers with regard to the quotas and incentives for their dealers.

In the literature there are adequate studies about the effect of customer satisfaction on service quality. On the other hand, some studies focus on the difference between customer satisfaction and service quality. Parasuraman et al. (1988) define the difference between satisfaction and service quality by defining perceived service quality as a global attitude or, in other words, perspective, which relates to knowledge of the service. On the other hand, a specific transaction may bring satisfaction. Many studies also support the argument that service quality is led by customer satisfaction. Bitner (1990) is an example in that his study develops a service encounter evaluation model which empirically studies the effects of satisfaction over service quality.

The manufacturers assume that their surveys are answered honestly and they use these answers in improving their brand quality. The weak points defined by customers are focused on to increase overall service quality. Furthermore, these scores are always connected to financial incentives in the case of dealers; thus, many dealers do not need to have these surveys answered honestly but would rather have buyers simply respond that they are completely satisfied.

This can be called manipulation by the dealers of their own satisfaction scores. In this context, salesmen essentially teach the customer to answer the surveys by marking the best point or give discounts based on the answers. Many dealers pay their sales force high bonuses for each high-scored survey their dealers receive. Consequently, the sales force mentions this score to the customer during the negotiation process and makes the customer promise to give the best number of points

Lastly, there are many studies in the literature that connect marketing efforts and sales figures by customer satisfaction index scores. Bagozzi (1974) proposed exchange as the most basic element of the marketing function. He defined the core concepts in the exchange paradigm and set a conceptual framework for an exchange system. He interpreted exchange as a process of a cause-and-effect relationship that depends on the actions of the players as well as on external factors.

Marketing transactions happen at a time when both company and customer expect to gain value by engaging in the exchange (Bagozzi, 1974). Thus, satisfaction after the exchange experience plays an important role in the ongoing and future relationship of the related parties in the exchange process.

8.2.4 Expectancy-disconfirmation framework

The Expectancy–Disconfirmation framework is another model in the literature about measuring service quality that is generally assumed to be a basis for other quality scales. In the literature there are also many examples of dimensions in satisfaction: product or service type, type of consumers, time period for evaluation, and intense social interaction.

These dimensions make satisfaction a difficult process to standardize and formulate in one model. Satisfaction theory has roots in the psychological studies of the 1930s and later studies began in the 1960s. The most popular model is based on the expectancy-disconfirmation (E-D) framework and was built by Richard Oliver (1980).

Satisfaction is defined in the E-D paradigm as an outcome of purchase and use. Satisfaction is the judgment of the consumer gained by the comparison of the

pre-purchase expectations and the actual performance and/or attributes of the product. If the realized performance is higher than the expectations, the disconfirmation is positive and results in satisfaction. If the performance is lower than expected, the disconfirmation is negative and results in dissatisfaction. Disconfirmation is a linear function of expectations and performance ($D = P - E$). However, in the literature, disconfirmation is used in the models as an independent variable to explain the dependent variable, which is satisfaction.

In reality, when the expected does not occur, the rating of the disconfirmation can be higher or lower than the difference of expectation and performance. This is similar when the unexpected occurs. This property of disconfirmation makes disconfirmation an independent antecedent of satisfaction. Oliver and DeSarbo (1988) warned that there is a possibility that some customers may be more expectations-influenced than purely disconfirmation-influenced. These cases are explained by the assimilation and contrast theories.

Oliver (1981) also defined satisfaction as the evaluation of the surprise in the purchase experience. This post-purchase excitement has a finite duration. After the loss of satisfaction, an attitude is constructed toward the store, product, and brand. He was not taking the re-purchasing and complaining as a part of the satisfaction process. However, current studies prefer not to separate these from the satisfaction process.

Modeling the processes with all antecedents and outcomes, together with the interactions between them, is a fashionable approach. Building models on statistical evidence was a very important task in periods very concerned with high efficiency during the 1970s and 1980s. As daily life started to become more and more

complicated towards the 2000s, dynamics in the satisfaction process varied so much that it became difficult to explain satisfaction through one complete model. Various types of consumers, the variety in products, increased distribution channels, and high interactions in social life with increased mobility and technology have multiplied and diversified in this new millennium.

The studies on satisfaction are becoming more exploratory in nature. Researchers try to handle various cases by using different satisfaction models rather than constructing models by survey outputs. Closed-ended questions and ratings on 7-point Likert scales of disconfirmation levels used to find out the reasons for the satisfaction or dissatisfaction are not sufficient in the current environment. Open-ended questions and exploratory research methods are becoming more and more popular to find out the reasons for satisfaction. Exploratory surveys display deficiencies in the traditional satisfaction model developed in the 1980s and bring new paradigms to the satisfaction theory.

The E-D model has been criticized in the literature because it is based on cognitive elements more than emotional aspects. Affective satisfaction modes can compensate for the weakness of the model. Then Oliver (1989) introduced five modes of satisfaction. These explain satisfaction as: (1) contentment, (2) pleasure, (3) relief, (4) novelty, and (5) surprise.

These modes can be considered as the overriding rules of the satisfaction theory, which has difficulties in explaining such cases by using standard components. It has also been discovered that satisfaction has different meanings for different consumers and cultures. This is shown explicitly in the research of Fournier and Mick (1999).

When consumers state the same satisfaction level on the 7-point Likert scale, this does not mean that they are satisfied in the same way. Satisfaction has content; otherwise, it would not be satisfaction. New satisfaction modes are identified in the data of Fournier and Mick (1999), who classified satisfaction as:

- Love,
- Resignation,
- Helplessness,
- Trust,
- Awe.

Fournier and Mick (1999) introduced a new balancing paradigm for the satisfaction of using technologies. Paradoxes seen here are technology specific and inevitable for most of the cases because of differences in the uses of technology and differences in consumers and their background. Satisfaction is described as successfully balanced paradoxes in their study. Choosing the proper type of technology and identifying attributes aligned with the user abilities, knowledge and experience, deciding on an appropriate area or sector to implement, and automating cumbersome applications are examples of the efforts to balance paradoxes.

Criticism of comparison paradigms states that they are concentrated only on one purchasing event and do not include the social interactions of the consumers. Focus groups in Fournier and Mick (1999) revealed the connection of product satisfaction to life satisfaction. In some cases, it has been observed that the satisfaction of other members of the family had an impact on the individual's satisfaction and this adds a social dimension to the satisfaction process.

In conclusion, the term “expectancy disconfirmation theory” is frequently mentioned in service quality literature, especially when it comes to the formulation of measurement instruments. Disconfirmation arises from discrepancies between prior expectations and perceived performance; therefore, by the literature review, (Oliver, 1980; 1981; Churchill & Surprenant, 1982; Oliver & De-Sarbo, 1988) we conclude that there may be three possibilities:

- zero disconfirmation occurs when a product performs as expected,
- positive disconfirmation occurs when the product performs better than expected,
- negative disconfirmation occurs when the product performs below expectations.

As explained before, the creators of the ServQual, PZB base service quality on the difference between customer expectations and perceived performances (Parasuraman et al. 1988). In other words, service quality is seen as the difference between what customers expect and their perception of the performance of a particular service provider. The subject of measurement of expectations and perceptions has come under significant debate.

Cronin and Taylor (1992), Brown et al. (1993) and Teas (1993) questioned the underlying disconfirmation paradigm, which conceptualizes service quality as the difference between customer perceptions and customer expectations. The former two researchers developed instruments to measure service quality based solely on customer perceptions, as they believed that there are shortfalls regarding the disconfirmation technique.

Brown et al. (1993) argued that the calculation of a difference score could lead to several problems; therefore, a non-difference score measure would be more desirable. In addition, the expected or desired level of service is almost always higher than the perceived level of actual service (1993). When both the expectations and perceptions are measured, the questionnaire would effectively be twice as long (Cronin & Taylor, 1994).

On the other hand, Parasuraman et al. (1993) state that a perceptions rating alone may not lead to the same practical implications as the expectations and perceptions score. They argue that the expectations and perceptions scoring method allows providers to understand better whether higher expectations or lower perceptions might be responsible for declining service quality assessment over time.

Lastly, the collective conceptual and empirical evidence neither demonstrates superiority for the non-difference score format nor warrants abandoning the difference score format as Brown et al. (1993) might imply (Parasuraman et al. 1993). In the absence of adequate measurement instruments, Jacoby (1978) wrote that most of the measures are only measures because someone says that they are, not because they have been shown to satisfy standard measurement criteria. Our study continues with the research design chapter.

CHAPTER 9

RESEARCH DESIGN

Quality and efficiency are the two bases of this study in terms of automobile aftersales services. For the quality part, which is the subject of this section, ServQual is selected because of its superiority to any other quality measurement scales. Despite the criticisms of ServQual, it is still the best option for our study. The use of the ServQual model in assorted industries is a reason for choosing this method for this study. Research validity advantage also gives status to this method (Heung et al., 2000).

On the other hand, ServQual, in addition to showing the level of service quality, points out to firms critical ways to better trace customer perceptions and expectations over time (Wensley & Weitz, 2002). In the automobile aftersales sector, besides measuring the service quality, it is important to understand the customer expectations and perceptions.

The advantages/disadvantages and literature examples of each of the other important alternatives has been discussed in previous sections. As seen in the literature, ServQual has been adapted by many sectors, and there are many studies about this adoption process. ServQual is modified in nearly all studies according toly with the sector and country studied. Thus, in our study to analyze the quality of automobile aftersales services in Turkey, the same processes were performed. This section includes the academic steps taken to reach an AutoServQual which will be suitable for Turkish automobile aftersales customers.

9.1 Measuring instrument

As mentioned above, ServQual is the starting point for this part of our research. I intended to base this research on this scale originated by Parasuraman, Zeithaml and Berry (PZB, 1988) and developed by Cronin and Taylor (1992). The former suggest that service quality is a measure of the difference between customers' expectations and perceptions. The latter suggest that only perception is important when measuring the level of service quality.

In the present study, because it aims to measure the level of service quality as Cronin and Taylor stated, the perception aspect of ServQual is examined and modified by various steps to reach an AutoServQual scale applicable to the automotive aftersales services sector in Turkey.

Furthermore, this research provides information concerning customer perceptions and expectations in a new examination system designed for automobile aftersales service providers. Implementation of the new system aims to increase the level of service quality as perceived by customers. As we can see from the literature review section, ServQual has five dimensions:

- Tangibility,
- Reliability,
- Responsiveness,
- Assurance,
- Empathy.

Based on the literature, the dimensions included in our study are the same as the five dimensions above. These assumptions came from the literature review of the service quality and automotive industry, but were subject to change after the research was carried out. Our study aimed to understand the details of the dimensions from the results of many studies, including focus groups, expert opinions and surveys. Ultimately, we hope to see a modified version of ServQual, which will be applicable to Turkey. This part will explain the academic steps about how the AutoServQual emerged.

9.2 Focus group interviews

The purpose of our study is to understand the dimensions of service quality in automobile aftersales services, and to achieve this goal we needed a qualitative research design. By exploratory research, we tried to calibrate the ServQual scale to our study and understand the dimensions of service quality in automobile aftersales services in Turkey.

In exploratory studies, besides focus group interviews, different study methods such as case studies, verbal protocol analysis, cognitive mapping, critical incident technique (CIT), participant observation and individual in-depth interviews were used.

In focus groups, group interaction and synergy make the sum of knowledge greater than separate individual opinions. The distinguishing feature of focus groups is the explicit use of group interaction to produce data and insight that would be less accessible without the interaction found in a group (Morgan, 1997).

Focus groups generate greater depth of information on an issue than a general count of single opinions gleaned from a survey (Carson et al., 2001). As a result, the focus group was our choice as a starting point. In our study, in accordance with the purposes of the research, three focus groups were used in order to generate ideas about the construct. Carson et al. (2001) state that most focus group research seeks some element of homogeneity so that opinions stem from a factor of commonality among participants. This can be age group, lifestyle, consumption patterns, expertise or experience.

According to Morgan (1997), a range from six to ten is the rule of thumb for group size even though there are no strict lower and upper boundaries. Carson et al. (2001) affirm that the contemporary view of an appropriate number of respondents in each group is from five to eight. Saturation is the criterion in determining the number of groups. Saturation is the point at which additional data collection no longer generates new understanding.

In accordance with the ideas above, we formed three focus groups, each consisting of six or seven people. The first six people were automotive service business professionals still working with the leading automotive brands in Turkey. They were all married and ranged in age from 33 to 45. They were working in the service departments of different automotive distributors and their main task was to check the processes of their service dealers all over Turkey. Moreover, they all owned a car so they were both business professionals and aftersales customers in the automobile services sector.

The second focus group of six people consisted of automobile aftersales customers waiting for their cars to be repaired at a car service repair shop. They

ranged between 22 and 54 years of age, and the group included both married and unmarried participants. The advantage here was that each respondent in this group was an aftersales service customer and had fresh ideas about the service given to their cars.

The third focus group consisted of automobile service station employees and managers who were working in our field of study. This last group consisted of seven people, aged between 29 and 42, and included both married and unmarried participants. The first group consisted of five males and one female and the second group consisted of three males and three females, whereas the third group consisted of three males and four females.

As advised in the literature, the researcher acted as moderator, controlling both the dynamics of the group discussion and the topics that were discussed. He was careful not to bias the participants' responses. The researcher tried not to become too involved with group discussions and did not impose his own sense of what was important but let the members speak their opinions freely about automobile services and the service quality dimensions.

Focus group interviews are done to generate knowledge from multiple perspectives. In order to get the best result from this method, the meeting was recorded. These records were used for both content analysis and scale development. Despite having the same purpose, the questions were reworded and recycled in other questions to review the issue again. The following open-ended items were the focal points during the focus group interviews:

- 1-) What are the most important expectations of the car service to which you bring your car? Try to describe your preferences.

2-) Think about the service station where you bring your car, and talk about the conditions which fail to meet your expectations.

3-) What are your most essential expectations when you consider the service given to your car in aftersales service stations?

4-) Can you share any other aftersales service-related issues that you consider important in the car service business? (Any problems you faced, or suggestions/comments)

9.3 Item generation process

In the development of a scale that seeks to measure aftersales service quality through the five aforementioned dimensions, we followed the recommendations of Robinson, Shaver, and Wrightsman (1991) about scale construction and evaluation. They state that the first step for scale builders, and the first dimension on which their work can be evaluated, is writing or locating items to include in a scale. They also assume the scale builder knows the research field for constructing an instrument which would cover the main theoretical constructs well enough to be useful for other studies. They state minimal considerations for constructing a scale as follows:

1. Proper sampling of content: Sampling of items is an important process and needs careful study of the details of the content. Here, the experience of the researcher is very important. In our study, the researcher had more than ten years experience in the automobile aftersales business, which is an important advantage, but the item generation process was done with the help of business professionals and the advisor, apart from the researcher.

2. Simplicity of item wording: The wording of the items is another important determinant of the success of the scale generated. We found in the literature that less complex and less stuffy items bring better results. Presser and Converse (1986), Bradburn and Sudman (1982), and Meadow and Robinson (1982) have recommendations on this subject.
3. Item analysis: This last process is a very broad process which requires an understanding of the researcher by the respondents. Using the same language in terms of the researched subject is very important.

These recommendations are also processed in our study, as will be seen in the next chapters. The data from focus groups was collected by recording the answers, and decoded by writing each opinion on a piece of paper.

The variables produced by group members were used to develop a questionnaire about the components of service quality in automobile aftersales services, and to generate a scale for Turkish automobile aftersales customers, which is called AutoServQual and will be tested quantitatively in the research.

To make use of the ideas generated from both focus groups, a detailed understanding of the variables was needed. According to Morgan (1997), neither the group nor the individual constitutes a separable unit of analysis. Instead, our analytic efforts must seek a balance that acknowledges the interplay between these two levels of analysis. Three common ways of coding focus group transcripts take note of (a) all mentions of a given code, (b) whether each group's discussion contains a given code, or (c) whether each individual participant mentions a given code.

Descriptive counting is especially useful in research projects that compare distinctively different groups to determine how often various topics are mentioned at

different times. The ideas coming from focus groups were analyzed and the results were interpreted in light of the research construct. There are at least three overlapping sorts of activities that go into data analysis: data reduction, data display and the drawing and verifying of conclusions (Griggs, 1987).

Griggs (1987) also state that data reduction is used to organize data. These data are an input for more meaningful analysis. This step is one of the most important ones. Data reduction is not ignoring data or throwing it away. Here, the aim is to bring the data to a manageable position.

The focus group results were examined according to data reduction purposes. Here, expert opinions from sector professionals and service managers are used to generate and categorize items, and are thoroughly examined in the next sections.

The focus group results were organized into different topics to make the data more understandable. In other words, we grouped together the statements that had a similar pattern of meaning. This was needed because according to Griggs (1987), showing the data and analysis in one place makes it easier to compare different sets of data and to see where further analyses are called for.

Determining a base for item categorization was not organized by only the authors' capability; here the professionals from automobile aftersales sector and opinions of the experts were important decision variables for item categorization. Reliability and validity analysis can be conducted only after items that share similar patterns are grouped, so data display was needed before verification.

9.4 Content analysis

The steps in content analysis on the research construct are carried out based on Zimmer and Golden's (1988) article. The results of open-ended questions are transcribed into Table 14 with the name of the themes and number of occurrences (frequency). Table 14, 15, 16, 17 and 18 shows the results of these processes. The first 22 items are the ones that are come from the original ServQual scale, and the next ones are those that were added by this study.

Table 14. Items for the Content Analysis (First Sorter)

Theme	Frequency
Up-to-date Equipment	2
Quality of Physical Environment	7
Neat Staff	7
Compatible Physical Facilities	2
Delivery of the Service at the Time Promised	12
Sincerity of the Staff	10
Trustworthiness	8
Keeping Promises	7
Keeping Accurate Records	6
Telling Customers the Exact Time of Service	7
Quick Solution to Problems	17
Concerned Staff	25
Availability to Respond to Customers	12
Trustworthy Staff	9
Confidence in Transactions	4
Politeness of the Staff	9
Adequate Support from the Producer	6
Individual Attention	12
Employees' Personal Attention	7
Understanding the Needs of Customers	18
Focus on Customer Expectations	12
Convenient Operating Hours	2
Parking Convenience	5
Taking Advantage of Technology	9
Certificates of Quality Standards	4
Comfortable Waiting Lounge	3
Accurate detection of the Failure	11
Use of Original Products	10
Repairs According to Procedures	7
Reliable Repair work	10
Personal Information Security	11
Compatible Staff	4
Adequate Transportation Facilities	3
Qualified Labor Force	12
Replacement Vehicle During Repair	5
Equal Treatment	5
Attentive Service	6
Knowledgeable Staff	7
Trained Staff	14
Informative Explanations	16
Reasonable Pricing	22
Guaranteed Maintenance	6
Payment Options	2
Offering Gifts and Promotions	3
Delivery Quality	3
Total	379

A second sorter also categorized the results:

Table 15. Items for the Content Analysis (Second Sorter)

Theme	Frequency
Up-to-date Equipment	2
Quality of Physical Environment	6
Neat Staff	5
Compatible Physical Facilities	2
Delivery of the Service at the Time Promised	13
Sincerity of the Staff	9
Trustworthiness	7
Keeping Promises	8
Keep Accurate Records	7
Telling Customers the Exact Time of Service	7
Quick Solution to Problems	15
Concerned Staff	24
Availability to Respond to Customers	14
Trustworthy Staff	9
Confidence in Transactions	4
Politeness of the Staff	10
Adequate Support from the Producer	7
Individual Attention	10
Employees' Personal Attention	5
Understanding the Needs of Customers	21
Focus on Customer Expectations	12
Convenient Operating Hours	3
Parking Convenience	5
Taking Advantage of Technology	9
Certificates of Quality Standards	5
Comfortable Waiting Lounge	3
Accurate detection of the Failure	9
Use of Original Products	11
Repairs According to Procedures	8
Reliable Repair work	10
Personal Information Security	11
Compatible Staff	4
Adequate Transportation Facilities	4
Qualified Labor Force	10
Replacement Vehicle During Repair	4
Equal Treatment	5
Attentive Service	7
Knowledgeable Staff	7
Trained Staff	16
Informative Explanations	15
Reasonable Pricing	22
Guaranteed Maintenance	6
Payment Options	3
Offering Gifts and Promotions	3
Delivery Quality	2
Total	379

After the initial sorting of the researcher was compared with that of the independent sorter, the following items were agreed upon, as shown in the table.

Table 16. Agreed Items for the Content Analysis

Theme
Up-to-date Equipment
Quality of Physical Environment
Neat Staff
Compatible Physical Facilities
Parking Convenience
Taking Advantage of Technology
Certificates of Quality Standards
Comfortable Waiting Lounge
Delivery of the Service at the Time Promised
Sincerity of the Staff
Trustworthiness
Keeping Promises
Keep Accurate Records
Accurate detection of the Failure
Use of Original Products
Repairs According to Procedures
Reliable Repairs
Personal Information Security
Telling Customers the Exact Time of Service
Quick Solution to Problems
Concerned Staff
Availability to Respond to Customers
Compatible Staff
Adequate Transportation Facilities
Qualified Labor Force
Replacement Vehicle During Repair
Equal Treatment
Attentive Service
Trustworthy Staff
Confidence in Transactions
Politeness of the Staff
Adequate Support from the Producer
Knowledgeable Staff
Trained Staff
Informative Explanations
Reasonable Pricing
Guaranteed Maintenance
Individual Attention
Employees' Personal Attention
Understanding the Needs of Customers
Focus on Customer Expectations
Convenient Operating Hours
Payment Options
Offering Gifts and Promotions
Delivery Quality

Out of 379 categories identified, 348 categories were found to match those of the researcher and the sorter. This shows a percentage agreement of $348/379=0.91$ or 91%.

The categories were then grouped into the ServQual model in accordance with descriptions in the previous section.

Table 17. Items for Dimension Analysis (First Sorter)

Theme	Frequency
Tangibility	
Up-to-date Equipment	2
Quality of Physical Environment	6
Neat Staff	5
Compatible Physical Facilities	2
Parking Convenience	5
Taking Advantage of Technology	9
Certificates of Quality Standards	3
Comfortable Waiting Lounge	3
Reliability	
Delivery of the Service at the Time Promised	12
Sincerity of the Staff	10
Trustworthiness	7
Keeping Promises	7
Keeping Accurate Records	6
Accurate detection of the Failure	11
Use of Original Products	8
Repairs According to Procedures	7
Reliable Repairs	8
Personal Information Security	10
Responsiveness	
Telling Customers the Exact Time of Service	7
Quick Solution to Problems	15
Concerned Staff	22
Availability to Respond to Customers	11
Compatible Staff	4
Adequate Transportation Facilities	3
Qualified Labor Force	10
Replacement Vehicle During Repair	4
Equal Treatment	4
Attentive Service	6
Assurance	
Trustworthy Staff	8
Confidence in Transactions	4
Politeness of the Staff	8
Adequate Support from the Producer	6
Knowledgeable Staff	7
Trained Staff	14
Informative Explanations	13
Reasonable Pricing	20
Guaranteed Maintenance	5
Empathy	
Individual Attention	11
Employees' Personal Attention	5
Understanding the Needs of Customers	18
Focus on Customer Expectations	12
Convenient Operating Hours	2
Payment Options	2
Offering Gifts and Promotions	3
Delivery Quality	3
	348

This was again grouped by the independent sorter.

Table 18. Items for Dimension Analysis (Second Sorter)

Theme	Frequency
Tangibility	
Up-to-date Equipment	2
Quality of Physical Environment	5
Neat Staff	5
Compatible Physical Facilities	2
Parking Convenience	4
Certificates of Quality Standards	5
Adequate Transportation Facilities	4
Comfortable Waiting Lounge	2
Reliability	
Delivery of the Service at the Time Promised	11
Sincerity of the Staff	8
Trustworthiness	6
Keeping Promises	6
Keeping Accurate Records	7
Accurate detection of the Failure	8
Use of Original Products	10
Repairs According to Procedures	7
Reliable Repairs	9
Responsiveness	
Telling Customers the Exact Time of Service	7
Quick Solution to Problems	12
Concerned Staff	21
Availability to Respond to Customers	13
Compatible Staff	2
Taking Advantage of Technology	8
Qualified Labor Force	9
Informative Explanations	14
Trained Staff	15
Equal Treatment	5
Assurance	
Trustworthy Staff	9
Confidence in Transactions	3
Politeness of the Staff	10
Adequate Support from the Producer	7
Knowledgeable Staff	7
Personal Information Security	11
Reasonable Pricing	21
Guaranteed Maintenance	6
Empathy	
Individual Attention	10
Employees' Personal Attention	5
Understanding the Needs of Customers	20
Focus on Customer Expectations	12
Convenient Operating Hours	3
Replacement Vehicle During Repair	4
Payment Options	3
Offering Gifts and Promotions	3
Attentive Service	5
Delivery Quality	2
	348

9.5 Reliability analysis

Reliability analysis for dimension distribution was needed. As seen from the above two categorization tables, 45 themes were assigned to five categories in different ways. As seen from the tables, 38 out of 45 themes matched in both categorizations.

$$Z = \frac{k - Ek}{[np(1-p)]^{1/2}}$$

k : number of matches = 38

Ek : expected number of matches = $45/5 = 9$

n : total number of items = 45

p : probability that two judges will assign a theme to the same category = $1/5$

$$Z = (38 - 45/5) / (45 * 1/5 * 4/5)^{1/2} = 29 / 2.683 = 10.8$$

In this case, the Z score 10.8 exceeds a critical Z score of 2.33 ($\alpha = 1\%$).

So it is observed that the result is significant.

On the other hand, for the reliability analysis, the following formula was used:

$$R = \frac{N * \text{Average Agreement}}{[1 + (N-1) * \text{Average Agreement}]}$$

N : Number of judges

$$R = \frac{(2 * 38/45)}{[1 + (2-1) * 38/45]} = 1.68 / 1.84$$

$$R = 0.917$$

This result shows that reliability value 91.7% is higher than the minimum reliability value of 85%. So this shows a sufficient reliability level for the analysis.

As the pilot survey is now ready, the next issue is sample design.

CHAPTER 10

RESEARCH METHODOLOGY

The steps to formulate and generate a survey for Turkish automobile aftersales customers are the main aims of this part of the study. This chapter shows the methodology for the development of AutoServQual scale. The sampling method, scale design, survey preparation and implementation, and the adjustment of the pilot survey are also explained in this section. To develop a scale, we have to talk about our sample first.

10.1 Sampling method

The sampling method refers to the way of selecting the sample units. The most important point is to decide whether to use a probability or a non-probability sample. In this research the probability sampling method was chosen for the target population. Due to the sampling method selected, a convenient sample size can be calculated. In addition, the confidence level had to be specified. We had a sample size of 250, which is higher than the minimum requirement of 30, for some sample statistics to follow the normal distribution.

10.2 Scale design

In this part of the study, the researcher attempted to develop a scale to measure components of service quality for the automobile aftersales sector in Turkey. The

procedural framework suggested by Lundstrom and Lamont (1976) was used for that purpose. According to their framework, methodological stages in the scale development process are as follows:

1. A definition of the construct to be scaled and the generation of statements for inclusion in an item pool,
2. Selection of type of scaling procedure to be used,
3. Reliability testing of scale properties,
4. Validation of final scale properties.

10.2.1 Development of scale statements

In order to define a research construct properly, a comprehensive literature review and focus group interview were conducted, as described in previous sections. On the basis of these viewpoints and focus group interviews, the components of service quality in automobile aftersales sector in Turkey were defined as including tangibles, reliability, responsiveness, assurance and empathy.

The major components of the constructs were operationalized to include the following factors:

- The Tangibles dimension, including up-to-date equipment, quality of physical environment, neat staff, compatible physical facilities, parking convenience, taking advantage of technology, certificates of quality standards, and a comfortable waiting lounge.
- The Reliability dimension, including delivery of the service at the time promised, sincerity of the staff, trustworthiness, keeping promises, keeping

accurate records, accurate detection of the failure, use of original products, repairs according to procedures, reliable repair work, and personal information security.

- The Responsiveness dimension, including telling customers the exact time of service, quick solution to problems, concerned staff, availability to respond to customers, compatible staff, adequate transportation facilities, qualified labor force, replacement vehicle during repair, equal treatment and attentive service.

- The Assurance dimension, including trustworthy staff, confidence in transactions, politeness of the staff, adequate support from the producer, knowledgeable staff, trained staff, informative explanations, reasonable pricing, and guaranteed maintenance.

- The Empathy dimension, including individual attention, employees' personal attention, understanding the needs of the customers, focus on customer expectations, convenient operating hours, payment options, offering gifts and promotions, and delivery quality.

Following Churchill's (1979) suggestion, once the dimensions were identified, a pool of items needed to be generated for each dimension of the construct.

Based on a review of related literature and the result of a focus group discussion and taking into consideration the Turkish cultural context, these 45 statements were developed for scale design.

10.2.2 Scale selection

A Likert-type scale and percentage rating scale were used for the same statements. The researcher chose to use these scales in order to allow inclusion of a large number of diverse statements that were believed necessary to scale comprehensively and to enable consumers to understand quickly how to respond.

The researcher prepared two questionnaires consisting of 46 questions. These questionnaires include 45 statements and a last question in which the respondent is required to divide 100 points into five dimensions.

10.2.3 Reliability testing of scale properties

Two reliability analyses are conducted for each scale. First, all the items of the reliability test were conducted by computing the coefficient alpha. The coefficient alphas of each scale were computed as follows:

Likert Summated Rating Scale and Split Half Method results are provided in the Appendix A.

Reliability Coefficients:

N of cases = 250 N of Items = 45

Alpha = 0.937

Reliability Coefficients

N of cases = 250 N of Items = 45

Alpha = 0.775

A reliability coefficient of 70% or higher is considered as acceptable in most social science applications. Therefore, it can be assumed that the items of the scale are reliable. It can also be said that our scale is reliable from the results of the Split Half Method. Secondly, each dimension's reliability test was conducted by computing coefficient alphas. Inter-item Correlation Matrix from SPSS is also included in Appendix B.

10.2.4. Validity analysis of scale properties

This study is a refinement of the original ServQual instrument and the pilot study sample was not convenient for validity analysis. The detailed validity analysis of AutoServQual will be covered in the related chapters in the next part with the higher sample size. Here, the validity results of the original ServQual are assumed to be valid to continue the study.

ServQual is a survey study which is based on expectations, perceptions and gap scores. So many studies in the literature evaluate the universality of ServQual, including those of Buttle, 1996; Carman, 1990; Cronin & Taylor, 1994.

Convergent and discriminant validity problems are also noted (Buttle, 1996). Despite the criticisms, the ServQual survey is widely used because of its advantage in providing a basic skeleton for adaptation to fit the specific research needs of various studies in the literature.

To evaluate the validity of the ServQual instrument, understanding the logic of service quality concept is a must. Quality has both subjective and objective dimensions, known as humanistic and mechanistic components (Parasuraman, Zeithaml & Berry (PZB), 1988). Mostly physical attributes are used to measure the

quality of goods by indicators, including number of defects, performance and durability.

On the other hand, service quality is more difficult to examine. Inseparability, heterogeneity, and intangibility of production and consumption features in service quality make service quality measurement difficult. To determine the validity of their ServQual model, PZB (1988) studied five different service categories: credit cards, securities brokerage, long distance telephone calls, retail banking, and lastly, the appliance maintenance and repair sectors.

Additional evidence for the validity of the ServQual is provided by mean difference tests across subject groups formed by overall quality ratings of each attendant firm. They decreased 97 items to 54 items first, and then 34 items by exploratory factor analysis and oblique rotation. Furthermore, the originators of the ServQual survey adapted their 34 items survey to different data sets of four firms and by validity analysis, the number of items decreased to 22, and five factors remained.

The literature also contains examples of comparisons for the validity analysis of original ServQual and adapted versions. Nearly all findings reveal that validity results become better by the adaptation of the ServQual to different countries and different sectors.

Llosa (2007) conducted a literature review of validity results of the original and adapted ServQual studies in five continents and found that the validity results are better in non-English speaking surveys.

Moreover, there are many studies in the literature in which the adapted and/or translated versions of both ServQual and ServPerf give the highest validity scores. This study also uses an adapted ServQual study. The last part of the study will examine the validity of AutoServQual by using a high sample size.

10.3 Survey preparation

This section explains the survey preparation process.

10.3.1 Pilot study survey

The pilot study survey to be used in this thesis was prepared as explained in the previous sections and outsourced for the field study to a professional research firm. They conducted the survey using tablets and face-to-face interviews with people based in the provinces where they lived. In the sections that follow, a detailed distribution of participants according to their provinces is given.

Survey questions were displayed to users in four groups:

- (1) Prerequisite questions,
- (2) Demographics,
- (3) Main survey, including 45 shuffled questions from five dimensions,
- (4) Dimension-specific questions.

This survey was conducted with Turkish customers, so Turkish was the selected survey language. The Turkish version of the survey is translated by the cooperation of businessman and academicians.

Here it is time to talk about the translation of the survey, which was done by the cooperation of a group consisting of four people, including the author. Besides the author, two were business professionals from multinational automobile aftersales companies, and the third person had a graduate degree in English language and literature. The result came from the alternative translations by the group members.

10.3.2 Demographic questions

In addition to ServQual measures, seven questions were inserted into fewer than two groups: The first group consisted of two questions as a prerequisite to continuing the survey. If the answer for both questions was "Yes," then the interviewer continued to other questions. The first group of questionnaires was used to ensure that the respondents were in the population of targeted automobile aftersales customers. The two starting questions of our survey were:

Q1. Do you have an automobile?

Q2. Have you ever taken your car to a car-service ?

Afterwards, demographic questions were presented. Questions three to seven were demographic questions designed to collect demographic characteristics of the sample. The second groups of questions which aim to identify the basic characteristics of the sample are gender (Q3), age (Q4), province of residence (Q5), occupation (Q6), income level (Q7).

10.3.3 AutoServQual scale pilot survey questions

The original ServQual scale was developed by Parasuraman et al. (1988) for four different services. Then subsequent studies used the ServQual, either by removing some irrelevant questions or adapting questions according to the sector and country in which the survey was to be conducted.

The original ServQual model has 22 questions in five dimensions.

1) Tangibles (4 questions)

Up-to-Date Equipment

Quality of Physical Facilities

Neatly Dressed Staff

Compatible Physical Materials

2) Reliability (5 questions)

Delivery of the Service at the Time Promised

Sincerity of the Staff (Sympathetic and Reassuring)

Trustworthiness

Keeping Promises

Keeping Accurate Records

3) Responsiveness (4 questions)

Telling Customers the Exact Time of Service

Quick Solution to Problems (Prompt Service)

Concerned Staff (Willing to help customers)

Availability to Respond to Customers

4) Assurance (4 questions)

Trustworthy Staff

Confidence in Transactions

Politeness of the Staff

Adequate Support from the Producer

5) Empathy (5 questions)

Individual Attention

Employees' Personal Attention

Understanding the Needs of the Customers

Focus on Customer Expectations

Convenient Operating Hours

To begin with, the tangibles dimension contains items which measure the up-to-date equipment, quality of physical environment, neatly-dressed staff, and compatible physical facilities. In this study, the original ServQual tangibles factor questions are deployed as the same, without any adaptation or addition and are kept as they were in the original ServQual study.

Therefore, four more questions were added to the survey parking convenience, taking advantage of technology, certificates of quality standards, and comfortable waiting lounge. Table 19, 20, 21, 22, and 23 are showing the dimension based explanations.

Table 19. Tangibles Dimension

Abbreviation	Original Question	Survey Question
	Questions Coming From ServQual	
TAN1	Up-to-Date Equipment	Modern Görünümlü Ekipmanlar
TAN2	Quality of Physical Facilities	Fiziki Mekan Kalitesi
TAN3	Neat Dressed Staff	Temiz Görünümlü Personel
TAN4	Compatible Physical Materials	Uyumlu ve Anlaşılır Materyaller
ekTAN1	Questions Added to ServQual Parking Convenience	Park Etme Kolaylığı Teknolojik İmkanlardan Yararlanma
ekTAN2	Taking Advantage of Technology	
ekTAN3	Certificate of Quality Standards	Kalite Standartları Belgesi
ekTAN4	Comfortable Waiting Lounge	Konforlu Bekleme Salonu

The Tangibles dimension questions were translated into Turkish by explanatory additions without changing their meaning. The TAN4 question was elaborated to exactly measure what it purposes in terms of automobile aftersales sector. It aimed to ask if the service materials were clearly understood and were keeping up with the service provided.

The ekTAN1 question was asked in the survey with the addition of easiness of entry and exit to better reflect the main purpose of the question.

The question ekTAN2 measured the level of technology integration to the service processes and the question ekTAN3 included examples of abbreviations of these quality standards certificates (TSE: Turkish Standardization Institute, ISO: International Organization for Standardization) to remind the respondents of these documents.

Lastly, the ekTAN4 question asked about the comfort of reception and waiting lounge.

On the other hand, the Reliability dimension contains items which measure delivery of the service at the time promised, sincerity of the staff, trustworthiness, keeping promises, keeping accurate records.

In this study, the original ServQual reliability factor questions were deployed without any adaptation or addition and are kept as in the original ServQual study.

Therefore, five more questions were added to survey measuring reliability dimension: accurate detection of the failure, use of original products, repairs according to procedures, reliable repair work, and personal information security.

Table 20. Reliability Dimension

Abbreviation	Original Question	Survey Question
	Questions Coming From ServQual	
REL1	Delivery of the Service at the Time Promised	İşlemin belirlenen sürede bitirilmesi
REL2	Sincerity of the Staff (Sympathetic and Reassuring)	Müşteriye Karşı Anlayışlı ve Rahatlatıcı Davranılması
REL3	Trustworthiness	Güvenilirlik
REL4	Keeping Promises	Verilen Sözlerin Tutulması
REL5	Keeping Accurate Records	Kayıtların Hatasız Tutulması
	Questions Added to ServQual	
ekREL1	Accurate Detection of Failure	Arızanın ve Bedelinin Doğru Analizi
ekREL2	Use of Original Products	Orijinal Ürün Kullanılması
ekREL3	Repairs According to Procedures	Prosedüre Uygun Onarım
ekREL4	Reliable Repair work	Hatasız ve Güvenilir Onarım
ekREL5	Personal Information Security	Tutulan Kayıtların Güvenliği

The Reliability dimension includes ten questions which were translated into Turkish without changing their meaning. The REL2 question was about being sympathetic and reassuring which is expressed as sincerity of the staff in English but translated just the same in the Turkish survey to exactly measure what it purports to measure in the automobile aftersales sector.

The ekREL1 was often mentioned in focus groups, about the failure to accurately detect faults by the service station and the tendency towards unnecessary part replacement and repeated repairs.

This question also includes opinions on the pre-arranged price of the repair, which should be explained to the customer before the service process begins.

Other ekREL items all came from previous studies about Reliability dimension of automobile aftersales sector. ekREL5 measures the importance of the security of the information taken from customers during the aftersales processes.

The responsiveness dimension contains items measuring telling customers the exact time of service, quick solution to problems, concerned staff, availability to respond to customers.

In this study, original ServQual responsiveness factor questions were kept the same as in the original study without any ServQual adaptation or addition.

Therefore, five more questions were added to the survey which measured the reliability dimension. These questions are compatible staff, adequate transportation facilities, qualified labor force, replacement vehicle during repair, equal treatment and attentive service.

Table 21. Responsiveness Dimension

Abbreviation	Original Question	Survey Question
	Questions Coming From ServQual	
RES1	Telling Customers Exactly the Time of Service	Tam Olarak Servis Zamanının Bildirmek
RES2	Quick Solution to Problems (Prompt Service)	Müşteri Taleplerine Hızlı Cevap Vermek
RES3	Concerned Staff (Willing to help customers)	Müşteriye Yardımcı Olmaya Her Zaman İstekli Olmak
RES4	Availability to Respond to Customers	Müşteri Taleplerine Cevap Veremeyecek Kadar Yoğun Olmamak
ekRES1	Questions Added to ServQual	
	Compatible Staff	Uyumlu Çalışan Personel
ekRES2	Adequate Transportation Facilities	Alternatif Ulaşım Olanakları
ekRES3	Qualified Labor Force	Gelen Taleplere Hızlı ve Yeterli Cevaplar Verebilmek
ekRES4	Replacement Vehicle During Repair	Yedek Araç Verilmesi
ekRES5	Equal Treatment	Müşterilere Eşit Muamele
ekRES6	Attentive Service	Dikkatli ve Özenli Çalışma

The Responsiveness dimension includes ten questions including four from the original ServQual items and six questions added by this study. These questions were translated into Turkish without changing their meaning. The RES2 question was about giving prompt service, which means a quick solution to vehicle problems in the automobiles aftersales sector.

The res3 question about the willingness of the employees to help customers is regarded as concerned staff in our study, but this item was directly translated into Turkish in our survey to exactly measure what it purposed in the ServQual.

As mentioned above, questions added to ServQual came from the focus groups and ekRES1 is about the compatibility of the staff, one with the other. Like other service businesses, automobile aftersales services also require cooperation among the staff.

For the car services sector, one of the main problems is leaving the car at the service and returning by alternative transportation, which we tried to measure in ekRES2, which is also related to the same issue in terms of long-term repairs.

There are many issues about car service that need qualified service staff, including dealing with telephone calls regarding any failures or questions about vehicles. Here, ekRES3 measures the importance of having a qualified labor force. The ekRES5, which is about the equal treatment of customers by the personnel, was also often mentioned in focus groups. Finally, the ekRES item is about the carefulness of the staff.

The Assurance dimension contains items which measure the trustworthiness of staff, confidence in transactions, politeness of the staff, and adequate support from the producer. In this study, original ServQual assurance factor questions were deployed without any adaptation or addition and were kept as in the original ServQual study.

Therefore, five more questions were added to survey measuring assurance dimension: knowledgeable staff, trained staff, informative explanations, reasonable pricing, and guaranteed maintenance.

Table 22. Assurance Dimension

Abbreviation	Original Question	Survey Question
ASS1	Questions Coming From ServQual Trustworthy Staff	Güvenilir Olmak İşlemlerde Güvende Hissetmek
ASS2	Confidence in Transactions	Personelin Kibarlığı
ASS3	Politeness of the Staff	
ASS4	Adequate Support From the Producer Questions Added to ServQual	Üretici Firma Desteği
ekASS1	Knowledgeable Staff	Bilgili Personel
ekASS2	Trained Staff	Eğitimli Personel
ekASS3	Informative Explanations	Aydınlatıcı Açıklamalar
ekASS4	Reasonable Pricing	Ücret-Hizmet Dengesi
ekASS5	Guaranteed Maintenance	Garantili Onarım

The Assurance dimension includes nine questions which include four from the original ServQual items and five questions added by this study. These questions were translated into Turkish without changing their meaning. The ASS1, ASS2 and ASS3 questions are about the staff being trustworthy, polite and making the customer feel confident. The ASS4 item is about adequate support by the firms, which translates as the producer company in our survey because of the dealership system of the automobile aftersales sector.

The vehicle is produced by a company and sold by others, so the technical support given by the producer to the dealers is required to have higher service quality. Questions added to ServQual for the Assurance dimension also came from the focus groups. Items ekASS1 and ekASS2 are about the knowledge and training level of the staff, whereas the ekASS3 concerned the level of explanation about the service. As in all services, reasonable pricing is important in automobile aftersales, and is included in our study as ekASS4. Lastly, ekASS5 is about the guaranteed maintenance of the processes done in automobile aftersales services.

The empathy dimension contains items which measured individual attention, employees' personal attention, understanding the needs of the customers, focus on customer expectations, and convenient operating hours. In this study, the original ServQual empathy factor questions were deployed without any adaptation or addition and were kept as in the original ServQual study. However, three more questions were added to survey measuring assurance dimension: payment options, offering gifts and promotions, and delivery quality.

Table 23. Empathy Dimension

Abbreviation	Original Question	Survey Question
	Questions Coming From ServQual	
EMP1	Individual Attention	Bireysel İlgî
EMP2	Employees' Personal Attention	Kişisel Olarak İlgili Personel
EMP3	Understanding the Needs of Customers	Müşteri İhtiyaçlarını Anlamak Müşteri Beklentisine Odaklanmak
EMP4	Focus on Customer Expectations	Uygun Çalışma Saatleri
EMP5	Convenient Operating Hours	
	Questions Added to ServQual	
ekEMP1	Payment Options	Ödeme Alternatifleri Hediye ve Promosyon Önerilmesi
ekEMP2	Offering Gifts and Promotions	
ekEMP3	Delivery Quality	Kaliteli Teslimat

The empathy dimension includes eight questions, five from the original ServQual items and three questions added by this study. These questions were translated into Turkish carefully without changing their meaning. The EMP1 and EMP2 items measure similar concepts from different perspectives.

The first question measures the attention of the service provider, whereas the second examines the attention of the employees. EMP3 and EMP4 are about understanding the needs of customers and focusing on customer expectations. The last original question is about convenient operating hours for all customers.

The three added items are about payment options in the service, offering gifts and promotions after the processes, and clean delivery of the vehicle after the service

process. After the item generation process, there were 45 questions in AutoServQual, which is the basis of this part of the study. This expansion includes 23 questions in different dimensions.

Item generation is explained above and the dimension distribution of the items was also done by the expert opinion of a group which consisted of three people, two business professionals and one academician, in addition to the author. Expanded ServQual, in other words, the pilot study of AutoServQual, included 45 questions from the same five dimensions.

1) Tangibles (8 questions)

Up-to-Date Equipment,

Quality of Physical Facilities,

Neatly Dressed Staff,

Compatible Physical Materials,

Parking Convenience,

Taking Advantage of Technology,

Certificate of Quality Standards,

Comfortable Waiting Lounge,

2) Reliability (10 questions)

Delivery of the Service at the Time Promised,

Sincerity of the Staff (Sympathetic and Reassuring),

Trustworthiness,

Keeping Promises,

Keeping Accurate Records,

Accurate detection of Failure,

Use of Original Products,

Repairing According to Procedures,

Reliable Repairs,

Personal Information Security,

3) Responsiveness (10 questions)

Telling Customers the Exact Time of Service,

Quick Solution to Problems (Prompt Service),

Concerned Staff (Willing to help customers),

Availability to Respond to Customers,

Compatible Staff,

Adequate Transportation Facilities,

Qualified Labor Force,

Replacement Vehicle during Repair,

Equal Treatment,

Attentive Service,

4) Assurance (9 questions)

Trustworthy Staff,

Confidence in Transactions,

Politeness of the Staff,

Adequate Support from the Producer,

Knowledgeable Staff,

Trained Staff,

Informative Explanations,

Reasonable Pricing,

Guaranteed Maintenance,

5) Empathy (8 questions)

Individual Attention,

Employees' Personal Attention,

Understanding the Needs of the Customers,

Focus on Customer Expectations,

Convenient Operating Hours,

Payment Options,

Offering Gifts and Promotions,

Delivery Quality,

10.4 Implementing the pilot survey and adjusting the scale

This section includes the sampling frame, characteristics of the respondents in pilot study, scale development steps, factor analysis, variability and purification of the AutoServQual items and dimensions.

10.4.1 Sampling frame

In general, when it is impossible to take measurements from all of the population, two main types of sampling techniques are available, namely, nonprobability and probability.

Nonprobability sampling is a technique which does not use chance selection procedures. Selection of these techniques relies on the personal judgment of the researchers. On the other hand, probability sampling is a sampling procedure in which each member of the population has a fixed probabilistic chance of being selected for the sample (Malhotra, 1993).

Probability sampling methods have two things in common: firstly, random selection is involved to some point and, secondly, each element has a known nonzero probability of being sampled. The main examples of probability sampling methods are:

- A. Multistage Sampling,
- B. Cluster Sampling,
- C. Probability Proportional to Size Sampling,
- D. Stratified Sampling,
- E. Simple Random Sampling, and
- F. Systematic Sampling.

The population in this research consisted of customers that were servicing their vehicles at various dealerships throughout the country. Stratified sampling has many potential benefits according to Freedman (1984).

Firstly, dividing the population into distinct, independent strata can enable researchers to draw inferences about specific subgroups that may be lost in a more generalized random sample.

Secondly, utilizing a stratified sampling method can lead to more efficient statistical estimates. Finally, since each stratum is treated as an independent population, different sampling approaches can be applied to different strata, potentially enabling researchers to use the approach best suited for each identified subgroup within the population (Edward et al., 2014).

So, to reflect the Turkish aftersales customer population better, stratified random sampling method was selected. AutoServQual has to come from ideas that reflect not only particular districts, but the overall population of Turkey. Strata are combined according to the Turkish population, as shown in Table 24.

10.4.2 Number of respondents based on districts

The number of respondents from all regions of Turkey was included in this study. Table 24 shows the distribution of the pilot study sample.

Table 24. Number of Respondents in Pilot Study

AutoServQual Pilot Study Stratified Sample				
#	District	Population	Ratio	Number of Respondents
1	İstanbul	14.377.018	18.50%	46
2	Western Marmara	3.351.582	4.31%	11
3	Aegean	10.023.549	12.90%	32
4	Eastern Marmara	7.332.137	9.44%	24
5	Western Anatolia	7.499.242	9.65%	24
6	Mediterranean	9.906.771	12.75%	32
7	West part of Middle Anatolia	3.886.251	5.00%	13
8	Western Black Sea	4.493.559	5.78%	14
9	Eastern Black Sea	2.566.840	3.30%	8
10	Northeast Anatolia	2.206.326	2.84%	7
11	East part of Middle Anatolia	3.801.911	4.89%	12
12	Southeast Anatolia	8.250.718	10.62%	27
Total		77.695.904		250

Target Sampling was done according to the Turkish population and, as explained above, the number of respondents was determined in accordance with the population of the districts. This sample was the target sample, but it may differ slightly from the results because we found the respondents according to these strata, but these respondents might have been living in another city, for which reason the city results might not be the same because of the difference between the city where the surveys were conducted and the city where the respondents lived.

The research showed that from 312 people. Sixty-two were eliminated by the first two prerequisite questions. When we examine the basic characteristics of the sample, it is seen that there were 137 males and 113 females.

The age distribution showing the number of respondents and age distribution showing the percentage of respondents is provided in Table 25 and Table 26.

Table 25. Age Distribution Figures in Pilot Study

	18-24	25-40	41-55	56-	Total
Males	10	72	45	10	137
Females	10	59	36	8	113
Total	20	131	81	18	250

Table 26. Age Distribution Percentages in Pilot Study

	18-24	25-40	41-55	56-	Total
Males	4%	29%	18%	4%	55%
Females	4%	24%	14%	3%	45%
Total	8%	52%	32%	7%	100%

As seen from Table 26, 52% of the respondents were aged between 25 and 40, and a detailed examination showed that 53% of the males and 52% of the females were aged between 25 and 40. The minimum ratios came from the 18-24 and 56- age groups.

Respondents younger than 25, but having a car and visiting a car service constituted 8% of the sample. As car ownership started by the mid-twenties, this is a

result of the eliminating questions. The table 27 is about the income level distribution of the respondents and Table 28 shows the percentages.

Table 27. Income Level Distribution (Number of Respondents)

	0-1000	1000-2500	2501-4000	4000+	Total
Males	1	36	57	43	137
Females	1	26	63	23	113
Total	2	62	120	66	250

Table 28. Income Level Distribution (Percentage of Respondents)

	0-1000	1000-2500	2501-4000	4000+	Total
Males	0.4%	14%	23%	17%	55%
Females	0.4%	10%	25%	9%	45%
Total	1%	25%	48%	26%	100%

The income level distribution tables show the respondents' income level, the most crowded category of which is the 2501-4000 TL level, which has 23% of the males and 25% of the females. Again, the smallest income category has a very low percentage, which may be a result of prerequisite questions, which eliminated respondents who did not have a car.

In Turkey it is impossible to own a car at such a low income level. Another interesting point is the 17% of males who have more than 4000 TL income. Here females are 9%. Table 29 shows the cities where the respondents lived.

Table 29. Distribution of the Respondents by City

City	Percentage	Males	Percentage	Females	Percentage
ADANA	13%	23	9%	9	4%
ANKARA	10%	9	4%	15	6%
BURSA	10%	12	5%	12	5%
EDIRNE	4%	6	2%	5	2%
ELAZIG	2%	2	1%	2	1%
ERZURUM	3%	5	2%	2	1%
GAZIANTEP	11%	10	4%	17	7%
ISTANBUL	18%	22	9%	24	10%
IZMIR	13%	21	8%	11	4%
MALATYA	3%	6	2%	2	1%
SAMSUN	6%	10	4%	6	2%
SIVAS	4%	6	2%	5	2%
TRABZON	3%	5	2%	3	1%
Total	100%	137	55%	113	45%

Istanbul is the leading city in the female category and the second city in the male category. Adana has the greatest number of male respondents. There are respondents from all parts of Turkey.

On the other hand, Istanbul and Izmir have the next highest number of male respondents, while Gaziantep and Ankara have the next highest number of female respondents.

This variety might be because of inter-strata differences and might help the variance of the sample, which is a reflection of the population. The last statistics concern the professions that had the highest ratios among our pilot study respondents. Table 30 shows the gender distribution of the respondents.

Table 30. Gender Distribution of the Respondents

	Males		Females	
	# of Respondents	Profession	# of Respondents	Profession
1	14	Student	16	Student
2	12	Retired	13	Retired
3	10	Businessman	10	Officer
4	9	Engineer	8	Teacher
5	8	Officer	6	Nurse

The first two rankings are the same in both genders. Students are the highest number and retired people come next in both the male and female categories. Officers rank 5th in the male and 3rd in the female category.

Businessmen and engineers rank 3rd and 4th in the male category, whereas teacher and nurse rank 4th and 5th in the female category

Here, another important issue is that there is no profession that dominates our study, because in both parts when the percentage of the highest occupations was calculated, the result was less than 10%, which shows a good diversity in terms of participants' profession.

10.4.3 Survey method selection

In this part, we explain the survey method selection of the pilot study of AutoServQual scale in Turkey. As mentioned above, the draft or pilot study of AutoServQual scale has 46 questions which were to be eliminated after the pilot study. Here, there are many alternatives for conducting the survey with respondents.

Churchill (1979) lists three methods of administering survey questionnaires: personal interview, telephone interview, and mail questionnaire. All these alternatives have advantages and disadvantages. The most expensive one is generally personal interview because this method, which is also known as face-to-face survey, can be utilized for a specific population by many researchers at the same time.

The researchers often prefer the personal interview method because of its many advantages. High response rates are the first advantage. The next advantage is higher tolerance for longer surveys, which was the main need in our survey.

The great number of questions in the pilot study of AutoServQual forced us to select face-to-face survey despite its high cost. One of the most successful companies in Turkey was selected and the survey was conducted professionally in each district of Turkey and the results were reported to the authors.

Because of its cost-effectiveness and efficiency advantages, another method for administering survey questionnaires became popular. This new system uses the advantages of electronic means (e-mail or online questionnaire software). Table 31 includes a number of considerations concerning the different survey methods (Malhotra, 1993).

Table 31. Comparison of Survey Methods

Type of the Survey	By phone	By Interviews at Home	By Interviews at Mall	By Mail Surveys	By E-Mail	By Online Methods
Data collection flexibility	Medium to high	High	High	Low	Low	Medium to high
Question diversity	Low	High	High	Medium	Medium	Medium to high
Physical stimuli use	Low	Medium to high	High	Medium	Low	Medium
Control of sample	Medium to high	Potentially high	Medium	Low	Low	Low to medium
Data collection environment control	Medium	Medium to high	High	Low	Low	Low
Field force control	Medium	Low	Medium	High	High	High
Data quantity	Low	High	Medium	Medium	Medium	Medium
Rate of response	Medium	High	High	Low	Low	Very Low
Respondent anonymity	Medium	Low	Low	High	Medium	High
Obtaining sensitive information	High	Low	Low	High	Medium	High
Interviewer bias potential	Medium	High	High	None	None	None
Speed	High	Medium	Medium to high	Low	High	Very high
Cost	Medium	High	Medium to high	Low	Low	Low

According to the information gathered by our research company, in-home and mall interviews are the most expensive alternatives, and our study was conducted in these two categories. As Malhotra (1993) states, face-to-face interviews are high in response rates and are more convenient for a greater number of questions. These advantages determined our survey method selection for the pilot study of AutoServQual.

10.4.4 Purification and reliability of the items

As mentioned in previous chapters, numerous methods regarding item analysis can be found in the literature, but, of course, multidimensional analysis is the ultimate item analytic procedure.

Researchers need not go so far as to factor-analyze their data to select items to be included or discarded, but an item inter-correlation matrix (on perhaps a small subsample or pretest sample) can be a simple and convenient surrogate for determining which items to include, particularly when using most of the statistical packages available for personal computers (Robinson et al., 1991).

This technique was also implemented in our study where iterative factor analysis, which will be explained later, was used. Four stage elimination procedures were followed.

First, we eliminated the highly correlated items; next came the overall factor and reliability analysis; then factor and reliability analysis for five separate dimensions was applied, and finally overall factor and reliability analysis with the remaining variables determined the scale. In the first step, an inter-item correlation matrix of all items was listed and the list is provided in Appendix C Table 86.

Thus, highly correlated items are assumed to measure similar concepts, so the elimination started with these items. Highly correlated items came mainly from the same dimensions, so this was the result of questions with excess detail.

The expert opinions of a group consisting of four people—the author, the advisor and two aftersales business professionals—who eliminated the following

questions because of their high correlation scores are TAN1, TAN2, TAN3, and TAN4.

Involved in the first stage of the scale purification was the entire 45-item instrument whose coefficient alpha was calculated (Cronbach, 1951), according to Churchill's (1979) recommendations. In the first step, the multi-item correlation scores decreased the number of items to 38. These results constituted the first phase of our reliability analysis; the second step is overall factor and reliability analysis.

Berthon (2005) advises the elimination of all items whose corrected item-to-total correlation is less than 0.40 in their study. In our study the consensus was to eliminate the items that had a value less than 0.30, resulting in the removal of four items. Factor analysis results are provided in Appendix D.

Thus, the second phase of our scale purification includes the elimination of the items whose corrected item total correlation was less than 0.30, which resulted in the exclusion of a further four items. This process left a total of 34 items by the end of the second step.

In the second step, four items were deleted according to their corrected item-total correlation value. The third step is the factor and reliability analysis for five separate dimensions. All dimensions' results are shown in the following tables. Here, the only elimination came from reliability dimension because of the rotated matrix of the reliability dimension.

All other dimension had no problem in rotated component matrix figures except reliability, which showed no problems only after the elimination of REL1, REL2 and REL3.

The results for the third step, overall factor and reliability analysis, are shown in the following SPSS results figures.

Finally, overall factor and reliability analysis of the remaining items is processed by SPSS and the results allowed three more dimensions to be eliminated, which reduced the number of remaining dimensions to 28. The pilot study of AutoServQual has 45 questions from five dimensions, whereas after the factor and reliability analysis this number becomes 28, including all five dimensions.

CHAPTER 11

AUTOSERVQUAL SCALE

As explained above, iterative processes revised the AutoServQual and the updated version consisted of five dimensions and included 28 questions.

The first step was to eliminate very highly correlated items and this resulted in the elimination of seven items. The second step was to examine the overall factor and reliability analysis and we looked at the corrected item total correlation results resulted in the elimination of four more items.

The third step was to evaluate each dimension separately; three items were deleted after this process. The fourth and the last step was to consider overall factor and reliability analysis for the remaining 31 items. The result was to delete three more items. After all these processes, the eliminated questions and those remaining are given below.

Table 32 shows all the details about the finalized version of AutoServQual and includes all the items with their specific dimensions and also gives information about the processes taken for the elimination. It is obvious that the tables also show the updated version of AutoServQual, which is to be used in further analysis in this study.

Table 32. Finalized AutoServQual

Abbreviation	Item	Update Status
TAN1	Up-to-Date Equipment	Eliminated, Step 2
TAN2	Quality of Physical Facilities	Eliminated, Step 2
TAN3	Neatly Dressed Staff	Eliminated, Step 2
TAN4	Compatible Physical Materials	Eliminated, Step 2
REL1	Delivery of the Service at the Time Promised	Eliminated, Step 3
REL2	Sincerity of the Staff (Sympathetic and Reassuring)	Eliminated, Step 3
REL3	Trustworthiness	Eliminated, Step 3
REL4	Keeping Promises	Modified
REL5	Keep Accurate Records	Remained the same
RES1	Telling Customers Exactly the Time of Service	Modified
RES2	Quick Solution to Problems (Prompt Service)	Eliminated, Step 4
RES3	Concerned Staff (Willing to help customers)	Remained the same
RES4	Availability to Respond to Customers	Remained the same
ASS1	Trustworthy Staff	Eliminated, Step 1
ASS2	Confidence in Transactions	Modified
ASS3	Politeness of the Staff	Modified
ASS4	Adequate Support from the Producer	Eliminated, Step 1
EMP1	Individual Attention	Remained the same
EMP2	Employees' Personal Attention	Eliminated, Step 1
EMP3	Understanding the Needs of the Customers	Modified
EMP4	Focus on Customer Expectations	Eliminated, Step 1
EMP5	Convenient Operating Hours	Eliminated, Step 4
ekTAN1	Parking Convenience	Modified
ekTAN2	Taking Advantage of Technology	Modified
ekTAN3	Certificate of Quality Standards	Modified
ekTAN4	Comfortable Waiting Lounge	Modified
ekREL1	Accurate Detection of Failure	Remained the same
ekREL2	Use of Original Products	Modified
ekREL3	Repairing According to Procedures	Eliminated, Step 4
ekREL4	Reliable Repairing	Remained the same
ekREL5	Personal Information Security	Remained the same
ekRES1	Compatible Staff	Remained the same
ekRES2	Adequate Transportation Facilities	Remained the same
ekRES3	Qualified Labor Force	Modified
ekRES4	Replacement Vehicle During Repair	Eliminated, Step 1
ekRES5	Equal Treatment	Modified
ekRES6	Attentive Service	Remained the same
ekASS1	Knowledgeable Staff	Remained the same
ekASS2	Trained Staff	Eliminated, Step 1
ekASS3	Informative Explanations	Remained the same
ekASS4	Reasonable Pricing	Remained the same
ekASS5	Guaranteed Maintenance	Eliminated, Step 1
ekEMP1	Payment Options	Remained the same
ekEMP2	Offering Gifts and Promotions	Modified
ekEMP3	Delivery Quality	Remained the same

AutoServQual emerged by using many processes. We followed many recommendations from the literature for scale construction and evaluation, as

comprehensively described in previous sections. The tangibles dimension consists of only added items, so these added items were modified in accordance with the opinions of the author and experts. The reliability and responsiveness dimensions show a combination of original ServQual items and added items. The assurance and empathy dimensions both include two items from the original ServQual scale and three items are added to these dimensions in this study.

AutoServQual has five dimensions, the same as the original ServQual scale; in the processed version, the tangibles dimension includes four modified variables, the reliability dimension includes one modified and one original ServQual items and four added items. The responsiveness dimension consists of three original ServQual items, one of them modified, and five added items. The assurance and empathy dimensions accommodate two original ServQual items with three recently added items. Following these changes, the updated AutoServQual for Turkish automobile aftersales customers was as follows:

1) Tangibles (4 questions)

Entry-Exit and Parking Convenience,

Take Advantage of Technology,

Certificate of Quality Standards,

Visually Appealing Waiting Lounge,

2) Reliability (6 questions)

Keeping Promises on Timing,

Keep Accurate Records,

Accurate Detection of Failure,

Use of Only Original Products,

Reliable Repairing,

Personal Information Security,

3) Responsiveness (8 questions)

Telling Customers the Exact Time of the Service,

Concerned Staff (willing to help customers),

Availability to Respond to Customers,

Compatible Staff,

Adequate Transportation Facilities,

Qualified Labor Force,

Equal Treatment,

Attentive Service,

4) Assurance (5 questions)

Confidence in Transactions,

Politeness of the Staff,

Knowledgeable Staff,

Informative Explanations,

Reasonable Pricing,

5) Empathy (5 questions)

Individual Attention,

Knowing the Needs of the Customers,

Payment Options,

Offering Gifts and Promotions,

Delivery Quality,

In the updated AutoServQual version, two prerequisite questions remain the same but a third question was added:

Q3. Select the car brand service station that you visit most frequently.

The brand of the car service station selected in Q3 was inserted into the following AutoServQual questions as a variable, and the respondent identified his/her defined car brand every time (s)he answered the questions .

Thus, the demographic questions' number started from number 4 instead of number 3. Moreover, one more demographic question was added which asked about the education level of the respondents. After the adjustments, the AutoServQual was ready to measure the service quality level of Turkish automobile aftersales customers in Turkey.

The next part will look for the results of this survey, which was conducted with the participation of aftersales customers of various automobile brands in Turkey. The updated and final version of AutoServQual is given inside this study.

CHAPTER 12

ASSESSMENT OF AUTOSERVQUAL IN TURKEY

The last part of our study aims to assess AutoServQual in the Turkish automobile aftersales customers empirically. The outline of this part includes a brief explanation about the automobile sector in Turkey, which examines automobile sales, automobile service and spare parts issues separately.

Then, the survey and the sample are explained. The research results given in the next chapter include item and brand-based detailed results, reliability and validity analysis of the scale, exploratory factor analysis and confirmatory factor analysis. Lastly, the conclusion and further discussions are also included in this part of the study.

The automotive industry in Turkey emerged for the purpose of import substitution in the 1960s and gained great velocity, especially after the Customs Union Agreement. In its short history, the Turkish automotive sector has become one of the major production centers and in terms of export volume this sector is the leader among other sectors in Turkey. On the other hand, the aftersales business is of great importance in the literature in terms of gaining lifelong consumers (Egonsson, 2013).

The relationship between a customer and a company was based on a product centric view; nevertheless, today there is an interactive relationship between these two parties. Ultimately, spare parts distribution and sales is another important and critical subject when the automobile sector is examined. All these subsectors of automotive industry are explained in the related chapter of this study.

The survey of this study includes the data of 30 brands from Turkey automobile aftersales market, which captures more than 97% of the Turkish automobile aftersales industry. As we saw from the previous part of our study, the body section of the updated AutoServQual includes 28 questions. The average values of each question are calculated for each brand and we describe the highest and the lowest score for each question in the related section.

The subject of the next chapter is an examination of all results, item by item, to show the strong and weak aspects of each brand in the automobile aftersales business in Turkey. The highest and lowest scores of each dimension are explained. Furthermore, information on the scores of each brand, ranked from the highest to the lowest brands, will be supplied.

As in many other industries, in the automobile aftersales business, the competition level is very high, so these results aim to provide information to the related parties in order to evaluate and improve their performance by showing their weak points in accordance with the views of their own customers who visited their aftersales service stations.

Lastly, the item-based results are explained in the research results section. A reliability and validity analysis was conducted. In addition, structural equation modeling techniques, including exploratory factor analysis and confirmatory factor analysis, were applied and explained in steps. For these calculations, Microsoft Excel, SPSS and Amos software were used. This part of the study contributes to the literature the empirical assessments of a scale which has been developed for automobile aftersales customers and also notifies automobile brands in Turkey about their aftersales performance through the eyes of their customers.

CHAPTER 13

AUTOMOBILE SECTOR IN TURKEY

The automobile sector in Turkey is the main subject of this chapter. Subsections are automobile sales, automobile aftersales and automobile spare parts. We start with the automobile sales.

13.1 Automobile sales

This part briefly explains one of the main motivators of the automobile sector, which is automobile sales division. Without the sale of automobiles, nobody can consider aftersales and/or spare parts.

13.1.1 Sector

The automotive industry, which began to develop in Europe in the eighteenth century, continued this development in twentieth century through the increased use of production line and mass production systems. The United States was the pioneering country in terms of these technological production systems.

On the other hand, the lean production system, which was originated in Japan in the 1960s, gave Asian countries the opportunity to catch up with European and US technology and also to have high export volumes in terms of the automobile industry. According to data gathered from OICA (the Organisation Internationale des Constructeurs d'Automobiles: International Organization of Motor Vehicle

Manufacturers), the yearly total production in the automotive sector in 2000 was more than 58 million, and these units increased by 44% to a total of more than 84 million in 2013.

Furthermore, 75% of the production consists of automobiles for private use, while the remaining part is the total of other types, including light and heavy commercial vehicles, motorcycles, minibuses, trucks, buses, and so on. The global automotive industry was significantly affected by the economic crisis in 2008, but rebounded in 2010 with a demand increase of 13%, and sales reached more than 81 million units in 2012 (Source: Turkish Competition Authority).

In Turkey the automotive industry started for the purpose of import substitution in the 1960s and gained great momentum, especially after the Customs Union Agreement. In recent years, the Turkish automotive sector has become one of the major production centers and this sector is the leader among other sectors in Turkey in terms of export volume. In Turkey there are also many production facilities for important global brands in the automobile industry.

Today, twelve important brands have factories in Turkey and 63 brands are represented through 39 companies. The motor vehicle (automotive) industry in our country shows a tendency towards growth.

When the period from 2002 to 2012 is analyzed, it is obvious that the total number of motor vehicles in the car park has steadily increased. This increase also reflects demand and is affected by many macro and micro economic factors. The macroeconomic factors may be economic crisis, growth, real income growth, and general competitiveness, whereas the microeconomic factors may include the campaign policies of the providers and the level of competitiveness of the sector.

According to the reports of Turkish Competition Authority, a significant portion of imported vehicles are seen in the new vehicles sales figures. When we view the period from 2003 to 2013, we see that 68% of the passenger-car market, 45% of light commercial vehicles, and 29% of heavy commercial vehicles consist of imported vehicles.

The overall average of the industry in terms of imported vehicle ratio for the same period is 57%. In Turkey the average age of a car is high. For 2012, the average age for a car in our country is twelve years. When examined in segment-based details, only the truck average age is under 10 years; other segments have an average age of over 10. According to TUIK (Türkiye İstatistik Kurumu, English: Turkish Statistical Institute), 43% of passenger vehicles and 31% of commercial vehicles in Turkey are over ten years old.

On the other hand, when we look at the statistics for price increase in the automotive industry, we observe that the high competitiveness of the market caused a lower price increase than the inflation rate from 2002 to 2012. Besides, the profit margins side being the same, it is seen that profit margins have generally diminished in the same period. Here, the point is that profit margins obtained from sales in the automotive sector are lower than the profit margin obtained from after-sales operations, despite the high gross sales figures in sales.

Thus, the suppliers and also the dealers have to place more importance on their after-sales activities to make higher profits. The average profit margin of suppliers between the years 2003-2013 was 4.16% in unused car sales divisions, and 23.58% in spare parts sales. When the 2003-2006 and 2007-2013 periods are compared, it is obvious that the profit margins in unused car sales decreased, and this

may be the result of great competition among the car brands in the Turkish market. Despite the decrease in profit margins of unused car sales, the margins for the after-sales division showed a trend towards increase.

The profit margin in spare parts sales increased as a result of the effect of the subsidy in the lost profits in sales divisions. The same scenario is valid for the dealers. Despite the high income from car selling, the suppliers and dealers make low profits, but on the other hand, they get higher profits from the after-sales processes.

Thus, the most important issue is to understand that the sale of a car is a prerequisite for having an after-sales income. So the companies ignore the profits in car sales in order to make customers buy their brands so as to gain after-sales income from those customers. This strategy defeats the aim of profit margins in new car sales sector. In Turkey, 90% of the dealers are placed in category 3S (Sales – Service – Spare Parts) plazas, which means that they all have unused car sales, mechanic services, body service, spare parts distribution and sales departments. Thus, they can absorb the loss of one department by profits from the other.

The automotive sector in Turkey is a dynamic and growing sector. Although, there were economic crises in the last decade, the automotive sector in Turkey looks forward to an increase in profitability. The market in Turkey is dominated by the sales of passenger cars, and the majority of these cars are imported. As previously mentioned, the demand for automobile sales in Turkey is affected by many macro and micro indicators.

The main macro indicators may be GNP, per capita real income and foreign exchange rates; the micro indicators may consist of the competitiveness of the sector

and the aggressiveness of the brands. The total number of authorized brand dealers in Turkey was nearly 2,100 in 2002; this number surpassed 2,800 in 2012 (TCA).

The city-based number of vehicles in Turkey parallels the population of the cities. Istanbul has the biggest value as there are more than 3.5 million vehicles. The second city is Ankara, with the value of 1.6 million vehicles, and the third city is Izmir with a value of 1.1 million. Tunceli, on the other hand, has the lowest value as there are only 7,780 vehicles, and Hakkari comes next with the value of 9,203 vehicles. When we look at the types of the vehicles, the results are proportionate with the overall numbers, except for the motorcycles in Antalya (TUIK). The highest number of motorcycles in Turkey is registered in Antalya with the value of 257,357 — more than 10% of all motorcycles in Turkey.

Furthermore, the total number of vehicles in Turkey increased from 8.6 million to 18.8 million between 2002 and 2014. When the distribution of cars registered according to their fuel type is examined, the ratio of gasoline was 75% in 2002, whereas it was 29% in 2014; for diesel it was 4% in 2002 and 31% in 2014; and lastly, for LPG, the ratio was 14% in 2002 and 41% in 2014 (TUIK).

Within the scope of the TUIK and the Turkish Competition Authority (TCA) assessments relating to the market of motor vehicle sales, the following conditions are observable in the sector. The Turkish automotive sector generally seems to have a growing and dynamic market, although the sector has a demand structure which could be affected by economic crisis in some years. Most of the sales in the market occur as passenger car sales and, for passenger cars especially, the Turkish market faces domination by imported products.

Another issue concerning the industry is the average age of a car, which is 12 years in Turkey, as mentioned above. There was no real increase in car prices between 2005 and 2013, which is an important indicator of the high competition in the automotive sector. Here, the price increase was compared to the inflation rate in Turkey. Profit margins gained from sales by providers were less than the profit margins from aftersales operations. In the last decade, profit margins gained from sales have decreased, although the profit margin gained from spare parts has increased.

The profit margin distribution of providers has the same trend as that of the dealers in terms of departmental differences. Although the profit margins gained from sales had a bigger share in the gross sales of distributors and dealers, profit margins gained from after-sales operations had a higher net profit. Moreover, in the last decade, despite the increase in the number of dealers, the net profit margin of the dealers was stable.

In Turkey, the number of authorized dealers has an upward trend and, despite the very high investment costs, the dealers are generally 3S plaza, which is another phenomenon that has not changed in the last couple of decades in Turkey. As a result of the high settlement costs, in the last decade there has been an increase of new car services which are only service stations, but 3S plazas are still more than 90%.

High operating costs force dealers to have more than one brand in the same plaza, which is officially possible in Turkey. The increase in the number of additional sales/service of other brand enterprises is at an unprecedented level and will obviously increase in the future because of efficiency and cost advantages.

13.1.2 Figures

Besides producing the car, to bring the produced car to the customer is another important issue. In the past, the meeting between the motor vehicle producer and its buyer was arranged by stores generally owned by producers. Similar to the situation throughout the world, in Turkey car manufacturers, most of whom were importers, carried out distribution of vehicles through their own shops at the beginning.

Afterwards, authorized dealerships emerged and developed in accordance with many procedural criteria. To become an authorized dealer of a brand there are minimum requirements in physical facilities, financial structure, personnel qualifications and many other obligatory conditions. These conditions vary across countries.

In Turkey, to become a dealer of a brand is one of the most demanding businesses in terms of capital needs. For example, in France or other countries in Europe, you may see dealers' premises situated under an apartment building, but in Turkey, to obtain a 3S dealership, you have to secure a large piece of land and use the land only for your dealership. This brings high fixed costs in terms of entry into this business, and taxes are also high in Turkey, so in addition to the cars themselves being very expensive, these factors place another financial burden on the dealers in terms of business capital.

The automotive sector in Turkey has a great tendency to grow, and the number of vehicles is increasing tremendously. The total number of vehicles in Turkey was more than six million in 2002, but it increased to 12 million in 2012 (TUIK). In the car park, it is seen that most of the vehicles are passenger cars and

pick-up type light commercial products; trucks, minibuses and buses also have a small share in the total number.

The demand for motor vehicle products has also increased in the last decade, which increased the import volume of the Turkish economy. The high average age of Turkey car park signals the market to continue its growing trend in the future. This trend will be seen mostly in passenger cars and light commercial vehicles because of their dominance in Turkish market.

According to TCA, the producers and the dealers have an average 3% gross margin from their sales activities, and a 25% gross margin average from their after-sales activities, but when we look at the net figures both have a total average of 4% net profit margin in the sector from the 3S activities in general.

Besides authorized dealerships, the producer-owned shops are also part of the sector, and they also get their highest profits from maintenance and repair services, which are part of their after-sales job. The net income from sales has one to eight ratios when compared with the income from aftersales activities (TCA).

The registered number of vehicles in Turkey has had an annual growth rate of 7.71% in the last decade according to TUIK reports. For 2003, the increase in the number of registered cars was 3.39% when compared with the previous year, but the ratio for 2004 is 20.65 %, representing a remarkable growths. This shows a postponed demand in 2003 because of the economic crisis in Turkey between 2001 and 2002. The demand for car sales was greatly affected by the economic crisis and recovery takes a long time.

Nevertheless, as in the other sectors, there was an irrepressible demand which was postponed and we see that this postponed demand generated high sales figures in

2004. In the same year, the car scrapping incentive put into operation by the government also affected these figures.

In 2008 and 2009 the sector experienced lower than the average growth rate.. In these years, growth was 5.56% and 4.13%, respectively, which reflected the global economic crisis in that period. When the lower refractives are examined, it is seen that the growth in the last decade has not a stable trend, which shows the unforeseen structure of the automotive market. Furthermore, every year there is an increase in the number of cars in the Turkey car park, which is a result of the net registration values.

Net registration value is the excess between the registration values and deregistration values for the vehicles in the traffic. Deregistered vehicles are the ones that finish their economic life or the ones that have big accidental damage that is more expensive to repair than buying a new one.

When vehicles are examined according to their segments, apart from 2004, in the period 2003 – 2012, except for 2004, there was a higher increase in the passenger car segment compared to other segments. The light-commercial vehicles segment is another segment which had positive growth rate for all these years. But the increase in light- commercial segment faced a decrease in the growth rate between 2004 and 2009 (TUIK).

For trucks, 2004 had the highest growth rate because of the scrapping incentives, which continued, though with a great decrease, in 2005. Growth continued till 2009 but in 2010 the growth rate in the truck segment had negative values. Another important issue is the import ratio on each segment, and in Turkey the passenger cars segment is dominant, representing 70% of the total.

As mentioned, after 2005 the price increase of vehicles was less than the inflation rate in Turkey as a result of high competition. In Turkey, according to TUIK, there are differences in the price of the same car based on the region where these cars are sold. This variation is a result of different use habits and demand characteristics of different regions in Turkey. When the price increase of vehicles is detailed by their fuel type, it is seen that the price increase of diesel cars was parallel to the inflation rates in Turkey, whereas the price increase in gasoline-fuelled cars was far less than the inflation rate in the last decade (TUIK).

13.2 Automobile aftersales

13.2.1 Sector

The after-sales business is highly important in the literature in terms of gaining lifelong consumers (Egonsson, 2013). The relationship between a customer and a company used to be based on a product centric view; however, today there is an interactive relationship between these two parties. This two-sided relationship has gained important velocity and today customers have to be the main focus to maintain a long-term relationships (Gaiardelli et al., 2007). Generation of value is needed to create a good relationship between the buyer and the seller (Palmatier, 2006; Perreault & Cannon, 1999).

Furthermore, after-sales services, as in all sectors, is an advantage for the company to generate extra profits in the same business channel. Customers also prefer the car brand which has a convenient service close to them (Saccani et al.,

2007). In most manufacturing industries, after-sales services are recognized as a potential source of competitive advantage, profit, and revenue (Gaiardelli, 2007; Dezvane & Bundschuh, 2003).

Research has shown that after-sales in automotive industries contribute to more than three times the purchase price in turnover than (Wise & Baumgartner, 1999). Many studies in the literature have stated the importance of integrating aftersales services into the core business in various manufacturing industries, including the automotive industry (Kallenberg & Oliva, 2003; Gilbert & Gadiesh, 1998).

Moreover, strategy for aftersales is mainly an important evil, a costly and time consuming strategy which is needed to stay competitive (Lele, 1997).

Customers not only bear the cost of the purchase price of a vehicle, but they also bear many other expenses while using the car. Insurance payments and government taxes costs are some examples, but the most important cost comes from after-sales expenditures.

Customers gather information about the variety of brands and models on the market prior to the purchase of the vehicle and choose among the alternatives. However, repair and maintenance needs will emerge after the purchase is realized.

This situation also affects customers' vehicle purchase choices and constitutes information asymmetry due to high technical expertise needs of the after-sales businesses.

13.2.2 Figures

Motor vehicle maintenance and repair services can be grouped into three parts. The first one is the routine maintenance and repair services, which are offered for a fee at regular intervals. The second one is the repair service in terms of failure or damage to a car, and the last one is the change of parts, which is done for free under warranty.

Both the repair of damaged vehicles and the periodic maintenance and repair services can be done by either official or private service stations in Turkey. The customer is free to choose; in contrast, parts replacement under warranty can be done only in officially authorized service stations.

Therefore, particularly when compared with margins of the sales area, the average profit margin of authorized distributors on maintenance and repair area is still quite high. When the aftersales business is examined in Turkey, it is seen that the average turnover of the authorized services is much higher than the average turnover of the independent services.

Thus, the authorized distributors are considered to be more powerful in the market because of their high average revenue which is gained from maintenance and repair activities of vehicles.

It is obvious that the profit margins of independent service stations are lower than the profit margins of authorized service stations in order to attract customers to choose them in terms of repair and maintenance services.

The general profit margin of maintenance and repair services is in the range of 15 – 35% in Turkey (TCA). Research shows that vehicles up to three years old are

mostly taken to authorized service stations by their owners; for 3 – 5 year-old vehicles there is a competition between independent and authorized service stations, but for vehicles older than five years, there is a dominance of independent services.

On the other hand, the owners of vehicles whose cars are still in the warranty period prefer authorized services for their maintenance and repair operations. Nearly 90% of the owners prefer authorized services for their operations within the warranty period.

Also, 50% of customers prefer to take their cars to the dealer where they made the purchase of the car. The ratio of the preference of independent service stations within the warranty period is 10% (TCA). Mainly customers of the independent service stations come from those with vehicles outside the warranty period.

Extended warranty practices increase the preference of authorized service stations whereas high hourly labor prices decrease this preference. In Turkey, the increase in hourly labor prices in auto maintenance and repair market has been above the inflation rate in the last decade, according to TUIK. In addition to the hourly labor prices, another issue is the expertise difference between authorized service stations and independent ones.

The authorized services have a high level of relationship with the producers, and the producers train the employees of the service station periodically. This training, together with the process enforcements of the producers, increases the service quality of the authorized services, which is one of the main subjects of this study.

Trade relations between the insurance companies and aftersales services market is another important factor in terms of after-sales business efficiency because the insurance firms are permanent customers of car services with their high-volume payments when their customers' cars are damaged. This condition brings the insurance firms to an advantageous position which results in high discount rates given to the insurance companies.

Service stations are competing in these discount rates to profit from a high volume of the insurance companies' payments in their gross profits.

Literally, the service business is faced with the concept of economies of scale, so the service stations are looking for big customers such as insurance companies in our case, to gain the advantage of economies of scale.

Relationships between sellers and buyers may be seen as similar to the relationship between wives and husbands (Kandampully, 2010; Celuch, 2006; Zineldin, 2002; Wilson, 1999; Hunt & Morgan, 1994; Dwyer, 1987). This relationship does not end after a purchase transaction; the overview of this relationship determines the forthcoming decisions of the buyer on future purchases. Such a relationship can be seen as creating a life-time customer.

There are several brands which work to create lifetime customers for their products. In other words, they try to get married to their customers. To create customer loyalty depends on creating relationships (Guttek, 2002); so the company has to understand and work for a strategy to capture the customer after the wedding. The life-time customer concept emerges and the companies try to be the choice of the customer in their next car purchase.

13.3 Automobile spare parts

13.3.1 Sector

Motor vehicles are associated with the combination of more than five thousand different parts which differ in terms of nature, material structure, technology, production processes and the location for the production. In the production of these parts, iron, steel, light metals, plastics, rubber, textiles, glass, electronic devices, paint and other chemicals are used and combined with technologic superiority.

Moreover, the vehicle manufacturer produces only 20% of these components itself, and the remaining parts come from the supplier industry. These suppliers perform production of the parts within the framework of the design and specifications which are determined by the car manufacturer. The spare parts sector is another industry which is highly related to the car service industry. It may be called a supplier of the car service industry.

The spare parts industry in Turkey has had a growing tendency in the last decade, except for the year 2008, when the effects of the global crisis are observed. When the sector is examined on an activity basis, there are two main options for a company to operate in this sector. The first is to produce for assemblies of the vehicle producers and the second is to produce for the replacement market. In Turkey, the production of spare parts is mainly for assembly.

Additionally, the production for the replacement market is also growing but still the market size is captured by the production of the main assemblies of car manufacturers. Therefore, this condition makes obvious that the spare parts industry

is highly connected to the car manufacturing industry, and it seems that this connection is not going to break off in the near future.

Another aspect is the profit margin level of the sector, and in Turkey, it is seen that the profit margin for the sales to the replacement market is nearly %12, whereas the profit margin for the sales to the assembly market is between 5 and 10%. Although the profit margin for the replacement market is high, the total volume of the replacement market is very low.

The main cause of this low volume is that service stations prefer to buy spare parts from the car manufacturer, not from the parts' manufacturer. This shows the reality that the car manufacturer is the main and dominant customer of the spare parts producer and the car manufacturer also makes profits from the trade of these spare parts.

In Turkey, 90% of service stations buy spare parts from their car manufacturer. The only, and growing, exception here is the insurance companies which have started to buy parts from spare parts producers and send the needed spare parts to the service stations for their customers' damaged cars.

In the spare parts market, the number of players and the variety of production is high, which results in high information asymmetry for the customers. In Turkey, the enterprises which operate in the spare parts industry have steadily increased their turnover in the last decade and the main revenue in this industry comes from the production and sales of spare parts for assembly. There is also a parallel course between the inflation rate of the country and the spare parts' price increase.

According to TUIK data, in Turkey, the spare parts price increase has paralleled the inflation rate during the last decade. It is also remarkable in this

industry that, despite its low volume, sales for the replacement market have also grown in the last decade. As a result, the profitability of sales to assembly is higher than the profitability of sales to the replacement market. Furthermore, the production quantities in the spare parts market follow a parallel course with the size of the car park of the country.

13.3.2 Figures

The aftersales business, including the maintenance and repair services and the spare parts market, is the flotation ring for the automotive sector in terms of surviving with the low incomes of sales business. According to TOBB (Türkiye Odalar ve Borsalar Birliği, English: The Union of Chambers and Commodity Exchanges of Turkey), there were 6,625 companies in 2012 which were operating in the area of maintenance and repair of motor vehicles, and the number increased to 6,773 in 2013.

However, there are also nearly 3.000 authorized dealers actively operating in this sector. Nearly half of these dealers are only operating in the after-sales market, whereas the other half of them have sales operations as well. These figures show the registered number of car service stations in Turkey, where there are also many unregistered repair stations.

The number of motor vehicles which constitute the car park of a country is changed by two factors. The first one is the increasing factor of new registration of vehicles and the second factor is de-registration, which is decreasing, shows the number of vehicles that cannot be used anymore.

Thus the difference of these two factors gives the net car park increase and, in Turkey, the net figures are very high showing the great increase in the last decade in the car park of Turkey.

In the previous sections, we mentioned that the average age of the car in Turkey is 12 years. This average car age directly signals the competition between the authorized service stations and independent service stations, so the rivalry will increase in the future by the expected decrease in the average age.

However, as the manufacturers offer a two- or three-year warranty and has a commitment for free repair apart from damage caused by user mistake, the customers mostly prefer the authorized service stations in the earlier years of their vehicles. Thus, the average age of the car park is a signal about the distinction of preference for authorized and independent service stations.

Ultimately, the average age of the car is another important indicator for both new car sales and after-sales activities. It is noteworthy that 37% of the vehicles in the car park in Turkey are older than ten years. On the other hand, up to three years old vehicles constitute 23% of the car park. In other words, 76% of the cars are older than three years (TUIK). This appearance of the car park can be interpreted as one of the important factors that will increase the demand for new vehicles in the future. As well as the importance of this data for the future of the sales sector, it is also important for the present situation of the after-sales sector because today most of the manufacturers provide a two- or three-year warranty, so customers prefer authorized services during this period, but at the end of this period, the customers turn to independent service stations.

13.4 Sales and aftersales relationship in automotive

On the other hand, when the age distribution of motor vehicles in Turkey is examined for the last decade, there seems an obvious increase in new car sales, which decreases the average age of motor vehicles in Turkey. Moreover, the owners of new cars prefer authorized services, in other words, dealerships, and as the car gets older, most turn to independent service stations.

Profitability figures also differ from one region to another in terms of the after-sales sector in Turkey (TCA). It also changes from one brand to another but there is an obvious trend showing that 3S dealerships make money mostly from the after-sales operations of the cars they have sold. They have a 3 – 4% profit margin in new car sales, which is lost as a result of high competition and thus they try to be more effective in terms of service and spare parts operations. Dealers mainly profit from maintenance and repair services of cars whose owners prefer these stations for their operations. So to have higher after-sales income, a dealer has to sell more vehicles which, as a result, brings higher competition in new car sales sector.

In dealerships, the profit margin of maintenance and repair services is eight times the profit margin of new car sales. Moreover, this is the main cause of domination of 3S points in automobile services sector, because most dealers finance their overall costs from after-sales activities. Thus, in order to have more efficient and profitable aftersales activities, they have to sell more vehicles. Warranty operations also act as a motivator for the customers to prefer authorized service stations and these operations are an advantage for the authorized service stations to slam independent service stations.

CHAPTER 14

SURVEY AND SAMPLE CHARACTERISTICS

The characteristics of our survey and the samples used in our study are explained in detail in this section.

14.1 Survey characteristics

Our survey results include data on 30 brands from Turkey automobile aftersales market, which captures more than 97% of Turkish automobile aftersales industry.

We did not have any brand restrictions or quotas when we applied the survey, but the results signal a parallel relationship with the car park figures in Turkey.

Nearly 10% of our results come from the users of the Renault brand, which is the leading brand, and next comes Opel and Fiat, which account for nearly 9% of the results.

Volkswagen and Toyota, which are important brands of automobile production all over the world come next in our survey results. Ford and Hyundai have the same percentage (6.5%) of the respondents using these brands.

Peugeot and Citroen, brands of the same origin, are the next brands by a close percentage, and Nissan is number ten, accounting for 5% of the respondents as shown in the table. Table 33 shows the brand distribution of the sample.

Table 33. Brand Distribution of the Sample

Brand Distribution of the Sample			
1.	Renault	57	9.50%
2.	Opel	55	9.17%
3.	Fiat	51	8.50%
4.	Volkswagen	47	7.83%
5.	Toyota	41	6.83%
6.	Ford	39	6.50%
7.	Hyundai	39	6.50%
8.	Peugeot	33	5.50%
9.	Citroen	31	5.17%
10.	Nissan	30	5.00%
11.	Mercedes-Benz	23	3.83%
12.	Audi	22	3.67%
13.	Honda	19	3.17%
14.	BMW	18	3.00%
15.	Seat	15	2.50%
16.	Kia	10	1.67%
17.	Skoda	10	1.67%
18.	Mini	8	1.33%
19.	Volvo	8	1.33%
20.	Chrysler	7	1.17%
21.	Land Rover	6	1.00%
22.	Mitsubishi	6	1.00%
23.	Alfa Romeo	5	0.83%
24.	Mazda	5	0.83%
25.	Daihatsu	4	0.67%
26.	Suzuki	4	0.67%
27.	Jeep	3	0.50%
28.	Jaguar	2	0.33%
29.	Porsche	1	0.17%
30.	Subaru	1	0.17%
	Total	600	100.00%

The brands in the first half of the middle part of Table 33 included Mercedes, Audi, Honda, BMW and Seat that had between 3.83% and 2.50%. The second half of the middle part included Kia, Skoda, Mini, Volvo and Chrysler with around 1% of

the respondents. The last ten brands in our survey results were Land Rover, Mitsubishi, Alfa Romeo, Mazda, Daihatsu, Suzuki, Jeep, Jaguar, Porsche and Subaru.

Next, statistics reflected the best and worst brands for each item and dimension but the basis was the first 26 brands, because brands having fewer than four respondents were excluded from this comparison on account of subjectivity problems.

The survey had two prerequisite questions. The first of these two questions was about having a car. When the respondents' answer was negative for this question, then the survey was not continued.

The respondents who owned a car filled in the survey. On the other hand, the second prerequisite question was questioning the condition of taking a car to the aftersales service station.

Our study was about the service quality in automobile aftersales stations and without visiting an aftersales station the answers would be invalid. So the survey was conducted by the respondents who answered affirmatively to both of these questions.

As we can see from the previous part of our study, the body section of the updated AutoServQual included 28 questions. The average values of each question were calculated for each brand and we showed the highest and the lowest score for each question in this section.

As we know, both the original ServQual and the updated AutoServQual had five dimensions as explained many times in this study: tangibles, reliability, responsiveness, assurance and empathy.

The dimensions of AutoServQual and their items are given below:

- Tangibles (4 questions)

Entry-Exit and Parking Convenience,

Take Advantage of Technology,

Certificate of Quality Standards,

Visually Appealing Waiting Lounge,

- Reliability (6 questions)

Keeping Promises on Timing,

Keep Accurate Records,

Accurate detection of Failure,

Use of Only Original Products,

Reliable Repairing,

Personal Information Security,

- Responsiveness (8 questions)

Telling Customers Exactly the time of the Service,

Concerned Staff (Willing to help customers),

Availability to Respond to Customers,

Compatible Staff,

Adequate Transportation Facilities,

Qualified Labor Force,

Equal Treatment,

Attentive Service,

- Assurance (5 questions)

Confidence in Transactions,

Politeness of the Staff,

Knowledgeable Staff,

Informative Explanations,

Reasonable Pricing,

- Empathy (5 questions)

Individual Attention,

Knowing the Needs of the Customers,

Payment Options,

Offering Gifts and Promotions,

Delivery Quality,

14.2 Sample characteristics

The sample for this study included 600 automobile aftersales customers in Turkey.

The first two questions were prerequisite questions, which checked the appropriateness of the applicant by ascertaining ownership of a car, and included

having had the car serviced at least once. Respondents from 23 cities in Turkey participated in the survey but the highest number of respondents lived in Istanbul. The sample had a ratio of 70:30 in terms of gender, as shown in Table 34.

Table 34. Gender Distribution of the Sample

Gender of Respondents		
Male	420	70%
Female	180	30%
Total	600	100%

The next statistics for the sample was the occupation distribution of the respondents. The manager category included high level employees in the private sector and led the occupation distribution of our sample by more than 22%. Next came the student category, which was comprised of those university students who owned a car. Tradesman and engineers were the next categories respectively with a ratio of nearly 10%. Doctors, retired people, bankers and teachers were the other categories which had nearly 5% of the respondents. Other occupations comprised a ratio of less than 5%, and are shown in Table 35.

Table 35. Occupation Distribution of the Sample

Occupation of Respondents		
Manager	134	22.33%
Student	83	13.83%
Tradesman	61	10.17%
Engineer	59	9.83%
Doctor	32	5.33%
Retired	32	5.33%
Banker	29	4.83%
Teacher	25	4.17%
Accountant	23	3.83%
Marketer	20	3.33%
Officer	17	2.83%
Academician	17	2.83%
Salesman	16	2.67%
Technician	14	2.33%
Air hostess	10	1.67%
Architect	10	1.67%
Lawyer	9	1.50%
Housewife	9	1.50%
	600	100.00%

As explained above, the survey was conducted in 23 cities in Turkey, and the regional distribution of these cities is given in Table 36, using the comparison of the populations of each region in Turkey.

The number of cities from each region reflects the population density of the country. Istanbul is the biggest city in Turkey, and was included in Marmara region, which was the area where the highest number of respondents lived.

Table 36. Regional Distribution of the Sample

Regional Distribution		
Region	Population	City
Eastern Anatolia	14,258,955	4
Marmara	25,227.842	7
Central Anatolia	11,218,388	4
Northern Anatolia	7,060,399	2
Southern Anatolia	9,906,771	2
Western Anatolia	10,023.549	4
	77,695,904	23

Moreover, there were three more statistics that we give information on in our sample, before going on to the most important category, brand distribution. Age distribution, income level distribution and education level distribution are the sample statistics that will be explained next. Age distribution statistics is given in Table 37.

Table 37. Age Distribution of the Sample

Age Distribution of the Sample		
Age Interval	# of Resp.	Percentage
18-25	126	21.00%
26-40	281	46.83%
41-55	162	27.00%
56+	31	5.17%
Total	600	100.00%

When the age distribution of the sample is examined, it is obvious that nearly half of the respondents were from the second interval, which consisted of people aged between 26 and 40. This category is also the highest category in the Turkish population, which proved the appropriateness of the sample in terms of age

distribution. Respondents aged between 41 and 55 were in the next highest category, with 27%, and the 18-25 age category was third with 21%. The category with the least number of respondents aged was the one named over 56 years of age, which was of 5% in our sample. Table 38 shows the income level distribution.

Table 38. Income Level Distribution of the Sample

Income Distribution of the Sample		
Income Level (TL)	# of Resp.	Percentage
0 – 1000	12	2.00%
1001 – 2500	152	25.33%
2501 – 4000	285	47.50%
4001+	151	25.17%
Total	600	100.00%

Of the 600 respondents, nearly half had an income level between 2501-4000 TL. This category constituted 47% of the whole. There was a tie in terms of being the second highest category between 1001 – 2500 TL and 4001 + TL income level intervals. Only 2% of the respondents had an income less than 1000 TL. Table 39 shows the education level distribution of the sample.

Table 39. Education Level Distribution of the Sample

Education Level of the Respondents		
Education Level	# of Resp.	Percentage
Primary School	32	5.33%
High School	156	26.00%
University	354	59.00%
Graduate Level	58	9.67%
Total	600	100.00%

The last statistics about the demographics of our sample were about the education level of the respondents. The percentage of respondents who were university graduates was high, at nearly 60%. The next category was high school graduates with 26%. The graduate-level category in Table 39 includes the respondents who had a Master's or PhD degree, nearly 10%. Lastly, more than 5% of our respondents were only primary school graduates.

The sampling method refers to the way of selecting sample units. The most important point is to consider the decision of using a probability or a non-probability sample. In this research, the probability sample method was chosen for the target population. Since the sampling method was determined, a convenient sample size could be calculated.

In addition, the confidence level should be specified. We had a sample size of 600, which was higher than the minimum requirement of 30 for normal distribution. The sampling and scale characteristics were explained in the previous part of this study.

The next chapter examines all results, item by item, to show the strong and weak sides of each brand operating in the automobile aftersales business in Turkey. The highest and lowest scores of each dimension will also be explained.

Furthermore, information about each brand will be supplied and can be found in the related tables. Like many other industries, in the automobile aftersales business the competition level is very high, so these results allow the related parties to evaluate and improve their performance by examining their weak points as seen by their own customers who visited their aftersales service stations.

CHAPTER 15

RESEARCH RESULTS

15.1 Item-based results

First, the analysis is about the minimum, maximum, mean and standard deviation of each item. These items are arranged according to their question numbers and grouped according to their dimensions. All questions had a minimum of 1 and maximum of 5, which showed that they were objective questions which could have results ranging from 1 to 5. The detailed statistics are also explained in Table 40.

Table 40. Some Statistics about the Questions

DIMENSIONS	QUESTIONS	MIN	MAX	MEAN	ST.DEV
TANGIBLES	Q1. Entry-Exit and Parking Convenience	1	5	4.192	0.948
	Q2. Take Advantage of Technology	1	5	4.148	0.997
	Q3. Certificate of Quality Standards	1	5	4.122	0.96
	Q4. Visually Appealing Waiting Lounge	1	5	4.027	0.941
RELIABILITY	Q5. Keeping Promises on Timing	1	5	4.023	0.94
	Q6. Keep Accurate Records	1	5	4.059	0.939
	Q7. Accurate Detection of the Failure	1	5	4.079	0.945
	Q8. Use of Only Original Products	1	5	4.008	0.972
	Q9. Reliable Repairing	1	5	3.892	0.977
	Q10. Personal Information Security	1	5	3.88	1.002
RESPONSIVENESS	Q11. Telling Customers the Exact Time of the Service	1	5	4.027	0.973
	Q12. Concerned Staff	1	5	3.99	0.926
	Q13. Availability to Respond to Customer Requests	1	5	3.982	0.96
	Q14. Compatible Staff	1	5	4.005	0.971
	Q15. Adequate Transportation Facilities	1	5	3.997	0.952
	Q16. Qualified Labor force	1	5	3.988	0.945
	Q17. Equal Treatment	1	5	3.853	0.941
	Q18. Attentive Service	1	5	3.879	0.9
ASSURANCE	Q19. Feeling Safe in Transactions	1	5	3.486	1.15
	Q20. Politeness of the Staff	1	5	3.588	1.019
	Q21. Knowledgeable Staff	1	5	3.73	0.954
	Q22. Informative Explanations	1	5	3.862	0.966
	Q23. Reasonable Pricing	1	5	3.583	1.033
EMPATHY	Q24. Individual Attention	1	5	3.829	1.021
	Q25. Knowing the Needs of the Customers	1	5	3.573	1.134
	Q26. Payment Options	1	5	4.055	0.895
	Q27. Offering Gifts and Promotions	1	5	3.355	1.12
	Q28. Delivery Quality	1	5	4.209	0.962

The questions were also lined up according to their overall mean values to see which of all the brands performed best and to see which item of all brands performed weakest. The highest mean came from question number 28, which was about delivery quality and number 1, which was about entry, exit and parking convenience.

All brands performed well in these items because they are the main prerequisites for being a high quality automobile aftersales service station. On the other hand, the lowest scores came from Offering Gifts and Promotions and Confidence in Transactions, which were problematic for nearly all brands. Mean values of other items are also given in Table 41 for comparison.

Table 41. Mean Results of the Questions

	MEAN	QUESTIONS
1.	4.209	Q28. Delivery Quality
2.	4.192	Q1. Entry-Exit and Parking Convenience
3.	4.148	Q2. Take Advantage of Technology
4.	4.122	Q3. Certificate of Quality Standards
5.	4.079	Q7. Accurate Detection of Failure
6.	4.059	Q6. Keeping Accurate Records
7.	4.055	Q26. Payment Options
8.	4.027	Q11. Telling Customers the Exact Time of the Service
9.	4.027	Q4. Visually Appealing Waiting Lounge
10.	4.023	Q5. Keeping Promises on Timing
11.	4.008	Q8. Use of Only Original Products
12.	4.005	Q14. Compatible Staff
13.	3.997	Q15. Adequate Transportation Facilities
14.	3.990	Q12. Concerned Staff
15.	3.988	Q16. Qualified Labor force
16.	3.982	Q13. Availability to Respond to Customer Requests
17.	3.892	Q9. Reliable Repairing
18.	3.880	Q10. Personal Information Security
19.	3.879	Q18. Attentive Service
20.	3.862	Q22. Informative Explanations
21.	3.853	Q17. Equal Treatment
22.	3.829	Q24. Individual Attention
23.	3.730	Q21. Knowledgeable Staff
24.	3.588	Q20. Politeness of the Staff
25.	3.583	Q23. Reasonable Pricing
26.	3.573	Q25. Knowing the Needs of the Customers
27.	3.486	Q19. Confidence in Transactions
28.	3.355	Q27. Offering Gifts and Promotions

The first dimension of our study was the tangibles dimension and the first question of this dimension was about the entry-exit and parking convenience. The result for this specific question shows a mean of 4.192, which makes this question

number 2 of all questions. Tables numbered between 42-69 shows the results of all survey questions.

Table 42. Results for Question 1

Q1. Entry-Exit and Parking Convenience		
1.	4.86	Chrysler
2.	4.60	Alfa Romeo
3.	4.50	Daihatsu
4.	4.50	Skoda
5.	4.50	Volvo
6.	4.43	Mercedes-Benz
7.	4.33	Mitsubishi
8.	4.28	BMW
9.	4.28	Volkswagen
10.	4.24	Opel
11.	4.21	Honda
12.	4.20	Mazda
13.	4.18	Fiat
14.	4.17	Land Rover
15.	4.15	Ford
16.	4.14	Audi
17.	4.10	Kia
18.	4.08	Hyundai
19.	4.07	Seat
20.	4.04	Renault
21.	4.02	Toyota
22.	4.00	Suzuki
23.	3.93	Nissan
24.	3.90	Citroen
25.	3.67	Peugeot
26.	3.63	Mini
Mean	4.192	

This ranking showed that one of the best issues for all of the brands was the convenience of entry-exit and parking, which is a must for high quality automobile aftersales stations. All brands check the parking, entry and exit capabilities of their

service station candidates before opening their stations in order to provide convenient areas according to the potential. Now it is time to look at brand performance on the first question.

Chrysler and Alfa Romeo were the leading two brands in terms of entry, exit and parking convenience among 26 brands, followed by Daihatsu, Skoda and Volvo. On the other hand, Mini had the lowest score, followed by Peugeot and Citroen. Nissan and Suzuki were other brands having scores of less than four from the first question of the tangibles dimension, which was about entry, exit and parking convenience.

The second item on our first dimension questioned the relationship of our brands by technology. Taking advantage of technology was evaluated in this question. The results on these items showed a mean value of 4.148. It is impossible for an automobile brand to close its eyes to technologic developments, so this high mean score reflected the effort of the brands to adopt the new technologies to their daily business. The brand detailed scores for these items are provided.

Table 43. Results for Question 2

Q2. Take Advantage of Technology		
1.	4.86	Chrysler
2.	4.67	Land Rover
3.	4.63	Volvo
4.	4.60	Alfa Romeo
5.	4.50	Mitsubishi
6.	4.39	Mercedes-Benz
7.	4.25	Daihatsu
8.	4.22	Opel
9.	4.21	Honda
10.	4.20	Seat
11.	4.18	Audi
12.	4.17	BMW
13.	4.11	Volkswagen
14.	4.08	Ford
15.	4.05	Renault
16.	4.03	Hyundai
17.	4.00	Fiat
18.	4.00	Kia
19.	4.00	Mazda
20.	4.00	Skoda
21.	3.88	Toyota
22.	3.87	Nissan
23.	3.75	Mini
24.	3.75	Suzuki
25.	3.74	Citroen
26.	3.73	Peugeot
Mean	4.148	

Chrysler, Land Rover, Volvo and Alfa Romeo were the leading brands in terms of taking advantage of new technologies. The main characteristics of these four brands were that they had a target of high-income level customers who look for technological improvements. These high scores reflect the importance given to technology by these brands.

The brands that had the lowest scores were Peugeot, Citroen, Suzuki and Mini as seen in Table 43. Nissan and Toyota were also brands that had an average score of less than 4 in taking advantage of new technologies.

Table 44. Results for Question 3

Q3. Certificate of Quality Standards		
1.	5.00	Chrysler
2.	4.67	Mitsubishi
3.	4.50	Volvo
4.	4.39	Mercedes-Benz
5.	4.39	BMW
6.	4.30	Skoda
7.	4.26	Honda
8.	4.25	Daihatsu
9.	4.23	Volkswagen
10.	4.20	Alfa Romeo
11.	4.18	Ford
12.	4.17	Land Rover
13.	4.13	Opel
14.	4.08	Hyundai
15.	4.07	Seat
16.	4.00	Mazda
17.	4.00	Suzuki
18.	3.96	Fiat
19.	3.95	Audi
20.	3.93	Renault
21.	3.90	Toyota
22.	3.87	Nissan
23.	3.85	Peugeot
24.	3.71	Citroen
25.	3.70	Kia
26.	3.50	Mini
Mean	4.122	

The third item for the tangibles dimension was having certificates of quality standards. This question tried to identify the use of such standards in aftersales service stations by asking the customers.

This item was again one of the items that had a high mean score, because nearly all brands have a requirement for quality standards in their service stations. 4.122 was the overall mean score for question number 3. The overall performance of all brands for this item is given in Table 44.

Chrysler, Mitsubishi and Volvo are the brands which led by their high average scores. All Chrysler customers in our survey answered this question by giving a score of 5, which made this the brand leader with a 5.00 average. Mercedes and BMW services ranked 4th and 5th on this item. Mini was at the bottom of the table, followed by Kia, Citroen and Peugeot. Nissan, Toyota, Renault, Audi and Fiat, which were the other brands that had an average score of less than 4. The mean score of other brands is also listed in the tables.

The last item of the tangibles dimension was about having a visually appealing waiting lounge, which is also another important item for the automobile aftersales customers because these customers need a comfortable waiting lounge while their cars are being serviced. This item ranked number nine of all 28 items with a mean score of 4.027 showing the overall average of all brands, but detailed scores are provided in Table 45.

Table 45. Results for Question 4

Q4. Visually Appealing Waiting Lounge		
1.	4.71	Chrysler
2.	4.50	Land Rover
3.	4.39	Mercedes-Benz
4.	4.33	Mitsubishi
5.	4.28	BMW
6.	4.25	Volvo
7.	4.20	Seat
8.	4.19	Volkswagen
9.	4.18	Ford
10.	4.10	Skoda
11.	4.09	Audi
12.	4.00	Alfa Romeo
13.	4.00	Fiat
14.	4.00	Mazda
15.	4.00	Opel
16.	4.00	Toyota
17.	3.97	Nissan
18.	3.95	Honda
19.	3.94	Peugeot
20.	3.90	Citroen
21.	3.82	Renault
22.	3.75	Daihatsu
23.	3.75	Suzuki
24.	3.74	Hyundai
25.	3.40	Kia
26.	3.25	Mini
Mean	4.027	

Chrysler was again at the top, followed by Land Rover, Mercedes, Mitsubishi and BMW in having a comfortable and visually appealing waiting lounge. These brands are mainly high-class cars that have luxury showrooms and comfortable customer waiting areas. At the bottom of the list, Mini, Kia, Hyundai, Suzuki and Daihatsu are seen, which, except for the Mini, are all cheaper cars whose service

stations are not well designed in Turkey. Other brands are mainly very close to each other as seen in the Table 45.

In this tangibles dimension, which includes four items, Chrysler was the champion, taking the lead in all four items. Volvo and Mercedes follow Chrysler in this dimension. The losers in this dimension included Mini, which had unorganized service stations, followed by Citroen and Suzuki, which had the lowest scores in the tangibles dimension.

The reliability dimension had six items which included keeping promises on time, keeping accurate records, accurate detection of the failure, use of only original products, reliable repairing, and personal information security. Each of these dimensions will be examined in detail in this section.

The first item of this dimension was keeping promises on time, which had an overall mean score of 4.023 and ranked 10th among 28 items. The brand-specific results are shown on the next table.

Volvo, Chrysler and Land Rover were the top three brands at keeping promises on time, followed by Ford, Honda, Audi and Mini. Suzuki had the lowest score, followed by Nissan, Toyota, Mazda and Kia. Renault and Fiat were the other two brands that had an average score less than 3.90 on these questions.

Table 46. Results for Question 5

Q5. Keeping Promises on Timing		
1.	4.63	Volvo
2.	4.57	Chrysler
3.	4.50	Land Rover
4.	4.43	Mercedes-Benz
5.	4.23	Ford
6.	4.16	Honda
7.	4.14	Audi
8.	4.13	Mini
9.	4.06	BMW
10.	4.04	Volkswagen
11.	4.00	Alfa Romeo
12.	4.00	Daihatsu
13.	4.00	Mitsubishi
14.	4.00	Seat
15.	3.96	Opel
16.	3.94	Peugeot
17.	3.94	Citroen
18.	3.90	Skoda
19.	3.90	Hyundai
20.	3.88	Fiat
21.	3.88	Renault
22.	3.80	Kia
23.	3.80	Mazda
24.	3.78	Toyota
25.	3.70	Nissan
26.	3.25	Suzuki
Mean	4.023	

The second item of the reliability dimension is keeping accurate records, which is very important for the processes of a car because accurate records are required to increase the reliability of a service station. This item was ranked number

6, with a mean value of 4.059 which shows that many brands are good at keeping accurate records.

Table 47. Results for Question 6

Q6. Keep Accurate Records		
1.	4.63	Volvo
2.	4.50	Mitsubishi
3.	4.43	Chrysler
4.	4.40	Alfa Romeo
5.	4.35	Mercedes-Benz
6.	4.33	Land Rover
7.	4.28	BMW
8.	4.25	Daihatsu
9.	4.23	Audi
10.	4.21	Volkswagen
11.	4.12	Fiat
12.	4.08	Ford
13.	4.00	Mazda
14.	4.00	Mini
15.	4.00	Seat
16.	3.95	Honda
17.	3.93	Renault
18.	3.93	Toyota
19.	3.89	Opel
20.	3.85	Peugeot
21.	3.82	Hyundai
22.	3.81	Citroen
23.	3.80	Kia
24.	3.80	Skoda
25.	3.70	Nissan
26.	3.25	Suzuki
Mean	4.059	

Volvo, Mitsubishi and Chrysler are the top three brands in terms of keeping accurate records, followed by Alfa Romeo and Mercedes. Suzuki again has the lowest score in keeping accurate records. Nissan, Suzuki, Skoda and Kia are other

brands which have low scores. Furthermore, Citroen, Hyundai, Peugeot and Opel have an average score of under 3.90 for the second question on the reliability dimension.

Table 48. Results for Question 7

Q7. Accurate Detection of the Failure		
1.	4.71	Chrysler
2.	4.50	Mitsubishi
3.	4.50	Volvo
4.	4.39	Mercedes-Benz
5.	4.33	Land Rover
6.	4.29	Opel
7.	4.24	Fiat
8.	4.20	Alfa Romeo
9.	4.20	Seat
10.	4.19	Volkswagen
11.	4.09	Audi
12.	4.00	Daihatsu
13.	4.00	Kia
14.	4.00	Mazda
15.	4.00	Toyota
16.	4.00	Hyundai
17.	3.95	Ford
18.	3.94	Citroen
19.	3.91	Peugeot
20.	3.89	Honda
21.	3.89	BMW
22.	3.84	Renault
23.	3.80	Skoda
24.	3.75	Mini
25.	3.75	Suzuki
26.	3.70	Nissan
Mean	4.079	

The third item of the reliability dimension is accurate detection of failure, which is one of the core businesses of automobile aftersales stations. This item was

ranked number 5 among all items by an average mean score of 4.079, which shows the importance given to this item by all brands. The scores for each brand are listed in the next table.

Chrysler, Mitsubishi and Volvo are the leading brands in this item which signals their ability to detect the failure of a car. Mercedes, Land Rover and Opel are the following brands that are also good at failure detection. Service stations of Nissan have the lowest score, which is followed by Suzuki, Mini, Skoda, and Renault. BMW and Honda are the other two automobile brands whose services have a score less than 3.90 in terms of accurate detection of failure.

The fourth item of the reliability dimension is the usage of only original products, which is another important issue for automobile aftersales customers. The original products usage ranked 11 among all items with a mean of 4.008, which may be a result of strategies of the distributors to force the service stations to use only original spare parts.

Chrysler, Land Rover and Mitsubishi are the leading three brands in terms of using only original products. Mercedes, Volvo, Volkswagen and Alfa Romeo are the followers on this item.

Suzuki consistently has the lowest score in this item as on many of the other reliability items. Kia, Citroen and Mini have the next lowest scores. Also, Skoda, Nissan, Daihatsu, and Hyundai have an average score that is lower than 3.80 in using only original products.

Table 49. Results for Question 8

1.	4.71	Chrysler
2.	4.67	Land Rover
3.	4.67	Mitsubishi
4.	4.39	Mercedes-Benz
5.	4.38	Volvo
6.	4.21	Volkswagen
7.	4.20	Alfa Romeo
8.	4.14	Fiat
9.	4.13	Seat
10.	4.11	BMW
11.	4.00	Audi
12.	3.97	Ford
13.	3.95	Honda
14.	3.95	Renault
15.	3.93	Opel
16.	3.88	Peugeot
17.	3.85	Toyota
18.	3.80	Mazda
19.	3.79	Hyundai
20.	3.75	Daihatsu
21.	3.70	Nissan
22.	3.70	Skoda
23.	3.63	Mini
24.	3.61	Citroen
25.	3.60	Kia
26.	3.50	Suzuki
Mean	4.008	

The fifth item of the reliability dimension is reliable repairing, which is again one of the most important items of our survey. Reliable repair has a mean average of 3.892 and ranked 17th of 28 items, which proves that all brands have to increase their efforts in terms of reliable repair.

Table 50. Results for Question 9

Q9. Reliable Repair		
1.	4.57	Chrysler
2.	4.50	Land Rover
3.	4.50	Volvo
4.	4.33	Mitsubishi
5.	4.17	Mercedes-Benz
6.	4.13	Ford
7.	4.11	Volkswagen
8.	4.07	Seat
9.	4.00	Alfa Romeo
10.	4.00	Mazda
11.	3.97	Citroen
12.	3.88	Mini
13.	3.86	Audi
14.	3.82	Peugeot
15.	3.80	Fiat
16.	3.79	Renault
17.	3.76	Opel
18.	3.74	Hyundai
19.	3.72	BMW
20.	3.63	Nissan
21.	3.63	Honda
22.	3.61	Toyota
23.	3.50	Daihatsu
24.	3.50	Skoda
25.	3.50	Suzuki
26.	3.10	Kia
Mean	3.892	

Chrysler, Land Rover and Volvo are the three top automobile brands in terms of reliable repair work, which are followed by Mitsubishi and Mercedes. Ford, Volkswagen and Seat have also have average scores of more than 4.00 on the reliable repair question. Kia has a very low result, and next comes Suzuki, Skoda and Daihatsu, each with the same average score. Toyota, Honda and Nissan have average scores which are lower than 3.70 on reliable repairs.

The last item of the reliability dimension is personal information security, which is not an issue only for automobile aftersales stations. Security of personal information has to be kept private in all businesses. The ranking of this item is 18, with an average mean of 3.880, which shows that all brands have to work more to increase the importance given to personal information security.

Table 51. Results for Question 10

Q10. Personal Information Security		
1.	4.80	Alfa Romeo
2.	4.35	Mercedes-Benz
3.	4.33	Land Rover
4.	4.33	Mitsubishi
5.	4.29	Chrysler
6.	4.13	Volkswagen
7.	4.13	Volvo
8.	4.06	BMW
9.	4.05	Ford
10.	4.00	Audi
11.	4.00	Daihatsu
12.	3.96	Fiat
13.	3.89	Opel
14.	3.87	Seat
15.	3.75	Mini
16.	3.70	Kia
17.	3.70	Skoda
18.	3.67	Nissan
19.	3.65	Renault
20.	3.62	Hyundai
21.	3.61	Peugeot
22.	3.54	Toyota
23.	3.45	Citroen
24.	3.40	Mazda
25.	3.37	Honda
26.	3.25	Suzuki
Mean	3.880	

Alfa Romeo, Mercedes, Land Rover and Mitsubishi are the leading brands in terms of personal information security, followed by Chrysler, Volkswagen and Volvo. BMW and Ford are the other brands that have an average score of more than 4.00. Suzuki again has the lowest score, where Honda, Mazda and Citroen follow at the bottom of the list.

The reliability dimension has six items that are all explained in detail. Reliability was scored according to the efforts of the brands and evaluated by the customers. These questions are measured and compare the reliability level of different brands in Turkey. Suzuki is the loser in terms of reliability, along with Kia and Citroen. Mitsubishi, Chrysler and Volvo are the winners on this dimension.

The responsiveness dimension included eight items, each of which are explained. This dimension included items regarding telling customers the exact time of the service, concerned staff (willing to help customers), availability to respond to customers, compatible staff, adequate transportation facilities, qualified labor force, equal treatment, and attentive service.

The first item of the responsiveness dimension was telling customers the exact time of the service, which aims to measure the knowledge of customers about the time the service has been or will be provided.

This item was ranked 8th with an average mean of 4.027 among all 28 items, which shows that the brands are careful about telling customers the exact time of the service.

Table 52. Results for Question 11

Q11. Telling Customers the Exact Time of the Service		
1.	4.57	Chrysler
2.	4.40	Alfa Romeo
3.	4.35	Mercedes-Benz
4.	4.33	Land Rover
5.	4.25	Volvo
6.	4.23	Volkswagen
7.	4.17	Mitsubishi
8.	4.13	Mini
9.	4.11	BMW
10.	4.10	Skoda
11.	4.07	Seat
12.	4.03	Hyundai
13.	4.00	Daihatsu
14.	4.00	Mazda
15.	3.95	Audi
16.	3.95	Opel
17.	3.88	Peugeot
18.	3.84	Fiat
19.	3.84	Honda
20.	3.83	Nissan
21.	3.83	Toyota
22.	3.82	Ford
23.	3.81	Renault
24.	3.77	Citroen
25.	3.75	Suzuki
26.	3.70	Kia
Mean	4.027	

Chrysler, Alfa Romeo, Mercedes and Land Rover are the leading brands that tell their customers exactly the time of the service. Volvo, Volkswagen and Mitsubishi come next. Kia, Suzuki and Citroen have the lowest average mean scores in this item, followed by Renault, Ford, Toyota and Nissan. The second item of the responsiveness dimension is about having concerned staff. The attributes of these are analyzed mainly in this dimension. Customers have the right to learn the projected

price that they will pay when the service is finished, so the concerned staff solves any problems using their relationship skills. This item was ranked 14th with a mean average of 3.990 among all 28 items. Detailed brand results are given in Table 53.

Table 53. Results for Question 12

Q12. Concerned Staff		
1.	4.60	Alfa Romeo
2.	4.57	Chrysler
3.	4.33	Land Rover
4.	4.26	Mercedes-Benz
5.	4.20	Mazda
6.	4.17	Mitsubishi
7.	4.13	Mini
8.	4.09	Volkswagen
9.	4.02	Fiat
10.	4.02	Opel
11.	4.00	Audi
12.	4.00	BMW
13.	4.00	Volvo
14.	3.93	Seat
15.	3.90	Skoda
16.	3.90	Hyundai
17.	3.89	Renault
18.	3.89	Honda
19.	3.85	Peugeot
20.	3.79	Ford
21.	3.75	Daihatsu
22.	3.75	Suzuki
23.	3.71	Toyota
24.	3.70	Kia
25.	3.70	Nissan
26.	3.58	Citroen

Alfa Romeo, Chrysler and Land Rover were the top brands in terms of having concerned staff. Mercedes, Mazda, Mitsubishi and Mini followed. The brands that had an average mean of more than 4.00 were Volkswagen, Fiat and Opel. On the other hand, Citroen, Nissan and Kia had the lowest average means and whereby Toyota, Suzuki, Daihatsu and Ford.

The third item of the responsiveness dimension was about availability to respond to customers' requests and was ranked 16th by a mean average of 3.982 among 28 items. This item was about the responsiveness of the service personnel in both telephone and personal requests. Being too busy is an important problem which delays the service processes and affects customer satisfaction levels.

Alfa Romeo, Chrysler, and Mercedes have the highest average means in terms of availability to respond to customers requests and the brands following were Land Rover, Daihatsu, BMW, Audi and Volkswagen. At the bottom of the list we have Mini, Skoda, Mazda, Hyundai, Citroen and Peugeot.

Table 54. Results for Question 13

Q13. Availability to Respond to Customer Requests		
1.	4.80	Alfa Romeo
2.	4.57	Chrysler
3.	4.50	Volvo
4.	4.39	Mercedes-Benz
5.	4.33	Land Rover
6.	4.25	Daihatsu
7.	4.17	BMW
8.	4.09	Audi
9.	4.04	Volkswagen
10.	4.00	Mitsubishi
11.	3.96	Renault
12.	3.94	Fiat
13.	3.93	Seat
14.	3.91	Opel
15.	3.89	Honda
16.	3.87	Nissan
17.	3.80	Toyota
18.	3.80	Kia
19.	3.79	Ford
20.	3.75	Suzuki
21.	3.73	Peugeot
22.	3.68	Citroen
23.	3.62	Hyundai
24.	3.60	Mazda
25.	3.60	Skoda
26.	3.50	Mini
Mean	3.982	

The fourth item of the responsiveness dimension is having staff who have good relationships with each other. The customers should be able to observe this positive relationship. The aim of this item was to measure the compatibility of the staff. Compatible staff item is ranked number 12 with a mean of 4.005 among all 28 items. Scores of each and every brand are shown in Table 55.

Table 55. Results for Question 14

Q14. Compatible Staff		
1.	4.71	Chrysler
2.	4.39	BMW
3.	4.26	Mercedes-Benz
4.	4.25	Volvo
5.	4.20	Mazda
6.	4.17	Land Rover
7.	4.17	Mitsubishi
8.	4.10	Kia
9.	4.10	Skoda
10.	4.09	Audi
11.	4.09	Opel
12.	4.00	Alfa Romeo
13.	4.00	Daihatsu
14.	4.00	Fiat
15.	4.00	Mini
16.	4.00	Suzuki
17.	3.97	Citroen
18.	3.96	Volkswagen
19.	3.91	Renault
20.	3.87	Ford
21.	3.87	Seat
22.	3.77	Hyundai
23.	3.73	Peugeot
24.	3.66	Toyota
25.	3.60	Nissan
26.	3.26	Honda
Mean	4.005	

Chrysler was again the top brand. BMW, Mercedes, Volvo and Mazda came next. These brands were evaluated by their customers as having compatible staff. However customers of Honda, Nissan, Toyota, Peugeot and Hyundai evaluated their brands negatively in this item. The mean averages of Seat, Ford, Renault, Volkswagen and Citroen are under 4.00 in the item measuring the staff compatibility.

The fifth item of the responsiveness dimension was about adequate transportation facilities. The location of a service station should be easily accessible because when the customers leave their cars at the service station, they have to have an alternative solution for transportation. Many service stations provide different solutions in such situations. This item was ranked 13th, with a mean average of 3.997, among 28 items, and details of the results are given in Table 56.

Table 56. Results for Question 15

Q15. Adequate Transportation Facilities		
1.	4.38	Volvo
2.	4.25	Daihatsu
3.	4.22	Mercedes-Benz
4.	4.20	Alfa Romeo
5.	4.17	Volkswagen
6.	4.17	Land Rover
7.	4.17	Mitsubishi
8.	4.14	Chrysler
9.	4.10	Skoda
10.	4.00	Audi
11.	4.00	BMW
12.	4.00	Ford
13.	4.00	Mini
14.	3.96	Fiat
15.	3.95	Honda
16.	3.95	Opel
17.	3.94	Peugeot
18.	3.90	Hyundai
19.	3.88	Renault
20.	3.87	Seat
21.	3.84	Citroen
22.	3.83	Toyota
23.	3.80	Kia
24.	3.80	Mazda
25.	3.75	Suzuki
26.	3.67	Nissan
Mean	3.997	

Volvo, Daihatsu, Mercedes and Alfa Romeo hadve the highest scores in terms of having adequate transportation facilities. Volkswagen, Land Rover and Mitsubishi are the brands which followed. On the other hand, Nissan, Suzuki, Mazda and Kia are at the bottom of the list with their low scores. Other brands with an average mean below 3.90 are Toyota, Citroen, Seat and Renault.

Number six on the responsiveness dimension was qualified labor force. Labor is one of the most important aspects of companies in the services sector, and automobile aftersales stations have to work with many personnel. The qualification and training level of this workforce is another important issue. This item was ranked 15th with an average mean of 3.988, among 28 items. The detailed results are also given in Table 57.

Chrysler, Alfa Romeo, Mercedes and Volvo had the highest scores in terms of having qualified labor force. Land Rover, Audi, Mitsubishi and BMW follow, and Mazda, Peugeot, Nissan and Toyota are at the bottom of this list. To have a qualified labor force requires training, which is costly, and some brands do not give enough importance to these training activities because of the high costs. Nevertheless, this cost is increased by misapplications of the spare parts by the untrained workforce. The optimal solution is having this training online, which decreases the costs and increases the knowledge level of the staff.

Table 57. Results for Question 16

Q16. Qualified Labor force		
1.	4.43	Chrysler
2.	4.40	Alfa Romeo
3.	4.39	Mercedes-Benz
4.	4.38	Volvo
5.	4.33	Land Rover
6.	4.23	Audi
7.	4.17	Mitsubishi
8.	4.11	BMW
9.	4.00	Mini
10.	4.00	Opel
11.	4.00	Volkswagen
12.	3.97	Hyundai
13.	3.95	Ford
14.	3.95	Renault
15.	3.90	Citroen
16.	3.90	Skoda
17.	3.89	Honda
18.	3.87	Seat
19.	3.84	Fiat
20.	3.80	Kia
21.	3.75	Daihatsu
22.	3.75	Suzuki
23.	3.73	Toyota
24.	3.70	Nissan
25.	3.64	Peugeot
26.	3.60	Mazda
Mean	3.988	

The seventh item of the responsiveness dimension was equal treatment, which aims to measure the equality in transactions of an automobile aftersales station to each and every customer. This item ranked 21st among 28 items with an average

mean value of 3.853. This ranking is at a low level, which shows that all brands have to improve their efforts for equal treatment to all their customers.

Table 58. Results for Question 17

Q17. Equal Treatment		
1.	4.40	Alfa Romeo
2.	4.29	Chrysler
3.	4.25	Daihatsu
4.	4.25	Volvo
5.	4.20	Mazda
6.	4.17	Land Rover
7.	4.11	BMW
8.	4.00	Mini
9.	4.00	Suzuki
10.	3.85	Volkswagen
11.	3.79	Peugeot
12.	3.78	Opel
13.	3.77	Audi
14.	3.74	Hyundai
15.	3.74	Mercedes-Benz
16.	3.74	Renault
17.	3.73	Seat
18.	3.72	Ford
19.	3.69	Fiat
20.	3.68	Honda
21.	3.67	Mitsubishi
22.	3.60	Kia
23.	3.55	Citroen
24.	3.54	Toyota
25.	3.53	Nissan
26.	3.40	Skoda
Mean	3.853	

Alfa Romeo, Chrysler, Daihatsu, Volvo and Mazda are the top brands in providing equal treatment to their customers. Land Rover and BMW are also above

4.00 in average mean according to evaluation of their customers. Skoda, Nissan and Toyota have the lowest scores in this item and they are preceded by Citroen, Kia, Mitsubishi, Honda and Fiat. The rest have an average mean of more than 3.70 in terms of equal treatment.

Table 59. Results for Question 18

Q18. Attentive Service		
1.	4.57	Chrysler
2.	4.38	Volvo
3.	4.22	BMW
4.	4.17	Land Rover
5.	4.13	Mercedes-Benz
6.	4.13	Mini
7.	4.00	Opel
8.	3.94	Peugeot
9.	3.94	Volkswagen
10.	3.89	Honda
11.	3.87	Hyundai
12.	3.87	Seat
13.	3.83	Mitsubishi
14.	3.80	Alfa Romeo
15.	3.80	Mazda
16.	3.78	Fiat
17.	3.75	Renault
18.	3.75	Daihatsu
19.	3.75	Suzuki
20.	3.72	Ford
21.	3.71	Citroen
22.	3.68	Audi
23.	3.60	Kia
24.	3.59	Toyota
25.	3.50	Nissan
26.	3.50	Skoda
Mean	3.879	

The last item of the responsiveness dimension was attentive service. This item is about being careful in all procedures and processes while a car is serviced in an automobile aftersales station. This last item is ranked as 19th with an average mean of 3.879, among 28 items. Detailed scores of each brand are given in Table 59.

Chrysler, Volvo, BMW and Land Rover were the top scorers in this item. Mercedes, Mini and Opel also had a mean average of more than 4.00. On the other hand, Skoda, Nissan and Toyota were the lowest scoring brands which are preceded by Kia, Audi, Citroen and Ford.

Responsiveness dimension had the maximum number of items when compared with our dimensions. All eight dimensions are evaluated and explained in terms of customer evaluation scores. Alfa Romeo, Chrysler, Mercedes, Volvo and Daihatsu were the winners of this dimension, whereas Nissan, Toyota, Skoda and Kia were the losers.

Assurance was the fourth dimension and included five items: confidence in transactions, politeness of the staff, knowledgeable staff, informative explanations, and reasonable pricing. All of the items in this dimension are explained for each and every automobile brand.

The first item of the assurance dimension was about confidence in transactions. This item examined the comfort and safety of the customers in all transactions when their cars were serviced. The first item of the assurance dimension was ranked 27th, with an average mean of 3.486, which was one of the lowest averages. This value means that there is a lack of success for all automobile brands in Turkey in terms of the confidence customers feel in aftersales transactions.

Table 60. Results for Question 19

Q19. Confidence in Transactions		
1.	4.00	Mazda
2.	3.91	Mercedes-Benz
3.	3.88	Mini
4.	3.75	Daihatsu
5.	3.75	Suzuki
6.	3.73	Audi
7.	3.67	BMW
8.	3.63	Volvo
9.	3.60	Seat
10.	3.57	Chrysler
11.	3.50	Mitsubishi
12.	3.49	Volkswagen
13.	3.45	Peugeot
14.	3.42	Honda
15.	3.42	Citroen
16.	3.41	Toyota
17.	3.41	Hyundai
18.	3.40	Alfa Romeo
19.	3.38	Opel
20.	3.33	Fiat
21.	3.33	Land Rover
22.	3.25	Renault
23.	3.23	Nissan
24.	3.13	Ford
25.	3.00	Kia
26.	3.00	Skoda
Mean	3.486	

Mazda, Mercedes, Mini are the top brands, followed by Daihatsu, Suzuki and Audi. Nevertheless, the average mean values of these brands are also very low. This item shows one of the important issues that the aftersales companies should work on.

Skoda, Kia and Ford are the brands at the bottom of the list with very small mean average values. Nissan, Renault, Land Rover and Fiat also have very low mean average values.

Table 61. Results for Question 20

Q20. Politeness of the Staff		
1.	4.29	Chrysler
2.	4.00	Mercedes-Benz
3.	3.91	Volkswagen
4.	3.83	BMW
5.	3.77	Citroen
6.	3.75	Daihatsu
7.	3.75	Mini
8.	3.72	Hyundai
9.	3.67	Land Rover
10.	3.65	Renault
11.	3.63	Volvo
12.	3.56	Ford
13.	3.56	Opel
14.	3.55	Peugeot
15.	3.53	Fiat
16.	3.50	Audi
17.	3.50	Mitsubishi
18.	3.50	Suzuki
19.	3.47	Seat
20.	3.42	Honda
21.	3.41	Toyota
22.	3.40	Mazda
23.	3.30	Skoda
24.	3.20	Alfa Romeo
25.	3.20	Kia
26.	3.20	Nissan
Mean	3.588	

The second item of the assurance dimension was politeness of the staff. This item aims to measure the politeness level of the employees of automobile aftersales stations in Turkey. This item was ranked 24th with a mean average value of 3.588, among 28 items. This is again a low score which shows the lack of politeness in automobile aftersales service stations in Turkey.

The only brands with a mean average of more than 4.00 were Chrysler and Mercedes. Volkswagen, BMW, Citroen, Daihatsu, Mini and Hyundai are good in terms of politeness of the staff. On the other hand, Nissan, Kia, Alfa Romeo and Skoda have the lowest mean averages and are preceded by Mazda, Toyota, Honda and Seat.

The third item of the assurance dimension was having knowledgeable staff. This item aims to measure the knowledge level of the service employees from the observations of the customers. This item was ranked 23rd, with a mean average value of 3.730 among all 28 items. The specific details based on all brands are given in Table 62.

The brands with an average mean value of more than 4.00 were Suzuki, Land Rover, Chrysler, Mercedes and Alfa Romeo. Volkswagen, BMW, Volvo and Hyundai followed these in terms of having knowledgeable staff. Therefore, Nissan and Honda have the lowest mean average values and these were preceded by Mitsubishi, Kia and Daihatsu.

Table 62. Results for Question 21

Q21. Knowledgeable Staff		
1.	4.25	Suzuki
2.	4.17	Land Rover
3.	4.14	Chrysler
4.	4.09	Mercedes-Benz
5.	4.00	Alfa Romeo
6.	3.89	Volkswagen
7.	3.89	BMW
8.	3.88	Volvo
9.	3.79	Hyundai
10.	3.75	Fiat
11.	3.73	Peugeot
12.	3.71	Toyota
13.	3.67	Opel
14.	3.63	Mini
15.	3.62	Ford
16.	3.61	Citroen
17.	3.60	Mazda
18.	3.60	Seat
19.	3.60	Skoda
20.	3.60	Renault
21.	3.59	Audi
22.	3.50	Daihatsu
23.	3.50	Kia
24.	3.50	Mitsubishi
25.	3.42	Honda
26.	3.27	Nissan
Mean	3.730	

The fourth item of the assurance dimension was about providing informative explanations. Every customer needs an informative and clear explanation about the details of the service provided to his/her car. This item ranked 20th, with a mean average value of 3.862 among all 28 items.

Table 63. Results for Question 22

Q22. Informative Explanations		
1.	4.30	Mercedes-Benz
2.	4.25	Daihatsu
3.	4.25	Suzuki
4.	4.20	Alfa Romeo
5.	4.14	Chrysler
6.	4.00	BMW
7.	4.00	Ford
8.	4.00	Volkswagen
9.	3.93	Opel
10.	3.83	Mitsubishi
11.	3.82	Renault
12.	3.82	Hyundai
13.	3.82	Audi
14.	3.80	Fiat
15.	3.80	Mazda
16.	3.80	Seat
17.	3.77	Citroen
18.	3.76	Toyota
19.	3.75	Mini
20.	3.70	Skoda
21.	3.67	Peugeot
22.	3.63	Nissan
23.	3.63	Honda
24.	3.63	Volvo
25.	3.60	Kia
26.	3.50	Land Rover
Mean	3.862	

This dimension has low average mean values overall, so even the best brands might have low mean averages. The brands with a mean average value of less than 4.00 are Mercedes, Daihatsu, Suzuki, Alfa Romeo and Chrysler. BMW, Ford and Volkswagen are just on the boundary. Therefore, according to their customers, Land Rover, Kia, Volvo, Honda and Nissan had the lowest mean average values on having knowledgeable staff.

The last item of the assurance dimension was reasonable pricing. Pricing is one of the most important debates between companies and customers in every business sector. In the automobile aftersales business, pricing should be reasonable for the service provided. This item was ranked 25th with a mean average value of 3.583 among 28 items in the survey.

Table 64. Results for Question 23

Q23. Reasonable Pricing		
1.	4.00	Suzuki
2.	3.88	Mini
3.	3.80	Fiat
4.	3.80	Mazda
5.	3.79	Volkswagen
6.	3.75	Daihatsu
7.	3.75	Volvo
8.	3.73	Seat
9.	3.70	Mercedes-Benz
10.	3.64	Peugeot
11.	3.64	Audi
12.	3.64	Opel
13.	3.62	Ford
14.	3.56	Hyundai
15.	3.56	BMW
16.	3.53	Renault
17.	3.50	Mitsubishi
18.	3.50	Skoda
19.	3.48	Citroen
20.	3.47	Chrysler
21.	3.46	Toyota
22.	3.40	Kia
23.	3.33	Land Rover
24.	3.30	Nissan
25.	3.20	Alfa Romeo
26.	3.14	Honda
Mean	3.583	

Suzuki was the only brand having an average mean value above or equal to 4.00. Mini, Fiat, Mazda and Volkswagen were other brands at the top of our survey results with mean average values below Suzuki. On the other hand, Honda, Alfa Romeo, Nissan, Land Rover and Kia are the brands which have very low average mean values. Brands have generally have low mean average values in terms of having reasonable pricing.

The assurance dimension generally has low mean average values, according to Turkish automobile aftersales customers. Mercedes, Suzuki and Mini were the winner of this dimension despite their low average mean values. On the other hand, Honda, Alfa Romeo and Kia were the losers in the assurance dimension.

The last dimension was empathy, which contained five items; these included individual attention, knowing the needs of the customers, payment options, offering gifts and promotions and delivery quality. This last dimension will also be explained for all items and all brands in the following paragraphs.

The first item of the empathy dimension showed the level of individual attention to all customers. This item questions the level of attention presented to each and every customer. This item ranked 22nd, with an average mean of 3.829 among 28 items. This ranking showed that according to their customers, the efforts of the brands in Turkey were unsuccessful.

Table 65. Results for Question 24

Q24. Individual Attention		
1.	4.40	Mazda
2.	4.13	Volvo
3.	4.09	Volkswagen
4.	4.00	Alfa Romeo
5.	4.00	Daihatsu
6.	4.00	Mercedes-Benz
7.	4.00	Mitsubishi
8.	4.00	Suzuki
9.	3.96	Fiat
10.	3.92	Hyundai
11.	3.89	Honda
12.	3.85	Ford
13.	3.84	Opel
14.	3.80	Skoda
15.	3.77	Audi
16.	3.73	Nissan
17.	3.73	Seat
18.	3.71	Citroen
19.	3.70	Renault
20.	3.70	Kia
21.	3.67	BMW
22.	3.63	Toyota
23.	3.61	Peugeot
24.	3.50	Land Rover
25.	3.50	Mini
26.	3.43	Chrysler
Mean	3.829	

Mazda, Volvo and Volkswagen were the best-ranked brands. Alfa Romeo, Daihatsu, Mitsubishi, Mercedes and Suzuki also have slightly higher mean average values. Chrysler, Mini, Land Rover, Peugeot and Toyota are the brands with extremely low mean averages in terms of showing all customers individual attention.

The second item of the empathy dimension was knowing the needs of the customers. This item is very important not only in automobile aftersales business. In every business, understanding customer needs is an important issue. This item ranked 26th, with an average mean of 3.573 among 28 items. The brand-specific details are given in Table 66.

Table 66. Results for Question 25

Q25. Knowing the Needs of the Customers		
1.	4.00	Suzuki
2.	4.00	Volvo
3.	3.83	Mitsubishi
4.	3.77	Citroen
5.	3.75	Mini
6.	3.74	Mercedes-Benz
7.	3.73	Seat
8.	3.70	Volkswagen
9.	3.67	Hyundai
10.	3.67	Peugeot
11.	3.67	Land Rover
12.	3.65	Renault
13.	3.64	Opel
14.	3.62	Ford
15.	3.60	Mazda
16.	3.53	Nissan
17.	3.50	Daihatsu
18.	3.47	Honda
19.	3.45	Audi
20.	3.40	Alfa Romeo
21.	3.37	Toyota
22.	3.35	Fiat
23.	3.33	BMW
24.	3.30	Kia
25.	3.14	Chrysler
26.	3.00	Skoda
Mean	3.573	

This item also had a very low average mean. There are only two brands that had an average mean value of 4.00: Suzuki and Volvo. These two brands are at the top in this item. They are followed by Mitsubishi, Citroen, Mini, Mercedes, Seat and Volkswagen. On the other hand, Skoda, Chrysler, Kia, BMW, Fiat, Toyota and Alfa Romeo are the brands with very low mean average scores.

Table 67. Results for Question 26

Q26. Payment Options		
1.	4.39	Mercedes-Benz
2.	4.33	Mitsubishi
3.	4.30	Skoda
4.	4.29	Chrysler
5.	4.27	Seat
6.	4.25	Suzuki
7.	4.20	Alfa Romeo
8.	4.15	Hyundai
9.	4.13	Volvo
10.	4.11	BMW
11.	4.11	Volkswagen
12.	4.10	Citroen
13.	4.07	Opel
14.	4.05	Renault
15.	4.05	Honda
16.	4.03	Ford
17.	4.00	Daihatsu
18.	4.00	Land Rover
19.	3.92	Fiat
20.	3.91	Peugeot
21.	3.91	Audi
22.	3.88	Mini
23.	3.87	Nissan
24.	3.83	Toyota
25.	3.70	Kia
26.	3.60	Mazda
Mean	4.055	

The third item of the empathy dimension was about providing alternative payment options. This item questioned the variety of payment options presented in the automobile aftersales service stations. This item ranked 7th with a mean average of 4.055 among 28 items, which could be regarded as a high score. This mean average shows the importance given by the brands to this issue.

Mercedes, Mitsubishi and Skoda are the top brands in terms of providing alternative payment options. Chrysler, Suzuki and Seat followed. Mazda, Kia, Toyota, Nissan and Mini had the lowest average mean scores in this item. The brands with a mean average of less than 4.00 were Audi, Peugeot and Fiat.

The fourth item of the empathy dimension was about offering gifts and promotions. This item questioned the automobile aftersales brands in terms of providing their customers with gifts and promotions when they bring their car to the service station.

This item ranked 28th with a mean average of 3.355 among 28 items. In other words, this item had the lowest mean average among all items, which shows that not all brands offer enough gifts and promotions to their customers.

Table 68. Results for Question 27

Q27. Offering Gifts and Promotions		
1.	3.88	Mini
2.	3.75	Daihatsu
3.	3.75	Volvo
4.	3.72	BMW
5.	3.71	Chrysler
6.	3.67	Land Rover
7.	3.65	Mercedes-Benz
8.	3.55	Citroen
9.	3.55	Audi
10.	3.55	Opel
11.	3.50	Mitsubishi
12.	3.40	Alfa Romeo
13.	3.40	Seat
14.	3.36	Peugeot
15.	3.30	Skoda
16.	3.26	Renault
17.	3.21	Volkswagen
18.	3.20	Nissan
19.	3.18	Hyundai
20.	3.03	Ford
21.	3.00	Mazda
22.	3.00	Suzuki
23.	2.95	Toyota
24.	2.94	Fiat
25.	2.90	Kia
26.	2.84	Honda
Mean	3.355	

There is not any brand that has a mean average over 3.90. Mini, Daihatsu and Volvo are the top brands of this item despite their low mean average scores. There are rare scores in our survey results below 3.00 on this item. The brands that have a

lower mean average than 3.00 are Honda, Kia, Fiat and Toyota. Suzuki and Mazda are just on the boundary.

Table 69. Results for Question 28

Q28. Delivery Quality		
1.	5.00	Mitsubishi
2.	4.67	Land Rover
3.	4.63	Volvo
4.	4.61	Mercedes-Benz
5.	4.60	Alfa Romeo
6.	4.60	Mazda
7.	4.44	BMW
8.	4.43	Chrysler
9.	4.30	Volkswagen
10.	4.25	Daihatsu
11.	4.25	Suzuki
12.	4.16	Fiat
13.	4.14	Audi
14.	4.10	Skoda
15.	4.08	Hyundai
16.	4.05	Honda
17.	4.04	Opel
18.	4.02	Renault
19.	4.00	Ford
20.	3.95	Toyota
21.	3.94	Peugeot
22.	3.93	Seat
23.	3.90	Citroen
24.	3.90	Nissan
25.	3.75	Mini
26.	3.70	Kia
Mean	4.209	

The last item of the Empathy dimension, which was also the last item of the survey, was delivery quality. This item questioned the quality level of the serviced

cars after the service processes were completed. This item is ranked as 1st with a mean average of 4.209, among all 28 items. This result shows that the automobile aftersales brands are very good at delivery quality.

One brand has a score of 5.00, which means that all of its customers gave the maximum score to this brand on this item. This brand is Mitsubishi, which is followed by Land Rover, Volvo and Mercedes. On the other hand, Kia, Mini, Nissan and Citroen have the lowest mean average scores in terms of delivery quality. Also, three brands are under the level of 4.00: Seat, Peugeot and Toyota.

The empathy dimension was the last dimension in our study examined in all of its items. The winners in this dimension were Mitsubishi, Mercedes and Volvo whereas the losers were Kia, Toyota and Chrysler. Some brands were best in one dimension but worst in another dimension, indicating the issues that need to be considered to increase the service quality level in their aftersales service stations.

15.2 Reliability and validity analysis

This study used Structural Equation Modeling (SEM) techniques applied by SPSS and AMOS software. This section reports on the exploratory factor analysis and confirmatory factor analysis, which were used to analyze the updated AutoServQual. To avoid measurement error, the indicators of the constructs should be valid and reliable.

Reliable measures are free of random error (Kline, 1998). Kline (1998) and Trochim (2006) give a brief summary of reliability. Four types of reliability are

explained in these studies: internal consistency reliability, inter rater (inter observer) reliability, test-retest reliability and alternate (parallel) forms reliability.

Internal consistency reliability aims to measure the consistency of the results within a test across items. Kline (1998) states the importance of internal consistency reliability in his study and used split-half reliability together with internal consistency reliability. This concept is explained in his study as the stability of the respondents across separate halves. This method was applicable to our study and we did the analysis as described in the following pages.

Inter-rater or, in other words, inter-observer reliability was used to analyze the degree of consistency in estimates by different observers or raters on the same phenomenon. This may simply be called the calibration of the raters. This method was not suitable for our data because it was not possible to get the examiners to assess the alignment of test scores of each individual.

Test-retest reliability is for analyzing the consistency of a measure from a certain time to another one in the future. The correlation is effected from the time passed between the two analyses. This type of reliability assesses the change or consistency of the responses over a given time period. This type of reliability measurement was not suitable for our study because we had only one time of measurement.

Lastly, alternate (parallel) forms reliability aims to measure the relationship between two tests which are constructed from the same content in the same way. This reliability analysis type could not be applied in our study because AutoServQual, like many other scales, employs only one form of questionnaire.

On the other hand, according to Trochim (2006), split-half reliability is one of the four major reliability analyses. This study categorized other types as Cronbach's alpha, average item-total correlation and average inter-item consistency. The similarity of the subjects who responded to the items within the same scale is to be assessed by all internal consistency reliability analysis.

The average of all possible split-half estimates is mathematically equivalent to Cronbach's alpha although it is not measured by calculation, according to Trochim (2006). We applied internal consistency reliability tests using SPSS software. Thus, the Cronbach's alpha were calculated and shown in Table 70.

Table 70. Cronbach's Alpha Results

Cronbach's Alpha Values of Factors		
	Cronbach's Alpha	Number of Items
Tangibles	0.861	4
Reliability	0.891	6
Responsiveness	0.903	8
Assurance	0.858	5
Empathy	0.846	5

The adequate level for Cronbach alpha value is 0.70 (Kline, 1998). All values in our study are well above this level. These results indicate excellent reliability for the AutoServQual scale, which has high Cronbach's alpha values. On the other hand, all individual items within our dimensions in the scale were examined for their contribution to the alpha values and inter-item correlations.

Again, we saw high values in terms of corrected item total correlation values despite the factor characteristics of the original ServQual. All items in the AutoServQual dimensions correlate highly with the remaining items within the scale, as seen in Table 71.

Table 71. Results of Inter-item Correlations within Factors

Inter-item Correlations within Factors			
	Min (Corrected item-total correlation)	Max (Corrected item-total correlation)	Removal of items for better Cronbach's alpha
Tangibles	0.679	0.723	None
Reliability	0.596	0.747	None
Responsiveness	0.525	0.776	ekRES2 (0.909)
Assurance	0.621	0.758	None
Empathy	0.487	0.717	ekEMP2 (0.866)

Minimum and maximum correlation values as corrected item total correlation values are given in Table 71 as well as the items that cause an increase in the Cronbach's alpha value if they are moved are listed in Table 71. This condition exists in only two dimensions.

The first one is ekRES2 item for the responsiveness dimension and the second one is ekEMP2 for the empathy dimension. These items were not removed in this step, because their alpha values were higher than 0.7. For the tangibles, reliability and assurance dimensions, all items affect the Cronbach's alpha values negatively if they are removed from the scale.

Descriptive Statistics were also taken from SPSS software to show the skewness and kurtosis of the values. Skewness and kurtosis values of indicators are inside the acceptance level intervals (Curran et al., 1996). Besides showing the skewness and kurtosis values, this figure was also used to give the new names of the AutoServQual items.

New items were named according to their existing dimensions, but they took an ASQ abbreviation before their dimension names. For example, the first item of the tangibles dimension in the AutoServQual was named ASQtan1, which signals all the

details. AutoServQual had 28 items: ASQtan1, ASQtan2, ASQtan3, ASQtan4, ASQrel1, ASQrel2, ASQrel3, ASQrel4, ASQrel5, ASQrel6, ASQres1, ASQres2, ASQres3, ASQres4, ASQres5, ASQres6, ASQres7, ASQres8, ASQass1, ASQass2, ASQass3, ASQass4, ASQass5, ASQemp1, ASQemp2, ASQemp3, ASQemp4 and ASQemp5. All of these items are shown in descriptive statistics figures by their old and new names. The next two figures showed the results of split half measures of the AutoServQual scale.

In the literature survey, reliability analysis also includes split half reliability tests. In our study, we also conducted this measurement by two different methods. By definition, split half reliability analysis is a measurement of consistency where the survey is split into two parts and the results are evaluated as two different surveys. In other words, each half is compared with the other. When there is consistency, the researcher is able to believe that his scale is measuring the same thing.

Here, the important issue was how to divide the questions. One method divided only from the middle, and the second method grouped odd and even numbered questions.

AutoServQual was analyzed according to both methods and the results are given in the related figures. The high values show the reliability success of the AutoServQual scale. Also, Table 73 and Table 74 show the Split-half statistics results.

Table 72. Some Descriptive Statistics of the Sample

Descriptive Statistics									
	Auto ServQual	N	Mean	Std. Deviation	Varianc e	Skewness		Kurtosis	
	Dimensio n	Stati stic	Statisti c	Statistic	Statistic	Statisti c	Std. Error	Statisti c	Std. Error
ekTAN1	ASQtan1	600	3.80	1.002	1.005	-1.187	.100	1.310	.199
ekTAN2	ASQtan2	600	3.91	.973	.946	-1.374	.100	2.199	.199
ekTAN3	ASQtan3	600	3.88	.926	.857	-1.470	.100	2.852	.199
ekTAN4	ASQtan4	600	3.87	.960	.923	-1.345	.100	2.189	.199
REL4	ASQrel1	600	4.07	.948	.898	-1.726	.100	3.475	.199
REL5	ASQrel2	600	4.01	.997	.993	-1.502	.100	2.441	.199
ekREL1	ASQrel3	600	3.89	.971	.944	-1.408	.100	2.237	.199
ekREL2	ASQrel4	600	3.91	.952	.906	-1.397	.100	2.429	.199
ekREL4	ASQrel5	600	3.89	.945	.893	-1.381	.100	2.343	.199
ekREL5	ASQrel6	600	3.70	.941	.885	-1.048	.100	1.465	.199
RES1	ASQres1	600	4.00	.960	.922	-1.431	.100	2.513	.199
RES3	ASQres2	600	3.96	.941	.885	-1.505	.100	2.806	.199
RES4	ASQres3	600	3.93	.940	.883	-1.349	.100	2.391	.199
ekRES1	ASQres4	600	3.78	.900	.810	-1.277	.100	2.333	.199
ekRES2	ASQres5	600	3.38	1.150	1.323	-.399	.100	-.916	.199
ekRES3	ASQres6	600	3.56	1.019	1.038	-.885	.100	.407	.199
ekRES5	ASQres7	600	3.64	.954	.911	-1.096	.100	1.415	.199
ekRES6	ASQres8	600	3.80	.966	.933	-1.373	.100	2.139	.199
ASS2	ASQass1	600	3.96	.939	.882	-1.575	.100	3.070	.199
ASS3	ASQass2	600	4.01	.945	.893	-1.577	.100	3.068	.199
ekASS1	ASQass3	600	3.55	1.033	1.066	-.774	.100	.201	.199
ekASS3	ASQass4	600	3.76	1.021	1.042	-1.053	.100	.914	.199
ekASS4	ASQass5	600	3.52	1.134	1.285	-.753	.100	-.240	.199
EMP1	ASQemp1	600	3.92	.972	.946	-1.441	.100	2.406	.199
EMP3	ASQemp2	600	3.81	.977	.955	-1.194	.100	1.594	.199
ekEMP1	ASQemp3	600	3.98	.895	.801	-1.790	.100	4.164	.199
ekEMP2	ASQemp4	600	3.26	1.120	1.254	-.414	.100	-.858	.199
ekEMP3	ASQemp5	600	4.06	.962	.926	-1.826	.100	3.788	.199
Valid N	(list wise)	600							

Table 73. Split-half Measure Results

SPLIT HALF RELIABILITY MEASURE				
SPLIT HALF (ORDERED)				
TANGIBLES	Reliability Statistics			
	Cronbach's Alpha	Part 1	Value	.776
			N of Items	2 ^a
		Part 2	Value	.799
			N of Items	2 ^b
		Total N of Items		4
	Correlation Between Forms			.713
	Spearman-Brown Coefficient	Equal Length		.832
		Unequal Length		.832
	Guttman Split-Half Coefficient			.832
RELIABILITY	Reliability Statistics			
	Cronbach's Alpha	Part 1	Value	.850
			N of Items	3 ^a
		Part 2	Value	.811
			N of Items	3 ^b
		Total N of Items		6
	Correlation Between Forms			.731
	Spearman-Brown Coefficient	Equal Length		.845
		Unequal Length		.845
	Guttman Split-Half Coefficient			.844
	a. The items are: ASQtan1, ASQtan2. b. The items are: ASQtan3, ASQtan4.			
RESPONSIVENESS	Reliability Statistics			
	Cronbach's Alpha	Part 1	Value	.888
			N of Items	4 ^a
		Part 2	Value	.857
			N of Items	4 ^b
		Total N of Items		8
	Correlation Between Forms			.652
	Spearman-Brown Coefficient	Equal Length		.789
		Unequal Length		.789
	Guttman Split-Half Coefficient			.788
	a. The items are: ASQres1, ASQres2, ASQres3, ASQres4. b. The items are: ASQres5, ASQres6, ASQres7, ASQres8.			
ASSURANCE	Reliability Statistics			
	Cronbach's Alpha	Part 1	Value	.781
			N of Items	3 ^a
		Part 2	Value	.757
			N of Items	2 ^b
		Total N of Items		5
	Correlation Between Forms			.724
	Spearman-Brown Coefficient	Equal Length		.840
		Unequal Length		.845
	Guttman Split-Half Coefficient			.827
	a. The items are: ASQass1, ASQass2, ASQass3. b. The items are: ASQass3, ASQass4, ASQass5.			
EMPATHY	Reliability Statistics			
	Cronbach's Alpha	Part 1	Value	.818
			N of Items	3 ^a
		Part 2	Value	.556
			N of Items	2 ^b
		Total N of Items		5
	Correlation Between Forms			.727
	Spearman-Brown Coefficient	Equal Length		.842
		Unequal Length		.846
	Guttman Split-Half Coefficient			.814
	a. The items are: ASQemp1, ASQemp2, ASQemp3. b. The items are: ASQemp3, ASQemp4, ASQemp5.			

Table 74. Split-half Measure Results (Odd and Even)

SPLIT HALF RELIABILITY MEASURE				
SPLIT HALF (ODD vs. EVEN)				
TANGIBLES	Reliability Statistics			
	Cronbach's Alpha	Part 1	Value	.685
			N of Items	2 ^a
		Part 2	Value	.731
			N of Items	2 ^b
	Total N of Items			4
	Correlation Between Forms			.823
	Spearman-Brown Coefficient	Equal Length		.903
		Unequal Length		.903
	Guttman Split-Half Coefficient			.903
a. The items are: ASQtan1, ASQtan3. b. The items are: ASQtan2, ASQtan4.				
RELIABILITY	Reliability Statistics			
	Cronbach's Alpha	Part 1	Value	.888
			N of Items	4 ^a
		Part 2	Value	.857
			N of Items	4 ^b
	Total N of Items			8
	Correlation Between Forms			.652
	Spearman-Brown Coefficient	Equal Length		.789
		Unequal Length		.789
	Guttman Split-Half Coefficient			.788
a. The items are: ASQres1, ASQres2, ASQres3, ASQres4. b. The items are: ASQres5, ASQres6, ASQres7, ASQres8.				
RESPONSIVENESS	Reliability Statistics			
	Cronbach's Alpha	Part 1	Value	.774
			N of Items	4 ^a
		Part 2	Value	.840
			N of Items	4 ^b
	Total N of Items			8
	Correlation Between Forms			.881
	Spearman-Brown Coefficient	Equal Length		.937
		Unequal Length		.937
	Guttman Split-Half Coefficient			.937
a. The items are: ASQres1, ASQres3, ASQres5, ASQres7. b. The items are: ASQres2, ASQres4, ASQres6, ASQres8.				
ASSURANCE	Reliability Statistics			
	Cronbach's Alpha	Part 1	Value	.762
			N of Items	3 ^a
		Part 2	Value	.712
			N of Items	2 ^b
	Total N of Items			5
	Correlation Between Forms			.779
	Spearman-Brown Coefficient	Equal Length		.876
		Unequal Length		.880
	Guttman Split-Half Coefficient			.839
a. The items are: ASQass1, ASQass3, ASQass5. b. The items are: ASQass5, ASQass2, ASQass4.				
EMPATHY	Reliability Statistics			
	Cronbach's Alpha	Part 1	Value	.834
			N of Items	3 ^a
		Part 2	Value	.623
			N of Items	2 ^b
	Total N of Items			5
	Correlation Between Forms			.670
	Spearman-Brown Coefficient	Equal Length		.803
		Unequal Length		.808
	Guttman Split-Half Coefficient			.779
a. The items are: ASQemp1, ASQemp3, ASQemp5. b. The items are: ASQemp5, ASQemp2, ASQemp4.				

Discriminant validity is assessed when the average variance extracted scores are higher than the correlation between factors, and convergent validity is assessed when the average variance extracted scores passes 0.70 levels. ServQual is weak in dimensionality, as explained in the literature review of this study.

There are many criticisms of this unidimensionality of the ServQual. AutoServQual is a scale produced from the original ServQual and also shows unidimensionality. So for validity issues, they are both weak scales but there are many studies on the validity of ServQual in the literature. The service quality literature rejects the five-factor structure of ServQual and further suggests that the five dimensions are inter-correlated (see Babakus & Boiler 1992; Babakus & Mangold 1992; Carman 1990; Cronin & Taylor 1992; Parasuraman, Zeithaml, & Berry 1988, 1991). AutoServQual scores were nearly the same as the original ServQual statistics. The analysis continued, using the exploratory factor analysis and confirmatory factor analysis, which examines the empirical results of the AutoServQual scale.

15.3 Exploratory factor analysis

Exploratory Factor Analysis (EFA) is used for uncovering the underlying structure of the large variable sets. This is a statistical method of factor analysis used in multivariate statistics. The underlying relationships within the data sets are identified by exploratory factor analysis.

Here, the main goal was to confirm the factor analysis results, which were originally calculated by Parasuraman (2005) on the original ServQual scale. The

same considerations were applied to the AutoServQual which originated from the previous part of this study. The Kaiser-Meyer-Olkin measure of sampling adequacy value was very high, with a significance value of zero, which shows that this sample was sufficient for the analysis. Table 75 shows the Spss results.

Table 75. KMO and Bartlett's Test Results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.971
Approx. Chi-Square		14519.985
Bartlett's Test of Sphericity	Df	378
	Sig.	,000

The AutoServQual has the same number of dimensions as the original ServQual. Five dimensions remained the same whether or not the items were adapted for AutoServQual. The original ServQual scale was found unidimensional in various studies (Cronin & Taylor, 1992). Then Parasuraman, Zeithaml and Berry (1994) stated that these unidimensional results were because of the characteristics of the services.

Furthermore, the ServQual scale was tested by Carmen (1990) in four different services, including an acute care hospital, a dental school clinic, a tire store, and a business school placement center.

The results provided enough evidence to prove the reliability of the scale despite the unidimensional characteristics of the scale. The uniqueness of the dimensions without diminishing the reliability of the scale was again one of the important results.

A factor analysis result of our study is given in Table 76. Pattern matrix grouped the items from the same dimensions.

Table 76. Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	15.832	56.543	56.543	15.424	55.085	55.085
2	2.273	8.118	64.661	2.006	7.163	62.248
3	.837	2.988	67.649	.513	1.833	64.081
4	.758	2.708	70.357	.491	1.753	65.834
5	.681	2.434	72.790	.351	1.252	67.087
6	.618	2.205	74.996			
7	.586	2.092	77.088			
8	.524	1.872	78.960			
9	.513	1.832	80.792			
10	.468	1.672	82.464			
11	.430	1.535	83.999			
12	.391	1.398	85.397			
13	.381	1.359	86.756			
14	.362	1.294	88.050			
15	.354	1.263	89.313			
16	.320	1.144	90.457			
17	.311	1.112	91.570			
18	.279	.996	92.566			
19	.274	.977	93.543			
20	.265	.945	94.488			
21	.247	.882	95.370			
22	.226	.808	96.178			
23	.217	.777	96.954			
24	.206	.737	97.692			
25	.186	.663	98.354			
26	.167	.596	98.950			
27	.158	.563	99.513			
28	.136	.487	100.000			

Extraction Method: Maximum Likelihood.

Table 77 shows the groupings of the items.

Table 77. Pattern Matrix Results

Pattern Matrix ^a					
	Factor				
	1	2	3	4	5
ASQtan1	1.595				
ASQtan2	1.150				
ASQtan3	.938				
ASQtan4	1.464				
ASQrel1			-2.000		
ASQrel2			-1.702		
ASQrel3			.325		
ASQrel4			.218		
ASQrel5			-.192		
ASQrel6			.725		
ASQres1		-.247			
ASQres2		-.526			
ASQres3		-.390			
ASQres4		.469			
ASQres5		1.467			
ASQres6		1.137			
ASQres7		1.219			
ASQres8		1.379			
ASQass1					-.436
ASQass2					-.480
ASQass3					-.200
ASQass4					-.302
ASQass5					-.293
ASQemp1				-.228	
ASQemp2				-.159	
ASQemp3				-.426	
ASQemp4				.240	
ASQemp5				-.510	

Extraction Method: Maximum Likelihood.

Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 61 iterations.

In the literature, one of the most frequent criticisms of ServQual is unidimensionality. Finn and Lamb (1991) could not provide support for the multidimensionality of the ServQual. In such studies, factors are grouped according to the original ServQual dimensions.

Likewise, in Table 77 groupings were based on the original ServQual. Factor 1 shows the tangibles dimension of AutoServQual, Factor 2 signals the responsiveness dimension, Factor 3 states the reliability dimension, Factor 4 shows the empathy dimension and Factor 5 is grouped as the assurance dimension. Therefore, more comments and considerations will be given in the confirmatory factor analysis section.

The exploratory factor analysis has to be used when there is no prior hypothesis about factors or patterns of measured variables (Finch, 1997). More accurate EFA procedures come when each factor in the analysis is represented by multiple measured variables. Exploratory factor analysis bases its theory on the common factor model which expresses measured variables as a common factor model including unique factors, and errors of measurement. A confirmatory factor analysis was also applied to AutoServQual, the results of which will be seen in the next section.

15.4 Confirmatory factor analysis

Confirmatory factor analysis (CFA) is basically for verifying the factor structure of a set of observed variables. This statistical technique lets the researcher to test his/her hypothesis about a relationship between the observed variables and their underlying latent constructs. We used the Amos 16 Framework version for CFA analysis in this study to verify the research results. AutoServQual data was taken from the SPSS software in SPSS data format and processed by Amos software. Microsoft Excel was also used for some tabulations and calculations. The figure shows the AutoServQual which is portrayed in Amos software.

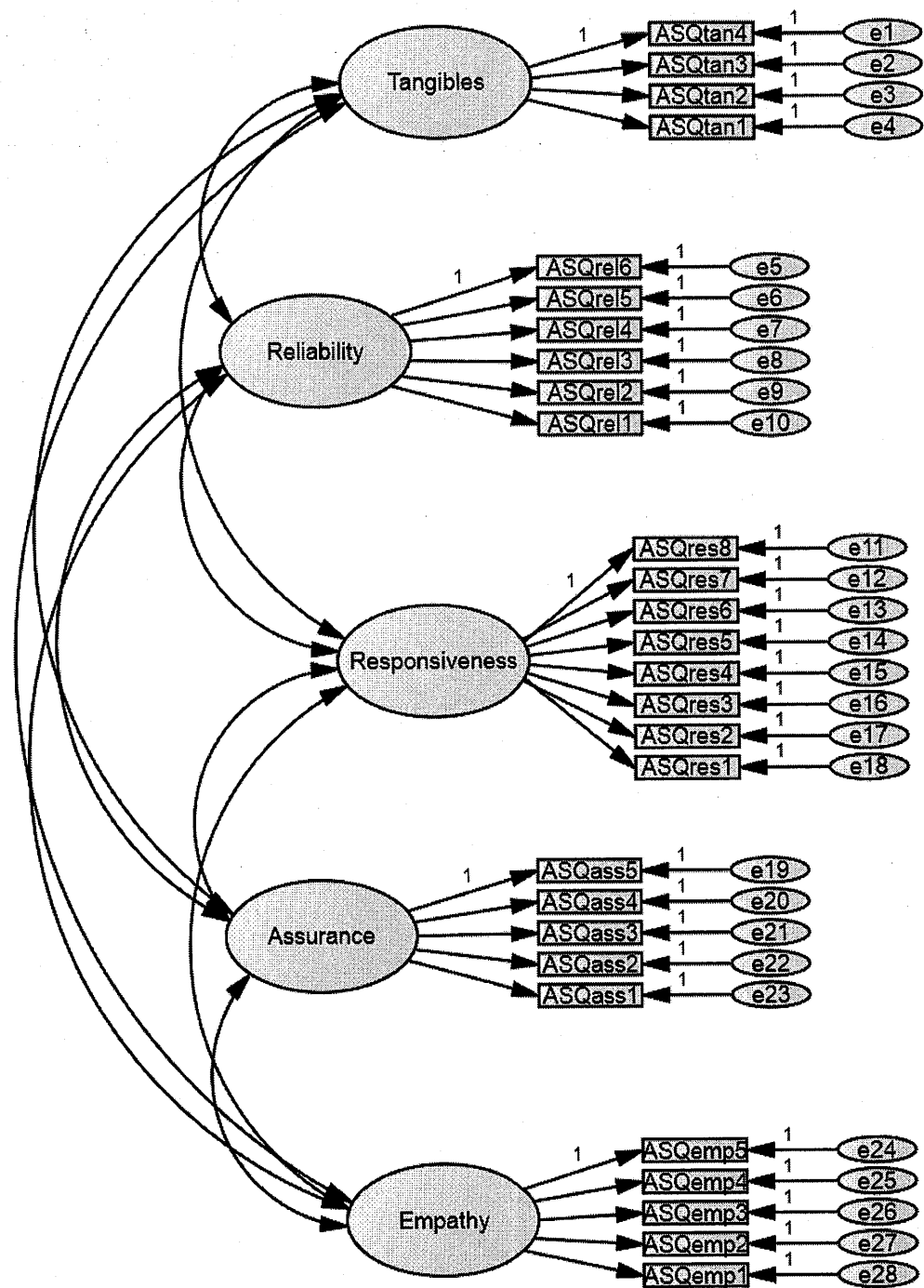


Figure 1. The model by the Amos software

Coefficients of the first items for every dimension were set to 1. This is a prerequisite of Amos software but there is an alternative such as setting the variance of each factor to one to solve equations in Amos software.

The software program automatically sets all errors to have a correlation of one with the items to which they are related. A confirmatory factor analysis was run over the graphical representation of our AutoServQual model. Before running the system to measure how well the model fit into our sample, we checked whether an admissible solution existed or not.

There were no standardized coefficients which exceeded 1.00 and no negative error variances were calculated. The values that equal one were the results of unidimensionality of the original ServQual, which was also the case for AutoServQual. The calculated model is also shown in the next figure.

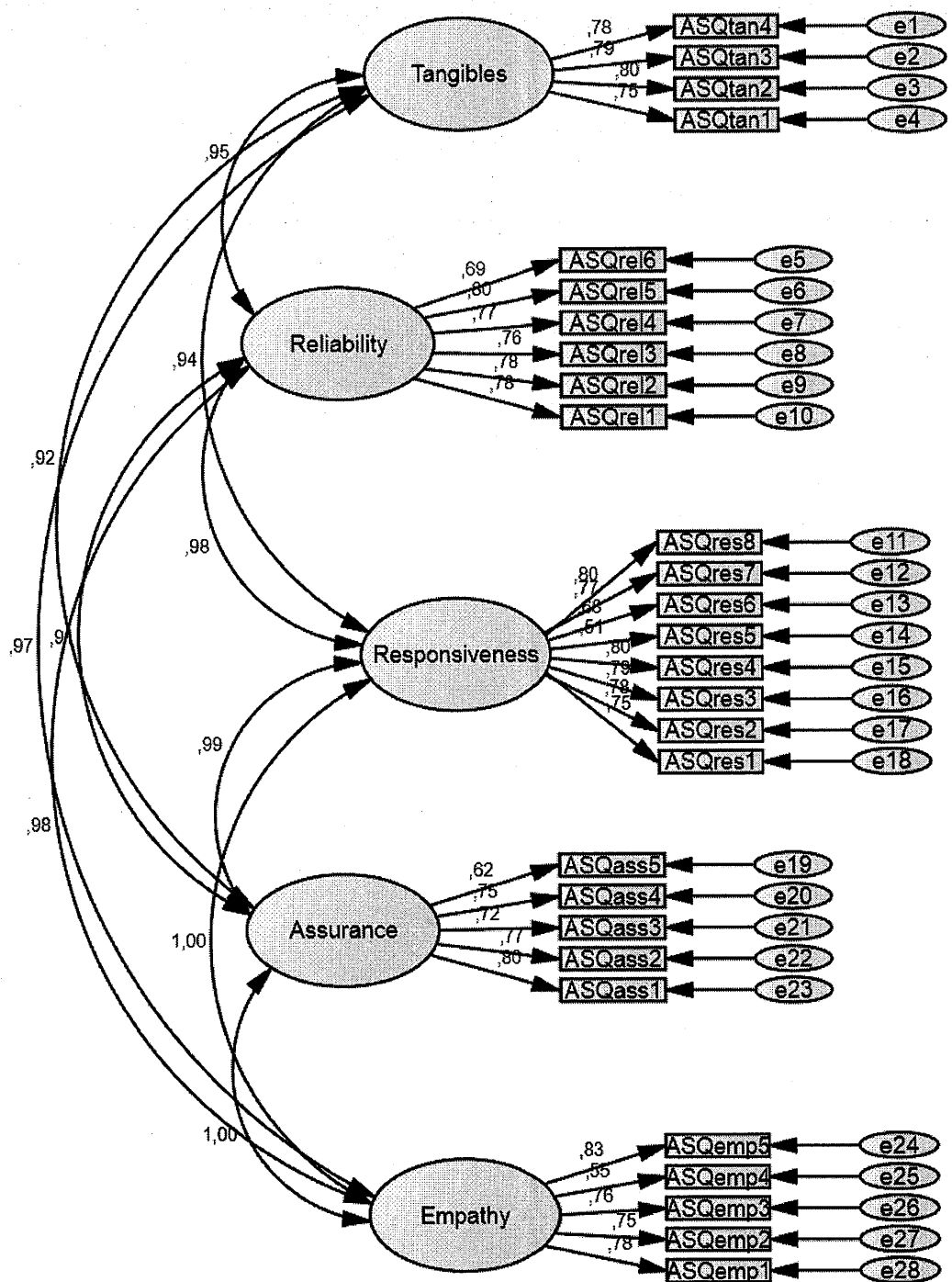


Figure 2. The model by the calculated results

Confirmatory factor analysis by Amos revealed the weak items that decreased the quality of the survey. It was expected that the removal of these items might increase the reliability of the survey.

To determine these weak items the rule of thumb is to check the output figure. In the output file of Amos, under the estimates function, the figures of all items are listed under the heading of standardized regression weights.

According to these results, as shown in Appendix E, Table 89 and Table 90 we had two items that had values below 0.6. These items were ASQres5 with a value of 0.507 and ASQemp4 with a value of 0.550. Brown (2006) states that variances are explained by the squares of correlations estimated.

As seen in Appendix E, only 25.7% of the variance of ASQres5 is explained by its error, e14. The error variable of ASQres5, e14 is larger than all other variances in order to contribute unexplained variance of ASQres5. The analysis process will go on by iterations because each change affects all other results. It is obvious that the other weak item, ASQemp4, which had the smallest value after the ASQres5 has a very low value. As seen in Appendix E, only 30.4% of the variance of ASQemp4 is explained by its error, e25.

The error variable of ASQemp4, e25 is larger than all other variances in order to contribute unexplained variance of ASQemp4. ASQemp4 is also an item which was added to the AutoServQual and was about offering gifts and promotions by automobile aftersales services in Turkey. As seen before, this item had the lowest mean average in our study. Automobile aftersales services in Turkey were very weak in terms of offering gifts and promotions to their customers.

Brown (2006) states that variances are explained by the squares of correlations estimated. As seen in Appendix E, the third weak item is ASQass5, for which only 38.3% of the variance of ASQass5 is explained by its error, e19. The error variable of ASQass5, e19 is larger than all other variances in order to contribute unexplained variance of ASQass5.

The model is given in the figure. There were two ways to proceed. One way was to remove weak items that had an estimate value lower than 0.7 but for the ones whose value was higher than 0.7, protection of those items was another choice. These items were determined by difficult academic processes, so to eliminate them was not easy. We then proceeded by using the second way, which was finding out the close relationships between some of the items.

As mentioned above, to consider all the details before deleting an item should be the strategy in such cases. So we did not continue by deleting more items. The covariance of two errors was freely calculated when two questions were similarly worded or by measuring the close constructs with reversed or close wordings (Brown, 2006). This is called influence of method effects in the literature.

Brown (2006) states that the covariance between such items is not based on the influence of distinct and substantively important latent dimensions and that it reflects an artifact of response styles associated with the wording of these items.

Thus, the next step was to determine these relationships and show them in the model. The model was re-specified and recalculated according to relationships between the wordings of some items with the approval of the automobile aftersales business experts, the researcher and the academicians. The re-specified model is given below.

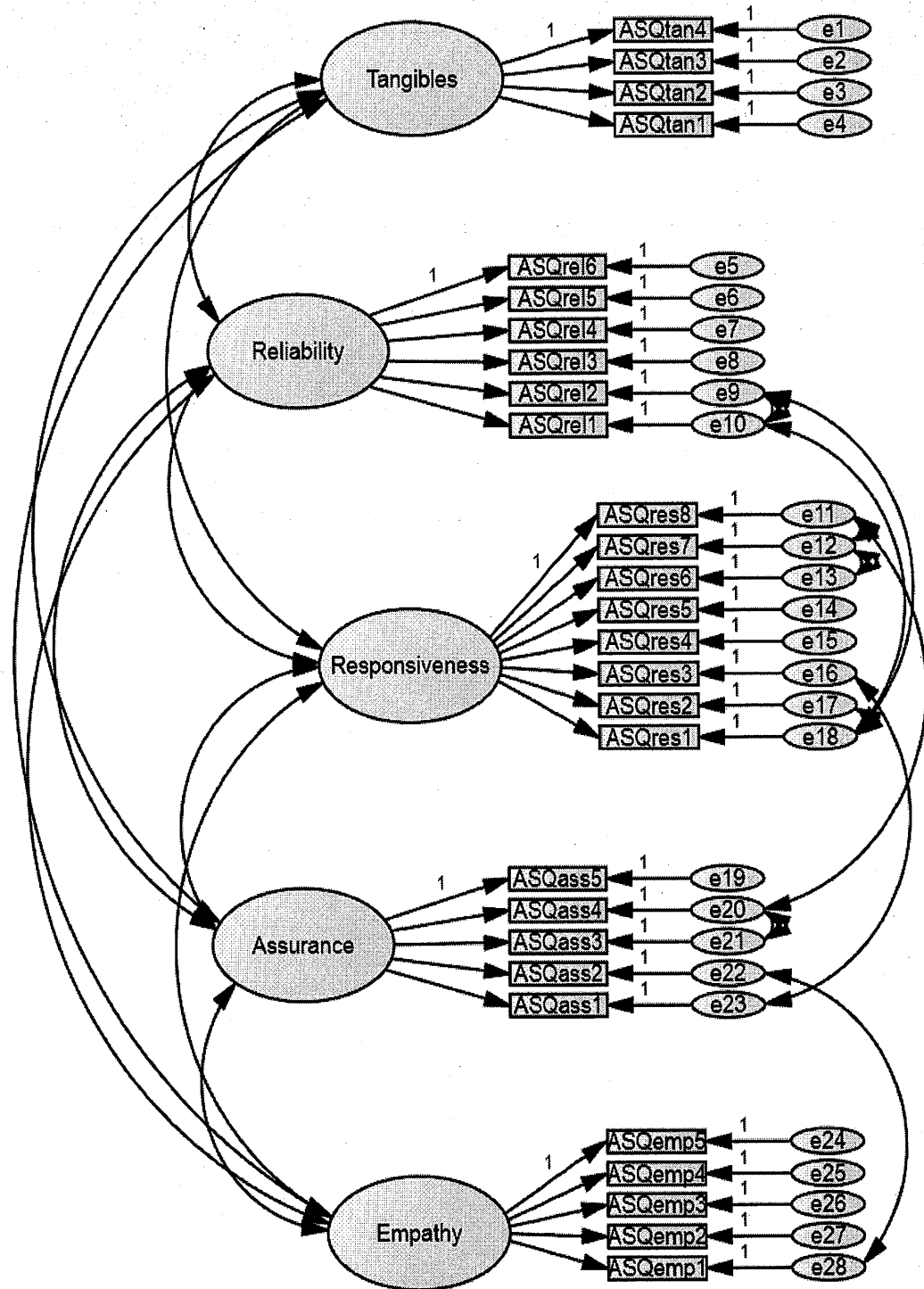


Figure 3. Re-specified model by Amos

These wording relationships included the measurement of related issues in the automobile aftersales service business. For example, there was a relationship between politeness of the staff and individual attention of the staff. Furthermore, informative explanations of the staff item is related to the attentive service staff item because an attentive service employee always gives informative explanations.

These relationships were approved by both the researchers and the business professionals from the sector. The next tables show the Amos software results of the re-specified model. The model fit statistics before and after these relationship connections are provided in the tables in Appendix F.

Brown (2006) explains that root mean square error of approximation (RMSEA) compensates for the effect of the model complexity by conveying discrepancy in fit (not exact but reasonable fit) per each df. RMSEA is a statistical calculation method first introduced by Steiger and Lind (1980).

The root mean square error of approximation (RMSEA) evaluates the wellness of the model by unknown and optimally chosen parameter estimates. These estimates are chosen according to their fit to the population's covariance matrix (Byrne, 1998). Diamantopoulos and Siguaw (2000) cite RMSEA as one of the most successful and informative fit indices because of the sensitivity when considering the number of estimated parameters in the model.

Moreover, this formula looks for parsimony in that RMSEA chooses the model with the lesser number of parameters. There are very recommendations for RMSEA boundary levels and intervals.

MacCallum (1996) states that a range of 0.05 to 0.10 should be considered as an indication of fair fit, whereas values above 0.10 are evaluated as a signal of poor fit. MacCallum (1996) also states that root mean square error of approximation (RMSEA) has an ability to calculate a value which has a confidence interval calculated around this value.

Due to the known distribution values of these statistics this is possible and also subsequently allows for testing the null hypothesis more precisely (McQuitty, 2004). The general interval for this value is between 0 and 0.10 but a value below 0.08 shows a good fit. Our model had a value smaller than 0.10 as seen in the table. It was 0.116 before the related item connections but after these connections, the results came to an acceptable level of 0.092 as seen in Appendix F.

CHAPTER 16

CONCLUSION

In conclusion, this part of our study aimed to use AutoServQual as a tool for empirical analysis of Turkish automobile aftersales customers. Results are provided in a detailed format. First a brief explanation was made about the Turkish automotive industry. Automobile sales, automobile aftersales, and automotive spare parts, known as 3S business models, are the main branches of the automotive industry.

Nowadays the 4S business model, which includes security services as a fourth branch, is declared to be the best by some automotive brands. Then the AutoServQual research findings were explained in both item-based and brand-based characteristics.

Confirmatory factor analysis (CFA) and exploratory factor analysis (EFA) were also applied to the data to ensure that the model and statistical tests proved the reliability of the model by good scores. Further studies might include testing the AutoServQual scale in a different country and also testing AutoServQual by using a wider sample. This scale was constructed in accordance with the results obtained from Turkish automobile aftersales customers. Thus, it is ready for use by automobile brands in Turkey.

There are more than ten million cars in Turkey and our sample included only a relatively small number of car owners. Thus, testing AutoServQual using a greater number of aftersales customers may yield better results and also give more information to the brands about their position vis-à-vis other brands. Each

automotive brand in Turkey has a specific survey design and using the AutoServQual scale will bring advantages in terms of unity in results and objectivity.

Future studies may also include sustainability issues, which are also gaining in importance for all industries. An emerging area in supply chain practice is green supply chain management (SCM), which integrates environmental management with traditional SCM. Green supply chain management is seen as an important step companies need to take on the road to sustainable practices.

The SCOR model (Supply Chain Operations Reference) was developed by the the Supply Chain Council (SCC, now merged with APICS) in order to guide companies applying SCM principles. The GreenSCOR model was also developed as an integrated green SCM tool that allows companies to manage their supply chain's environmental impacts, resulting in more efficient operations which have minimal impact on the environment (Akkucuk, 2015). Service dealers carry out an important function in the product recalls which frequently take place in this industry and more research may be carried out in this field (Gencer & Akkucuk, 2015).

Customer relationship management (CRM) is another field that service dealers need to pay close attention to. The data they keep on customers and share with the headquarters may be an important key to successfully retaining and managing relationships with the customers. Companies strive to maintain better customer relationships through CRM programs aimed at managing the flow of information, interacting with the customers, and in the end, formulating individualized offerings for them. Globalization has led to the development of the new notion of global customer relationship management as opposed to having independent local CRM programs operating in the subsidiaries. This study presents

the issues facing the implementation of such Global CRM programs and provides important conceptual frameworks as proposed in the literature (Akkucuk, 2013).

APPENDIX A

RELIABILITY RESULTS OF ANALYSIS

Table 78 and Table 79 show the Spss results for our sample.

Table 78. Spss Results for the Sample

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.924	.937	45

Table 79. SPSS Results of Reliability Statistics

Reliability Statistics

Cronbach's Alpha	Part 1	Value	.858
		N of Items	23 ^a
	Part 2	Value	.879
		N of Items	22 ^b
	Total N of Items		45
Correlation Between Forms			.775
Spearman-Brown Coefficient	Equal Length		.873
	Unequal Length		.873
Guttman Split-Half Coefficient			.871

APPENDIX B

UPDATED AUTOSERVQUAL DIMENSION BASED STATISTICS

Tables numbered between 80 and 85 are showing the AutoServqual statistics.

Table 80. Empathy Dimension Item-total Statistics Results

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
ekEMP1	23.52	4.765	.690	.604	.868
ekEMP2	23.52	4.732	.783	.759	.854
ekEMP3	23.48	4.909	.771	.733	.858
EMP1	23.68	4.578	.617	.460	.886
EMP3	23.53	4.868	.666	.525	.872
EMP5	23.53	4.885	.730	.574	.862

Table 81. Rotated Component Matrix Results

	Component	
	1	2
ekREL4	.863	
ekREL2	.835	.320
ekREL5	.776	
ekREL1	.715	
ekREL3	.694	
REL4	.606	.540
REL1		.857
REL3	.351	.810
REL2		.799
REL5	.557	.614

Table 82. Tangibles Dimension Item-total Statistics Results

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
ekTAN1	12.72	2.178	.800	.679	.807
ekTAN2	12.76	2.006	.755	.596	.822
ekTAN3	12.73	1.918	.736	.594	.836
ekTAN4	12.71	2.521	.646	.537	.867

Table 83. Reliability Dimension Item-total Statistics Results

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
REL4	28.22	6.628	.707	.650	.881
REL5	28.26	6.547	.692	.636	.881
ekREL1	28.38	5.962	.599	.399	.898
ekREL2	28.30	6.131	.834	.715	.865
ekREL3	28.36	6.112	.625	.441	.891
ekREL4	28.30	6.106	.846	.747	.864
ekREL5	28.30	6.285	.698	.547	.880

Table 84. Responsiveness Dimension Item-total Statistics Results

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
RES1	37.83	11.168	.699	.559	.942
RES2	37.88	10.647	.729	.602	.942
RES3	37.84	10.901	.824	.721	.936
RES4	37.90	10.567	.792	.685	.937
ekRES1	37.84	10.970	.794	.730	.937
ekRES2	37.87	10.795	.777	.726	.938
ekRES3	37.83	10.911	.807	.764	.937
ekRES5	37.88	10.609	.830	.871	.935
ekRES6	37.87	10.814	.822	.856	.936

Table 85. Assurance Dimension Item-total Statistics Results

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
ASS2	17.18	3.291	.720	.932	.873
ASS3	17.19	3.280	.733	.934	.870
ekASS1	17.26	3.219	.791	.649	.858
ekASS3	17.29	2.937	.721	.642	.875
ekASS4	17.26	2.978	.748	.662	.867

APPENDIX C

UPDATED SERVQUAL ITEM STATISTICS

Table 86. Item-total Statistics

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
TAN1	168.78	126.172	0.248		0.928
TAN2	168.91	125.851	0.202		0.929
TAN3	169.04	125.384	0.171		0.931
TAN4	169.41	128.789	-0.027		0.94
REL1	168.45	123.02	0.541		0.925
REL2	168.49	122.725	0.492		0.926
REL3	168.4	123.534	0.629		0.925
REL4	168.38	123.056	0.673		0.924
REL5	168.42	122.502	0.685		0.924
RES1	168.42	122.309	0.677		0.924
RES2	168.47	121.68	0.622		0.924
RES3	168.43	122.005	0.732		0.924
RES4	168.49	120.998	0.71		0.923
ASS2	168.82	126.073	0.306		0.927
ASS3	168.83	125.899	0.324		0.927
EMP1	168.62	120.374	0.611		0.924
EMP3	168.46	122.073	0.608		0.924
EMP5	168.46	121.647	0.701		0.924
ekTAN1	168.93	124.682	0.402		0.926
ekTAN2	168.97	123.393	0.434		0.926
ekTAN3	168.94	124.145	0.347		0.927
ekTAN4	168.92	124.789	0.449		0.926
ekREL1	168.54	121.446	0.524		0.925
ekREL2	168.46	121.326	0.755		0.923
ekREL3	168.53	121.584	0.57		0.925
ekREL4	168.46	121.712	0.717		0.924
ekREL5	168.47	121.808	0.659		0.924
ekRES1	168.43	122.455	0.683		0.924
ekRES2	168.46	121.519	0.711		0.924
ekRES3	168.42	122.181	0.704		0.924
ekRES5	168.48	121.455	0.709		0.924
ekRES6	168.46	121.952	0.71		0.924
ekASS1	168.9	124.487	0.466		0.926
ekASS3	168.93	124.316	0.369		0.927
ekASS4	168.9	124.407	0.383		0.927
ekEMP1	168.45	122.296	0.571		0.925
ekEMP2	168.46	121.952	0.653		0.924
ekEMP3	168.41	122.62	0.648		0.924

APPENDIX D

FACTOR ANALYSIS TABLES

Table 87 and Table 88 shows overall factor analysis results.

Table 87. Overall Item-total Statistics Results

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
EMP1	137.81	93.037	0.617		0.944
EMP3	137.66	94.394	0.63		0.944
EMP5	137.66	93.978	0.73		0.943
ekEMP1	137.64	94.439	0.607		0.944
ekEMP2	137.65	94.067	0.699		0.943
ekEMP3	137.6	94.738	0.689		0.944
REL4	137.58	95.322	0.694		0.944
REL5	137.62	94.799	0.709		0.944
RES1	137.62	94.654	0.697		0.944
RES2	137.66	93.83	0.664		0.944
RES3	137.62	94.316	0.761		0.943
RES4	137.68	93.317	0.746		0.943
ASS2	138.02	98.453	0.273		0.947
ASS3	138.03	98.3	0.291		0.947
ekTAN1	138.13	97.277	0.365		0.947
ekTAN2	138.17	96.421	0.377		0.947
ekTAN3	138.14	96.744	0.321		0.948
ekTAN4	138.12	97.533	0.391		0.946
ekREL1	137.74	93.769	0.546		0.945
ekREL2	137.66	93.583	0.797		0.943
ekREL3	137.72	93.984	0.587		0.945
ekREL4	137.66	93.776	0.776		0.943
ekREL5	137.66	93.991	0.7		0.943
ekRES1	137.63	94.668	0.716		0.944
ekRES2	137.66	93.792	0.747		0.943
ekRES3	137.62	94.293	0.753		0.943
ekRES5	137.67	93.587	0.761		0.943
ekRES6	137.66	94.162	0.75		0.943
ekASS1	138.09	96.855	0.454		0.946
ekASS3	138.12	96.856	0.345		0.947
ekASS4	138.09	96.975	0.354		0.947

Table 88. Refined Items' Overall Item-total Statistics Results

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
EMP1	123.72	73.08	0.588		0.936
EMP3	123.56	74.215	0.603		0.936
ekEMP1	123.55	74.072	0.6		0.936
ekEMP2	123.56	73.75	0.692		0.935
ekEMP3	123.51	74.339	0.681		0.935
REL4	123.48	74.909	0.679		0.936
REL5	123.52	74.459	0.693		0.935
RES1	123.52	74.363	0.678		0.935
RES3	123.53	74.098	0.737		0.935
RES4	123.59	73.199	0.725		0.935
ASS2	123.92	77.299	0.305		0.939
ASS3	123.93	77.172	0.322		0.939
ekTAN1	124.03	76.264	0.394		0.939
ekTAN2	124.07	75.457	0.406		0.939
ekTAN3	124.04	75.741	0.347		0.94
ekTAN4	124.02	76.518	0.42		0.938
ekREL1	123.64	73.589	0.529		0.937
ekREL2	123.56	73.452	0.774		0.934
ekREL4	123.56	73.596	0.755		0.934
ekREL5	123.57	73.692	0.691		0.935
ekRES1	123.53	74.354	0.699		0.935
ekRES2	123.56	73.604	0.728		0.935
ekRES3	123.52	73.969	0.742		0.935
ekRES5	123.58	73.386	0.746		0.934
ekRES6	123.56	73.894	0.735		0.935
ekASS1	124	75.972	0.477		0.937
ekASS3	124.03	75.931	0.365		0.939
ekASS4	124	76.036	0.376		0.939

APPENDIX E

AUTOSERVQUAL SURVEY RESULTS

Table 89. Standardized Regression Weights in Step 1

Standardized Regression Weights: (Group number 1 Default model)				
			Estimate	Squared Correlations
ASQtan1	<---	Tangibles	0.753	0.567
ASQtan2	<---	Tangibles	0.796	0.634
ASQtan3	<---	Tangibles	0.788	0.621
ASQtan4	<---	Tangibles	0.785	0.616
ASQrel1	<---	Reliability	0.784	0.615
ASQrel2	<---	Reliability	0.778	0.605
ASQrel3	<---	Reliability	0.764	0.584
ASQrel4	<---	Reliability	0.765	0.585
ASQrel5	<---	Reliability	0.796	0.634
ASQrel6	<---	Reliability	0.686	0.471
ASQres1	<---	Responsiveness	0.755	0.570
ASQres2	<---	Responsiveness	0.781	0.610
ASQres3	<---	Responsiveness	0.786	0.618
ASQres4	<---	Responsiveness	0.804	0.646
ASQres5	<---	Responsiveness	0.507	0.257
ASQres6	<---	Responsiveness	0.684	0.468
ASQres7	<---	Responsiveness	0.773	0.598
ASQres8	<---	Responsiveness	0.803	0.645
ASQass1	<---	Assurance	0.802	0.643
ASQass2	<---	Assurance	0.775	0.601
ASQass3	<---	Assurance	0.718	0.516
ASQass4	<---	Assurance	0.749	0.561
ASQass5	<---	Assurance	0.619	0.383
ASQemp5	<---	Empathy	0.831	0.691
ASQemp1	<---	Empathy	0.784	0.615
ASQemp2	<---	Empathy	0.752	0.566
ASQemp3	<---	Empathy	0.763	0.582
ASQemp4	<---	Empathy	0.551	0.304

Table 90. Variances in Step 1

Variances: (Group number 1 - Default model)				
	Estimate	S.E.	C.R.	P
Tangibles	0.567	0.05	11.251	***
Reliability	0.415	0.044	9.425	***
Responsiveness	0.6	0.051	11.831	***
Assurance	0.491	0.059	8.258	***
Empathy	0.636	0.051	12.406	***
e1	0.354	0.023	15.176	***
e2	0.324	0.021	15.119	***
e3	0.345	0.023	14.977	***
e4	0.434	0.028	15.595	***
e5	0.468	0.028	16.544	***
e6	0.327	0.021	15.75	***
e7	0.375	0.023	16.058	***
e8	0.391	0.024	16.064	***
e9	0.391	0.025	15.942	***
e10	0.345	0.022	15.881	***
e11	0.331	0.02	16.311	***
e12	0.366	0.022	16.513	***
e13	0.551	0.033	16.857	***
e14	0.982	0.057	17.137	***
e15	0.286	0.018	16.304	***
e16	0.337	0.021	16.433	***
e17	0.346	0.021	16.473	***
e18	0.396	0.024	16.607	***
e19	0.792	0.047	16.783	***
e20	0.456	0.028	16.113	***
e21	0.515	0.032	16.341	***
e22	0.356	0.022	15.856	***
e23	0.314	0.02	15.492	***
e24	0.288	0.018	15.837	***
e25	0.873	0.051	17.144	***
e26	0.334	0.02	16.556	***
e27	0.415	0.025	16.627	***
e28	0.364	0.022	16.398	***

APPENDIX F

AMOS MODEL FIT TABLES

Table 91 and Table 92 show the Amos model fit results.

Table 91. Model Fit Summary of the Re-specified Model (Before)

Model Fit Summary					
CMIN					
Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	66	3082.53	340	0	9.066
Saturated model	406	0	0		
Independence model	28	14770.68	378	0	39.076
RMR, GFI					
Model	RMR	GFI	AGFI	PGFI	
Default model	0.074	0.616	0.541	0.516	
Saturated model	0	1			
Independence model	0.506	0.107	0.041	0.1	
Baseline Comparisons					
Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	0.791	0.768	0.81	0.788	0.809
Saturated model	1		1		1
Independence model	0	0	0	0	0
Parsimony-Adjusted Measures					
Model	PRATIO	PNFI	PCFI		
Default model	0.899	0.712	0.728		
Saturated model	0	0	0		
Independence model	1	0	0		

NCP				
Model	NCP	LO 90	HI 90	
Default model	2742.53	2568.618	2923.815	
Saturated model	0	0	0	
Independence model	14392.68	13998.61	14793.09	
FMIN				
Model	FMIN	F0	LO 90	HI 90
Default model	5.146	4.579	4.288	4.881
Saturated model	0	0	0	0
Independence model	24.659	24.028	23.37	24.696
RMSEA				
Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	0.116	0.112	0.12	0
Independence model	0.252	0.249	0.256	0
AIC				
Model	AIC	BCC	BIC	CAIC
Default model	3214.53	3221.246	3504.728	3570.728
Saturated model	812	853.312	2597.153	3003.153
Independence model	14826.68	14829.53	14949.8	14977.8
ECVI				
Model	ECVI	LO 90	HI 90	MECVI
Default model	5.366	5.076	5.669	5.378
Saturated model	1.356	1.356	1.356	1.425
Independence model	24.752	24.095	25.421	24.757
HOELTER				
Model	HOELTER	HOELTER		
	0.05	0.01		
Default model	75	79		
Independence model	18	19		

Table 92. Model Fit Summary of the Re-specified Model (After)

Model Fit Summary					
CMIN					
Model	NPAR	CMIN	DF	P	CMIN/D F
Default model	76	2012.52	330	0	6.099
Saturated model	406	0	0		
Independence model	28	14770.68	378	0	39.076
RMR, GFI					
Model	RMR	GFI	AGFI	PGFI	
Default model	0.067	0.749	0.691	0.609	
Saturated model	0	1			
Independence model	0.506	0.107	0.041	0.1	
Baseline Comparisons					
Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	0.864	0.844	0.883	0.866	0.883
Saturated model	1		1		1
Independence model	0	0	0	0	0
Parsimony-Adjusted Measures					
Model	PRATIO	PNFI	PCFI		
Default model	0.873	0.754	0.771		
Saturated model	0	0	0		
Independence model	1	0	0		
NCP					
Model	NCP	LO 90	HI 90		
Default model	1682.52	1544.797	1827.69	1	
Saturated model	0	0	0		
Independence model	14392.68	13998.61	14793.0	9	
FMIN					

Model	FMIN	F0	LO 90	HI 90
Default model	3.36	2.809	2.579	3.051
Saturated model	0	0	0	0
Independence model	24.659	24.028	23.37	24.696
RMSEA				
Model	RMSEA	LO 90	HI 90	PCLOS E
Default model	0.092	0.088	0.096	0
Independence model	0.252	0.249	0.256	0
AIC				
Model	AIC	BCC	BIC	CAIC
Default model	2164.52	2172.254	2498.68	2574.68
Saturated model	812	853.312	2597.15	3003.15
Independence model	14826.68	14829.53	14949.8	14977.8
ECVI				
Model	ECVI	LO 90	HI 90	MECVI
Default model	3.614	3.384	3.856	3.626
Saturated model	1.356	1.356	1.356	1.425
Independence model	24.752	24.095	25.421	24.757
HOELTER				
Model	HOELTE R	HOELTE R		
Default model	0.05	0.01		
Independence model	112	117		
	18	19		

REFERENCES

- Akkucuk, U., & Carroll, J. D. (2006). PARAMAP vs. Isomap: a comparison of two nonlinear mapping algorithms. *Journal of Classification*, 23(2), 221-254.
- Akkucuk, U., & Küçükkancabaş, S. (2007). Analyzing The Perceptions Of Turkish Universities Using Multidimensional Scaling (Mds) Analysis. *Bogazici Journal of Economics and Administrative Sciences*, 21(1+ 2), 125-141.
- Akkucuk, U. (2008). Toplam Kalite Yönetimi ve Pazarlama. In *Güncel Pazarlama Yaklaşımlarından Seçmeler* (pp. 391-405). Ankara: Detay Yayıncılık.
- Akkucuk, U. (2009). İş Etiğinde Sarbanes-Oxley (SOX) Yasası'nın Etkisi ve Toplam Kalite Yönetimi Uygulamalarında Yansımaları. *İş Ahlakı Dergisi*, 2(3), 7-17.
- Akkucuk, U. (2015). Bir Çok Boyutlu Ölçekleme Tekniği Olarak Torgersen Ölçekleme Yöntemi Ve Temel Bileşenler Analizi İle Karşılaştırması. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi*, 25(25), 311-322.
- Akkucuk, U., & Carroll, J. D. (2010). Nonlinear mapping using a hybrid of PARAMAP and isomap approaches. In *Classification as a Tool for Research*(pp. 371-380). Berlin: Heidelberg.
- Akkucuk, U., Carroll, J. D., & France, S. L. (2013). Visualizing Data in Social and Behavioral Sciences: An Application of PARAMAP on Judicial Statistics. In *Algorithms from and for Nature and Life* (pp. 147-154). Berlin: Springer International Publishing.
- Akkucuk, U. (2014). From Local Information Systems to Global Customer Relationship Management. In Ü. Hacıoğlu, & H. Dinçer (Eds.) *Globalization and Governance in the International Political Economy* (pp. 299-305). Hershey, PA: Information Science Reference.
- Akkucuk, U. (2015). SCOR Model and the Green Supply Chain. *Handbook of Research on Waste Management Techniques for Sustainability*, 108. Hershey, USA: IGI Global.
- Akkucuk, U. (2016). Visualizing Big Data via a Mixture of PARAMAP and Isomap. *International Journal of Decision Sciences & Applications-IJDSA*, 1(1), 42-50.
- Akkucuk, U., & Artemel, M. N. (2016). Patent Data Visualization: A Regional Study. *International Journal of Research in Business and Social Science* (2147-4478), 5(3), 66-79.

- Ash, A. S., & Byrne-Logan, S. (1998, August). How well do models work? Predicting health care costs. In *Proceedings of the Section on Statistics in Epidemiology, American Statistical Association* (pp. 42-49).
- Avkiran, N. K. (2000). Rising productivity of Australian trading banks under deregulation 1986-1995. *Journal of Economics and Finance*, 24(2), 122-140.
- Avkiran, N. (2006). Productivity analysis in the service sector with data envelopment analysis. Available at SSRN 2627576.
- Babakus, E., & Boller, G. W. (1992). An empirical assessment of the SERVQUAL scale. *Journal of Business Research*, 24(3), 253-268.
- Babakus, E., & Mangold, W. G. (1992). Adapting the SERVQUAL scale to hospital services: an empirical investigation. *Health Services Research*, 26(6), 767.
- Bagozzi, R. P. (1974). Marketing as an organized behavioral system of exchange. *The Journal of Marketing*, 26(6) 77-81.
- Baker, F. B. (2001). *The basics of item response theory*. For full text: <http://ericae.net/irt/baker>.
- Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, 30(9), 1078-1092.
- Banker, R. D., & Maindiratta, A. (1988). Nonparametric analysis of technical and allocative efficiencies in production. *Econometrica: Journal of the Econometric Society*, 12(2), 1315-1332.
- Banker, R. D., & Morey, R. C. (1986). Efficiency analysis for exogenously fixed inputs and outputs. *Operations research*, 34(4), 513-521.
- Barron, F. H., & Barrett, B. E. (1996). Decision quality using ranked attribute weights. *Management Science*, 42(11), 1515-1523.
- Bell, R. A., & Morey, R. C. (1995). Increasing the efficiency of corporate travel management through macro benchmarking. *Journal of Travel Research*, 33(3), 11-20.
- Belton, V. (1986). A comparison of the analytic hierarchy process and a simple multi-attribute value function. *European Journal of Operational Research*, 26(1), 7-21.
- Belton, V., & Vickers, S. P. (1993). Demystifying DEA-a visual interactive approach based on multiple criteria analysis. *Journal of the Operational Research Society*, 883-896.

- Belton, V., & Stewart, T. J. (1999). DEA and MCDA: Competing or complementary approaches? *Advances in Decision Analysis* (pp. 87-104). Netherlands: Springer .
- Berthon, P., Ewing, M., & Hah, L. L. (2005). Captivating company: Dimensions of attractiveness in employer branding. *International Journal of Advertising*, 24(2), 151-172.
- Bessent, A. M., & Bessent, E. W. (1980). Determining the comparative efficiency of schools through data envelopment analysis. *Educational Administration Quarterly*, 16(2), 57-75.
- Bicheno, J. (1994). *The Quality 50: A Guide to Gurus, Tools, Wastes, Techniques and Systems*. Victoria: Nestadt.
- Bickel, P. J., & Freedman, D. A. (1984). Asymptotic normality and the bootstrap in stratified sampling. *The Annals of Statistics*, 11(2), 470-482.
- Bilgin, Gazi; (1999), Küresel Pazarlama Kapsamında Dünya Otomotiv Ticareti ve Türkiye Ekonomisinin Durumu, *Ankara: DTM Yayını*, 45s.
- Bitner, M. J. (1990). Evaluating service encounters: the effects of physical surroundings and employee responses. *Journal of Marketing*, 19(1), 69-82.
- Bolton, R. N., & Drew, J. H. (1991). A multistage model of customers' assessments of service quality and value. *Journal of Consumer Research*, 33(4), 375-384.
- Brans, J. P., & Mareschal, B. (1994). The PROMCALC & GAIA decision support system for multicriteria decision aid. *Decision Support Systems*, 12(4-5), 297-310.
- Brans, J. P., & Vincke, P. (1985). Note—A Preference Ranking Organisation Method: (The PROMETHEE Method for Multiple Criteria Decision-Making). *Management Science*, 31(6), 647-656.
- Brauers, W. K. M., Zavadskas, E. K., Peldschus, F., & Turskis, Z. (2008). Multi-objective decision-making for road design. *Transport*, 23(3), 183-193.
- Brauers, W. K. M., Zavadskas, E. K., Turskis, Z., & Vilutiene, T. (2008). Multi-objective contractor's ranking by applying the Moora method. *Journal of Business Economics and Management*, 9(4), 245-255.
- Bregar, A., Györkö, J., & Jurič, M. B. (2008). Interactive aggregation/disaggregation dichotomic sorting procedure for group decision analysis based on the threshold model. *Informatica*, 19(2), 161-190.
- Bolton, R. N., & Drew, J. H. (1991). A multistage model of customers' assessments of service quality and value. *Journal of Consumer Research*, 17(3), 375-384.

- Boulding, W., Kalra, A., Staelin, R., & Zeithaml, V. A. (1993). A dynamic process model of service quality: from expectations to behavioral intentions. *Journal of marketing research*, 30(1), 7.
- Bouman, M., & Van der Wiele, T. (1992). Measuring service quality in the car service industry: building and testing an instrument. *International Journal of Service Industry Management*, 3(4), 4-16.
- Boussofiane, A., Dyson, R. G., & Thanassoulis, E. (1991). Applied data envelopment analysis. *European Journal of Operational Research*, 52(1), 1-15.
- Bouyssou, D. (1999). Using DEA as a tool for MCDM: some remarks. *Journal of the operational Research Society*, 50(9), 974-978.
- Bowlin, W. F. (1998). Measuring performance: An introduction to data envelopment analysis (DEA). *The Journal of Cost Analysis*, 15(2), 3-27.
- Brown, T. J., Churchill, G. A., & Peter, J. P. (1993). Improving the measurement of service quality. *Journal of Retailing*, 69(1), 127-139.
- Buchanan, J. T., & Daellenbach, H. G. (1987). A comparative evaluation of interactive solution methods for multiple objective decision models. *European Journal of Operational Research*, 29(3), 353-359.
- Bucklin, L. P. (1977). *Structure, Conduct and Productivity in Distribution*. Bloomington: Indiana University Press.
- Bundschuh, R. G., & Dezvane, T. M. (2003). How to make after-sales services pay off. *McKinsey Quarterly*, (4), 116-127.
- Burley, H. T. (1995). Data envelopment analysis in ranking educational processes. *Research into higher education: Dilemmas, directions and diversions, Herdsa: Victoria*, 19-27.
- Bush, P. J., & Iannotti, R. J. (1990). A children's health belief model. *Medical Care*, 14(8), 69-86.
- Buttle, F. (1996). SERVQUAL: review, critique, research agenda. *European Journal of Marketing*, 30(1), 8-32.
- Buzzell, R. D., & Gale, B. T. (1987). *The PIMS principles: Linking strategy to performance*. New York: Simon and Schuster.
- Camanho, A. S., & Dyson, R. G. (1999). Efficiency, size, benchmarks and targets for bank branches: an application of data envelopment analysis. *Journal of the Operational Research Society*, 903-915.

- Camanho, A. S., & Dyson, R. G. (2005). Cost efficiency measurement with price uncertainty: A DEA application to bank branch assessments. *European Journal of Operational Research*, 161(2), 432-446.
- Cannon, J. P., & Perreault Jr, W. D. (1999). Buyer-seller relationships in business markets. *Journal of Marketing Research*, 439-460.
- Capettini, R., Dittman, D. A., & Morey, R. C. (1985). Reimbursement rate setting for Medicaid prescription drugs based on relative efficiencies. *Journal of Accounting and Public Policy*, 4(2), 83-110.
- Carman, J. M. (1990). Consumer Perceptions Of Service Quality: An Assessment Of T. *Journal of Retailing*, 66(1), 33.
- Carman, J. M., & Langeard, E. (1980). Growth strategies for service firms. *Strategic Management Journal*, 1(1), 7-22.
- Carmone, F. J., Kara, A., & Zanakis, S. H. (1997). A Monte Carlo investigation of incomplete pairwise comparison matrices in AHP. *European Journal of Operational Research*, 102(3), 538-553.
- Carrico, C. S., Hogan, S. M., Dyson, R. G., & Athanassopoulos, A. D. (1997). Data envelopment analysis and university selection. *Journal of the Operational Research Society*, 1163-1177.
- Carrillat, F. A., Jaramillo, F., & Mulki, J. P. (2007). The validity of the SERVQUAL and SERVPERF scales: A meta-analytic view of 17 years of research across five continents. *International Journal of Service Industry Management*, 18(5), 472-490.
- Carson, D., Gilmore, A., Perry, C., & Gronhaug, K. (2001). *Qualitative marketing research*. New York: Sage.
- Celuch, K. G., Bantham, J. H., & Kasouf, C. J. (2006). An extension of the marriage metaphor in buyer-seller relationships: An exploration of individual level process dynamics. *Journal of Business Research*, 59(5), 573-581.
- Chandra, P., Cooper, W. W., Li, S., & Rahman, A. (1998). Using DEA to evaluate 29 Canadian textile companies—considering returns to scale. *International Journal of Production Economics*, 54(2), 129-141.
- Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, 2(6), 429-444.
- Charnes, A., Cooper, W. W., Golany, B., Seiford, L., & Stutz, J. (1985). Foundations of data envelopment analysis for Pareto-Koopmans efficient empirical production functions. *Journal of Econometrics*, 30(1), 91-107.

- Charnes, A., Cooper, W. W., Lewin, A. Y., & Seiford, L. M. (1994). Basic DEA models. In *Data Envelopment Analysis: Theory, Methodology, and Applications* (pp. 23-47). Netherlands: Springer.
- Charnes, A., Cooper, W. W., & Thrall, R. M. (1991). A structure for classifying and characterizing efficiency and inefficiency in data envelopment analysis. *Journal of Productivity Analysis*, 2(3), 197-237.
- Chase, R. B. (1977). Where does the customer fit in a service operation?. *Harvard Business Review*, 56(6), 137-142.
- Chen, S. J., & Hwang, C. L. (1992). Fuzzy multiple attribute decision making methods. *Decision Making in Manufacturing Environment Using Graph Theory* (pp. 289-486). Berlin: Heidelberg.
- Chen, Y. (2004). Ranking efficient units in DEA. *Omega*, 32(3), 213-219.
- Chi Cui, C., Lewis, B. R., & Park, W. (2003). Service quality measurement in the banking sector in South Korea. *International Journal of Bank Marketing*, 21(4), 191-201.
- Churchman, C. W., Ackoff, R. L., & Arnoff, E. L. (1957). Introduction to operations research. *Topics in OR*. NY: SIDALC. 71-82.
- Churchill Jr, G. A. (1979). A paradigm for developing better measures of marketing constructs. *Journal of Marketing Research*, 64-73.
- Churchill Jr, G. A., & Surprenant, C. (1982). An investigation into the determinants of customer satisfaction. *Journal of Marketing Research*, 491-504.
- Coelli, T. J., Rao, D. S. P., O'Donnell, C. J., & Battese, G. E. (2005). *An introduction to efficiency and productivity analysis*. Springer Science & Business Media.
- Converse, J. M., & Presser, S. (1986). *Survey questions: Handcrafting the standardized questionnaire* (No. 63). New York: Sage.
- Cook, W. D., & Hababou, M. (2001). Sales performance measurement in bank branches. *Omega*, 29(4), 299-307.
- Cook, W. D., Kress, M., & Seiford, L. M. (1993). On the use of ordinal data in data envelopment analysis. *Journal of the Operational Research Society*, 44(2), 133-140.
- Cook, W. D., Kress, M., & Seiford, L. M. (1996). Data envelopment analysis in the presence of both quantitative and qualitative factors. *Journal of the Operational Research Society*, 945-953.
- Cooper, W. W., Huang, Z., Lelas, V., Li, S. X., & Olesen, O. B. (1998). Chance constrained programming formulations for stochastic characterizations of

- efficiency and dominance in DEA. *Journal of Productivity Analysis*, 9(1), 53-79.
- Cooper, W. W., Park, K. S., & Yu, G. (1999). IDEA and AR-IDEA: Models for dealing with imprecise data in DEA. *Management Science*, 45(4), 597-607.
- Cooper, W. W., Seiford, L. M., & Tone, K. (2000). Data envelopment analysis. *Topics in DEA* London: Springer. 11 (5), 200-216..
- Cooper, W. W., Seiford, L. M., & Zhu, J. (2004). *Data envelopment analysis* (pp. 1-39). New Jersey: Springer
- Cooper, W. W., Seiford, L. M., & Tone, K. (2006). *Introduction to data envelopment analysis and its uses: with DEA-solver software and references*. Springer Science & Business Media.
- Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16(3), 297-334.
- Cronin Jr, J. J., & Taylor, S. A. (1992). Measuring service quality: a reexamination and extension. *The Journal of Marketing*, 55-68.
- Crosby, P. B. (1979). Quality is free: The art of making quality certain. *New York*.
- Curran, P. J., West, S. G., & Finch, J. F. (1996). The robustness of test statistics to nonnormality and specification error in confirmatory factor analysis. *Psychological methods*, 1(1), 16.
- Currim, I. S., & Sarin, R. K. (1984). A comparative evaluation of multiattribute consumer preference models. *Management Science*, 30(5), 543-561.
- Çoban, O. (2007). Türk otomotiv sanayiinde endüstriyel verimlilik ve etkinlik. *Erciyes Üniversitesi İktisadi ve İdari Bilimler Dergisi*, 29(29).
- Dantzig, G. B., & Cottle, R. W. (1963). *Positive (semi-) definite matrices and mathematical programming* (No. ORC-63-18-RR). California Univ Berkeley Operations Research Center.
- Deason, J. P. (1984). *A multiobjective decision support system for water project portfolio selections*.
- Dekker, D., & Post, T. (2001). A quasi-concave DEA model with an application for bank branch performance evaluation. *European Journal of Operational Research*, 132(2), 296-311.
- Denpontin, M., Mascarola, H., & Spronk, J. (1983). A user oriented listing of MCDM. *Revue Belge de Recherche Operationelle*, 23, 3-11.

- De Keyser, W., & Peeters, P. (1996). A note on the use of PROMETHEE multicriteria methods. *European Journal of Operational Research*, 89(3), 457-461.
- Diamantopoulos, A., Siguaw, J. A., & Siguaw, J. A. (2000). *Introducing LISREL: A guide for the uninitiated*. Sage.
- Doutt, J. T. (1984). Comparative productivity performance in fast-food retail distribution. *Journal of Retailing*, 60(3), 98-106.
- Dwyer, F. R., Schurr, P. H., & Oh, S. (1987). Developing buyer-seller relationships. *The Journal of marketing*, 11-27.
- Dyer, J. S., Fishburn, P. C., Steuer, R. E., Wallenius, J., & Zionts, S. (1992). Multiple criteria decision making, multiattribute utility theory: the next ten years. *Management science*, 38(5), 645-654.
- Dzemyda, G., Kurasova, O., & Medvedev, V. (2007). Dimension Reduction and Data. *Emerging Artificial Intelligence Applications in Computer Engineering: Real Word AI Systems with Applications in EHealth, HCI, Information Retrieval and Pervasive Technologies*, 160, 25.
- Dzemyda, G., & Petkus, T. (2001). Application of computer network to solve the complex applied multiple criteria optimization problems. *Informatica*, 12(1), 45-60.
- Edwards, W. (1977). How to use multiattribute utility measurement for social decision-making. *Systems, Man and Cybernetics, IEEE Transactions on*, 7(5), 326-340.
- Egonsson, E., Ly, T. T., & Bayarsaikhan, K. (2013). After-Sales Services and Customer Relationship Marketing: A multiple case study within the Swedish heavy equipment machinery industry.
- Elfring, T. (1989). The main features and underlying causes of the shift to services. *Service Industries Journal*, 9(3), 337-356.
- Epstein, M. K., & Henderson, J. C. (1989). Data Envelopment Analysis for Managerial Control and Diagnosis*. *Decision Sciences*, 20(1), 90-119.
- Evanoff, D. D., & Israilevich, P. R. (1991). Productive efficiency in banking. *Economic Perspectives*, 15(4), 11-32.
- Evans, J. R. (1984). Sensitivity analysis in decision theory. *Decision Sciences*, 15(2), 239-247.
- Färe, R., Grosskopf, S., Norris, M., & Zhang, Z. (1994). Productivity growth, technical progress, and efficiency change in industrialized countries. *The American economic review*, 66-83.

- Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society. Series A (General)*, 120(3), 253-290.
- Farrell, M. J., & Fieldhouse, M. (1962). Estimating efficient production functions under increasing returns to scale. *Journal of the Royal Statistical Society. Series A (General)*, 252-267.
- Favero, C. A., & Papi, L. (1995). Technical efficiency and scale efficiency in the Italian banking sector: a non-parametric approach. *Applied economics*, 27(4), 385-395.
- Federoff, M., & Courage, C. (2009). Successful user experience in an agile enterprise environment. In *Human interface and the management of information. Designing information environments* (pp. 233-242). Springer Berlin Heidelberg.
- Figueira, J., & Greco, S. (2004). Dealing with interactivity between bi-polar multiple criteria preferences in outranking methods. *Private communication*.
- Finch, J. F., West, S. G., & MacKinnon, D. P. (1997). Effects of sample size and nonnormality on the estimation of mediated effects in latent variable models. *Structural Equation Modeling: A Multidisciplinary Journal*, 4(2), 87-107.
- Finn, D. W., & Lamb Jr, C. W. (1991). An Evaluation of the SERVQUAL Scales in a Retailing Setting. *Advances in consumer research*, 18(1).
- Forman, E. H., & Selly, M. A. (2001). *Decision by objectives: how to convince others that you are right*. World Scientific.
- Førsund, F. R., & Sarafoglou, N. (2002). On the origins of data envelopment analysis. *Journal of Productivity Analysis*, 17(1-2), 23-40.
- Fournier, S., & Mick, D. G. (1999). Rediscovering satisfaction. *The Journal of Marketing*, 5-23.
- Frei, F. X., Harker, P. T., & Hunter, L. W. (1995). *Performance in consumer financial services organizations: Framework and results from the pilot study*. Wharton School.
- Fülöp, J. (2005, November). Introduction to decision making methods. In *BDEI-3 Workshop, Washington*.
- Gadiesh, O., & Gilbert, J. L. (1997). Profit pools: a fresh look at strategy. *Harvard Business Review*, 76(3), 139-147.
- Gaiardelli, P., Saccani, N., & Songini, L. (2007). Performance measurement of the after-sales service network—Evidence from the automotive industry. *Computers in Industry*, 58(7), 698-708.

- Gao, Y., Li, W. D., & You, X. Y. (2011). Research on the efficiency evaluation of China's railway transport enterprises with Network DEA. *China Soft Science*, 5, 176-182.
- Gemünden, H. G., & Hauschildt, J. (1985). Number of alternatives and efficiency in different types of top-management decisions. *European Journal of Operational Research*, 22(2), 178-190.
- Gencer, Y. G. (2013, May). Forecasting Car Demand with Different Methods. In *International Conference on Economic and Social Studies, 10-11 May, 2013, Sarajevo* (Vol. 1, No. 1). International Burch University.
- Gencer, Y. G., & Akkucuk, U. (2015). Reverse Logistics: Automobile Recalls and Other Conditions. *Handbook of Research on Waste Management Techniques for Sustainability*, 125.
- Gencer, Y. G. (2015). Mystery of Recycling: Glass and Aluminum Examples. *Handbook of Research on Waste Management Techniques for Sustainability*, 172.
- Gençer, Y. G. (2015). Relationship between New Online-socialized World and Organization Based Self Esteem. *The Online Journal of Communication and Media—October*, 1(4).
- Gershon, M., & Duckstein, L. (1984). A procedure for selection of a multiobjective technique with application to water and mineral resources. *Applied Mathematics and Computation*, 14(3), 245-271.
- Gilbert, D., & Wong, R. K. (2003). Passenger expectations and airline services: a Hong Kong based study. *Tourism Management*, 24(5), 519-532.
- Gillen, D., & Lall, A. (1997). Developing measures of airport productivity and performance: an application of data envelopment analysis. *Transportation Research Part E: Logistics and Transportation Review*, 33(4), 261-273.
- Ginevičius, R., Podvezko, V., & Raslanas, S. (2008). Evaluating the alternative solutions of wall insulation by multicriteria methods. *Journal of Civil Engineering and Management*, 14(4), 217-226.
- Georgescu-Roegen, N. (1951). The aggregate linear production function and its applications to von Neumann's economic model. *Activity analysis of production and allocation*, (13).
- Goicoechea, A., Stakhiv, E. Z., & Li, F. (1992). Experimental Evaluation of Multiple Criteria Decision Models for Application to Water Resources Planning.
- Golany, B., & Roll, Y. (1989). An application procedure for DEA. *Omega*, 17(3), 237-250.

- Golden, L., & Zimmer, M. (1988). Impressions of retail stores: a content analysis of consumer images. *Journal of retailing*, 64(3), 265-289.
- Goldman, A. (1992). Evaluating the performance of the Japanese distribution system. *Journal of Retailing*, 68(1), 11.
- Gotlieb, J. B., Grewal, D., & Brown, S. W. (1994). Consumer satisfaction and perceived quality: complementary or divergent constructs?. *Journal of applied psychology*, 79(6), 875.
- Görmez, N., Köksalan, M., & Salman, F. S. (2011). Locating disaster response facilities in Istanbul. *Journal of the Operational Research Society*, 62(7), 1239-1252.
- Griggs, S. (1987). Analysing qualitative data. *Journal of the Market Research Society*.
- Gronroos, C. (1978). A service-orientated approach to marketing of services. *European Journal of marketing*, 12(8), 588-601.
- Grönroos, C. (1982). An applied service marketing theory. *European journal of marketing*, 16(7), 30-41.
- Guitouni, A., & Martel, J. M. (1998). Tentative guidelines to help choosing an appropriate MCDA method. *European Journal of Operational Research*, 109(2), 501-521.
- Guitouni, A., Martel, J. M., Vincke, P., North, P. B., & Val-bblair, O. G. X. (1998). A framework to choose a discrete multicriterion aggregation procedure. *Defence Research Establishment Valcatier (DREV)*.
- Gutek, B. A., Groth, M., & Cherry, B. (2002). Achieving service success through relationships and enhanced encounters. *The Academy of Management Executive*, 16(4), 132-144.
- Harding, S., Barker, J., & Brown, G. J. (2006). Mask estimation for missing data speech recognition based on statistics of binaural interaction. *Audio, Speech, and Language Processing, IEEE Transactions on*, 14(1), 58-67.
- Harris, E. C. (Ed.). (2014). *Practices in Archaeological Stratigraphy*. Elsevier.
- Hartline, M. D., & Ferrell, O. C. (1996). The management of customer-contact service employees: An empirical investigation. *The Journal of Marketing*, 52-70.
- Hauner, D. (2005). Explaining efficiency differences among large German and Austrian banks. *Applied Economics*, 37(9), 969-980.

- Heung, V. C., Wong, M. Y., & Hailin, Q. (2000). Airport-restaurant service quality in Hong Kong: An application of SERVQUAL. *The Cornell Hotel and Restaurant Administration Quarterly*, 41(3), 86-6.
- Hill, N., & Alexander, J. (2000). *Handbook of customer satisfaction and loyalty measurement*. Gower Publishing, Ltd..
- Hobbs, B. F. (1986). What can we learn from experiments in multiobjective decision analysis?. *Systems, Man and Cybernetics, IEEE Transactions on*, 16(3), 384-394.
- Hobbs, B. F., Chankong, V., & Hamadeh, W. (1992). An Experiment in Water Resources Planning. *Water Resources Research*, 28(7), 1767-1779.
- Hodson, F. R., & Tăutu, P. (Eds.). (1971). *Mathematics in the archaeological and historical sciences* (pp. 215-252). Edinburgh: Edinburgh University Press.
- Howard, R. A. (1966). *Decision analysis: Applied decision theory* (pp. 55-71). Stanford Research Institute.
- Howard, J. A., & Sheth, J. N. (1969). *The theory of buyer behavior* (Vol. 14). New York: Wiley.
- Hughey, D. W., Chawla, S. K., & Khan, Z. U. (2003). Measuring the quality of university computer labs using SERVQUAL: A longitudinal study. *The Quality Management Journal*, 10(3), 33.
- Hwang, C. L., & Yoon, K. (1981). Multiple criteria decision making. *Lecture Notes in Economics and Mathematical Systems*.
- Ingene, C. A. (1982). Labor productivity in retailing. *The Journal of Marketing*, 75-90.
- Jacoby, J., & Chestnut, R. W. (1978). Brand loyalty: Measurement and management.
- Kaklauskas, A., Zavadskas, E. K., Raslanas, S., Ginevicius, R., Komka, A., & Malinauskas, P. (2006). Selection of low-e windows in retrofit of public buildings by applying multiple criteria method COPRAS: A Lithuanian case. *Energy and Buildings*, 38(5), 454-462.
- Kaklauskas, A., Zavadskas, E. K., & Trinkunas, V. (2007). A multiple criteria decision support on-line system for construction. *Engineering Applications of Artificial Intelligence*, 20(2), 163-175.
- Karni, R., Sanchez, P., & Tummala, V. R. (1990). A comparative study of multiattribute decision making methodologies. *Theory and Decision*, 29(3), 203-222.
- Keeney, R. L., & Raiffa, H. (1976). Decision with multiple objectives.

- Kendrick, J. W., & Creamer, D. B. (1965). Measuring company productivity: handbook with case studies. National industrial conference board.
- Kim, S. H., Park, C. G., & Park, K. S. (1999). An application of data envelopment analysis in telephone offices evaluation with partial data. *Computers & Operations Research*, 26(1), 59-72.
- Kline, R. B. (1998). Software review: Software programs for structural equation modeling: Amos, EQS, and LISREL. *Journal of psych educational assessment*, 16(4), 343-364.
- Kok, M. (1986). The interface with decision makers and some experimental results in interactive multiple objective programming methods. *European Journal of Operational Research*, 26(1), 96-107.
- Kok, M., & Lootsma, F. A. (1985). Pairwise-comparison methods in multiple objective programming, with applications in a long-term energy-planning model. *European Journal of Operational Research*, 22(1), 44-55.
- Lee, Y. L., & Hing, N. (1995). Measuring quality in restaurant operations: an application of the SERVQUAL instrument. *International Journal of Hospitality Management*, 14(3), 293-310.
- Legrady, K., Lootsma, F. A., Meisner, J., & Schellemans, F. (1984). *Multicriteria decision analysis to aid budget allocation* (pp. 164-174). Springer Berlin Heidelberg.
- Lehtinen, U., & Lehtinen, J. R. (1982). *Service quality: a study of quality dimensions*. Service Management Institute.
- Lele, M. M. (1997). After-sales service-necessary evil or strategic opportunity?. *Managing Service Quality: An International Journal*, 7(3), 141-145.
- Lewin, A. Y., Morey, R. C., & Cook, T. J. (1982). Evaluating the administrative efficiency of courts. *Omega*, 10(4), 401-411.
- Lewis, V. L., & Churchill, N. C. (1983). The five stages of small business growth. *Harvard business review*, 61(3), 30-50.
- Lewis, B. R. (1989). Quality in the service sector: a review. *International Journal of Bank Marketing*, 7(5), 4-12.
- Lewis, B. R. (1993). Service quality measurement. *Marketing Intelligence & Planning*, 11(4), 4-12.
- Linkov, I., Varghese, A., Jamil, S., Seager, T. P., Kiker, G., & Bridges, T. (2004). Multi-criteria decision analysis: a framework for structuring remedial decisions at contaminated sites. *Comparative risk assessment and environmental decision making*, 38, 15-54.

- Lockett, G., & Stratford, M. (1987). Ranking of research projects: Experiments with two methods. *Omega*, 15(5), 395-400.
- Lootsma, F. A., Mensch, T. C. A., & Vos, F. A. (1990). Multi-criteria analysis and budget reallocation in long-term research planning. *European Journal of Operational Research*, 47(3), 293-305.
- Lovell, C. K., & Pastor, J. T. (1997). Target setting: an application to a bank branch network. *European Journal of Operational Research*, 98(2), 290-299.
- Lundstrom, W. J., & Lamont, L. M. (1976). The development of a scale to measure consumer discontent. *Journal of Marketing Research*, 373-381.
- Lusch, R. F., & Ingene, C. A. (1979). The predictive validity of alternative measures of inputs and outputs in retail production functions. In *Proceedings of the 1979 Educators' Conference* (pp. 330-333).
- Lusch, R. F., & Moon, S. Y. (1984). An exploratory analysis of the correlates of labor productivity in retailing. *Journal of Retailing*, 60(3), 37-61.
- Lusch, R. F., & Serpkenci, R. R. (1990). Personal differences, job tension, job outcomes, and store performance: A study of retail store managers. *The Journal of Marketing*, 85-101.
- MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological methods*, 1(2), 130.
- MacKenzie, S. B., Podsakoff, P. M., & Fetter, R. (1993). The impact of organizational citizenship behavior on evaluations of salesperson performance. *The Journal of Marketing*, 70-80.
- Mareschal, B., & Brans, J. P. (1988). Geometrical representations for MCDA. *European Journal of Operational Research*, 34(1), 69-77.
- Masuda, T. (1990). Hierarchical sensitivity analysis of priority used in analytic hierarchy process. *International Journal of Systems Science*, 21(2), 415-427.
- Mazis, M. B., Ahtola, O. T., & Klippel, R. E. (1975). A comparison of four multi-attribute models in the prediction of consumer attitudes. *Journal of Consumer Research*, 38-52.
- McGinley, P. (2012). Decision analysis software survey. *OR/MS Today*, 39.
- McLaughlin, C. P., & Coffey, S. (1990). Measuring productivity in services. *International Journal of Service Industry Management*, 1(1), 46-64.
- McQuitty, S. (2004). Statistical power and structural equation models in business research. *Journal of Business Research*, 57(2), 175-183.

- Melão, N. (2005). Data envelopment analysis revisited: a neophyte's perspective. *International Journal of Management and Decision Making*, 6(2), 158-179.
- Mester, L. J. (1996). A study of bank efficiency taking into account risk-preferences. *Journal of Banking & Finance*, 20(6), 1025-1045.
- Mészáros, C., & Rapcsák, T. (1996). On sensitivity analysis for a class of decision systems. *Decision Support Systems*, 16(3), 231-240.
- Mill, R. C. (1989). *Managing for productivity in the hospitality industry*. Van Nostrand Reinhold.
- Miller, S. M., & Noulas, A. G. (1996). The technical efficiency of large bank production. *Journal of banking & finance*, 20(3), 495-509.
- Miller, T. I. (1984). The effects of employer-sponsored child care on employee absenteeism, turnover, productivity, recruitment or job satisfaction: what is claimed and what is known. *Personnel psychology*, 37(2), 277-289.
- Moghaddam, K. S., & Usher, J. S. (2011). Sensitivity analysis and comparison of algorithms in preventive maintenance and replacement scheduling optimization models. *Computers & Industrial Engineering*, 61(1), 64-75.
- Morey, R. C., Fine, D. J., Loree, S. W., Retzlaff-Roberts, D. L., & Tsubakitani, S. (1992). The trade-off between hospital cost and quality of care: an exploratory empirical analysis. *Medical Care*, 677-698.
- Morgan, D. L. (1997). *The focus group guidebook* (Vol. 1). Sage publications.
- Morgan, R. M., & Hunt, S. D. (1994). The commitment-trust theory of relationship marketing. *The journal of marketing*, 20-38.
- Nash, D., & Sterna-Karwat, A. (1996). An application of DEA to measure branch cross selling efficiency. *Computers & operations research*, 23(4), 385-392.
- Nelson, E. C., Rust, R. T., Zahorik, A., & Rose, R. L. (1992). Do patient perceptions of quality relate to hospital financial performance?. *Marketing Health Services*, 12(4), 6.
- Norman, M., & Stoker, B. (1991). *Data envelopment analysis: the assessment of performance*. John Wiley & Sons, Inc..
- Oliva, R., & Kallenberg, R. (2003). Managing the transition from products to services. *International journal of service industry management*, 14(2), 160-172.
- Oliver, R. L. (1980). A cognitive model of the antecedents and consequences of satisfaction decisions. *Journal of marketing research*, 460-469.

- Oliver, R. L. (1981). Measurement and evaluation of satisfaction processes in retail settings. *Journal of retailing*.
- Oliver, R. L., & DeSarbo, W. S. (1988). Response determinants in satisfaction judgments. *Journal of consumer research*, 495-507.
- Olson, D. L., Moshkovich, H. M., Schellenberger, R., & Mechitov, A. I. (1995). Consistency and Accuracy in Decision Aids: Experiments with Four Multiattribute Systems*. *Decision Sciences*, 26(6), 723-747.
- Palmatier, R. W., Gopalakrishna, S., & Houston, M. B. (2006). Returns on business-to-business relationship marketing investments: Strategies for leveraging profits. *Marketing Science*, 25(5), 477-493.
- Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1988). Servqual. *Journal of retailing*, 64(1), 12-40.
- Parasuraman, A., Berry, L. L., & Zeithaml, V. A. (1991). Refinement and reassessment of the SERVQUAL scale. *Journal of retailing*, 67(4), 420.
- Parasuraman, A., Berry, L. L., & Zeithaml, V. A. (1993). More on improving service quality measurement. *Journal of retailing*, 69(1), 140-147.
- Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1994). Alternative scales for measuring service quality: a comparative assessment based on psychometric and diagnostic criteria. *Journal of retailing*, 70(3), 201-230.
- Petkus, T., Filatovas, E., & Kurasova, O. (2009). Investigation of human factors while solving multiple criteria optimization problems in computer network. *Technological and Economic Development of Economy*, 15(3), 464-479.
- Pikkemaat, B., & Peters, M. (2006). Towards the measurement of innovation—A pilot study in the small and medium sized hotel industry. *Journal of Quality Assurance in Hospitality & Tourism*, 6(3-4), 89-112.
- Polatidis, H., Haralambopoulos, D. A., Munda, G., & Vreeker, R. (2006). Selecting an appropriate multi-criteria decision analysis technique for renewable energy planning. *Energy Sources, Part B*, 1(2), 181-193.
- Portela, M. C. A., Thanassoulis, E., & Simpson, G. (2004). Negative data in DEA: A directional distance approach applied to bank branches. *Journal of the Operational Research Society*, 55(10), 1111-1121.
- Ratchford, B. T., & Stoops, G. T. (1988). A Model And Measurement Approach For Studying Retail Products. *Journal of Retailing*, 64(3), 241.
- Reichheld, F. P., & Sasser, W. E. (1990). Zero defections: Quality comes to services. *Harvard business review*, 68(5), 105-111.

- Resti, A. (1997). Evaluating the cost-efficiency of the Italian banking system: What can be learned from the joint application of parametric and non-parametric techniques. *Journal of Banking & Finance*, 21(2), 221-250.
- Rho, S., & An, J. (2007). Evaluating the efficiency of a two-stage production process using data envelopment analysis. *International transactions in operational research*, 14(5), 395-410.
- Rios Insua, D. (1990). Sensitivity analysis in multi-objective decision making. *Lecture notes in economics and mathematical systems*.
- Robinson, J. P., Shaver, P. R., & Wrightsman, L. S. (1991). Criteria for scale selection and evaluation. *Measures of personality and social psychological attitudes*, 1(3), 1-16.
- Robinson, J. P., & Meadow, R. G. (1982). *Polls Apart: A Report from the Kettering Foundation*. Seven Locks Pr.
- Roy, B., & Bouyssou, D. (1986). Comparison of two decision-aid models applied to a nuclear power plant siting example. *European Journal of Operational Research*, 25(2), 200-215.
- Saaty, T. L. (1977). A scaling method for priorities in hierarchical structures. *Journal of mathematical psychology*, 15(3), 234-281.
- Saccani, N., Johansson, P., & Perona, M. (2007). Configuring the after-sales service supply chain: A multiple case study. *International Journal of Production Economics*, 110(1), 52-69.
- Sasser, W. E., Olsen, R. P., & Wyckoff, D. D. (1978). *Management of service operations: Text, cases, and readings*. Allyn & Bacon.
- Schaffnit, C., Rosen, D., & Paradi, J. C. (1997). Best practice analysis of bank branches: an application of DEA in a large Canadian bank. *European Journal of Operational Research*, 98(2), 269-289.
- Schoemaker, P. J., & Waid, C. C. (1982). An experimental comparison of different approaches to determining weights in additive utility models. *Management science*, 28(2), 182-196.
- Seiford, L. M., & Thrall, R. M. (1990). Recent developments in DEA: the mathematical programming approach to frontier analysis. *Journal of econometrics*, 46(1), 7-38.
- Sengupta, J. K. (2000). Efficiency analysis by stochastic data envelopment analysis. *Applied Economics Letters*, 7(6), 379-383.
- Sherman, H. D. (1981). Measurement of hospital technical efficiency: A comparative evaluation of data envelopment analysis and other approaches for locating

- inefficiency in health care organizations. *DBA thesis (Harvard University Graduate School of Business Administration, Boston, 1981).*
- Sherman, H. D., & Gold, F. (1985). Bank branch operating efficiency: Evaluation with data envelopment analysis. *Journal of banking & finance*, 9(2), 297-315.
- Sherman, H. D., & Ladino, G. (1995). Managing bank productivity using data envelopment analysis (DEA). *Interfaces*, 25(2), 60-73.
- Shostack, A. L. (1997). *Group Homes for Teenagers: A Practical Guide*. CWLA Press, c/o PMDS, 9050 Junction Drive, PO Box 2019, Annapolis Junction, MD 20701-2019; toll-free.
- Solnet, D., Kandampully, J., & Kralj, A. (2010). Legends of service excellence: The habits of seven highly effective hospitality companies. *Journal of Hospitality Marketing & Management*, 19(8), 889-908.
- Standards Association of Australia. Committee CE/18, Piling. (1995). *Piling-Design and installation*. Standards Australia.
- Steiger, J. H., & Lind, J. C. (1980, May). Statistically based tests for the number of common factors. In *annual meeting of the Psychometric Society, Iowa City, IA* (Vol. 758).
- Steuer, R. E., & Harris, F. W. (1980). Intra-set point generation and filtering in decision and criterion space. *Computers & Operations Research*, 7(1), 41-53.
- Stewart, T. J. (1992). A critical survey on the status of multiple criteria decision making theory and practice. *Omega*, 20(5), 569-586.
- Stewart, T. J. (1996). Relationships between data envelopment analysis and multicriteria decision analysis. *Journal of the Operational Research Society*, 654-665.
- Stillwell, W. G., Von Winterfeldt, D., & John, R. S. (1987). Comparing hierarchical and nonhierarchical weighting methods for eliciting multiattribute value models. *Management Science*, 33(4), 442-450.
- Sudman, S., & Bradburn, N. M. (1982). Asking questions: a practical guide to questionnaire design.
- Teas, R. K. (1993). Consumer expectations and the measurement of perceived service quality. *Journal of Professional Services Marketing*, 8(2), 33-54.
- Tecle, A., Fogel, M. M., & Duckstein, L. (1988). multicriterion analysis of forest watershed management alternatives I.
- Thanassoulis, E. (2001). *Introduction to the theory and application of data envelopment analysis*. Massachusetts: Kluwer Academic Publishers.

- Thanassoulis, E., Dyson, R. G., & Foster, M. J. (1987). Relative efficiency assessments using data envelopment analysis: an application to data on rates departments. *Journal of the Operational Research Society*, 397-411.
- Thompson, R. G., Singleton Jr, F. D., Thrall, R. M., & Smith, B. A. (1986). Comparative site evaluations for locating a high-energy physics lab in Texas. *Interfaces*, 16(6), 35-49.
- Triantaphyllou, E., & Sánchez, A. (1997). A Sensitivity Analysis Approach for Some Deterministic Multi-Criteria Decision-Making Methods*. *Decision Sciences*, 28(1), 151-194.
- Triantaphyllou, E., Shu, B., Sanchez, S. N., & Ray, T. (1998). Multi-criteria decision making: an operations research approach. *Encyclopedia of electrical and electronics engineering*, 15, 175-186.
- Triantaphyllou, E. (2000). Multi-criteria decision making methods. In *Multi-criteria Decision Making Methods: A Comparative Study* (pp. 5-21). Springer US.
- Tribe, J., & Snaith, T. (1998). From SERVQUAL to HOLSAT: holiday satisfaction in Varadero, Cuba. *Tourism management*, 19(1), 25-34.
- Trivedi, K. S., & Malhotra, M. (1993). Reliability and performability techniques and tools: A survey. In *Messung, Modellierung und Bewertung von Rechen-und Kommunikationssystemen* (pp. 27-48). Springer Berlin Heidelberg.
- Trochim, W. M. (2006). Survey research.
- Van Iwaarden, J., van der Wiele, T., Ball, L., & Millen, R. (2003). Applying SERVQUAL to web sites: An exploratory study. *International Journal of Quality & Reliability Management*, 20(8), 919-935.
- Vincke, P. (1992). *Multicriteria decision-aid*. John Wiley & Sons.
- Viteikiene, M., & Zavadskas, E. K. (2007). Evaluating the sustainability of Vilnius city residential areas. *Journal of civil engineering and management*, 13(2), 149-155.
- Wanke, P., & Barros, C. (2014). Two-stage DEA: An application to major Brazilian banks. *Expert Systems with Applications*, 41(5), 2337-2344.
- Weistroffer, H. R., Smith, C. H., & Narula, S. C. (2005). Multiple criteria decision support software. In *Multiple criteria decision analysis: state of the art surveys* (pp. 989-1009). Springer New York.
- Weitz, B. A., & Wensley, R. (2002). *Handbook of marketing*. Sage.

- Wheelock, D. C., & Wilson, P. W. (1995). Explaining bank failures: Deposit insurance, regulation, and efficiency. *The Review of Economics and Statistics*, 689-700.
- White III, C. C., Sage, A. P., & Dozono, S. (1984). A model of multiattribute decision-making and trade-off weight determination under uncertainty. *Systems, Man and Cybernetics, IEEE Transactions on*, (2), 223-229.
- Wilson, T. L. (1999). International after-sales services. *Journal of Global Marketing*, 13(1), 5-27.
- Winsberg, S., Akkucuk, U., & Carroll, J. D. (2003). Evaluating the Performance of EXSCAL Under Different Missing Data Scenarios.
- Wise, R., & Baumgartner, P. (1999). Go downstream: the new profit imperative in manufacturing. *Harvard business review*, 77(5), 133-141.
- Woodruff, R. B., Cadotte, E. R., & Jenkins, R. L. (1983). Modeling consumer satisfaction processes using experience-based norms. *Journal of marketing research*, 296-304.
- Yan, B., & McLaren, P. A. (2010, December). Measuring after-sales service quality in automobile retails: An application of the SERVQUAL instruments. In *Industrial Engineering and Engineering Management (IEEM), 2010 IEEE International Conference on* (pp. 2090-2094). IEEE.
- Yoo, T., & Hyun, J. K. (1998). International comparison of the black economy: Empirical evidence using micro-level data. *Unpublished paper*.
- Youssef, F., Nel, D., & Bovaird, T. (1995). Service quality in NHS hospitals. *Journal of Management in Medicine*, 9(1), 66-74.
- Zadeh, L. A. (1965). Fuzzy sets. *Information and control*, 8(3), 338-353.
- Zanakis, S. H., Mandakovic, T., Gupta, S. K., Sahay, S., & Hong, S. (1995). A review of program evaluation and fund allocation methods within the service and government sectors. *Socio-Economic Planning Sciences*, 29(1), 59-79.
- Zanakis, S. H., Solomon, A., Wishart, N., & Dublish, S. (1998). Multi-attribute decision making: A simulation comparison of select methods. *European journal of operational research*, 107(3), 507-529.
- Zavadskas, E. K., Kaklauskas, A., Peldschus, F., & Turskis, Z. (2007). Multi-Attribute Assessment of Road Design Solutions By Using The COPRAS Method. *Baltic Journal of Road & Bridge Engineering*, 2(4).

- Zavadskas, E. K., Turskis, Z., Tamošaitienė, J., & Marina, V. (2008). Multicriteria selection of project managers by applying grey criteria. *Technological and Economic Development of Economy*, 14(4), 462-477.
- Zavadskas, E. K., Turskis, Z., & Tamošaitienė, J. (2008). Contractor selection of construction in a competitive environment. *Journal of Business Economics and Management*, 9(3), 181-187.
- Zavadskas, E. K., Ustinovichius, L., & Peldschus, F. (2003). Development of software for multiple criteria evaluation. *Informatica*, 14(2), 259-272.
- Zavadskas, E. K., & Vilutienė, T. (2006). A multiple criteria evaluation of multi-family apartment block's maintenance contractors: I—Model for maintenance contractor evaluation and the determination of its selection criteria. *Building and environment*, 41(5), 621-632.
- Zavadskas, E., Viteikiene, M., & Saparauskas, J. (2007). Sustainable development assessment of cities and their residential districts. *Ekologija*, 53(Suppl), 49-54.
- Zhu, J. (2003). Imprecise data envelopment analysis (IDEA): A review and improvement with an application. *European Journal of Operational Research*, 144(3), 513-529.
- Zineldin, M. (2002). Developing and managing a romantic business relationship: life cycle and strategies. *Managerial Auditing Journal*, 17(9), 546-558.