A METHODOLOGY TO MEASURE CUSTOMER EXPECTATIONS BY USING KANO'S MODEL

AYHAN KÖKSEL

IŞIK UNIVERSITY
2014

A METHODOLOGY TO MEASURE CUSTOMER EXPECTATIONS BY USING KANO'S MODEL

AYHAN KÖKSEL

M.S., Industrial Engineering, Işık University, 2009

Submitted to the Graduate School of Science and Engineering
in partial fulfillment of the requirements for the degree of
Master of Science
in
Industrial Engineering

IŞIK UNIVERSITY
2014

IŞIK UNIVERSITY

GRADUATE SCHOOL OF SCIENCE AND ENGINEERING

A METHODOLOGY TO MEASURE CUSTOMER EXPECTATIONS BY USING KANO'S MODEL

AYHAN KÖKSEL

APPROVED BY:

Assoc. Prof. S. Çağlar Aksezer (Işık University) _____

(Thesis Supervisor)

Assoc. Prof. Seyhun Altunbay (Işık University) _____

Assist. Prof. O. Murat Anlı (Işık University) _____

APPROVAL DATE: 12/09/2014

A METHODOLOGY TO MEASURE CUSTOMER EXPECTATIONS BY USING KANO'S MODEL

Abstract

Kano's model has been extensively used to investigate the customer requirements and to determine which features of the product (or service) have the most impact on customer satisfaction (or dissatisfaction). During the application of the method, expectations of customers about the features of the product are translated into several categories. Although customer expectations based on the product features are categorized with this method, an expectation degree about the entire product cannot be obtained. The aim of this study is to determine an overall score of customer expectations for the product as a whole by using the categories which are determined by Kano's model. A customer-defined expectation score (CDES) is useful to identify the features that have a difficulty in satisfying customers. In addition to this, it will be determined whether a relationship exists between expectations of features, overall expectation and demographic characteristics of customers. Furthermore, it is also proposed to identify the product features which have the most impact on customer satisfaction and to determine the improvement amount to satisfy the different satisfaction goals by using the weighted goal programming method under a given budget constraint. As a result, critical product attributes that have the most impact on customer satisfaction will be identified along with their intensities and tradeoffs. Application of the proposed procedure is illustrated on two different case studies including educational software and automobile.

KANO MODELİ KULLANILARAK MÜŞTERİ BEKLENTİLERİNİN ÖLÇÜLMESİ İÇİN BİR YÖNTEM

Özet

Kano modeli, müşteri gereksinimlerinin araştırılması ve ürünün (veya hizmetin) hangi özelliklerinin müşteri memnuniyetine (veya memnuniyetsizliğine) daha fazla etki ettiğine karar verilmesi amacıyla yaygın olarak kullanılmaktadır. Yöntemin uygulanması sırasında, müşterinin ürün özellikleriyle ilgili beklentileri çeşitli kategorilerle ifade edilir. Bu metot ile ürün özellikleri bazında müşteri beklentileri belirlenmesine rağmen ürünün tamamı hakkında herhangi bir beklenti derecesi elde edilememektedir. Bu çalışma ile ürün özellikleri bazında belirlenen beklenti kategorilerinin sayısal hale getirilmesiyle, ürünün tamamı için bir toplam beklenti skorunun belirlenmesi amaçlanmıştır. Müşteri tanımlı beklenti skoru (MTBS) ile hangi ürün özelliklerinde müşteri beklentilerinin daha zor karşılandığı belirlenmeye çalışılmıştır. Ayrıca ürün özellikleri ve ürünün tamamı hakkında belirlenen toplam beklenti derecesi ile müşterilerin demografik özellikleri arasında bir ilişkinin olup olmadığı belirlenmeye çalışılmıştır. Bununla beraber belirli bir bütçe kısıtı altında müşteri memnuniyetini maksimum edecek ürün özelliklerinin belirlenmesi ve bu ürün özelliklerin ne kadar iyileştirilmesi gerektiği probleminin ağırlıklı hedef programlama yöntemi ile çözülmesi amaçlanmıştır. Burada önerilen yöntemler yazılım ve otomobil örnekleri olmak üzere iki farklı vaka analizi üzerinde uygulanmıştır.

Acknowledgements

I would like to thank to my supervisor, Assoc. Prof. S. Çağlar AKSEZER for his guidance, his great patience and his concern. Moreover, I would like to thank to Assoc. Prof. Seyhun ALTUNBAY and Asst. Prof. S. Tankut ATAN for their encouragements. I also thank to Asst. Prof. O. Murat Anlı for his help during my graduate studies.

To my parents

Table of Contents

List of Tables

List of Figures

Chapter 1
Introduction

1.1 Overview

Quality is one of the most important aspects of a product or service in worldwide markets to satisfy and meet the expectation of customers. Most companies realize that customer satisfaction is crucial for future business success. At macro level, customer satisfaction means, understanding and anticipating what customers want and how products and services supplied by a company to meet or exceed customer expectation. A high level of customer satisfaction is one of the most powerful indicator for the success of a business. Satisfied customers mean loyalty and they ensure a lasting cash flow, increase of market share and reputation. They are furthermore, less price sensitive and inclined to spend more on tried and tested products. Ultimate goal for the companies is to delight the customers while maximizing revenues.

Perception of quality has been changing for years as the technology evolves to new frontiers. Technology is improving day by day so people's needs and understanding of quality are changing at the same time. Since customers perceive goods and services in different ways, transition on goods to services makes important for organizations to reconsider what quality means and how it is related to customer satisfaction. Companies consequently need to develop, design, and provide their ability to produce goods and services with high customer experienced quality.

Inspired by Herzberg's Motivator-Hygiene theory, Professor Kano and his colleagues developed the theory of attractive quality. The theory is intended to help one better to understand how customers evaluate and perceive quality attributes. The theory of attractive quality explains the relationship between the degree of

sufficiency and customer satisfaction with a quality attribute. A quality attribute can be classified into five categories of perceived quality: attractive quality; must-be quality; reverse quality; one-dimensional quality; and indifferent quality. The theory of attractive quality predicts that quality attributes are dynamic, meaning that over time a given attribute may shift from one category to another.

1.2 Motivation

Kano's model is a useful tool to understand how customers evaluate products or services. This method is being used and has significant effect in various industries. The difficulty to measure perceived quality and the goal of producing a product which maximizes customer satisfaction as well as minimizing cost is an interesting dilemma of the methodology. The literature on Kano's model are inspiring to set up a mathematical model to maximize customer satisfaction and to minimize cost. Kano's model also express that not all customers alike. This hypothesis gives a change to examine customer segmentation by their demographical profiles. To produce products according to customers' demographics like gender, age and their monthly income provides competition advantage in market. The main purpose of this thesis is to identify the most attractive features of products to maximize customer satisfaction and to create customer segmentation by their demographic profile and to delight them.

1.3 Outline

After a brief introduction and motivation, a general description is made about customer satisfaction and purpose of Kano's model which also known as the theory of attractive quality. Chapter two contains literature review about various applications and theoretical researches about Kano's model. After this chapter, Kano's model is clearly explained step by step. The necessary questionnaire, formulas, worksheets and the way to use them are also given in this section. The next two chapters consist of two case studies. In the fourth chapter Kano's model is applied to an automobile and in the fifth chapter, the theory is applied to evaluate the perceived quality of an educational software. In the last chapter the results are discussed in detail.

Chapter 2
Literature Review

2.1 Concept of Customer Satisfaction and Kano's Model

Customer satisfaction is very important for business success and it will be became more important for future business. To achieve this success, firms should understand what customers will desire from products and services in the future. Firms should offer products and services which cause positive response on customer satisfaction to delight them. The question is, which product or service features are decisive for the satisfaction of customers and which features prevent dissatisfaction (Matzler, 1996). It is also known that satisfied customers are willing to pay more for high quality products and services (Hinterhuber et al., 1997). Satisfied customers are likely to buy more frequently and to purchase other goods and services offered by the firm (Reicheld and Sasser, 1990). The importance of customer satisfaction is defined as "Customer satisfaction is the ultimate objective of every business: not to supply, not to sell, not to service, but to satisfy the needs that drive customers to do business" (Hanan and Karp, 1989).

Ensuring customer satisfaction is also important to keeping the present customers. The costs of attracting new customers are much higher than the costs of keeping the present customers through an increased level of loyalty. The American Marketing Association estimates that it costs five times more to acquire a new customer than to keep one (Matzler, 1998).

Satisfied customers can be described as loyal customers. An increase in the customer loyalty rate by 5 percent can increase the profit of a business by 100 percent due to the fact that satisfied customers purchase the products of a company more often and in greater quantities. The positive quality image reduces the cost of attracting new

customers, and the high level of customer loyalty lowers transaction costs for existing customers (Matzler, 1996).

Herzberg (1966) introduced motivator-hygiene theory (M-H theory) which describes the relationship between job satisfaction and hygiene factors. According to his theory, the factors that cause job satisfaction are different from those that cause job dissatisfaction. In other words, the opposite of job satisfaction is not job dissatisfaction but, rather, no job satisfaction or vice versa.

Inspired by Herzberg's work, Kano and his colleagues improved and adapted the theory to quality. "Kano's Model" which is also known as the "Theory of Attractive Quality" was first developed by Dr. Noriaki Kano and his colleagues, is a useful tool to understand customer needs and their impact on customer satisfaction (Kano et al, 1984). Dr. Kano challenged the traditional idea on customer satisfaction that "more is better", which means the better you perform on each product or service attribute; the more satisfied the customers will be. That means customer satisfaction has been used as a one-dimensional construction. Instead, Kano held that performance on product and service attributes is not equal in the eyes of the customers. Performance on certain categories of attributes produces higher levels of satisfaction than others (Zultner, 2006). A distinction between satisfaction and dissatisfaction was first introduced in the two factor theory of job satisfaction. In essence, the theory posits that the factors that cause job dissatisfaction are different from the factors that cause job satisfaction. The theory of attractive quality is a useful method to better understand different aspects of how customers evaluate a product or offering (Lars Witell, 2007). This theory has gained exposure and acceptance through articles in various marketing, quality, and operations management journals. The theory of attractive quality has been applied in strategic thinking, business planning, and product development to demonstrate lessons learned in innovation, competitiveness, and product compliance.

The theory of attractive quality originated because of the lack of explanatory power of a one dimensional recognition of quality. For example, people are satisfied if the packaging of milk extends the expiration date. For a quality attribute such as leakage, people are not satisfied if the package does not leak, but they are very dissatisfied if it

does. The one dimensional view of quality can explain the role expiration but not leakage. To understand the role of quality attributes, Kano presents a model based on customer satisfaction with specific quality attributes and their degree of sufficiency. The theory explains how the relationship between the degree of sufficiency and customer satisfaction with a quality attribute can be classified into five categories of perceived quality (Martin Löfgren, 2008).

After the Kano's model introduced in 1984 by Dr. Noriaki Kano and his colleagues, Better et al. (1993) issued the instruction, experience ideas, and the theories that have evolved using Kano's model within CQM (Center for Quality of Management) companies. In this study both theoretical and practical ways of Kano's model discussed in detail. Matzler and Hinterhuber (1998) integrated Kano's model into quality function deployment to make products development projects more successful. Also, in this way product development projects can be managed more systematically. Huiskonen and Pirttila (1998) analyzed the logistics customer service requirements by using the Kano's model of quality element classification, and discussed the potential benefits that can be achieved by applying this approach to a logistics customer service process. Tan and Shen (2000) integrated Kano's model in the planning matrix of quality function deployment. They also introduced the improvement ratio which is the parameter represents the relationship between customer satisfaction and product or service performance. Bruce Han and his colleagues (2001) also used Kano's model in QFD (Quality Function Deployment) to classify the customer requirements. It is also used a goal programming model to choose the design which minimizes negative deviations from target levels of customer requirements. Yang (2005) refined Kano's model and divided Kano's first four categories into eight categories as highly attractive, less attractive, high value added, low value added, critical, necessary, potential and care-free. Based on this model, firms can obtain a more accurate understanding of the quality attributes from the customer's perspective. Witell and Löfgren (2007) classified the attributes according to the different methods such as original five-level Kano questionnaire, three-level Kano questionnaire, classification directly and classification via importance. Here, the three-level Kano questionnaire is a simplified version of the original five-level Kano questionnaire. Lee and Huang (2009) designed the Kano questionnaire using fuzzy theory. In this study, they developed a mathematical

calculation performance according to the Kano's two-dimensional fuzzy mode. Baki and his colleagues (2009) integrated Servqual and Kano's model into QFD. Both Servqual and Kano's model are used in this paper to identify the customer needs for logistics services.

Table 2.1 An Overview of the Literature

Author	Year	Context	Journal	Number of Respondents
Moura, P. S., Saraiva, P.	2001	The development of an ideal kindergarten	Total Quality Management	62
Yang, C. C.	2003	Service Quality Measurement	Managing Service Quality	150
Ernzer, M., Kopp, K.	2003	Life Cycle Design	Proceeding of Eco Design	25
Fundin, A., Nilsson, L.	2003	E-services	Asian Journal of Quality	359
Bhattacharyya, S. K., Zillur, R.	2004	Banking	European Business Review	50
Shahin, A.	2004	Travel Agent	International Journal of Quality & Reliability Management	30
Szmigin, I., Reppel, A. E.	2004	Internet Based Community	European Journal of Marketing	4.229
Witell, L., Fundin, A.	2005	Dynamics of Service Attributes	International Journal of Service Industry Management	193
Löfgren, M., Witell, L.	2005	Packaging	American Society for Quality	250
Yang, C. C.	2005	Air-conditioner	Total Quality Management	150
Hsu, Y., Hsu, C., Bing, P.	2007	Airline Industry	International Conference on Logistics, Shipping and Port Management	249
Witell, L., Löfgren, M.	2007	E-services	Managing Service Quality	430
Tontini, G.	2007	Beer Mug	Total Quality Management	289
Chen, C., Chuang, M.	2008	Mobile Phone	International Journal of Production Economics	60
Chen, L., Hsu, C., Chang, P.	2008	On-line Game	IEEE	105
Delice, E. K., Güngör, Z.	2011	Washing Machine	International Journal of Product Research	-

Chapter 3
Kano's Model

3.1 Introduction to Kano's Model

Kano's model also known as the theory of attractive quality is a useful method to understand the customer needs, categorize them and realize the customer satisfaction according to relevant categories. Traditional idea on customer satisfaction is "more is better" that the better you perform on each product or service attribute, the more satisfied the customers will be. Instead of this idea, Kano suggested a theory that performance on product and service attributes are not equal in the eyes of the customers. Kano classified the quality attributes into five categories. These categories can be identified using a specific questionnaire which is named as Kano's Questionnaire. The questionnaire contains two types of questions for each customer requirement; functional and dysfunctional. According to the answers of these two questions the requirement can be classified into one of the five quality categories for each customer. Each requirement can also be categorized according to the most encountered category.

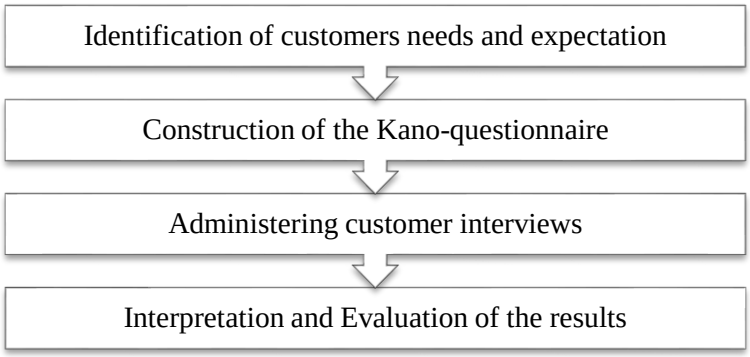

Figure 3.1 Steps of the Kano's Methodology

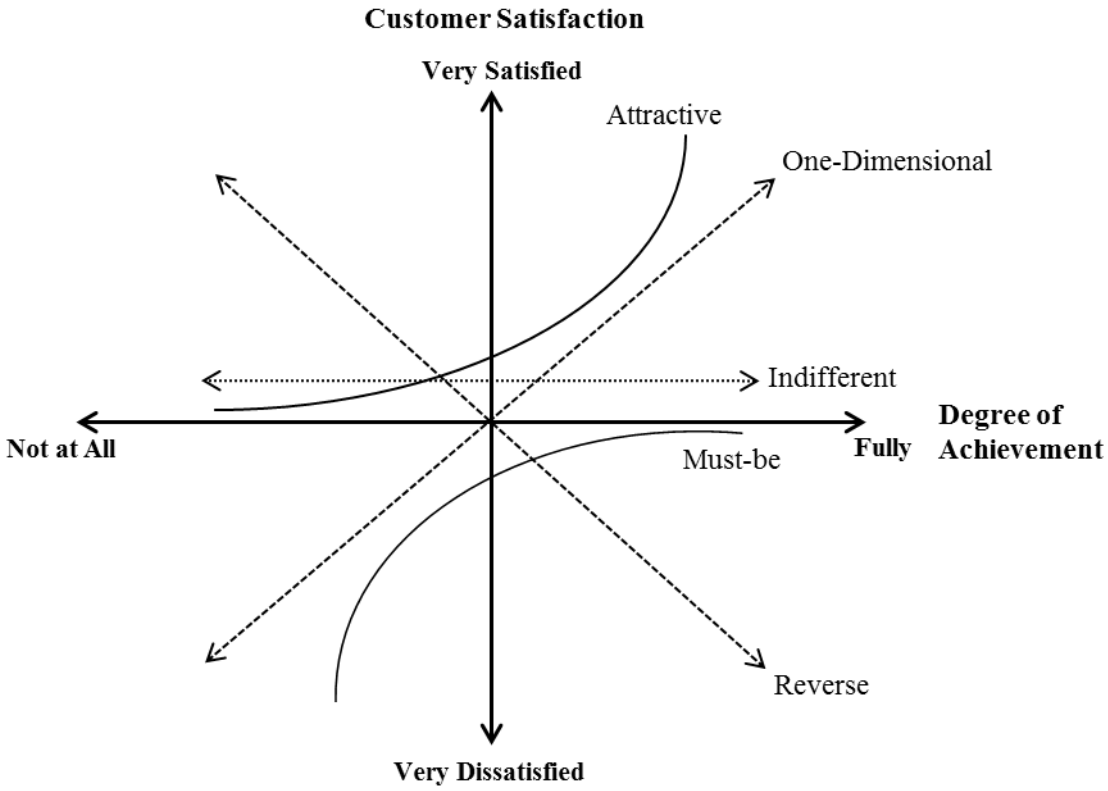

Figure 3.2 Customer Satisfaction Model

The figure is given above represents the relationship between customer satisfaction and degree of achievement. On the horizontal axis in the diagram the physical sufficiency of a certain quality attribute is displayed. The vertical axis shows satisfaction with a certain quality attribute.

3.2 Classification of Attributes

According to Professor Kano a quality (attribute, requirement, need or feature) can be classified into five categories. The theory explains how the relationship between the degree of sufficiency and customer satisfaction with a quality attribute can be classified into five categories of perceived quality. The advantages of classifying customer requirements by means of the Kano's method are:

- Product requirements are better understood. The product criteria which have the greatest influence on the customer satisfaction can be identified. Classifying product requirements can be used to focus on priorities for

product and service development. It is, for example, not very useful to invest in improving must-be requirements which are already at a satisfactory level, but better to improve one-dimensional or attractive requirements as they have a greater influence on perceived product quality and consequently on the customers' level of satisfaction.

- Kano's method provides valuable help in trade-off situations in the product development stage. If two product requirements cannot be met simultaneously due to the technical or financial reasons, the criterion which has the greatest influence on customer satisfaction can be identified.

- Must-be, one-dimensional and attractive requirements differ, as a rule, in the utility expectations of different customer segments. From this starting point, customer-tailored solutions for special problems can be elaborated, which guarantees an optimal level of satisfaction in the different customer segments.

- Discovering and fulfilling attractive requirements creates a wide range of possibilities for differentiation. A product which merely satisfies the must-be and one-dimensional requirements is perceived as average and therefore interchangeable (Matzler, 1996).

The quality attributes can be classified as attractive quality, must-be quality, one dimensional quality, indifferent quality and reverse quality.

3.2.1 Attractive Quality (A):

Attractive quality is the requirements that beyond customers' expectations and these requirements can be described as surprise attributes. These requirements are also unexpected by the customers and if these are fulfilled, there will be a high rate of customer satisfaction. But the absence of these requirements will not constitute dissatisfaction. The requirements in this category have the maximum effect on customer satisfaction. The followings are some examples of attractive quality requirements:

- Providing a way for passengers to plug in their laptop into a power source while in flight.

- A thermometer on a package of milk showing the temperature
- Sunroof
- Tablet and smart phone versions of the educational software

3.2.2 Must-be Quality (M):

Must-be quality is essential requirements in the eyes of the customers. Presence of these requirements does not create a positive impact on customer satisfaction. But it will cause a great dissatisfaction with the lack of requirements. These requirements are so basic that customers would not state them unless the service sector fails to perform them (Cheng Lim et al., 1999). Briefly, it can be said that if a must-be requirement is not fulfilled, the customer is not even interested in product at all. The followings are some examples of must-be requirements:

- Having friendly sales assistants for a shop
- Getting their baggage on time and in one piece
- Having good brakes

3.2.3 One-Dimensional Quality (O):

One-Dimensional requirements have a linear effect on customer satisfaction. These requirements result in satisfaction when fulfilled and dissatisfaction when not fulfilled (Kano et al. 1984). This factor is also termed ‘more is better’. The more functional the product or service is with respect to the requirement, the more satisfied the customer and, vice versa, less functionality results in more dissatisfaction (Shanin & Zairi, 2009). The followings are some examples of one-dimensional requirements:

- Fast delivery; the faster the delivery, the more customers like
- Speed of check-in at an airport
- Gas mileage
- Easy to transfer data to other software

3.2.4 Indifferent Quality (I):

These requirements do not create an impact on customer satisfaction whether fulfilled or not. These requirements are important for identifying the attributes which have no effect on customer satisfaction. Here are some examples of indifferent requirements from case studies:

- Metallic paint
- Pop-up window about updates
- Multiple language choice

3.2.5 Reverse Quality (R):

These requirements cause customer dissatisfaction when they are fulfilled but the customer is satisfied when they are unfulfilled. These requirements also show that not all customers are alike. There may be a good market segmentation opportunity here (Berger, 1993). Here are some examples of reverse requirements:

- Some customers may prefer high-tech products while others prefer more basic products

3.2.6 Questionable (Q):

This category represents the requirements that are not understood by customers. It is also possible that the answer of the question is given incorrectly. Normally, the answers do not fall into this category. So, if a requirement has a %5 questionable category of the answers, the requirement may have skeptical answers which indicate that the customer didn't understand the question.

3.3 The Kano Questionnaire

Kano and his colleagues believe that the attractive, must-be, one-dimensional, indifferent and reverse customer requirements can be classified through a customer questionnaire (Berger, 1993). To determine which quality is in which classification, a questionnaire must be applied. When formulating the questions, the voice of the customer is considered. The customer may not understand the technical parts of the

products. So, the questions are asked in the eyes of the customers. In addition, if someone asks about the technical solutions of a product, it can easily happen that the question is not correctly understood.

In Kano questionnaire, there is a pair of questions for each attribute that is included in the questionnaire. Each question has two parts; “functional form of the question” and “dysfunctional form of the question”.

Table 3.1 Functional and Dysfunctional Questions of Kano Model

Questions	Answers
(Functional Form) How do you feel if that feature is present in the product? (Dysfunctional Form) How do you feel if that feature is not present in the product?	1) I like it that way 2) It must be that way 3) I am neutral 4) I can live with it that way 5) I dislike it that way

In each part of the question, the customer should select one of five alternatives. The first question concerns the reaction of the customer if the product has that feature or the feature is presented well (functional form of the question), the second concerns his reaction if the product does not have that feature or the feature is not presented well (dysfunctional form of the question).

Before implementing the questionnaire the questions should be tested whether the questions are understandable or not by one or two people. After testing the questions, a method should be decided to implement the questionnaire like telephone, face to face, mail or e-mail. The most common method is e-mail because of the lower cost. But return rate may be lower too. In literature there is a wide range for number of interviews changing from tenths to thousands. However, only 20 to 30 customer interviews in homogenous segments suffice to determine approximately 90 to 95 percent of all possible product requirements (Griffin and Hauser 1993).

The questionnaire also contains some background questions like gender, age and job. This background data may be useful for customer segmentation. In the last section of questionnaire the participants are asked how they rate the importance of the features given. It might be helpful to have the customer rank the individual product criteria of the current product and to determine the relative importance of the individual product criteria (self-stated importance). This will help us to establish our priorities for product development and to make improvements if necessary. The participants can rate between 1 and 10 which indicates that 1 is not important and 10 is very important.

Table 3.2 Kano Importance Level

	1	2	3	4	5	6	7	8	9	10
Importance of the Requirement										

The general idea of this survey is to classify all features according to the theory of attractive quality and then use importance weights as an indicator of prior features within a quality category.

3.4 Kano Evaluation Table

According to the answers of the functional and dysfunctional part of the questions, customer requirements can be categorized by using Kano's evaluation table.

Table 3.3 Kano Evaluation Table

Customer Requirements		Dysfunctional Question				
		I like it that way	It must be that way	I am neutral	I can live with it that way	I dislike it that way
Functional Question	I like it that way	Q	A	A	A	O
	It must be that way	R	I	I	I	M
	I am neutral	R	I	I	I	M
	I can live with it that way	R	I	I	I	M
	I dislike it that way	R	R	R	R	Q

The intersection cell of the answers of functional and dysfunctional questions is represents the classification of feature according to relevant customer. An example is given below to illustrate the way of filling out the survey.

How do you feel, if a road computer is presented?	☒ I like it that way ☐ It must be that way ☐ I am neutral ☐ I can live with it that way ☐ I dislike it that way
How do you feel, if a road computer is not presented?	☐ I like it that way ☐ It must be that way ☐ I am neutral ☒ I can live with it that way ☐ I dislike it that way

Customer Requirements		Dysfunctional Question				
		I like it that way	It must be that way	I am neutral	I can live with it that way	I dislike it that way
Functional Question	I like it that way	Q	A	A	A	O
	It must be that way	R	I	I	I	M
	I am neutral	R	I	I	I	M
	I can live with it that way	R	I	I	I	M
	I dislike it that way	R	R	R	R	Q

Table of Results

Customer Requirement	A	O	M	I	R	Q	Total
Road Computer	1						1
Gas Mileage							
Sunroof							

How would you rank the importance of road computer?

☐	☐	☐	☒	☐	☐	☐	☐	☐	☐
1	2	3	4	5	6	7	8	9	10

Unimportant Very Important

Figure 3.3 Evaluation Process

If the functional part of the question is “I like it that way” and the dysfunctional part of the question is “I can live with it that way”, then the category should be attractive. The results for each part of the questions are combined, and the results are found for every question. This algorithm is applied for all participants and for every customer requirement.

If the individual product requirements cannot be unambiguously assigned to the various categories, the evaluation rule “M>O>A>I” is very useful. When making decisions about product developments, primarily those features have to take into consideration which has the greatest influence on the perceived product quality. First, those requirements have to be fulfilled which cause dissatisfaction if not met. When deciding which attractive requirements should be satisfied, the decisive factor is how important they are for the customer. This can be determined by using “self-stated importance” in the surveys (Matzler, 1996). The theory of attractive quality predicts that product attributes are dynamic, that is, overtime an attribute will change from being indifferent, to attractive, to one-dimensional, and to must-be. Kano et al. (2001) provided empirical evidence for the dynamics of the television remote control that had followed a life cycle such as: attractive quality→one dimensional quality→must be quality. By investigating customer perceptions of remote controls through Kano’s questionnaires in 1983, 1989, and 1998, Kano (2001) shows that the remote control was an attractive attribute in 1983, a one-dimensional attribute in 1989, and a must be item in 1998 (Löfgren, 2011).

Figure 3.4 Life Cycle for Successful Quality Attributes

3.5 Analysis of the Questionnaire

By using the Kano’s questionnaire, two types of coefficients could be calculated; better and worse. The better coefficient indicates that the customer satisfaction will increase as much as that number by providing that quality attribute. In other words, it is showed that how strongly a product feature may influence satisfaction.

To calculate the better coefficient which means average positive impact on customer satisfaction, it is necessary to add the attractive and one-dimensional columns and divide by the total number of attractive, one-dimensional, must-be and indifferent responses for the relevant customer requirement.

The worse number indicates that the customer satisfaction will decrease as much as worse number by not providing that quality attribute. For the calculation of worse coefficient which means the average impact on dissatisfaction, it is necessary to add the must-be and one-dimensional columns and divide by the total number of attractive, one-dimensional, must-be and indifferent responses for the relevant customer. It is used the same normalizing factor for the denominator of the formula for better and worse coefficients. The maximum value of better coefficient can be +1 while the minimum value of it 0, and the maximum value of worse coefficient can be 0 while the minimum value of it -1.

Consequently, the greater the absolute value of the number is close to 1, the more is the effect of the indicator. For better coefficient, if the result is closer to 1, it means, greater influence on customer satisfaction. But if the result is close to 0, it means little influence on customer satisfaction. For worse coefficient, if the result is close to -1, it means greater influence on customer dissatisfaction, but if the result is close to 0, it means little influence on customer dissatisfaction. The formulas of the better and worse coefficients are given below.

$$Better = \frac{A+O}{A+O+M+I} \tag{3.1}$$

$$Worse = \frac{M+O}{A+O+M+I} * (-1) \tag{3.2}$$

where A, is the number of participants indicate that the attribute is attractive. O, is the number of participants indicate that the attribute is one dimensional. M is the number of participants indicate that the attribute is must be. I, is the number of participants indicate that the attribute is indifferent.

A self-stated importance questionnaire is also used to understand the relative importance of each requirement for customers. This questionnaire can be helpful to focus on the most important requirements. In general, self-stated importance data is used to rank the requirements which have same classification category. The importance of the requirement is asked to customers and the customers select an importance level from a 1-10 rating scale.

An example result for a Kano questionnaire is given in Table 3.4 and Table 3.5. For this example, 59.1% of customers defined the navigation as an attractive requirement and 29.5% of them defined as indifferent and so on. Because of the attractive category has the most percent, the classification for navigation is defined as attractive requirement and it has an average 6.33 importance level on a 1-10 rating scale.

Table 3.4 Result of the Classification-1

Product Requirement	A	M	O	I	R	Q	Classification
Navigation	**59,1**	8,0	3,4	29,5	0,0	0,0	A
Cruise Control	35,2	6,8	9,1	**44,3**	4,5	0,0	I
Gas Mileage	15,9	29,5	**48,9**	4,5	0,0	1,1	O

By using the equations 3.1 and 3.2, better and worse coefficients can be calculated to define the impact on customer satisfaction depend on the fulfilment of requirement or not. That means, customer satisfaction will increase as 0.63 by providing that feature and it will decrease as 0.11 by not providing that feature.

Table 3.5 Results of the Classification-2

Product Requirement	Classification Agreement	Category Strength	Total Strength	Better	Worse	Stated Importance
Navigation	59,1	29,5	70,5	0,63	-0,11	6,33
Cruise Control	44,3	9,1	51,5	0,46	-0,17	6,16
Gas Mileage	48,9	19,3	94,3	0,66	-0,79	9,19

There are some definitions that can be useful to analyze the classification results. Classification agreement (CA) represents the percentage of the respondents who have agreed on the final classification. Category strength (CS) is the difference

between the two highest categories. CS gives an idea that how strong the final category on the second highest category. Total strength is the total percentage of attractive, one-dimensional and must-be responses (Lee and Newcomb, 1997). Numerator of better and worse coefficients are directly affected by those categories and so that total strength represents how totally the feature has a strength on customer satisfaction.

Chapter 4
Automobile Case Study

4.1 Introduction

The idea on that transporting people rather than goods primarily on roads created the automobile. The first modern automobile is invented by Karl Benz in 1886. Automobiles are equipped with controls used for driving, parking, passenger comfort and safety. However new controls have been added to the automobiles as the technology evolves like air conditioning, navigation systems and in car entertainment. Today, automobile is still the most important vehicles for transporting people. According to the statistics about automotive sector, 19.2 million automotive vehicles (automobiles and commercial vehicles) are produced in China and 10.4 million are produced in USA. Approximately 1 million are produced in Turkey which is ranked as 16^{th} in the world in production and 8 hundred thousand vehicles are sold in Turkey (LMC Automotive Statistics, 2012).

Automotive vehicles are the products which affected mostly by the technology, they have lots of features and models preferred by the customers. Automotive industry makes these changes of features to meet customer expectations and to affect them. So, customers become more demanding over the years because there are lots of models and features, mean that role of these features and models become more important, as it can be used to meet expectations. One question of immediate interest is how improved or modified car models and features contribute to enhanced customer satisfaction.

In this case study, features of an automobile is examined through the eyes of the customer using Kano's model. The aim of this case study is to identify the most

attractive features on an automobile and to find the improvement amounts of features to meet the customer satisfaction by using goal programming method.

4.2 Kano Questionnaire

A survey consisting of a self-stated importance and a Kano questionnaire was carried out to the students in Işık University about automobile features. There are three sections in the questionnaire. The first section is for obtaining information about the participants like age, gender, profession and average monthly income. The second section contains functional and dysfunctional questions of the Kano's questionnaire. And in the last section, there is a self-stated importance level for each requirement to weight the requirements between customers.

The questionnaire is filled out by the participants via a website named jetanket. Jetanket is a free website to prepare online professional surveys. The results of the survey can be taken both graphically and as dataset. The dataset of survey in excel format is very useful for data analysis.

In the second section of the survey, the functional and the dysfunctional form of the questions are asked to the participants. The most important features of an automobile which taken into consideration by customers are determined by investigating several websites and interviewing with customers in advance. 30 automobile features are identified according to the customer needs and grouped in five categories as interior, exterior, security, technical and after sales features. The selected automobile features are given in Table 4.1.

To understand the customer's point of view for the features, the following questions are asked to the participants:

- How do you feel if ... feature is present in your automobile?
- How do you feel if ... feature is not present in your automobile?

The steps of Kano's model that is mentioned before, are applied for the automobile case study. There are 60 questions in the survey which 30 of them are functional and

30 of them are dysfunctional. These 60 questions are analyzed and 30 results are found according to the answers of the related functional and dysfunctional questions.

Table 4.1 Automobile Features

Interior Features	
• Leather Upholstery Seat	• Navigation
• Driver and Passenger Seats	• Cruise Control
• Automatic Gearbox	• Sunroof
• Road Computer	• Dashboard
Exterior Features	
• Fog Lamp	• Metallic Paint
• Xenon Lamp	• Automatically Folding Rearview
• Steel Wheels	• Blinker on the Rearview
Security Features	
• ABS (Anti-lock Breaking System)	• Roof and Knee Airbag
• ESP (Electronic Stability Program)	• Seatbelt Reminder System
• SRS Airbag (Supplemental Restraint System)	• Parking Sensor
Technical Features	
• Diesel Engine	• Horsepower
• 4 Wheel Drive	• Gas mileage
• Engine Capacity	
After Sales Features	
• Maintenance Cost	• Selling Price of Second Hand
• Scope of Warranty	• Insurance Premiums
• Kilometer-based Warranty	

4.3 Analysis of the Participants

Kano automobile survey is reached to 104 people who are clicked the survey link and begin to fill out. But 92 of them are filled out completely. During the examination of the survey results, it is seen that 4 of the answers are invalid because of the fact that all the questions have the same result (e.g. all the answers are like “I like it that way” and all of their weights have the same number). As a result 88 of the 104 answers are valid and they are used in the case study. The response rate is 84.6% which is a very high value. 63.6% of the participants are male and 36.4% are female. 34.1% of the participants are student, 34.1% are engineer, and 15.9% are academician. 53,4% of the participants are indicated that they have a monthly

income less than 1500TL, %46,6 of the participants have a monthly income between 1501-4500TL and there is no participant which has an income higher than 4501TL.

Table 4.2 Demographic Profile of the Participants of Automobile Survey

		Frequency	Percent (%)
Response Status	Completed	88	84,6
	Incomplete	12	11,5
	Invalid	4	3,8
	Total	104	100
Gender	Male	56	63,6
	Female	32	36,4
Age	18-25	65	73,9
	26-40	21	23,9
	41-65	2	2,3
Profession	Student	30	34,1
	Engineer	30	34,1
	Academician	14	15,9
	Official	7	8
	Others	7	8
Monthly Income	Less than 1500	47	53,4
	1501-4500	41	46,6

4.4 Data Analysis

After completing all of the steps of Kano's model, the features can be analyzed in detailed. As a result, 13 of 30 features are classified as attractive attribute, 5 of them are classified as one-dimensional attribute, 5 of them are classified as must-be attribute, and 4 of them are classified as indifferent attribute.

There are also some features which are not significantly classified according to classifications mentioned above. These features can be classified as a combination of two classification.

In this case study, 1 feature is classified as a combination of attractive and one-dimensional requirement; 1 feature is classified as a combination of attractive and indifferent requirement; 1 feature is classified as a combination of must-be and attractive requirement. The whole classification results can be seen in Table 4.3.

Table 4.3 Results of the Automobile Survey

	A	M	O	I	R	Q	Classification	Classification Agreement	Category Strength	Total Strength	Better	Worse	Stated Importance
Interior Features													
Leather Upholstery Seat	51,1	0,0	4,5	29,5	14,8	0,0	**A**	51,1	21,6	55,6	0,65	-0,05	4,66
Driver and Passenger Seats	27,3	17,0	27,3	23,9	4,5	0,0	**A - O**	27,3	0,0	71,6	0,57	-0,46	7,06
Automatic Gearbox	34,1	3,4	5,7	31,8	25,0	0,0	**A**	34,1	2,3	43,2	0,53	-0,12	5,49
Road Computer	58,0	6,8	11,4	21,6	2,3	0,0	**A**	58,0	36,4	76,1	0,71	-0,19	6,77
Navigation	59,1	8,0	3,4	29,5	0,0	0,0	**A**	59,1	29,5	70,5	0,63	-0,11	6,33
Cruise Control	35,2	6,8	9,1	44,3	4,5	0,0	**I**	44,3	9,1	51,1	0,46	-0,17	6,16
Sunroof	56,8	0,0	3,4	33,0	6,8	0,0	**A**	56,8	23,9	60,2	0,65	-0,04	5,38
Dashboard	40,9	10,2	13,6	35,2	0,0	0,0	**A**	40,9	5,7	64,8	0,55	-0,24	6,95
Exterior Features													
Fog Lamp	17,0	43,2	19,3	19,3	1,1	0,0	**M**	43,2	23,9	79,5	0,37	-0,63	7,65
Xenon Lamp	35,2	8,0	9,1	35,2	12,5	0,0	**A - I**	35,2	0,0	52,3	0,51	-0,19	5,69
Steel Wheels	46,6	10,2	11,4	30,7	1,1	0,0	**A**	46,6	15,9	68,2	0,59	-0,22	6,06
Metallic Paint	34,1	6,8	12,5	44,3	2,3	0,0	**I**	44,3	10,2	53,4	0,48	-0,20	5,89
Automatically Folding Rearview	46,6	10,2	12,5	29,5	1,1	0,0	**A**	46,6	17,0	69,3	0,60	-0,23	6,63
Blinker on the Rearview	36,4	8,0	10,2	40,9	4,5	0,0	**I**	40,9	4,5	54,5	0,49	-0,19	6,30
Security Features													
ABS (Anti-lock Breaking System)	13,6	44,3	30,7	11,4	0,0	0,0	**M**	44,3	13,6	88,6	0,44	-0,75	9,49

ESP (Electronic Stability Program)	28,4	28,4	18,2	25,0	0,0	0,0	**M - A**	28,4	0,0	75,0	0,47	-0,47	8,45
SRS Airbag (Supplemental Restraint System)	10,2	47,7	30,7	11,4	0,0	0,0	**M**	47,7	17,0	88,6	0,41	-0,78	9,26
Roof and Knee Airbag	22,7	29,5	23,9	22,7	1,1	0,0	**M**	29,5	5,7	76,1	0,47	-0,54	8,48
Seatbelt Reminder System	12,5	28,4	21,6	27,3	10,2	0,0	**M**	28,4	1,1	62,5	0,38	-0,56	7,36
Parking Sensor	43,2	17,0	15,9	21,6	2,3	0,0	**A**	43,2	21,6	76,1	0,60	-0,34	7,17
Technical Features													
Diesel Engine	50,0	4,5	14,8	26,1	3,4	1,1	**A**	50,0	23,9	69,3	0,68	-0,20	7,69
4 Wheel Drive	50,0	2,3	4,5	37,5	4,5	1,1	**A**	50,0	12,5	56,8	0,58	-0,07	6,06
Engine Capacity	44,3	4,5	5,7	29,5	15,9	0,0	**A**	44,3	14,8	54,5	0,59	-0,12	6,44
Horsepower	42,0	6,8	12,5	36,4	2,3	0,0	**A**	42,0	5,7	61,4	0,56	-0,20	7,18
Gas mileage	15,9	29,5	48,9	4,5	0,0	1,1	**O**	48,9	19,3	94,3	0,66	-0,79	9,19
After Sales Features													
Maintenance Cost	18,2	27,3	45,5	9,1	0,0	0,0	**O**	45,5	18,2	90,9	0,64	-0,73	9,10
Scope of Warranty	20,5	26,1	44,3	9,1	0,0	0,0	**O**	44,3	18,2	90,9	0,65	-0,70	8,78
Kilometer-based Warranty	22,7	9,1	25,0	37,5	5,7	0,0	**I**	37,5	12,5	56,8	0,51	-0,36	7,16
Selling Price of Second Hand	20,5	8,0	44,3	21,6	5,7	0,0	**O**	44,3	22,7	72,7	0,69	-0,55	8,24
Insurance Premiums	30,7	11,4	39,8	13,6	4,5	0,0	**O**	39,8	9,1	81,8	0,74	-0,54	8,22

Better and worse coefficients are given in Figure 4.1 to identify the impact on customer satisfaction visually. Red bar represents the negative impact on customer satisfaction when the feature is not presented well, and blue bar represents the positive impact on customer satisfaction when the feature is presented well. The longer the blue bar represents the more effect on customer satisfaction while the longer the red bar represents the more sensitive effect on customer dissatisfaction.

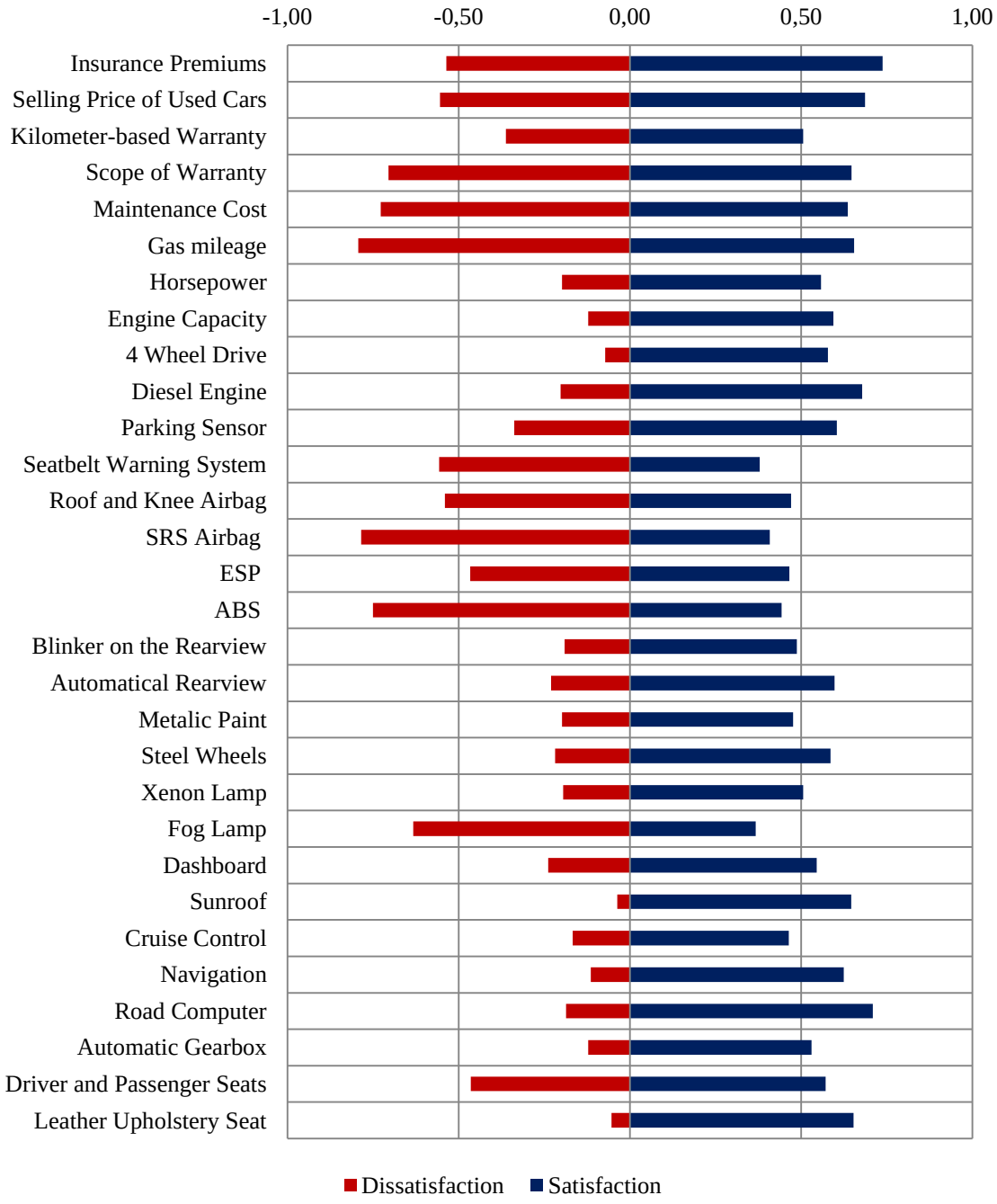

Figure 4.1 Impact of product features on satisfaction and dissatisfaction

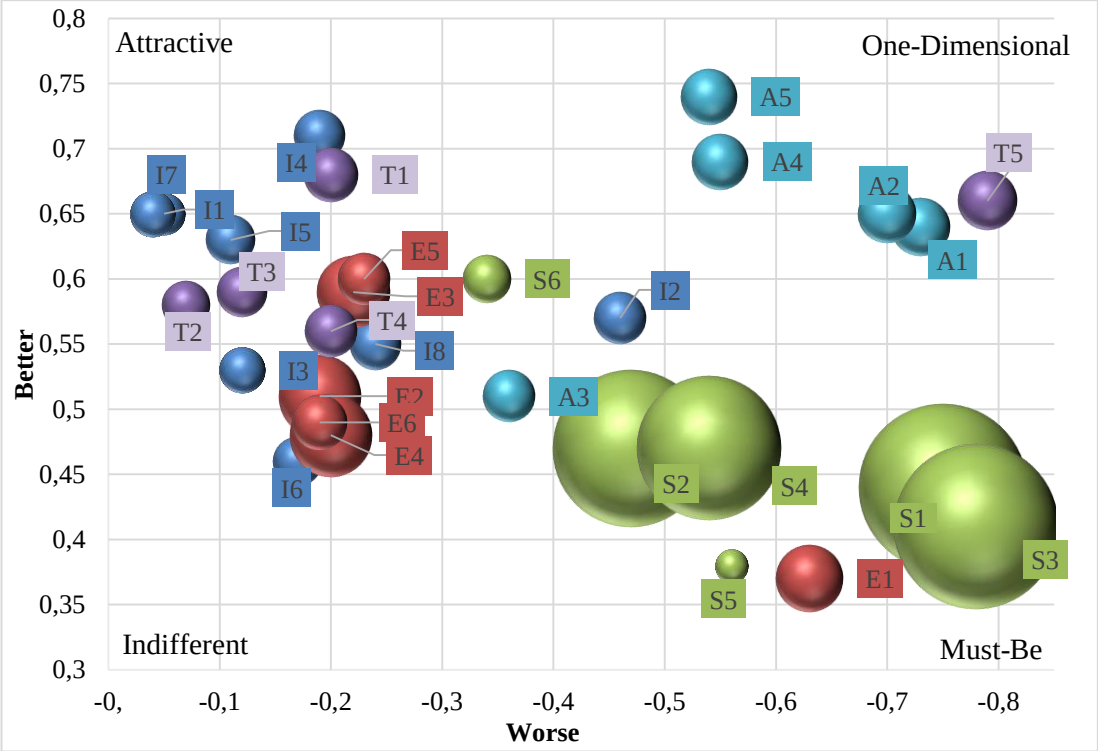

Figure 4.2 Better and Worse Diagram for Automobile Features

Figure 4.2 represents the automobile features on a better-worse scatter diagram. X-axis represents the worse coefficients while Y-axis represents the better coefficients. The size of the bubbles are the average weights of the features. This diagram is useful to investigate the clustering of features. In general, safety attributes (S) are tend to be classified as a must-be requirement and average importance of them are higher than the other features except S5 and S6 features. After sales attributes are (A) tend to be classified as a one-dimensional requirement which are located on the upper-right side of the diagram. Interior (I), exterior (E) and technical (T) requirement are generally clustered on the left side of the diagram. In general, these three categories have lower worse values according to security and after sale features.

4.5 Non-Preemptive Goal Programming Model

Non-preemptive goal programming is a useful method to minimize the total weighted deviations from the goals. Relative weights are assigned to deviations to define the importance between deviations. These weights acts as a per unit penalty

for failure to meet a stated goal and goal programming model can be inverted into a linear programming model having the objective of minimizing the total weighted deviations from the goals (Winston, 2003). The general form of non-preemptive goal programming model is given below.

$$\text{Min a} = \sum_{i=1}^{m} \left(\frac{u_i n_i}{k_i} + \frac{v_i p_i}{k_i}\right) \tag{4.1}$$

Subject to:

$f_i(x) + n_i - p_i = k_i$

$x \epsilon F$

$n_i, p_i \geq 0 \qquad i = 1, \ldots m$

where a is the achievement function that will be minimized, n_i is the negative deviation of i^{th} goal, p_i is the positive deviation of i^{th} goal, v_i is the weight of positive deviation, and u_i is the weight of negative deviation. k_i is the right-hand side value of the i^{th} constraint and k_i can also be used in the objective function to normalize the deviations. That will be helpful to obtain a total percentage deviation from goals.

The automobile case study contains 30 features in 5 categories which are interior, exterior, security, technical, and after sale. The most effective features can be selected by using better and worse coefficients to maximize the customer satisfaction under a limited cost. It is more significant to use weighted better and weighted worse coefficients to take into account the stated importance weights. In addition to this, a satisfaction level from -100 to +100 can be defined to measure the better and worse impacts on customer satisfaction by normalizing the coefficients. Followings are equations to calculate these values.

$$Better_j^{norm} = \frac{b_j s_j}{\sum_{j=1}^{n} b_j s_j} \tag{4.2}$$

$$Worse_j^{norm} = \frac{w_j s_j}{\sum_{j=1}^{n} w_j s_j} \tag{4.3}$$

Where b_j is the better coefficient and w_j is the worse coefficient of j^{th} feature. s_j represents the average stated-importance value of j^{th} feature. If all features are improved, sum of $better^{norm}$ value will equal to 100 and sum of $worse^{norm}$ value will

equal to 0. In the same way, if all of product features are not improved, sum of better^{norm} value will equal to 0 and sum of worse^{norm} value will equal to -100.

Goal programming approach gives an advantage for deciding the features that have maximum degree on customer satisfaction for different satisfaction goals in each category. For automobile case study, one would like to set different satisfaction goals to decide the improvement ratio of features for each category. These categories may also have different weights for customers and producers. Non-preemptive goal programming approach is used to minimize the total unwanted weighted deviations of satisfaction goals by using better^{norm} and worse^{norm} coefficients. The model is given below.

$$\text{Min a} = u_1 n_1 + u_2 n_2 + u_3 n_3 + u_4 n_4 + u_5 n_5 \qquad (4.4)$$

Subject to:

$$\sum_{j=1}^{8} \left(b_j^N x_j - w_j^N y_j\right) + n_1 - p_1 = k_1$$

$$\sum_{j=9}^{14} \left(b_j^N x_j - w_j^N y_j\right) + n_2 - p_2 = k_2$$

$$\sum_{j=15}^{20} \left(b_j^N x_j - w_j^N y_j\right) + n_3 - p_3 = k_3$$

$$\sum_{j=21}^{25} \left(b_j^N x_j - w_j^N y_j\right) + n_4 - p_4 = k_4$$

$$\sum_{j=26}^{30} \left(b_j^N x_j - w_j^N y_j\right) + n_5 - p_5 = k_5$$

$$\sum_{j=1}^{30} c_j x_j \leq B$$

$$x_j + y_j = 1$$

$$n_i, p_i, x_j, y_j \geq 0$$

$$j = 1, \ldots, 30$$

where a, is the achievement function which has five satisfaction deviations. In this case, negative deviations are unwanted for the satisfaction goals. n_i represents the negative deviations, p_i represents the positive deviations from goals. v_i and u_i represent the weights of positive and negative deviations respectively. One could want to weight one of the relevant categories to make it more important than others by using v_i and n_i variables. b_j^N is the normalized better coefficient and w_j^N is the normalized worse coefficient of j^{th} feature. x_j represents the improvement amount of j^{th} feature which has a value between 0 and 1. Value of 1 means a maximum amount of improvement is required to obtain the maximum satisfaction and value of 0 means no improvement is required. y_j represent the lack of improvement amount and has a value between 0 and 1 again. Because of the fact that total value of x_j and y_j is equal to 1, y_j will have a value of $1-x_j$ which represents the lack of improvement amount of j^{th} feature. k_i is the satisfaction goal that will be achieved. c_j is the cost of j^{th} feature to improve it by 1 unit and finally B is the total budget to improve the product.

In this case study, the satisfaction goals are decided for interior features as 20, for exterior features as 13, for security features as 17, for technical features as 15, and for after sale features as 20. A total satisfaction goal for an automobile is decided as 85 which is the sum of the goals of five categories. Total budget to achieve these goals is decided as $10,000. The model is solved by using LINDO solver which output of it is given in Appendix A.2. The summary of result is given in table below.

Table 4.4 LINGO Results for Improvement Value of Features

Deviations								
N(1)	7,61	N(4)	1,48		P(1)	0,00	P(4)	0,00
N(2)	0,00	N(5)	3,71		P(2)	0,00	P(5)	0,00
N(3)	0,00				P(3)	0,00		
Interior								
XI(1)	0,00	YI(1)	1,00		XI(5)	1,00	YI(5)	0,00
XI(2)	1,00	YI(2)	0,00		XI(6)	1,00	YI(6)	0,00
XI(3)	0,00	YI(3)	1,00		XI(7)	0,85	YI(7)	0,15
XI(4)	1,00	YI(4)	0,00		XI(8)	0,00	YI(8)	1,00
Exterior								
XE(1)	1,00	YE(1)	0,00		XE(4)	1,00	YE(4)	0,00
XE(2)	0,21	YE(2)	0,79		XE(5)	1,00	YE(5)	0,00
XE(3)	1,00	YE(3)	0,00		XE(6)	1,00	YE(6)	0,00

Security								
XS(1)	1,00	YS(1)	0,00		XS(4)	1,00	YS(4)	0,00
XS(2)	0,74	YS(2)	0,26		XS(5)	1,00	YS(5)	0,00
XS(3)	1,00	YS(3)	0,00		XS(6)	1,00	YS(6)	0,00
Technical								
XT(1)	0,00	YT(1)	1,00		XT(4)	0,00	YT(4)	1,00
XT(2)	0,00	YT(2)	1,00		XT(5)	1,00	YT(5)	0,00
XT(3)	0,00	YT(3)	1,00					
After Sale								
XA(1)	1,00	YA(1)	0,00		XA(4)	1,00	YA(4)	0,00
XA(2)	1,00	YA(2)	0,00		XA(5)	1,00	YA(5)	0,00
XA(3)	0,00	YA(3)	1,00					

As a result, a total 26.18 deviation value is occurred which 7.61 of it is the deviation of interior goal (n_1), 14.86 of it is the deviation of technical goal, and 3.71 of it is the deviation of after sale goal. The total satisfaction goal was decided as 85 but 58.82 of it can be achieved under specified budget constraint. To understand the relationship between budget and customer satisfaction a chart is given in 4.3. The model is solved for under different budget constraints and it is seen that to achieve a total 85% percent of customer satisfaction, at least 15,700$ is required for given improvement costs.

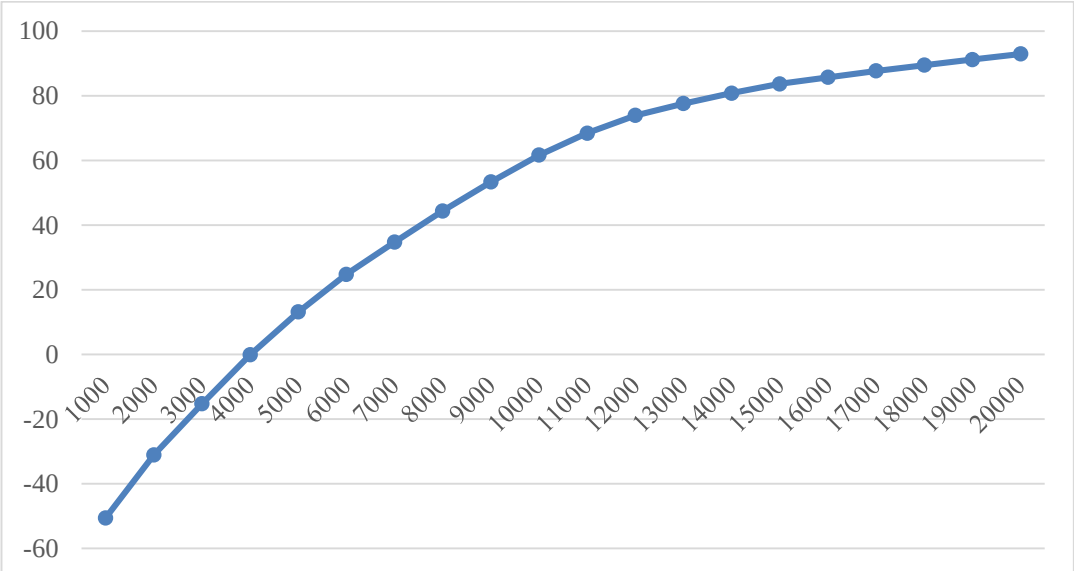

Figure 4.3 Relationship Between Budget and Customer Satisfaction

Chapter 5
Educational Software Case Study

5.1 Introduction

Computers have brought about a revaluation not only in specific sectors but also every aspect of our life. Education system is also affected directly with technological developments. Students are tended to be learn easily with the usage of computer. While the number of educational software products are increasing, its producers are trying to satisfy the customers to sell their products. Most software packages help students memorize information or learn a skill. Eight characteristics of top-quality educational software features are identified by Patricia Brogan (2001) to lead the producers to create an effective educational software products. These are:

- Plain and simple interface. Are the key screens well-designed, and can students move from one activity to another? Navigation of the program should be intuitive for learners at the grade level the software is designed for, and icons should be intuitive.
- Meaningful, but not fancy, graphics. Graphics are only valuable if they support the educational intent. Otherwise, they're a distraction.
- Easy exits. Most software contains far more information than a student can process. Make sure it's easy for the student to exit a specific task-or even the entire program-before frustration sets in.
- Intelligent interactivity. Drag-and-drop ability and other things that require students to do something can enhance interaction and retention of information greatly.
- Speed. Students have short attention spans and enjoy fast-paced video games and television shows. Slow educational software will lose them, especially for schools that do not have superfast internet connections.

- Feedback loops. Good educational software provides some type of feedback to students and teachers that indicates a student's progress. This information should be in an easy-to-understand format, such as bar graphs. Some software packages also may return the student to information on the topic with which he is struggling.
- Personalization. Students should be able to log into a system under their own name and retrieve their previous scores. Software also should perform some type of pre-screening of a student's achievement level, so that subsequent work will be at an appropriate level.
- Information vs. instruction. Multimedia dictionaries and other reference materials are useful, but they are not educational by themselves. They must be used within a planned curriculum to achieve specific goals. Teachers will need to supply the interactivity to draw out the best use of these types of resources (Brogan, P., 2001).

Although these are general characteristics of an educational software, these characteristics helped to identify the customer needs through a software product that are using at universities for education.

Software is also help us to use time efficiently especially working with huge data. Another advantage of using computer software is to analyze data easily and to make inferences using statistical methods.

Different kinds of software products are used at schools especially at universities. In this case study, educational software packages which used at industrial engineering department at Işık University is studied. In generally, the educational software packages that are used can be grouped in three titles; "statistical software packages" like Minitab, SPSS; "simulation software packages" like Arena, Vensim; "solver packages" like Lindo, Lingo and GAMS. If students are thought to be as customers and software packages as products, it could be applied Kano methodology to software products to evaluate the perceived quality in the eyes of the customers.

The aim of this study is to develop an educational statistical software package for students at industrial engineering department by understanding the requirements of students.

5.2 Kano Questionnaire

A survey was carried out to Işık University students about educational software packages. There are three sections in the questionnaire. In the first section, it was asked to students some demographic profile questions like gender and age. It was also asked them their semester at university and their experience about statistical software. The second part of questionnaire contains functional and dysfunctional questions of Kano's model. In the third and last section, there is a self-stated importance level for each requirement to weight the requirements.

Before deciding the features of a statistical software package, some interviews had done with students, and common characteristics of statistical packages had investigated. After interview and investigation steps, 20 features are determined and these features are grouped in four categories (Table 5.1). So, 40 questions are asked to the students which 20 of them are functional and 20 of them are dysfunctional. The questionnaire is filled out again by the participants via jetanket.com. The following functional and dysfunctional questions are asked to the participants:

- How do you feel if ... feature is present in software package?
- How do you feel if ... feature is not present in software package?

In each part of the questions, the customer should select one of five alternatives:

1) I like it that way
2) It must be that way
3) I am neutral
4) I can live with it that way
5) I dislike it that way

Table 5.1 Educational Statistical Software Features

Help Menu	
• E-support system	• Official forum site to share information
• Pop-up window about updates	• Sample applications
• Pop-up window to display errors	• Search engine bar
• Frequently asked question section	• Multiple language choice

Technical	
• Optimization Module	• Easy to create multiple charts
• Simulation Module	• Random Number Generator
Personalize	
• Transparent window	• Easy to change colors, fonts, background
• Limited version according to students request	• File password option
Compatibility	
• Tablet and smart phone version	• Mac and Linux version
• Macro tool	• Easy to transfer data to other software

5.3 Analysis of the Participants

Software survey is reached to 61 students who are clicked the survey link and begin to fill out. 85 percent of these students (52 of 61) completed the questionnaire. The rest of the students did not complete it. 52 percent of participants are male and 48 percent of participant are female. 23 percent of participants are junior (3^{th} year at university), 62 percent of them are senior (4^{th} year at university), and rest of them are graduated from Işık University. 54 percent of the participants used both Excel and Minitab. 33 percent of the participants used Excel, Minitab, and a different statistical program. 10 percent of them only used Excel for statistical analysis. In the following table, demographic profile of the participants are given in detail.

Table 5.2 Demographic Profile of the Software Survey Participants

		Frequency	Percent (%)
Response Status	Completed	52	85%
	Incomplete	9	15%
	Total	61	100%
Gender	Male	27	52%
	Female	25	48%
Age	Less than 20	1	2%
	20-22	20	38%
	22-24	29	%56
	More than 25	2	4%

Year	Junior	12	23%
	Senior	32	62%
	Graduated	8	15%
Software Experience	Excel	5	10%
	Excel, Minitab	28	54%
	Excel, Other	1	2%
	Excel, Minitab, SPSS	1	2%
	Excel, Minitab, Other	17	33%
	Total	52	100%

5.4 Data Analysis

The last step of Kano's model is to classify the features by combining functional and dysfunctional parts of the questions. 20 features are classified by using evaluation table and as a result, 2 features are classified as attractive, 5 features are classified as one-dimensional, 2 features are classified as must-be requirement. 10 features are classified as indifferent requirement which means in general students are not interested in most of the features of a software. There is also a combination of one-dimensional and indifferent feature (Table 5.3). According to self-stated importance questionnaire the most important features for students are "pop-up window to display errors", "easy to transfer data to other software", "optimization module" and "tablet and smart phone version". These features are classified as one-dimensional, a combination of one-dimensional and indifferent, one-dimensional and attractive respectively. The relationship between the classification and average importance is very interesting. Those four features' stated importance level are 8.37, 8.33, 8.27 and 8.08 respectively. The producer should decide the features that have the most impact on customer satisfaction and have the most importance through the eyes of customer and furthermore the categories are also taken in consideration. To overcome this problem a customer-defined expectation score is calculated by using Kano's model in the next section to measure the expectation of customers.

Table 5.3 Results of the Educational Software Survey

	A	O	M	I	R	Q	Classification	Classification Agreement	Category Strength	Total Strength	Better	Worse	Stated Importance
Help Menu													
E-support system	26,9	17,3	32,7	21,2	0,0	1,9	M	32,7	5,8	76,9	0,45	-0,51	7,10
Pop-up window about updates	9,6	13,4	5,8	65,4	3,8	1,9	I	65,4	52,0	28,8	0,24	-0,20	6,35
Pop-up window to display errors	13,5	38,5	26,9	21,2	0,0	0,0	O	38,5	11,5	78,8	0,52	-0,65	8,37
Frequently asked question section	13,5	11,5	50,0	23,1	1,9	0,0	M	50,0	26,9	75,0	0,25	-0,63	6,60
Official forum site to share information	28,8	11,5	13,5	44,2	1,9	0,0	I	44,2	15,4	53,8	0,41	-0,25	6,44
Sample applications	36,5	28,8	9,6	21,2	1,9	1,9	A	36,5	7,7	75,0	0,68	-0,40	7,96
Search engine bar	19,2	44,2	9,6	25,0	0,0	1,9	O	44,2	19,2	73,1	0,65	-0,55	7,75
Multiple language choice	23,1	11,5	13,5	51,9	0,0	0,0	I	51,9	28,8	48,1	0,35	-0,25	6,25
Technical													
Optimization module	21,2	32,7	19,2	26,9	0,0	0,0	O	32,7	5,8	73,1	0,54	-0,52	8,27
Simulation module	25,0	38,5	7,7	26,9	1,9	0,0	O	38,5	11,5	71,2	0,65	-0,47	7,98
Random number generator	19,2	11,5	23,1	46,2	0,0	0,0	I	46,2	23,1	53,8	0,31	-0,35	6,87
Easy to create multiple charts	30,8	21,2	13,5	34,6	0,0	0,0	I	34,6	3,8	64,4	0,52	-0,35	7,56

	A	O	M	I	R	Q	Classification	Classification Agreement	Category Strength	Total Strength	Better	Worse	Stated Importance
Personalize													
Transparent window	21,2	3,8	1,9	71,2	1,9	0,0	I	71,2	50,0	26,9	0,25	-0,06	4,58
Easy to change colors, fonts and background	36,5	9,6	3,8	50,0	0,0	0,0	I	50,0	13,5	50,0	0,46	-0,13	4,94
Limited version according to students request	26,9	13,5	0,0	57,7	1,9	0,0	I	57,7	30,8	40,4	0,41	-0,14	5,79
File password option	32,7	11,5	1,9	51,9	0,0	1,9	I	51,9	19,2	46,2	0,45	-0,14	6,40
Compatibility													
Tablet and smart phone version	61,5	17,3	1,9	17,3	0,0	1,9	A	61,5	44,2	80,8	0,80	-0,20	8,08
Mac and Linux version	26,9	11,5	11,5	50,0	0,0	0,0	I	50,0	23,1	50,0	0,38	-0,23	7,08
Macro tool	26,9	40,4	9,6	23,1	0,0	0,0	O	40,4	13,5	76,9	0,67	-0,50	7,65
Easy to transfer data to other software	19,2	32,7	15,4	32,7	0,0	0,0	O-I	32,7	0	67,3	0,52	-0,48	8,33

5.5 Customer-Defined Expectation Score

Kano's model is used to categorize the product features according to customer's perception. Better and worse coefficients are calculated according to percent of specific categories which these coefficients indicate the impact on customer satisfaction or dissatisfaction by providing or not providing relevant product attribute. But better and worse coefficients do not give an idea to measure how difficult to satisfy the customer for a certain feature.

Customer-defined expectation score (CDES) indicates a value in a 0-100 scale. This score demonstrates that how difficult it is to satisfy the customer on a certain product feature. The equation of CDES is given below.

$$CDES_{ij} = e_{ij} w_{ij} \tag{5.1}$$

where $CDES_{ij}$ is the customer-defined expectation score of i^{th} customer for j^{th} product attribute. w_{ij} is the relative importance of the feature which is filled out by customer in self-stated importance questionnaire. e_{ij} represents the difficulty to satisfy j^{th} feature which is identified according to functional and dysfunctional form of Kano's questionnaire. In this study only attractive, one-dimensional, must-be and indifferent categories are considered. The attractive, one-dimensional, must-be and indifferent categories are assigned as follow numerically.

$$e_{ij}^{M} = 10,\ e_{ij}^{O} = 5,\ e_{ij}^{A} = 3,\ e_{ij}^{I} = 1 \tag{5.2}$$

The evaluation rule is considered for deciding these assignments. The evaluation rule M>O>A>I is generally used when making decisions about product developments. Primarily, features have to be taken into consideration which have the greatest influence on customer satisfaction. First, those requirements have to be fulfilled which cause dissatisfaction if not met (Matzler et al, 1996). The evaluation rule can be used to define the expectation of customers. The order M, O, A, I also represents the expectation of customers because of the fact that attractive requirement is not

expected by customers and must-be requirement is a basic for customer (Watson, 2003).

By using the equation 5.1, an expectation score for a specific customer can be calculated for the product as a whole. This score demonstrates an average of how difficult it is to satisfy the customer for relevant product. The equation is given below where $CDES_i$ is an average customer-defined expectation score of i^{th} customer for product. n represents the number of features that are considered on the product.

$$CDES_i = \frac{\sum_{j=1}^{n} e_{ij} w_{ij}}{n} \quad (5.3)$$

An average expectation score can also be calculated for a specific product feature that represents the difficulty to satisfy relevant product feature for all customers. In this equation (5.4), $CDES_j$ represents an average customer-defined expectation score, m represents the number of customers (the number of participants that fill out the survey).

$$CDES_j = \frac{\sum_{i=1}^{m} e_{ij} w_{ij}}{m} \quad (5.4)$$

Finally, an overall customer-defined expectation score ($CDES_{overall}$) that represents the difficulty to satisfy the customers for relevant product. $CDES_{overall}$ is calculated using the equation 5.5.

$$CDES_{overall} = \frac{\sum_{i=1}^{m} \sum_{j=1}^{n} e_{ij} w_{ij}}{m*n} \quad (5.5)$$

The proposed procedure is applied to the software dataset. The CDES results of software case study is given in Table 5.4. The feature that has the highest score represents that customers are expecting a lot for relevant feature. In a different scope of view producers should take into consideration the highest score because the customers are expecting a lot for these features. In this case study “pop-up window to display errors”, “frequently asked question section”, and “optimization module”

have the most expectation score which means the producers should take into consideration these features first.

Table 5.4 CDES of Software Features

Help Menu (31,4)			
E-support system	39,2	Official forum site to share information	22,0
Pop-up window about updates	15,4	Sample applications	30,7
Pop-up window to display errors	45,5	Search engine bar	32,7
Frequently asked question section	44,6	Multiple language choice	20,8
Technical (33,3)			
Optimization Module	40,0	Easy to create multiple charts	29,6
Simulation Module	32,2	Random Number Generator	31,5
Personalize (12,9)			
Transparent window	8,6	Easy to change colors, fonts, background	13,4
Limited version according to students request	13,8	File password option	15,7
Compatibility (29,9)			
Tablet and smart phone version	25,7	Mac and Linux version	24,4
Macro tool	33,5	Easy to transfer data to other software	36,2

Due to equation 5.4, statistical analysis can be applied to test the CDES differences for student's gender and class year at university. To interpret the differences between these groups two sample t-test is conducted. The hypothesis is defined as;

H_0: $\mu_1-\mu_2=0$; there is no statistically significant difference between two groups
H_1: $\mu_1-\mu_2\neq0$; there is a statistically significant difference between two groups

First hypothesis is conducted to determine whether there is a statistically significant difference between CDES means of students according to class year based on the features. A t-test is conducted to junior and senior students using SPSS. An illustration of SPSS output is given in Table 5.5. H_0 is rejected for "multiple charts", "limited versions", and "file password" features which means there is a significant difference between these two groups while there is no significant difference for other features. SPSS output for all features are given in Appendix B.1.

Second hypothesis is conducted to determine whether there is a statistically significant difference between CDES means of students according to gender. In that hypothesis, there is no enough evidence to reject H_0 for all features (Appendix B.2).

Table 5.5 A Sample T-Test Results of CDES

Group Statistics					
	Year	N	Mean	Std. Deviation	Std. Error Mean
Multiple charts	3	12	12,9167	18,71537	5,40266
	4	32	31,6562	22,03020	3,89443
Limited version	3	12	6,0000	4,86172	1,40346
	4	32	15,7812	13,44219	2,37627
File password	3	12	6,8333	6,05780	1,74874
	4	32	18,8750	14,84490	2,62423

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Multiple charts	Equal variances assumed	,939	,338	-2,610	42	,013	-18,73958	7,18035	-33,23011	-4,24905
	Equal variances not assumed			-2,814	23,180	,010	-18,73958	6,65998	-32,51087	-4,96830
Limited version	Equal variances assumed	17,748	,000	-2,446	42	,019	-9,78125	3,99889	-17,85133	-1,71117
	Equal variances not assumed			-3,544	41,998	,001	-9,78125	2,75977	-15,35070	-4,21180
File password	Equal variances assumed	9,028	,004	-2,710	42	,010	-12,04167	4,44284	-21,00767	-3,07566
	Equal variances not assumed			-3,818	41,553	,000	-12,04167	3,15352	-18,40775	-5,67558

Chapter 6
Conclusion

6.1 Results of Research

Kano's model has been widely used to identify customer needs and categorize them through specific categories. Understanding of customer needs and measurement of customer's perception for specific products or services are a challenging situation. However, firms are aware of the importance of customer satisfaction

In this thesis, Kano's model is defined in detail and methodology of the model is explained step by step. Two case studies are conducted which one of them is an automobile and the other one is a software. The perception of customers to these two products are identified by using Kano's model.

After application of Kano's method to automobile case study, a weighted better and worse coefficients are calculated and a customer satisfaction value is determined between -100 and +100. Stated importance values are embed to better and worse coefficients by using this method. A non-preemptive goal programming model is set up to decide the features that will be improved to maximize customer satisfaction under a limited budget. The advantage of using a goal programming model is to decide different satisfaction goals according to different feature categories. In brief, producers can decide which product features will be improved and they can calculate an overall satisfaction value whether improving these features or not.

Kano's model is also applied to an educational software product. In this case study, a deeper analysis is done from customer's perspective. The expectation of customer is clarified by calculating customer-defined expectation score (CDES) which is a value between 0 and 100. The higher the number means the higher the expectation. This

score is calculated for expectation of one customer from a specific product feature, expectation of one customer from product, an average expectation of all customers from a product feature and an average overall expectation of customers from product. By using these data, statistical analysis was performed to investigate the expectation of customer according to their demographic profiles. That method can be used to create customer segmentation and to offer products according to their expectations.

6.2 Future Research

In the automobile case study, the improvement cost is assumed linearly increases while the improvement value increases. But in real life the relationship between improvement cost and improvement amount may not be linear. This nonlinearity can be considered to improve the model. An improvement of a feature may influence the other features. This can be considered using quality function deployment method.

In the software case study, students are considered as customers. But instructors or parents can be considered as customer according to type of educational software. CDES is a useful method to measure customer's expectations. This score can be applied for different groups to identify the difference between expectations according to different customer segments.

References

Birdogan, B., Basfirinci, C., S., Cilingir, Z., Ar, M. (2009), "An application of integrating SERVQUAL and Kano's model into QFD for logistics services – A case study from Turkey", *Asia Pacific Journal of Marketing and Logistics,* Vol. 21, No. 1, pp. 106-126.

Berger, C., Blauth, R., Boger, D., Bolster, C., Burchill, G., DuMouchel, W., Pouliot, F., Richter, R., Rubinoff, A., Shen, D., Timko, M., Walden, D (Fall 1993), "Kano's Methods for Understanding Customer-defined Quality", *Center for Quality Management,* Vol. 4, pp. 3-36.

Bhattacharyya, S. K., Rahman, Z. (2004), "Capturing the customer's voice, the centerpiece of strategy making", *European Business Review,* Vol. 16 No. 2, pp. 128-138.

Chen, CC., Chuang, MC. (2008), "Integrating the Kano model into a robust design approach to enhance customer satisfaction with product design", *International Journal of Production Economics,* pp. 667-681.

Chen, JK., Lee, YC. (2009). "A new method to identify the category of the quality attribute", *Total Quality Management,* Vol. 20, No. 10, pp.1139-1152.

Chen, YH., Su, CT. (2006), "A Kano-CKM Model for Customer Knowledge Discovery", *Total Quality Management,* Vol. 17, No. 5, pp 589-608.

Chien, TK. (2007), "Using the learning satisfaction improved model to enhance the teaching quality", *Quality Assurance in Education,* Vol. 15 No. 2, pp. 192-214.

Delice, E. K., Güngör, Z. (2009), "A new mixed integer linear programming model for development using quality function deployment", *Computers and Industrial Engineering,* Vol. 57, pp. 906-912.

Emery, C. R., Tian, R. G. (2002), "Schoolwork as Products, Professors as Customers: A Practical Teaching Approach in Business Education", *Journal of Education for Business,* Vol 78, No. 2, pp. 97-102.

Gruber, T., Abosag, I., Reppel, A. E., Szmigin, I. (2011). "Analyzing the preferred characteristics of frontline employees dealing with customer complaints – A cross-national Kano study", *The Total Quality Journal,* Vol. 23, No. 2, pp. 128-144.

Kano, N., Seraku, N., Takahashi, F., Tsuji, S. (1984), "Attractive Quality and Must-be Quality", Hinshitsu. *The Journal of the Japanese Society for Quality control,* pp. 39-48.

Kuo, YF. (2004), "Integrating Kano's Model into Web-community Service Quality", *Total Quality Management,* Vol. 15, No. 7, 925-939.

Lee, M. C., Newcomb, J. F., "Applying the Kano methodology to meet customer requirements: NASA's microgravity science program", *Quality Management Journal 4,* no. 3:95-110.

Lai, X., Xie, M., Tan, K. C. (2004), "Optimizing Product Design using the Kano Model and QFD", *International Engineering Management Conference,* Vol. 3, No. 18-21, pp. 1085-1089.

Lin, SP., Yang, CL., Chan, Yh., Sheu, C. (2010). "Refining Kano's 'quality attributes-satisfaction' model: A moderated regression approach", *International Journal of Production Economics,* 126, pp. 255-263.

Löfgren, M., Witell, L. (2005), "Kano's Theory of Attractive Quality and Packaging", *Quality Management Journal,* Vol.12, No 3, pp. 7-20.

Löfgren, M., Witell, L. (2008), "Two Decades of Using Kano's Theory of Attractive Quality: A Literature Review", *The Quality Management Journal,* Vol. 15, No. 1, pp. 59-75.

MacDonald, E., Backsell, M., Gonzalez, R., Papalambros, P. (2006), "The Kano Method's Imperfections, and Implications in Product Decision Theory", *International Design Research Symposium.*

Matzler, K., Hinterhuber, H. H. (1996), "How to delight your customers", *Journal of Product & Brand Management,* Vol. 5, No. 2, pp. 6-18.

Matzler, K., Hinterhuber H. H. (1998), "How to make product development projects more successful by integrating Kano's model of customer satisfaction into quality function deployment", *Technovation,*Vol. 18, No. 1, pp. 25-38.

Patricia, B. (2001), "The Good, The Bad, and the Useless: Recognizing the Signs of Quality in Educational Software", *American School Board Journal*.

Pezeshki, V., Mousavi, A., Grant, S. (2009), "Importance-performance analysis of service attributes and its impact on decision making in the mobile telecommunication industry", *Measuring Business Excellence,* Vol. 13, No. 1, pp. 82-92.

Sauerwein E., Bailom F., Matzler K., Hinterhuber H. H. (1996), "The Kano Model: How to Delight Your Customers", *Journal of Product and Brand Management 5*, pp. 6-18.

Shen, X. X., Tan, K. C., Xie, M. (2000), "An integrated approach to innovative product development using Kano's model and QFD", *European Journal of Innovation Management,* Volume 3, Number 2 , pp. 91-99.

Szmigin, I., Reppel, A. E., (2004), "Internet community bonding: the case of macnews.de", *European Journal of Marketing,* Vol. 38 No. 5/6, pp. 626-640.

Tan, K. C., Shen, X. X. (2000), "Integrating Kano's model in the planning matrix of quality function deployment", *Total Quality Management,* Vol. 11 no. 8, pp. 1141-1151.

Ting, S., Chen, C. (2002), "The asymmetrical and non-linear effects of store quality attributes on customer satisfaction", *Total Quality Management,* Vol. 13, No. 4, 547-569.

Tontini, G. (2007), "Integrating the Kano Model and QFD for Designing New Products", *Total Quality Management,* Vol. 18, No. 6, pp. 599-612.

Tontini, G., Silveira, A. (2007), "Identification of satisfaction attributes using competitive analysis of the improvement gap", *International Journal of Operations & Production Management,* Vol. 27, No. 5, pp. 482-500.

Wang, T., Ji, P. (2010). "Understanding customer needs through quantitative analysis of Kano's model", *International Journal of Quality & Reliability Management, Vol. 27, No. 2, pp. 173-184.*

Witell, L., Fundin, A. (2005), "Dynamics of service attributes: a test of Kano's theory of attractive quality", *International Journal of Service Industry Management,* Vol. 16 No. 2, pp. 152-168.

Witell, L., Löfgren, M. (2007), "Classification of quality attributes", *Managing Service Quality,* Vol. 17, No. 1, pp. 54-73.

Wu, HH., Tang, YT., Shyu, JW. (2010). "An integrated approach of Kano's model and Importance-Performance Analysis in identifying key success factors", *African Journal of Business Management,* Vol. 4, No. 15, pp. 3238-3250.

Yang, C. (2003), "Establishment and applications of the integrated model of service quality measurement", *Managing Service Quality,* Volume 13, Number 4, pp. 310-324.

Yang, C. (2005), "The Refined Kano's Model and its Application", *Total Quality Management,* Vol. 16, no. 10, 1127-1137.

Yang, C. (2011), "Identification of customer delight for quality attributes and its applications", *Total Quality Management,* Vol. 22, No. 1, pp. 83-98.

Zhao, M., Dholakia, R. R. (2009), "A multi-attribute model of web site interactivity and customer satisfaction", *Managing Service Quality,* Vol. 19, No. 3, pp. 286-307.

Appendix A LINGO Data

A.1 LINGO Codes

```
SETS:
Deviation/1..5/:n,p;
Interior/1..8/:xi,yi,better_int,worse_int,costi;
Exterior/1..6/:xe,ye,better_ext,worse_ext,coste;
Security/1..6/:xs,ys,better_sec,worse_sec,costs;
Technical/1..5/:xt,yt,better_tech,worse_tech,costt;
After_Sale/1..5/:xa,ya,better_as,worse_as,costa;
ENDSETS

DATA:
better_int=2.51,3.33,2.41,3.98,3.3,2.35,2.89,3.17;
better_ext=2.34,2.41,2.96,2.34,3.29,2.56;
better_sec=3.46,3.29,3.15,3.3,2.32,3.56;
better_tech=4.33,2.91,3.15,3.33,5.03;
better_as=4.83,4.73,3.02,4.71,5.04;

worse_int=0.27,3.8,0.77,1.51,0.82,1.23,0.25,1.95;
worse_ext=5.64,1.27,1.56,1.38,1.78,1.4;
worse_sec=8.33,4.65,8.46,5.36,4.83,2.85;
worse_tech=1.8,0.5,0.91,1.68,8.5;
worse_as=7.78,7.2,3.02,5.31,5.19;

costi=500,600,2000,200,300,150,450,1400;
coste=120,180,140,180,70,80;
costs=750,650,720,550,30,60;
costt=3500,3000,2000,1600,1400;
costa=1500,1200,900,700,350;
ENDDATA

MIN=n(1)+n(2)+n(3)+n(4)+n(5); !MAX_TOTAL=100 MIN=-100;
@SUM(Interior:((better_int*xi)-(worse_int*yi)))+n(1)-p(1)=20 ;!MAX=23.94
MIN=-10,6;
@SUM(Exterior:((better_ext*xe)-(worse_ext*ye)))+n(2)-p(2)=13;!MAX=15.9
MIN=-13,03;
@SUM(Security:((better_sec*xs)-(worse_sec*ys)))+n(3)-
p(3)=17;!MAX=19.08 MIN=-34,48 18;
@SUM(Technical:((better_tech*xt)-(worse_tech*yt)))+n(4)-
p(4)=15;!MAX=18.75 MIN=-13,39 17;
```

```
@SUM(After_Sale:((better_as*xa)-(worse_as*ya)))+n(5)-
p(5)=20;!MAX=22.33 MIN=-25,5 17;

@SUM(Interior: (costi*xi))+@SUM(Exterior:(coste*xe))+@SUM(Security:
(costs*xs))+@SUM(Technical: (costt*xt))+@SUM(After_Sale:
(costa*xa))<=10000;

@FOR(Interior:(xi+yi)=1);
@FOR(Exterior:(xe+ye)=1);
@FOR(Security:(xs+ys)=1);
@FOR(Technical:(xt+yt)=1);
@FOR(After_sale:(xa+ya)=1);
```

A.2 Output of LINGO

Global optimal solution found.
Objective value: 26.18362
Total solver iterations: 14

Variable	Value	Reduced Cost
N(1)	7.613617	0.000000
N(2)	0.000000	0.6586957
N(3)	0.000000	0.4287713
N(4)	14.86000	0.000000
N(5)	3.710000	0.000000
P(1)	0.000000	1.000000
P(2)	0.000000	0.3413043
P(3)	0.000000	0.5712287
P(4)	0.000000	1.000000
P(5)	0.000000	1.000000
XI(1)	0.000000	0.7088889
XI(2)	1.000000	0.000000
XI(3)	0.000000	10.77556
XI(4)	1.000000	0.000000
XI(5)	1.000000	0.000000
XI(6)	1.000000	0.000000
XI(7)	0.8491665	0.000000
XI(8)	0.000000	4.648889
YI(1)	1.000000	0.000000
YI(2)	0.000000	2.943333
YI(3)	1.000000	0.000000
YI(4)	0.000000	4.094444
YI(5)	0.000000	2.026667
YI(6)	0.000000	2.533333
YI(7)	0.1508335	0.000000
YI(8)	1.000000	0.000000
BETTER_INT(1)	2.510000	0.000000
BETTER_INT(2)	3.330000	0.000000
BETTER_INT(3)	2.410000	0.000000
BETTER_INT(4)	3.980000	0.000000
BETTER_INT(5)	3.300000	0.000000
BETTER_INT(6)	2.350000	0.000000
BETTER_INT(7)	2.890000	0.000000
BETTER_INT(8)	3.170000	0.000000
WORSE_INT(1)	0.2700000	0.000000
WORSE_INT(2)	3.800000	0.000000
WORSE_INT(3)	0.7700000	0.000000
WORSE_INT(4)	1.510000	0.000000
WORSE_INT(5)	0.8200000	0.000000
WORSE_INT(6)	1.230000	0.000000
WORSE_INT(7)	0.2500000	0.000000
WORSE_INT(8)	1.950000	0.000000
COSTI(1)	500.0000	0.000000

COSTI(2)	600.0000	0.000000
COSTI(3)	2000.000	0.000000
COSTI(4)	200.0000	0.000000
COSTI(5)	300.0000	0.000000
COSTI(6)	150.0000	0.000000
COSTI(7)	450.0000	0.000000
COSTI(8)	1400.000	0.000000
XE(1)	1.000000	0.000000
XE(2)	0.2119565	0.000000
XE(3)	1.000000	0.000000
XE(4)	1.000000	0.000000
XE(5)	1.000000	0.000000
XE(6)	1.000000	0.000000
YE(1)	0.000000	1.886275
YE(2)	0.7880435	0.000000
YE(3)	0.000000	0.5658068
YE(4)	0.000000	0.1365217E-01
YE(5)	0.000000	1.241969
YE(6)	0.000000	0.7933430
BETTER_EXT(1)	2.340000	0.000000
BETTER_EXT(2)	2.410000	0.000000
BETTER_EXT(3)	2.960000	0.000000
BETTER_EXT(4)	2.340000	0.000000
BETTER_EXT(5)	3.290000	0.000000
BETTER_EXT(6)	2.560000	0.000000
WORSE_EXT(1)	5.640000	0.000000
WORSE_EXT(2)	1.270000	0.000000
WORSE_EXT(3)	1.560000	0.000000
WORSE_EXT(4)	1.380000	0.000000
WORSE_EXT(5)	1.780000	0.000000
WORSE_EXT(6)	1.400000	0.000000
COSTE(1)	120.0000	0.000000
COSTE(2)	180.0000	0.000000
COSTE(3)	140.0000	0.000000
COSTE(4)	180.0000	0.000000
COSTE(5)	70.00000	0.000000
COSTE(6)	80.00000	0.000000
XS(1)	1.000000	0.000000
XS(2)	0.7380353	0.000000
XS(3)	1.000000	0.000000
XS(4)	1.000000	0.000000
XS(5)	1.000000	0.000000
XS(6)	1.000000	0.000000
YS(1)	0.000000	1.501453
YS(2)	0.2619647	0.000000
YS(3)	0.000000	1.607965
YS(4)	0.000000	1.109062
YS(5)	0.000000	3.874952
YS(6)	0.000000	3.242909
BETTER_SEC(1)	3.460000	0.000000

BETTER_SEC(2)	3.290000	0.000000
BETTER_SEC(3)	3.150000	0.000000
BETTER_SEC(4)	3.300000	0.000000
BETTER_SEC(5)	2.320000	0.000000
BETTER_SEC(6)	3.560000	0.000000
WORSE_SEC(1)	8.330000	0.000000
WORSE_SEC(2)	4.650000	0.000000
WORSE_SEC(3)	8.460000	0.000000
WORSE_SEC(4)	5.360000	0.000000
WORSE_SEC(5)	4.830000	0.000000
WORSE_SEC(6)	2.850000	0.000000
COSTS(1)	750.0000	0.000000
COSTS(2)	650.0000	0.000000
COSTS(3)	720.0000	0.000000
COSTS(4)	550.0000	0.000000
COSTS(5)	30.00000	0.000000
COSTS(6)	60.00000	0.000000
XT(1)	0.000000	18.29222
XT(2)	0.000000	17.52333
XT(3)	0.000000	9.895556
XT(4)	0.000000	6.154444
XT(5)	1.000000	0.000000
YT(1)	1.000000	0.000000
YT(2)	1.000000	0.000000
YT(3)	1.000000	0.000000
YT(4)	1.000000	0.000000
YT(5)	0.000000	3.761111
BETTER_TECH(1)	4.330000	0.000000
BETTER_TECH(2)	2.910000	0.000000
BETTER_TECH(3)	3.150000	0.000000
BETTER_TECH(4)	3.330000	0.000000
BETTER_TECH(5)	5.030000	0.000000
WORSE_TECH(1)	1.800000	0.000000
WORSE_TECH(2)	0.5000000	0.000000
WORSE_TECH(3)	0.9100000	0.000000
WORSE_TECH(4)	1.680000	0.000000
WORSE_TECH(5)	8.500000	0.000000
COSTT(1)	3500.000	0.000000
COSTT(2)	3000.000	0.000000
COSTT(3)	2000.000	0.000000
COSTT(4)	1600.000	0.000000
COSTT(5)	1400.000	0.000000
XA(1)	1.000000	0.000000
XA(2)	1.000000	0.000000
XA(3)	0.000000	0.2400000
XA(4)	1.000000	0.000000
XA(5)	1.000000	0.000000
YA(1)	0.000000	2.143333
YA(2)	0.000000	3.556667
YA(3)	1.000000	0.000000

YA(4)	0.000000	5.135556
YA(5)	0.000000	7.787778
BETTER_AS(1)	4.830000	0.000000
BETTER_AS(2)	4.730000	0.000000
BETTER_AS(3)	3.020000	0.000000
BETTER_AS(4)	4.710000	0.000000
BETTER_AS(5)	5.040000	0.000000
WORSE_AS(1)	7.780000	0.000000
WORSE_AS(2)	7.200000	0.000000
WORSE_AS(3)	3.020000	0.000000
WORSE_AS(4)	5.310000	0.000000
WORSE_AS(5)	5.190000	0.000000
COSTA(1)	1500.000	0.000000
COSTA(2)	1200.000	0.000000
COSTA(3)	900.0000	0.000000
COSTA(4)	700.0000	0.000000
COSTA(5)	350.0000	0.000000

Row	Slack or Surplus	Dual Price
1	26.18362	-1.000000
2	0.000000	-1.000000
3	0.000000	-0.3413043
4	0.000000	-0.5712287
5	0.000000	-1.000000
6	0.000000	-1.000000
7	0.000000	0.6977778E-02
8	0.000000	-0.2700000
9	0.000000	-0.8566667
10	0.000000	-0.7700000
11	0.000000	2.584444
12	0.000000	1.206667
13	0.000000	1.303333
14	0.000000	-0.2500000
15	0.000000	-1.950000
16	0.000000	-0.3868116E-01
17	0.000000	-0.4334565
18	0.000000	0.3337198E-01
19	0.000000	-0.4573478
20	0.000000	0.6344469
21	0.000000	0.3155169
22	0.000000	-3.256882
23	0.000000	-2.656213
24	0.000000	-3.224630
25	0.000000	-1.952723
26	0.000000	1.115917
27	0.000000	1.614907
28	0.000000	-1.800000
29	0.000000	-0.5000000
30	0.000000	-0.9100000
31	0.000000	-1.680000

32	0.000000	-4.738889
33	0.000000	-5.636667
34	0.000000	-3.643333
35	0.000000	-3.020000
36	0.000000	-0.1744444
37	0.000000	2.597778

Appendix B SPSS Outputs

B.1 Two Sample T-Test Results of CDES According to Class Year

Group Statistics					
	Class	N	Mean	Std. Deviation	Std. Error Mean
E_support_system	3	12	29,1667	25,23285	7,28410
	4	32	41,5938	31,94437	5,64702
Pop_up_window_updates	3	12	12,8333	12,60471	3,63867
	4	32	16,8750	22,63846	4,00195
Pop_up_window_errors	3	12	52,7500	38,22689	11,03515
	4	32	46,0000	27,38966	4,84185
Frequently_asked_questions	3	12	57,0833	16,01964	4,62447
	4	32	38,8438	33,28674	5,88432
Official_forum_site	3	12	24,5000	26,87513	7,75818
	4	32	21,3125	20,90908	3,69624
Sample_applications	3	12	34,1667	29,56298	8,53410
	4	32	30,2500	21,34962	3,77412
Search_engine_bar	3	12	45,5000	30,65201	8,84847
	4	32	30,0625	19,59582	3,46408
Multiple_language_choice	3	12	25,5833	22,41127	6,46958
	4	32	17,9688	18,32235	3,23897
Optimization_module	3	12	34,0833	28,19239	8,13844
	4	32	40,1562	32,59241	5,76158
Simulation_module	3	12	32,9167	27,76675	8,01557
	4	32	32,1562	23,01628	4,06874
Random_number_generator	3	12	20,0000	29,79628	8,60144
	4	32	31,5938	34,03590	6,01675
multiple_charts	3	12	12,9167	18,71537	5,40266
	4	32	31,6562	22,03020	3,89443
Transparent_window	3	12	7,0833	6,37407	1,84004
	4	32	8,0000	10,99853	1,94428
Colors_fonts_background	3	12	20,1667	24,01073	6,93130
	4	32	10,6562	10,39730	1,83800

Limited_version	3	12	6,0000	4,86172	1,40346
	4	32	15,7812	13,44219	2,37627
File_password	3	12	6,8333	6,05780	1,74874
	4	32	18,8750	14,84490	2,62423
Tablet_smart_phone_version	3	12	27,0000	10,98760	3,17185
	4	32	27,4688	18,89015	3,33934
Mac_Linux_version	3	12	25,3333	35,60473	10,27820
	4	32	25,7188	28,48795	5,03601
Macro_tool	3	12	36,8333	34,23404	9,88252
	4	32	30,0938	23,22035	4,10482
Transfer_of_data	3	12	44,7500	41,75279	12,05299
	4	32	35,2188	28,17541	4,98076
Overall	3	12	27,8083	12,57092	3,62891
	4	32	27,5406	8,56651	1,51436

Independent Samples Test										
	Levene's Test for Equality of Variances			t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
E_support_system	Equal variances assumed	2,078	,157	-1,210	42	,233	-12,42708	10,26691	-33,14656	8,29239
	Equal variances not assumed			-1,348	24,992	,190	-12,42708	9,21666	-31,40945	6,55529
Pop_up_window_updates	Equal variances assumed	1,933	,172	-,583	42	,563	-4,04167	6,93627	-18,03962	9,95629
	Equal variances not assumed			-,747	35,352	,460	-4,04167	5,40884	-15,01828	6,93495
Pop_up_window_errors	Equal variances assumed	5,491	,024	,652	42	,518	6,75000	10,35856	-14,15442	27,65442
	Equal variances not assumed			,560	15,440	,583	6,75000	12,05065	-18,87175	32,37175
Frequently_asked_questions	Equal variances assumed	14,051	,001	1,811	42	,077	18,23958	10,07022	-2,08295	38,56211
	Equal variances not assumed			2,437	39,092	,019	18,23958	7,48405	3,10281	33,37635
Official_forum_site	Equal variances assumed	3,169	,082	,416	42	,679	3,18750	7,65833	-12,26763	18,64263
	Equal variances not assumed			,371	16,263	,715	3,18750	8,59369	-15,00639	21,38139
Sample_applications	Equal variances assumed	1,014	,320	,487	42	,629	3,91667	8,04841	-12,32568	20,15901
	Equal variances not assumed			,420	15,513	,680	3,91667	9,33139	-15,91559	23,74893
Search_engine_bar	Equal variances assumed	1,089	,303	1,982	42	,054	15,43750	7,78919	-,28173	31,15673
	Equal variances not assumed			1,625	14,509	,126	15,43750	9,50239	-4,87618	35,75118
Multiple_language_choice	Equal variances assumed	2,906	,096	1,155	42	,255	7,61458	6,59280	-5,69022	20,91939
	Equal variances not assumed			1,052	16,830	,307	7,61458	7,23508	-7,66184	22,89101
Optimization_module	Equal variances assumed	,268	,607	-,570	42	,572	-6,07292	10,66263	-27,59097	15,44513
	Equal variances not assumed			-,609	22,761	,549	-6,07292	9,97146	-26,71247	14,56663

Simulation_module	Equal variances assumed	,441	,510	,092	42	,927	,76042	8,24258	-15,87378	17,39461
	Equal variances not assumed			,085	16,998	,934	,76042	8,98911	-18,20507	19,72591
Random_number_generator	Equal variances assumed	1,522	,224	-1,039	42	,305	-11,59375	11,16319	-34,12198	10,93448
	Equal variances not assumed			-1,104	22,488	,281	-11,59375	10,49696	-33,33576	10,14826
multiple_charts	Equal variances assumed	,939	,338	-2,610	42	,013	-18,73958	7,18035	-33,23011	-4,24905
	Equal variances not assumed			-2,814	23,180	,010	-18,73958	6,65998	-32,51087	-4,96830
Transparent_window	Equal variances assumed	,360	,552	-,271	42	,788	-,91667	3,38377	-7,74540	5,91206
	Equal variances not assumed			-,342	34,164	,734	-,91667	2,67693	-6,35589	4,52256
Colors_fonts_background	Equal variances assumed	6,845	,012	1,849	42	,071	9,51042	5,14236	-,86729	19,88812
	Equal variances not assumed			1,326	12,579	,208	9,51042	7,17086	-6,03411	25,05494
Limited_version	Equal variances assumed	17,748	,000	-2,446	42	,019	-9,78125	3,99889	-17,85133	-1,71117
	Equal variances not assumed			-3,544	41,998	,001	-9,78125	2,75977	-15,35070	-4,21180
File_password	Equal variances assumed	9,028	,004	-2,710	42	,010	-12,04167	4,44284	-21,00767	-3,07566
	Equal variances not assumed			-3,818	41,553	,000	-12,04167	3,15352	-18,40775	-5,67558
Tablet_smart_phone_version	Equal variances assumed	1,915	,174	-,081	42	,936	-,46875	5,81395	-12,20177	11,26427
	Equal variances not assumed			-,102	34,054	,920	-,46875	4,60563	-9,82796	8,89046
Mac_Linux_version	Equal variances assumed	,288	,594	-,037	42	,970	-,38542	10,32861	-21,22940	20,45856
	Equal variances not assumed			-,034	16,577	,974	-,38542	11,44564	-24,58070	23,80986
Macro_tool	Equal variances assumed	2,859	,098	,750	42	,457	6,73958	8,98729	-11,39750	24,87667
	Equal variances not assumed			,630	14,965	,538	6,73958	10,70111	-16,07394	29,55311
Transfer_of_data	Equal variances assumed	5,737	,021	,872	42	,388	9,53125	10,92955	-12,52548	31,58798
	Equal variances not assumed			,731	14,923	,476	9,53125	13,04157	-18,27866	37,34116
Overall	Equal variances assumed	2,499	,121	,081	42	,936	,26771	3,30890	-6,40993	6,94534
	Equal variances not assumed			,068	15,003	,947	,26771	3,93221	-8,11344	8,64886

B.2 Two Sample T-Test Results of CDES According to Gender

Group Statistics					
	Gender	N	Mean	Std. Deviation	Std. Error Mean
E_support_system	1	27	39,6667	32,81416	6,31509
	2	25	38,7600	30,46211	6,09242
Pop_up_window_updates	1	27	16,2593	18,64567	3,58836
	2	25	14,5200	20,44325	4,08865
Pop_up_window_errors	1	27	44,8148	28,29248	5,44489
	2	25	46,2400	33,69258	6,73852
Frequently_asked_questions	1	27	45,7037	32,43433	6,24199
	2	25	43,3600	32,47163	6,49433
Official_forum_site	1	27	23,7037	20,47478	3,94037
	2	25	20,1600	22,39174	4,47835
Sample_applications	1	27	25,2963	20,12235	3,87255
	2	25	36,4400	24,63074	4,92615
Search_engine_bar	1	27	30,9259	24,24542	4,66603
	2	25	34,6400	24,00674	4,80135
Multiple_language_choice	1	27	20,4815	21,26639	4,09272
	2	25	21,0800	20,53842	4,10768
Optimization_module	1	27	43,0370	31,40613	6,04411
	2	25	36,6400	31,50513	6,30103
Simulation_module	1	27	33,5926	20,97298	4,03625
	2	25	30,6000	27,31910	5,46382
Random_number_generator	1	27	33,7037	34,38002	6,61644
	2	25	29,1600	34,26816	6,85363
multiple_charts	1	27	30,7037	27,34370	5,26230
	2	25	28,4400	23,97930	4,79586
Transparent_window	1	27	9,8889	12,38899	2,38426
	2	25	7,2000	7,72442	1,54488
Colors_fonts_background	1	27	13,9259	18,05105	3,47393
	2	25	12,9200	11,37219	2,27444
Limited_version	1	27	11,2963	11,43481	2,20063
	2	25	16,4400	13,50333	2,70067
File_password	1	27	14,9630	13,85774	2,66692
	2	25	16,5600	15,01410	3,00282
Tablet_smart_phone_version	1	27	24,9630	13,67615	2,63198
	2	25	26,4400	19,31554	3,86311
Mac_Linux_version	1	27	24,2963	29,35959	5,65026
	2	25	24,5600	27,87185	5,57437

Macro_tool	1	27	32,5185	20,25486	3,89805
	2	25	34,4800	28,94120	5,78824
Transfer_of_data	1	27	39,7407	29,24248	5,62772
	2	25	32,2800	31,56939	6,31388
Overall	1	27	28,0037	6,70049	1,28951
	2	25	27,5720	11,65871	2,33174

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
E_support_system	Equal variances assumed	1,090	,302	,103	50	,918	,90667	8,80044	-16,76954	18,58287
	Equal variances not assumed			,103	49,999	,918	,90667	8,77485	-16,71814	18,53147
Pop_up_window_updates	Equal variances assumed	,006	,936	,321	50	,750	1,73926	5,42043	-9,14799	12,62651
	Equal variances not assumed			,320	48,597	,751	1,73926	5,43998	-9,19509	12,67361
Pop_up_window_errors	Equal variances assumed	2,017	,162	-,166	50	,869	-1,42519	8,60481	-18,70846	15,85809
	Equal variances not assumed			-,165	47,055	,870	-1,42519	8,66340	-18,85316	16,00279
Frequently_asked_questions	Equal variances assumed	,025	,875	,260	50	,796	2,34370	9,00730	-15,74798	20,43539
	Equal variances not assumed			,260	49,685	,796	2,34370	9,00770	-15,75164	20,43905
Official_forum_site	Equal variances assumed	,000	,985	,596	50	,554	3,54370	5,94422	-8,39562	15,48303
	Equal variances not assumed			,594	48,637	,555	3,54370	5,96508	-8,44583	15,53324

Sample_applications	Equal variances assumed	,529	,471	-1,792	50	,079	-11,14370	6,21722	-23,63135	1,34394
	Equal variances not assumed			-1,778	46,453	,082	-11,14370	6,26606	-23,75332	1,46591
Search_engine_bar	Equal variances assumed	,001	,981	-,555	50	,582	-3,71407	6,69773	-17,16686	9,73872
	Equal variances not assumed			-,555	49,766	,582	-3,71407	6,69513	-17,16321	9,73507
Multiple_language_choice	Equal variances assumed	,085	,772	-,103	50	,918	-,59852	5,80649	-12,26121	11,06417
	Equal variances not assumed			-,103	49,905	,918	-,59852	5,79857	-12,24584	11,04880
Optimization_module	Equal variances assumed	,094	,760	,733	50	,467	6,39704	8,73014	-11,13797	23,93205
	Equal variances not assumed			,733	49,669	,467	6,39704	8,73122	-11,14304	23,93711
Simulation_module	Equal variances assumed	1,640	,206	,445	50	,658	2,99259	6,72447	-10,51390	16,49908
	Equal variances not assumed			,441	44,977	,662	2,99259	6,79299	-10,68937	16,67456
Random_number_generator	Equal variances assumed	,242	,625	,477	50	,636	4,54370	9,52747	-14,59279	23,68019
	Equal variances not assumed			,477	49,718	,635	4,54370	9,52625	-14,59303	23,68043
multiple_charts	Equal variances assumed	,350	,557	,316	50	,753	2,26370	7,15639	-12,11033	16,63773
	Equal variances not assumed			,318	49,862	,752	2,26370	7,11983	-12,03789	16,56529
Transparent_window	Equal variances assumed	,615	,436	,930	50	,357	2,68889	2,89049	-3,11683	8,49461
	Equal variances not assumed			,946	44,011	,349	2,68889	2,84102	-3,03677	8,41454

Colors_fonts_background	Equal variances assumed	,865	,357	,238	50	,813	1,00593	4,22317	-7,47655	9,48841
	Equal variances not assumed			,242	44,258	,810	1,00593	4,15226	-7,36102	9,37287
Limited_version	Equal variances assumed	2,027	,161	-1,486	50	,144	-5,14370	3,46128	-12,09589	1,80849
	Equal variances not assumed			-1,476	47,231	,146	-5,14370	3,48373	-12,15116	1,86375
File_password	Equal variances assumed	,017	,896	-,399	50	,692	-1,59704	4,00356	-9,63843	6,44436
	Equal variances not assumed			-,398	48,779	,693	-1,59704	4,01614	-9,66871	6,47463
Tablet_smart_phone_version	Equal variances assumed	,004	,952	-,320	50	,750	-1,47704	4,61396	-10,74444	7,79037
	Equal variances not assumed			-,316	42,916	,754	-1,47704	4,67449	-10,90459	7,95051
Mac_Linux_version	Equal variances assumed	,116	,735	-,033	50	,974	-,26370	7,95338	-16,23855	15,71114
	Equal variances not assumed			-,033	49,965	,974	-,26370	7,93719	-16,20630	15,67889
Macro_tool	Equal variances assumed	1,550	,219	-,285	50	,777	-1,96148	6,88528	-15,79096	11,86800
	Equal variances not assumed			-,281	42,615	,780	-1,96148	6,97843	-16,03851	12,11555
Transfer_data_to_other_software	Equal variances assumed	,256	,615	,885	50	,381	7,46074	8,43259	-9,47662	24,39810
	Equal variances not assumed			,882	48,832	,382	7,46074	8,45791	-9,53755	24,45903
Overall	Equal variances assumed	9,653	,003	,165	50	,869	,43170	2,61242	-4,81550	5,67891
	Equal variances not assumed			,162	37,672	,872	,43170	2,66455	-4,96395	5,82735

Curriculum Vitae

Ayhan KÖKSEL was born on 20 January 1987, in İstanbul. He received his BS degree in Industrial Engineering in 2009 from Kırıkkale University. He worked as a research and teaching assistant at the department of industrial engineering of Işık University from 2009 to 2012. His research interests include operations research, system simulation, total quality management especially customer satisfaction. Since 2013 he has been an expert at planning, programming and coordination unit at Silkroad Development Agency.

Conference Proceedings

[1] Köksel, A., Aksezer, S. Ç., "Statistical Implications of Kano's Model", *Econometrics, Operational Research and Statistics, XII. International Symposium,* Pamukkale University, (2011).

[2] Köksel, A., Altunbay, S., "A System Dynamics Approach to Livestock Sector in Turkey", *YAEM 30. National Congress on Operational Research,* Sabancı University (2010).