Quality Function Deployment and Its Application on a Smartphone Design

B. Cerit, G. Küçükyazıcı, and G. Kalem

***Abstract*—The aim of this paper is exploring the application of the Quality Function Deployment (QFD) method on a new product development in accordance with customer expectations. The design of a new smart phone has been selected as the research case. QFD researches have been examined and literature scanning has been performed for the telecommunication industry. However, it was not easy to find so many QFD sample projects in the sector due to fact that product life cycle are completed very fast. It is required to grab competitive advantage by means of continuous review of new product development techniques because mobile communication technologies are so dynamic in many aspects. In addition, updated information and short history related to the telecommunication sector and mobile phone market including smart phones have been examined. It is aimed to understand QFD application well by explaining characteristics of smart phones and their development stages in the research.**

Index Terms—**Quality Function Deployment, Kano Model, Telecommunication, Smart phones**

I. Introduction

NOWADAYS, the ability to present new products to the market in a fast way while satisfying customer expectations is getting more importance for the entire customer focused firms. New quality techniques have started to appear in order to shorten the production loops, to enable the firms to respond to customer demands, and to gain advantage in the market. Quality Function Deployment (QFD) is one of these techniques, which has started and spread from the 'quality' concept so as for the firms to meet customer expectations. The majority of the firms are using QFD in today's business world, where fast responds to customer demands are gaining more importance every day.

QFD collects customer demands through various methods and converts them into technical necessities, which allows the resources to be allocated considering customer priorities. The focal point is the customers' requirements and expectations. Products are developed considering the determined targets and priorities. QFD is a method to guarantee the quality while the product is just beginning to be designed.

Mobile communication, where customer focus of QFD is the main subject, is one of the leading industries in Turkey. The industry players need a systematical approach in order to respond to customer requirements and expectations under fierce competition so as to continue being a player in this industry. QFD, which listens to the customers' voice and guarantees the quality of the product or the service, is a Quality Management Technique which can be applied in mobile communication industry's business conditions.

The aim of this study is to apply QFD methodology in order for Turkey's leading mobile communication operator to design a smart phone, which will be put on the market in the last quarter of the year 2013. In the first section, literature research is conducted in order to give brief information on QFD. In the second section, the case study of the operator is explained in detail. The operator has decided to name the smart phone project as "Gebze". Gebze Project was first presented as the local smart phone to the industry in the Mobile Worlds Congress, which was held in Barcelona on February. The QFD application also supports the Kano Model during the grouping and prioritization of the customer necessities, which enables more sensitive results. The findings are interpreted in the conclusion, taking customer expectations into account.

II. Literature Review

In smart phones market, it is very critical to apply quality techniques in a fast and correct way in order to meet the necessities of product/service market, since the demands are dynamic and unsteady. This will also assure the firms to consume their resources in the right way. Although QFD practices have been applied to the products and services of smart phones, any specific study regarding the design of the phones haven't been found during the literature survey. This shows the lack of QFD applications in this industry. More information regarding QFD-applied mobile communication industry is going to be given in detail in this section.

QFD methodology was applied in mobile service industry in a workstudy conducted in the University of Oulu in Finland in 2005. A general framework was proposed in order to improve mobile service design by using QFD concepts. QFD application was explained to the students and lecturers via an e-learning example, specially designed for that purpose. A

B. CERİT, is with the Industrial Engineering Department, Faculty of Management, İstanbul Technical University, Istanbul, 34367, TURKEY. (e-mail: ceritbu@itu.edu.tr).

G. KÜÇÜKYAZICI is with the Industrial Engineering Department, Faculty of Management, İstanbul Technical University, Istanbul, 34367, TURKEY. (e-mail: kucukyazicig@itu.edu.tr).

G. KALEM graduated from the Industrial Engineering Department, Faculty of Management, İstanbul Technical University, Istanbul, 34367, TURKEY. (e-mail: kalem@itu.edu.tr).

brain storming session was conducted between the search engineers in order to determine the most important technical properties demanded by the customers, and 7 properties were defined. Data Transfer Rate was found to be the most critical necessity in e-learning services [1].

Although there are so many mobile device producers, only Nokia has conducted academically known QFD studies. One of the main reasons which caused the firms not to spend time applying QFD may be the short product life cycles in this industry. Another reason may be the disadvantage of a large-scale House of Quality, which cannot be avoided in order to collect the necessies under the same roof. This disadvantage may override the easy-application and fast-learning advantages of QFD [2].

Nokia decided to conduct a comprehensive QFD study in 1998 in order to develop product definition processes. The first step was to focus on the Japan market, with the mission of "using QFD in describing the future products". The research was completed by collecting the customer's voice. The advantages of this study wil be summarised as follows [2]:

- The benefits which are provided by the mobile phones have been understood so as to be optimized in the future products.
- Necessities and/or problems which may not have been recorded by traditional methods have been explored.
- The main innovation proceesses appreciated by the customers have been discovered and focused on.

Nokia benefited from the QFD methodology in another study conducted in the University of Lappeenrannan in Finland in 2000, aiming to improve the efficiency of product development processes of mobile phones. Conflicting product parameters were intended to be detected and cleared. It is very important to understand customer expectaions correctly and respond to them as quickly and as truly as possible in the fierce competition market of mobile phones where customer demands vary too fast. Nokia has constituted a constant product development process via these QFD studies [3].

The University of Abu Dhabi conducted a QFD project in Pakistan in 2011 to increase customer satisfaction of Ufone and Mobilink. The data was collected from customers, employees and the managers of the operators.QFD Matrix was used in order to detect the customer requirements and to analyze the comparison of pre-paid services. The results indicate that QFD enables a firm not only to gain a competitive position, but also to have competitive advantage. QFD can be much better than traditional management tools provided that the managers listen to the customers' voice and make demanded adaptations in the products and services. The traditional tools just take the managers' aspect into account, however QFD listens to the customers [4].

The Institute of Technology at Linköping University in Sweden used QFD methodology at Ericsson Mobile Phone Production Center to increase the quality of production in 2002. The aim was to form a flexible production line by QFD, since QFD would enable knowing much more detail about customer needs. The facility at Linköping was one of the seven production facilities of Ericsson Mobile Communication (EMC). The main subject was flexibility so Ericsson needed to take care of some points while positioning itself in the mobile phone market, which are constant and sharp demand increases, growing product portfolios and increasing demands for customisation, the consumer market created by increaing competition, and fast variations in the market.

The basis of the study was Ericsson's focus on innovation, rather than Nokia's focus on customers. Nokia was the first producer to introduce replacement parts for mobile phones to the customers. Ericsson also wanted to increase its customer focus and A1018s was the first step to serve this intention. House of Flexibility was created at this point via QFD in order to convert competitive priorities to production output flexibilities. The results indicates that QFD is an important methodology not only for quality management bu also for the ceration of a flexible system [5].

III. CASE STUDY

In 2010 the firm started to launch its own smart phones to the market while it had been going on marketing world renowned smart phones such as iPhone and Samsung Galaxy series in Turkey. T11, T20, T21 and T30 are the smart phone models launched with the operator's own brand in 2011 and 2012. The firm targeted on mid and low level customer segments between the age of 16-55 having a smart phone first time. The firm uses two equipment manufacturers (Huawei and ZTE) in production of these smart phones. These companies' headquarters are located in China, but have operations all over the world. The operator determines the smart phone designs in terms of software and hardware before the mass production. Customer requirements and demands are playing main role in this point. Prototype devices are subjected to some tests by technical units of the firm and analyzed in detail before their launch.

Privacy has high importance in the mobile communication sector because of fierce competence. Therefore, prototype devices are tested by the firm's technical and non-technical employees internally as well as they use these smart phones in their daily lives. Consequently, defects and development areas are informed to the device manufacturers and these feed-backs go on until the mass production phase. Technical teams (engineers) perform some functionality and network performance tests for the devices. On the other hand, non-technical employees (sales and marketing teams) use these phones with the end user perspective.

Customer questionnaire is arranged in order to collect the voice of customer (VoC). Target customers being included in the project are the employees from sales, marketing, vendor management, terminal test and network quality assurance departments. As explained above, these persons have usage experience of T21 and T30 respectively. Distribution of questionnaire papers was handled via e-mail because the most of employees works in different locations of the firm.

3.1 Application Steps of Quality Function Deployment

3.1.1 The determination of satisfaction criteria

Initially, focus group meetings were performed with the attendance of network quality assurance and terminal testing teams and then important characteristics of a smart phone were discussed amongst these technical groups. In addition, some other meetings were arranged with the team who is responsible for only T series smart phones and acquired their help. On the other hand, all the literature was surveyed deeply and conference papers and articles published in international area were taken into consideration while determining these customer satisfaction criteria, which are Ease of use, Switch speed between the interfaces, Visuality (interface), Internet connection rate, Variety of applications, Long battery life, Entertainment platform such as music, video and game, Functionality, Network performance (calling, being called, data transfer etc.), Messaging (SMS, MMS, e-mail and instant messaging), Mobile payment, Map, navigation and location based services, Social media applications, Screen size and Sensitivity of touch screen [6-7].

3.1.2 The determination of target customer features

In the foreground of these satisfaction criteria for smart phones, non-technical teams from sales, marketing and vendor management department attended in the customer questionnaire. The biggest factor affecting this choice of this questionnaire group is that these persons are positioned so close to the real customers of the firm. Additionaly, these employees use the smart phones in their daily life under test process and have opportunities of trying device features and observing its performance. Thus, it was considered that questionnaire results tend to be quite similar to the real customers' outputs due to their strong relationship and direct communication with subscribers of the firm.

3.1.3 The determination of customer requirements' importance levels

The aim of QFD application on T30 smart phone which is launched after T21 is to find in which level the existing phone satisfies the customer requirements and expectations and also to point out the improvement points of the smart phone. Therefore, in the A section of questionnaire it is wanted questionnaire group to give a score between 1 and 5 for each satisfaction criterion. Here the score "1" means the lowest importance and "5" means the highest importance. The level of importance is calculated from average of replies to the customer requirements.

3.1.4 The analysis of customer satisfaction levels

In the B section of questionnaire it is wanted the customers to evaluate the satisfaction levels of T21 and T30 smart phones for their expectations. Here the score "1" means that the customer criterion is not satisfied at all, "5" means that the customer criterion is satisfied completely. Then after that arithmetic average is calculated from all replies.

The data extracted in this section can be seen in Figure 1. Sales advantage values are determined by the sales employees. "Improvement Ratio", "Absolute Weight" and "Relative Weight(%)" are calculated after determination of quality level and sales advantage values targetted.

$$\text{Improvement Ratio} = \frac{\text{Intended Quality Level}}{\text{Satisfaction of QFD Firm}} \quad (1)$$

$$\text{Absolute Weight} = (\text{Importance Level}) \times (\text{Improvement Ratio}) \times (\text{Sales Advantage}) \quad (2)$$

$$\text{Relative Weight (\%)} = \frac{\text{Absolute weight of any row}}{\text{Total absolute weight}} \times 100 \quad (3)$$

The results obtained from these formulas can be seen in Figure 1.

	Importance Level	T30 Satisfaction	T21 Satisfaction	Intended Quality	Corrected Improvement Ratio	Sales Advantage	Absolute Weight	Relative Weight
Ease of use	4,1	2,6	2,5	4,1	1,58	1,5	9,7	11,54
Switch speed between the interfaces	4,3	3,1	1,7	4,3	1,39	1,5	8,95	10,65
Visuality (interface)	3,5	3,1	2,2	3,5	1,13	1,2	4,74	5,64
Internet connection rate	3,8	3,3	2,5	3,8	1,15	1,2	5,25	6,25
Variety of applications	3,3	3,1	3	3,3	1,06	1	3,51	4,18
Long battery life	4,1	2,2	2,4	4,1	1,86	1,5	11,46	13,64
Entertainment platform such as music, video and	2,8	3	2,9	2,8	0,93	1	2,61	3,11
Functionality	3,7	3,1	2,2	3,7	1,19	1,2	5,3	6,31
Network performance (calling, being called, data	3,9	3,2	2,8	3,9	1,22	1,2	5,7	6,79
Messaging (SMS, MMS, e-mail and instant	3,8	3,5	2,4	3,8	1,09	1,2	4,95	5,89
Mobile payment	2,1	3	2,7	2,1	0,7	1	1,47	1,75
Map, navigation and location based services	2,7	3,2	2,5	2,7	0,84	1	2,28	2,71
Social media applications	3,7	3,6	2,8	3,7	1,03	1,2	4,56	5,43
Screen size	3,6	3,8	2,6	3,6	0,95	1,2	4,09	4,87
Sensitivity of touch screen	4,2	2,8	1,8	4,2	1,5	1,5	9,45	11,25

Fig 1. The analysis matrix of customer satisfaction levels

3.1.5 The determination of technical features

The brain storm meetings executed amongst terminal testing and network quality assurance departments enabled the determination of technical requirements that will satisfy the customer demands. Additionally, smart phones' technical specifications acquired from literature survey were included in this list. Lastly, technical features that take place in literature were examined in detail when the focus group meetings were arranged and then reduced to the following list. Thus, construction of house of quality (HoQ) and interpretation become easier. Literature survey is a significant part of this study. Especially up-to-date articles published after 2009 are

taken into consideration. The reason is that technical specifications evolved profoundly while the market had been passing from classical mobile phones to the smart phones.
Basic technical features determined for the smart phones are listed below [6-7]:

1. Network technology supported by device
2. Operating system
3. Hardware (HW) design
4. Software (SW) design
5. Processor (CPU) power
6. Memory capacity
7. Connection capabilities such as Bluetooth, WiFi, NFC and A/GPS.

3.1.6 The development of the correlation matrix between customer and technical requirements

Another questionnaire is utilized in order to measure the correlation level between customer and technical requirements as well. This study makes clear in which level each technical specification meets customer requirements. Some technical features determined by expert engineers in their areas may not be so necessary or completely necessary. This grading comes up with the correlation of two categories. Correlation matrix is formed after getting item weights of questionnaire results for the relationship between customer demands and technical requirements. The correlation values obtained here can be seen in Figure 2.

3.1.7 The calculation of technical requirements' absolute and relative importance levels

Absolute and relative importance levels are calculated by using the connections between customer demands and technical requirements and then written as shown in Figure 2.

Technical Requirements / Custormer Requirements	Network technology supported by device	Operating system	Hardware (HW) design	Software (SW) design	Processor (CPU) power	Memory capacity	Connection capabilities such as Bluetooth, WiFi, NFC and A/GPS	ABSOLUTE WEIGHT
Ease of use		9	3	9	9	3	3	9,7
Switch speed between the interfaces		9		9	9			8,95
Visuality (interface)		9		9				4,74
Internet connection rate	9	3	9	3	3	1	3	5,25
Variety of applications		9		3		3		3,51
Long battery life	3	3	9	3	1			11,46
Entertainment platform such as music, video and		3		1	3	9		2,61
Functionality	3	9	3	9	3	1	9	5,3
Network performance (calling, being called, data	9	1	9		1			5,7
Messaging (SMS, MMS, e-mail and instant	3	1		1	1	1		4,95
Mobile payment		3	3	9			9	1,47
Map, navigation and location based services	3	9		9	3	1	9	2,28
Social media applications	3	3		3	1	1		4,56
Screen size			9		3			4,09
Sensitivity of touch screen		3	9	3	3			9,45
Absolute Importance	184,2	425,4	373	402,2	281,5	85,46	126,3	
Relative Importance (%)	9,81	22,65	19,86	21,42	14,99	4,55	6,73	

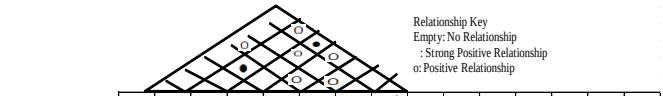
Fig 2. Absolute and relative importance levels

3.1.8 The determination of correlations amongst technical requirements

How technical features affect each other is handled in correlation matrix under the roof of house of quality. There are lots of weak or strong positive correlations between many technical specifications of smart phones. For instance, operating system plays significant role in software design of smart phone. At the present day, updated versions of operating systems seem quite user-friendly and bring lots of functions to the customer in a simple way. Besides there is a similar correlation between processor power and software design, but correlation level can be regarded as relatively weak because processor power does not affect directly.

3.1.9 The formation of House of Quality

At the last stage of the formation of house of quality, customer satisfaction values of T21 smart phone, previous model than T30, are extracted from questionnaire results and located on the House of Quality. It is shown in Figure 3.



Technical Requirements / Custormer Requirements	Importance Level	Network technology supported by devicei	Operating system	Hardware (HW) design	Software (SW) design	Processor (CPU) power	Memory capacity	Connection capabilities such as Bluetooth, WiFi, NFC and A/GPS	T30 Satisfaction	T21 Satisfaction	Intended Quality	Corrected Improvement Ratio	Sales Advantage	Absolute Weight	Relative Weight
Ease of use	4,1		9	3	9	9	3	3	2,6	2,5	4,1	1,58	1,5	9,7	11,54
Switch speed between the interfaces	4,3		9		9	9			3,1	1,7	4,3	1,39	1,5	8,95	10,65
Visuality (interface)	3,5		9		9				3,1	2,2	3,5	1,13	1,2	4,74	5,64
Internet connection rate	3,8	9	3	9	3	3	1	3	3,3	2,5	3,8	1,15	1,2	5,25	6,25
Variety of applications	3,3		9		3		3		3,1	3	3,3	1,06	1	3,51	4,18
Long battery life	4,1	3	3	9	3	1			2,2	2,4	4,1	1,86	1,5	11,46	13,64
Entertainment platform such as music, video and game	2,8		3		1	3	9		3	2,9	2,8	0,93	1	2,61	3,11
Functionality	3,7	3	9	3	9	3	1	9	3,1	2,2	3,7	1,19	1,2	5,3	6,31
Network performance (calling, being called, data	3,9	9	1	9		1			3,2	2,8	3,9	1,22	1,2	5,7	6,79
Messaging (SMS, MMS, e-mail and instant messaging)	3,8	3	1		1	1	1		3,5	2,4	3,8	1,09	1,2	4,95	5,89
Mobile payment	2,1		3	3	9			9	3	2,7	2,1	0,7	1	1,47	1,75
Map, navigation and location based services	2,7	3	9		9	3	1	9	3,2	2,5	2,7	0,84	1	2,28	2,71
Social media applications	3,7	3	3		3	1	1		3,6	2,8	3,7	1,03	1,2	4,56	5,43
Screen size	3,6			9		3			3,8	2,6	3,6	0,95	1,2	4,09	4,87
Sensitivity of touch screen	4,2		3	9	3	3			2,8	1,8	4,2	1,5	1,5	9,45	11,25
Absolute Importance		184,2	425,37	372,96	402,21	281,46	85,46	126,3							
Relative Importance (%)		9,81	22,65	19,86	21,42	14,99	4,55	6,73							

Fig 3. House of quality

3.1.10 The integration of Kano Model

The eventual purpose of QFD is high level customer satisfaction. It is assumed that each requirement for the service/product has the same influence on the customer satisfaction in this approach where as each requirement does not have the effect in same level while meeting these requirements. In this situation, Kano Model comes up with

effective approach in categorization and comprehension of the customer requirements. According to the influences of each customer requirement on customer satisfaction, different weight values are assigned. The examples from the literature survey show that the integration of Kano Model with QFD provides contribution efficiently to the high level customer satisfaction.

This categorization phase mentioned in Kano Model is carried out via applying Kano questionnaire consisting of one positive and one negative question.

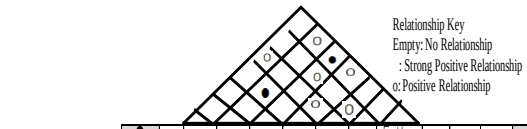
Kano questionnaire is arranged amongst the group who attended before to the QFD questionnaire at the beginning of the study. Then customer requirements for smart phone are categorized properly based on the replies of Kano questionnaire. This process is performed by separating them to the basic, linear and attractive requirements.

Kano improvement parameter (k) is selected ½, 1 and 2 for the basic, linear and attractive requirements respectively. The following formula is executed and improvement ratio (IR) is again calculated afterwards.

$$IR_{cor.} = (IR)^{1/k} \quad (4)$$

At the last stage of integration of Kano Model, absolute importance levels (absolute weight) are calculated by multiplying average importance level, corrected improvement ratio and sales advantage values for each customer requirements. Then absolute weight values are divided by the total value and relative weights (percentage) are obtained. The calculation of relative weights displays the most prominent requirements having priority for the customer satisfaction.

Finally, absolute importance and relative importance values are calculated in order to complete the house of quality after correction due to the Kano Model integration on the application of study. Correlation matrix, formed by the technical QFD questionnaire before, is utilized here to be able to calculate.



Custormer Requirements / Technical Requirements	BASIC NEEDS IN KANO	IMPORTANCE LEVEL	Network technology supported by device	Operating system	Hardware (HW) design	Software (SW) design	Processor (CPU) power	Memory capacity	Connection capabilities such as Bluetooth, WiFi, NFC and A/GPS	T30 Satisfaction	T21 Satisfaction	Intended Quality	Corrected Improvement Ratio	Sales Advantage	Corrected Absolute Weight	Corrected Relative Weight
Ease of use	D	4,1		9	3	9	9	3	3	2,6	2,5	4,1	1,58	1,5	9,72	11,17
Switch speed between the interfaces	D	4,3		9		9	9			3,1	1,7	4,3	1,39	1,5	8,97	10,31
Visuality (interface)	D	3,5		9		9				3,1	2,2	3,5	1,13	1,2	4,75	5,46
Internet connection rate	D	3,8	9	3	9	3	3	1	3	3,3	2,5	3,8	1,15	1,2	5,24	6,03
Variety of applications	D	3,3		9		3		3		3,1	3	3,3	1,06	1	3,50	4,02
Long battery life	D	4,1	3	3	9	3	1			2,2	2,4	4,1	1,86	1,5	11,44	13,15
Entertainment platform such as music, video and game	D	2,8		3		1	3	9		3	2,9	2,8	0,93	1	2,60	2,99
Functionality	T	3,7	3	9	3	9	3	1	9	3,1	2,2	3,7	1,42	1,2	6,30	7,25
Network performance (calling, being called, data transfer etc.)	T	3,9	9	1	9		1			3,2	2,8	3,9	1,49	1,2	6,97	8,02
Messaging (SMS, MMS, e-mail and instant messaging)	T	3,8	3	1		1	1	1		3,5	2,4	3,8	1,19	1,2	5,43	6,24
Mobile payment	H	2,1		3	3	9			9	3	2,7	2,1	0,84	1	1,76	2,03
Map, navigation and location based services	D	2,7	3	9		9	3	1	9	3,2	2,5	2,7	0,84	1	2,27	2,61
Social media applications	T	3,7	3	3		3	1	1		3,6	2,8	3,7	1,06	1,2	4,71	5,41
Screen size	T	3,6			9		3			3,8	2,6	3,6	0,9	1,2	3,89	4,47
Sensitivity of touch screen	D	4,2		3	9	3	3			2,8	1,8	4,2	1,5	1,5	9,45	10,86
Absolute Importance			200,39	437,52	386,31	414,93	285,96	87,03	137,91							
Relative Importance (%)			10,28	22,44	19,81	21,28	14,66	4,46	7,07							

Fig 4. House of quality after integration of Kano model

IV. CONCLUSION

First of all, the findings of the House of Quality have been analyzed, and development areas and necessary technical specifications have been determined. Later on the Kano Model has been included in order to prioritize the significance of customer necessities, and the new House of Quality has been built.

According to the analyses of the House of Quality, "Long battery life" is found to have the most weight with 13.64% relative weight raito amongst customer requirements. "Ease of Use" and "Touch-operated Sceen Sensibility" follow this with 11.54% and 11.25% relative weight ratios.

When looked at the correlation of customerrequirements and technical requirements, "Long Battery Life" is found to be possible via improvements in hardware design. Giving more space to the battery will increase its capacity. Locating the antenna at the right position will also improve battery life, since the mobile phone will lose less energy in order to communicate with the base station.

When the first House of Quality is examined in detail, "Operating System" is seen to have 22.65% relative importance ratio, which is the highest ratio amongst technical properties. "Software Design" is the second with 21.42% relative importance ratio, which is followed by "Hardware Design", "Processor Power", "the Technology of the Supported Network", "Connection Support, such as Bluetooth, WiFi, NFC, A/GPS", and "Memory Capacity".

So less is changed after including the Kano Model to the application. “Long Battery Life” and “Ease of Use” are the first and the second ratios, with the percentages of 13.15% and 11.17%. other customer requirements are in the same order with the QFD findings. “SMS” is in the category of the Basic Needs in Kano classification, rather than “Internet Connection Rate” in QFD. This indicated the increase of the characteristic of SMS, which necessitates putting more effort in supplying this attribute.

When the second House of Quality, which includes the Kano Model, is examined in detail, “Operating System” is seen to have 22.44% relative importance ratio, which is the highest ratio amongst technical properties. “Software Design” is the second with 21.28% relative importance ratio. Although relative importance ratios differ a little, the sequence of the basic QFD approach still stays the same. “The Technology of the Supported Network”, and “Connection Support, such as Bluetooth, WiFi, NFC, A/GPS” have higher relative importance ratios. Other technical characteristics show slight declines in their relative importance ratios.

New smart phones will be designed according to the results of the QFD Quality Management Technique, supported by the Kano Model. The phones are suggested to have the below mentioned properties as a result of this study:

- The usage of newer versions of Google Android operating system
- The design of a user friendly interface
- The addition of shortcuts to the main screen (like Google)
- Installing a higher capacity battery, preserving the hardware design
- Higher touch-screen sensitivity via IPS technology
- The use of a larger screen in hardware design (minimum 4 inch)

Smart phones have been analyzed from the customers’ point of view, using QFD and the Kano Model, and the most important specifications have been determined. While technical necessities have been determined by QFD, the classification of the customer requirements has been made by intergration the Kano Model to the QFD study.

In the study technical specifications are given under general titles in order to make them more interpretable and easier to establish HoQ matrix. Instead of this approach, these technical features can be rearranged in detail for the further research thereby reducing target features to more specific state. In this way work load is increased by this action, but the engineers can understand better how the customer requirements are satisfied effectively.

ACKNOWLEDGMENT

The study is selected from International Symposium on Engineering Artificial Intelligent and Applications ISEAIA 2013 (Girne American University).

REFERENCES

[1] X. Zheng, and P. Pulli, “Improving mobile services design: a QFD approach”, Computing and Informatics, Vol. 26, 2007, pp. 369–381.

[2] E. Ronney, P. Olfe, and G. Mazur, “Gemba research in the Japanese cellular phone market”, Public Presentation, QFD Institute, 2000. Available: http://www.mazur.net/works/nokia_gemba_research_in_japanese_cellular_market.pdf

[3] M. Valtasaari, “Design for customer needs: Utilization of quality function deployment in product development”, Department of Industrial Engineering and Management (MSc. Thesis), Lappeenrannan University of Technology, Finland, 2000.

[4] M. Hussain, L. Tsironis, and M. M. Ajmal, “A QFD strategy for improving customer satisfaction: case study of telecom companies of Pakistan”, Asian Journal on Quality, Vol. 12, 2011, pp. 282-295.

[5] B. M. West, and J. Olhager, “The house of flexibility: using the QFD approach to deploy manufacturing flexibility”, International Journal of Operations & Production Management, vol. 22, 2002, pp. 50-79.

[6] M. Haverila, “Cell phone usage and broad feature preferences: A study among Finnish undergraduate students”, Telematics and Informatics, Vol. 30, 2013, pp. 177-188.

[7] E. Sutherland, “Counting customers, subscribers and mobile phone numbers”, Info, Vol. 11, No. 2, 2009, pp. 6-23.

BIOGRAPHIES

B. CERİT was born in Istanbul, Turkey, in 1962. He received his B.S. and M.S. degrees in Industrial Engineering, and PhD. degree in Engineering Management at Istanbul Technical University, Istanbul, in 1983, 1986 and 1995, respectively.
He is a Lecturer in the Department of Industrial Engineering, Istanbul Technical University since 1996. His research interests include Quality Management, Human Resources Management, Production Planning, and Investment Planning.

G. KÜÇÜKYAZICI was born in Istanbul, Turkey, in 1981. She received her B.S. degree in Industrial Engineering at Yıldız Technical University, Istanbul, and her M.S. degree in Industrial Engineering at Istanbul Technical University, Istanbul, in 2003 and 2009, respectively. She is now a PhD. candidate in Industrial Engineering at Istanbul Technical University, Istanbul.
She is a Research Assistant in the Department of Industrial Engineering, Istanbul Technical University since 2010. Her research interests include Strategic Management, Quality Management, Decision Making, and Logistics.

G. KALEM was born in Istanbul, Turkey, in 1987. He received his B.S. in Telecommunications, and M.S. in Engineering Management at Istanbul Technical University, Istanbul, in 2010 and 2013, respectively.
He is a Radio Network Quality Engineer at Turkcell since 2011. His research interests include Telecommunications Management, and Quality Management.