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CUSTOMER-FOCUSED PRODUCT DEVELOPMENT AND A CASE STUDY IN TURKISH REFRIGERATOR MARKET

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ABSTRACT

As product life cycles are getting shorter, new products have to be developed in the shortest time in order to gain advantages against the competitors. Moreover, market requirements defining new features of products should be determined. Companies are continuously seeking for methods to provide their R&D teams with the necessary information about customer requirements. As customer requirements are also an important component of quality as well, embedding the customer expectations into the technical requirements is necessary. From this point of view, Quality Function Deployment (QFD) is presented in the study as a strategic marketing tool for the adaptation of the companies to the dynamic markets for product development. In the study, the methodology is supported with a case study in Turkish refrigerator market. Data gathered from Turkish consumers are used as customer expectations and QFD is used as a tool to convert these expectations to engineering requirements.

Keywords: Quality Function Deployment (QFD), House Of Quality (HOQ), Refrigerator, New Product Development, Customer Satisfaction.

MÜŞTERİ ODAKLI ÜRÜN GELİŞTİRME VE TÜRK BUZDOLABI PİYASASINDAN BİR UYGULAMA ÖRNEĞİ

ÖZET

Günümüzde ürünlerin piyasadaki arzedilebilirlilik süreleri kısaldıkça, rakiplere karşı üstünlük sağlanabilmesi için yeni ürünlerin en kısa süre içinde piyasaya sunulması giderek daha da çok gereklilik göstermeye başlamıştır. Buna ek olarak yeni ürünlerin özelliklerinin tayininde de piyasanın taleplerinin takip edilmesi başarı için önemli bir etkendir. Bu sebeplerden dolayı firmalar, ArGe Gruplarına müşteri taleplerini ulaştırabilmek adına sürekli yeni yöntemler aramaktadır. Müşteri ihtiyaçları aynı zamanda kalite açısından da önemli bir unsur olduklarından dolayı, müşteri beklentilerinin teknik tanımlamalar ile örtüşmesi de gereklilik arz etmektedir. Bu çalışmada Kalite Fonksiyon Yayılımı (KFY), firmaların dinamik pazar koşullarına adapte olabilmesi için stratejik bir pazarlama aracı olarak sunulmaktadır. Ayrıca çalışma kapsamındaki bu metodoloji Türk buzdolabı pazarındaki bir uygulama örneği ile de desteklenmektedir. Bu amaçla hazırlanan anket ile toplanan bilgiler teknik ihtiyaçların tanımlanmasında kullanılmıştır.

Anahtar Kelimeler: Kalite Fonksiyon Yayılım (KFY), Kalite Evi (KE), Buz Dolabı, Yeni Ürün Geliştirme, Müşteri Memnuniyeti.

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1. INTRODUCTION

To compete and survive in the global marketplace, companies have to pay attention to the needs of customers and offer them quality products or services satisfying their increasing expectations. Therefore, they need a management system that facilitates the continuous improvement of their operations and products. Firms must recognize the pursuit of desirable outcomes through these efforts as their critical management objective. To these ends, many firms are changing their business operations from a product-oriented approach to a marketing oriented approach (Lai, 2003).

A marketing oriented approach prerequisites that the customer satisfaction is the focal point of the firm culture. As satisfied customers make repeat purchases, customer satisfaction is a must for firm's success. Due to Kotler and Armstrong (Kotler and Armstrong, 1999), customer satisfaction is based on product's performance relative to customer's expectations. In order to create satisfied customers, first of all, the customer expectations have to be analyzed in order to understand the motives of a purchase, so that customer expectations are built in the product during the new product development stage. After that, different marketing approaches can be developed in order to "guide" the customers to choose among different products. "A customer is satisfied only if and when they say they are satisfied. The perception is his/her interpretation of the value received played back against expectations. This declaration does not require any objective evidence and it can be a declaration made with no reason" (Nowacki, 2001).

As quality is defined as fulfilling customer expectations, and customer expectations of the product play an important role in customer satisfaction, customer data should be gathered in order to find out these expectations. With different methods of gathering customer data (see figure 1), quality is built in the product.

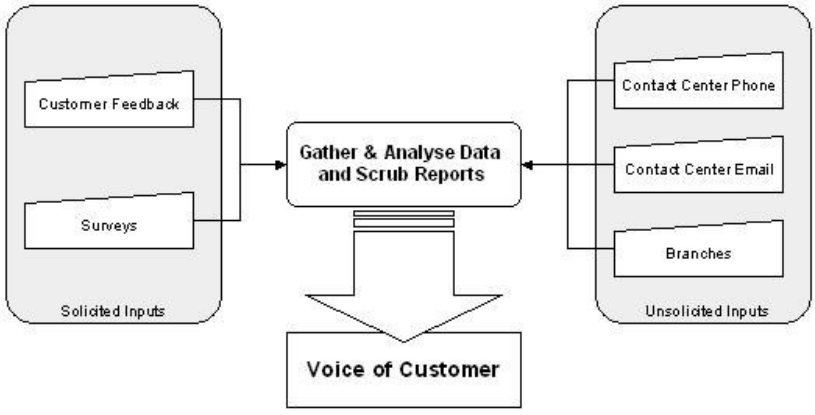

Figure 1. Methods of Gathering Customer Data, Based on Voice of Customer Process Flow (Clear, 2003)

Total Quality Management (TQM) combines the above mentioned points as a management technique. TQM aims to improve effectiveness, flexibility and competitiveness in a company as a whole. According to TQM philosophy, customer service and satisfaction is important components that will drive business strategy and serve as the ultimate measure of quality in assessing the business performance. Juran, one of the TQM pioneers, even recommends important evaluation that relate to customers satisfaction, (Oakland, 2003). According to Juran, customer satisfaction is achieved, customer expectations are fulfilled with the product; resulting in more market share and sales income. This is different from prior view called as "a product driven" in which companies or businesses are "pushing" their good into market place without considering the customer needs.

Quality Function Deployment (QFD) is a basic TQM tool that systematically develops customers' needs and expectations and translates them into technical requirements. QFD is principally customer driven. It means that this tool is set up with considering within industry factors as well as the customers' needs and interest towards the products or services rendered, (Terninko, 1997).

Combining and analyzing the solicited and unsolicited inputs, company receives the voice of the customer. Voice of the customer can be used for new product development or product enhancement. This results in a model consisting of the customer requirements describing the products. Quality function deployment (QFD) method is one of the methodologies that can be used for translating the voice of the customer into technical requirements thus to the product development process.

Considering the importance of customer satisfaction and expectations in the success of the firm, this study attempts to use QFD for integration. Following, the methodology of QFD will be explained. Then, the methodology of a research to gather customer expectations data is given, and the findings are used in the QFD model.

2. QFD

QFD is a technique for requirements engineering born out of the quality movement in the 1980's. QFD is defined as "a systematic and customer-focus design approach for identifying and prioritizing customer needs, translating these needs into product / service specifications, and tracking them throughout the product realization process" (Davis et al , 2004).

The QFD tool provides a graphical methodology for determining customer expectations. The QFD usually will show to the involved persons how the needs and expectations of the customers are fulfilled. These tools also indicate how the customers' interests are paralleled with the companies' interests. There are six basic elements of QFD, which are:

1. Determining the customers requirements (The QFD what)
2. Meeting how the requirements can be achieved (The QFD How) of the customers are critical to final product control
3. Relationship between the requirements and how they are to be met
4. Target values for the requirements
5. Relationships between how the requirements are to be met
6. A quantification of the importance of the requirements

Today's marketing focus is to achieve long-term profitability through satisfying customer needs and wants. In order to reach the long term objectives of the company, companies need to establish a strategic marketing orientation in their corporate strategy, so that a strategic fit is developed between the organization's long term goals and capabilities and its changing marketing opportunities. QFD is a set of planning and communication routines that focus and co-ordinate skills within an organization by first determining customer's needs and wants, and then design, manufacture and market goods that customers want to purchase and will continue to purchase. The QFD process strives to achieve the total quality objective by translating and diffusing customer needs and wants, the voice of the customers, vertically and horizontally throughout the organization.

As QFD forms an important link between customer needs and product specifications, it may be used as a tool for product realization process. The positioning of QFD in the product realization process is shown in the figure 2.

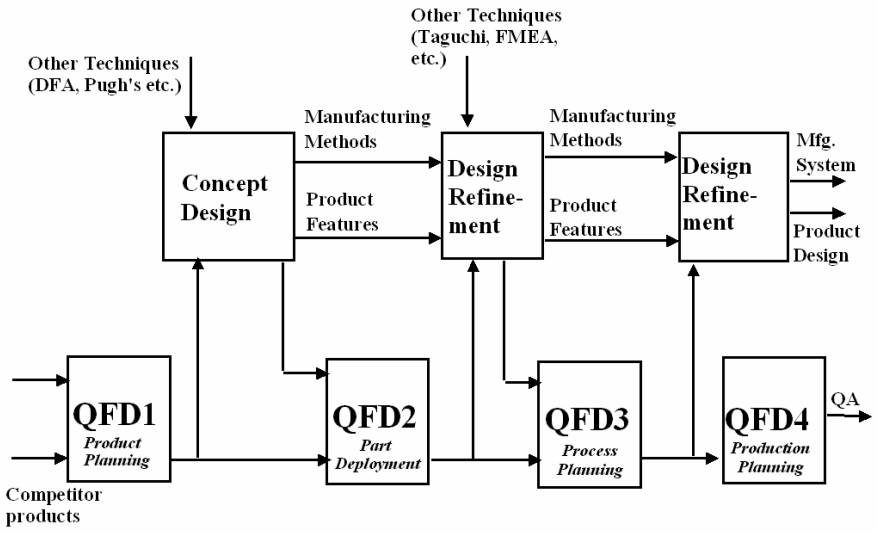

Figure 2. QFD and the Product Relization Lucas, UK (Davis et al, 2004)

Besides the product realization process, QFD can also be described as an approach to product design quality. The main aim of product design quality is to attempt to translate the voice of the customer into the language of the engineer. "The customer's wants are often called the "whatsa", or what QFD is ultimately supposed to improve. However, the consumer wants to define the outcome, the product attributes, but it does not give any clues about how this outcome will be achieved. It is necessary to determine the "howsa" or the design requirements that will determine how the customer requirements are to be fulfilled.

The core principle of QFD is a systematic transformation of customer requirements and expectations into measurable product and process parameters. In the first phase, the House of Quality (HOQ) is concerned with translating the purchase-decision-relevant attributes of a product that have been established (see fig. 6). These design features are subsequently transformed into part features during the parts development phase. The aim of the work preparation phase is then to describe crucial operating procedures on the basis of the specified part features." (Herrmann et al , 2000) This constitutes the missing "transfer function" of subjective customer requirements into the engineering details necessary for design and its production.

"*What do we expect from the QFD process?*" This is maybe the most important question that has to be asked in order to position and integrate the QFD process in a company. First of all, it has to be pointed out that QFD enables a customer focused organization culture by also enhancing the communication between different functional areas like R&D, production and marketing divisions.

The successful applications of QFD have produced many benefits such as providing a framework for planning and product development, assuring improved communication and sharing of information within a cross-functional team charged with developing a new product. It maintains customer ideas and requirements, in the customer's words, throughout the process and supports for understanding, consensus, and decision making, especially when complex relationships and trade-offs are involved. Moreover it creates of an informational base that is valuable for repeated cycles of product improvement and overall design cycle time is reduced, mainly due to a reduction in time-consuming design changes. Thus overall cost is reduced due to decreasing design changes and by eliminating redundant features and over-design.

QFD allows customers to prioritize their requirements, tells us how we are doing compared to our competitors, and then directs us to optimize those aspects of our service that will bring the greatest competitive advantage. Moreover, it offers producers an opportunity to enhance their own competitiveness and the ability to participate at world-class standards in the global economy.

Both TQM and QFD are methods to bring "customer voice" into design to improve customer satisfaction and value. But even QFD does not arise from the perspective of treating customers as equal partners, or sharing knowledge with customers, or educating customers to be more knowledgeable thus better consumers. The role for

QFD in TQM, the essential part of strategy or improvement is often to satisfy those customers whom the organization exists to serve. In the sense of TQM, QFD can be seen as an internal customer-supplier-relationship. QFD works as a supplier for different customers.

QFD consists of a customer driven quality cycle (see fig. 3), because the customer requirements consist of the "whatsa" and these are the most important part of the HOQ. It represents the requirements, needs and wishes of the customer summarized in a structured list. Affinity and Tree Diagram are commonly used to structure the requirements before placing them into the Customer Requirements section of the HOQ.

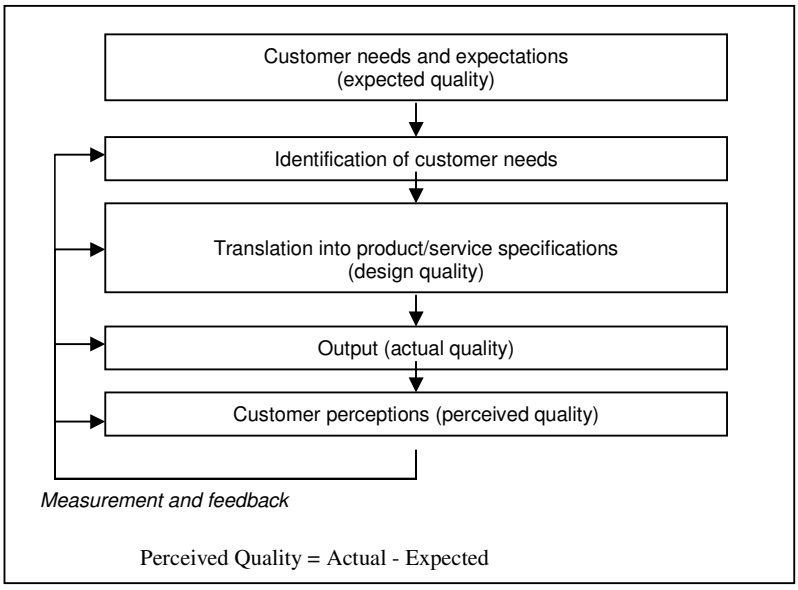

Figure 3. Customer Driven Quality Cycle (ROI Technology Conference, 2004)

The QFD view considers three levels of product attributes that are associated with customer satisfaction. Three levels of product attributes are articulated attributes, basic and excitement attributes and excitement factors. Articulated attributes are product or service characteristics that customers understand, can explain, and about which they have expectations regarding performance. These product attributes are linearly related to customer satisfaction so that better quality results in higher satisfaction and lower quality results in lower satisfaction. Basic and excitement attributes are different from articulated attributes in two ways. First, they are harder to identify because they are largely unspoken. Second, their relationships with customer satisfaction are exponential rather than linear. Although improvements in

basic attributes do not increase satisfaction levels appreciably, their absence generates strong dissatisfaction (e.g. a camcorder without a battery). Similarly, excitement factors generate very high levels of satisfaction, but their absence does not generate dissatisfaction. Excitement factors represent product attributes that were not previously considered by customers and are the most difficult drivers of satisfaction to identify because they lie outside of the customer's experience (Bond and Fink, 2003).

3. CASE STUDY

Due to the figures of BEYSAD (Association for Turkish White Goods Industry Suppliers), (BAYSAD, 2004) there is an upward trend in the production rates of refrigerators in Turkey (see table 1). The import and export figures of refrigerators indicate that the Turkish refrigerator market is growing rapidly. Additionally, Turkey is a refrigerator exporter. From this point of view, we have focused on the Turkish refrigerator market and as the focal point of this paper is the usage of QFD as a customer requirement management tool in product development, a case study in Turkish refrigerator market is conducted.

Table 1. Statistics on Turkish Refrigerator Market Based on BAYSAD, 2004

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Refrigerator Production Rate (x1000)	1247	1265	1637	1638	1850	1875	2139	2446	2483	3318	4286
Refrigerator Import Rate (x1000)	84	38	39	75	200	303	278	223	91	51	41
Refrigerator Export Rate (x1000)	397	586	802	695	784	818	1046	1088	1530	2247	3035
Market Potential	934	717	874	1018	1266	1360	1371	1581	1044	1122	1292

Findings of the study

In order to find out the customer expectations, a quantitative research was conducted with a structured questionnaire with 240 respondents. As sampling procedure, convenience sampling was used. The research was conducted in Istanbul in April 2005. The results of the research were analyzed with SPSS. As most of the questionnaires were conducted via Internet, the sample resulted in a higher education sample when compared to the population.

The survey has been made in Turkish and it consists of criteria that have to be evaluated by the participants, who chose among a scale from 1 to 5 prioritizing their choices. Therefore, 1 is symbolizing minimum importance and 5 stands for the maximum level of importance. In table 2, list of these features are given with the results of the survey.

Table 2. Customer Requirements and Their Relevance – Descriptive Statistics

Feature	Mean	Standard Deviation	Applicable in QFD?	Ranking
Long Life	4,559	0,594	Y	7
Durability	4,6522	0,5536	Y	4
Less energy consumption	4,5281	0,6965	Y	8
Cost/price	3,6725	0,9423	N	-
Free of charge on site delivery	4,1212	0,9569	N	-
Environmental friendly	4,1948	0,9142	N	-
At least 3 years of warranty period	4,4805	0,6905	Y	9
Refrig. Cooling speed	4,026	0,8389	Y	14
Meeting my design/style preferences	3,9083	0,9891	N	-
Different color map	2,8874	1,2284	N	-
Quietness	4,5714	0,6871	Y	6
Easiness by assembling	3,5913	1,1514	N	-
Wide technical support network	4,6407	0,5941	Y	5
Technical support priced less than competition	4,4416	0,7192	Y	10
Freezer cooling speed	4,0043	0,9302	N	-
No frost	4,697	0,5778	Y	3
No smells	4,7576	0,5913	Y	2
Easy to clean	4,2696	0,8444	Y	12
Interior volume capacity	4,4069	0,7511	Y	11
Known brand	3,6234	1,0092	N	-
Long time freshness of food and beverages	4,7576	0,4774	Y	1
Adjustable shelf and trial area	4,0783	0,8322	Y	13
Adjustable interior design	3,6304	1,097	N	-
Temperature variation	3,6652	1,0048	N	-

Then these results are used in order to define the customer requirements and built QFD Models for product planning and design deployment phases, which should help to find out whether design improvements are necessary by also demonstrating the competitive position. The last two phases of the usual QFD work is left out of scope of this paper, which are supposed to be included in further research.

The HOQ includes only the important customer requirements thus a ranking is computed within this table. In ranking 1 is characterizing the most important feature. Another important point is the usability of these requirements. When standard deviation of a requirement is too high, it means that there is no common necessity on this feature, thus this feature is not applicable in QFD. A closer look on the rankings

provides a good insight to this concern too. The features, defined as not applicable for the QFD model are also in lower places of the ranking, which supports the claim before.

Moreover the survey also includes demographic questions and open-ended questions about the refrigerator type, model and the time of the purchase. The results of these questions in the survey are in table 3. It is important to remark that most of the participants didn't know the model of their own refrigerator. The other open questions will be used for further research and are not investigated within the scope of this research.

Table 3. Consumer and Demographic Data

Question	Mean	Standard Deviation
Do you have a no-frost refrigerator? (1:yes, 2:no)	1,1659	0,3728
How old is your refrigerator?	5,2922	4,2509

What is your …

Age	19	21	22	23	24	25	26	27	29	30	31	32
Frequency	1	1	2	2	3	2	8	9	10	5	5	7

Age	33	34	35	37	38	39	42	43	44	45	60	N.A.
Frequency	2	2	4	1	3	2	3	1	1	1	1	3

Gender	Frq.
Male	23
Female	53
N.A.	3

Martial Status	Frq.
Married	21
Single	52
Divorced	3
N.A.	3

Education Level	Frq.
Primary School	0
High School	8
University	40
Masters or PhD degree	28
N.A.	3

4. QFD Model

For the visualization of HOQ and computation for QFD, the commercial code QFD Designer v3.15 of Qualisoft is used. First of all the features in the questionnaire are used as customer requirements in the HOQ. Therefore the ranking from the questionnaire is used in order to eliminate unnecessary features for QFD. Based on these conditions, the technical requirements are constructed as follows:

- Refrigerator temp. variation
- Refrigerator temp. range (on/off cycle)
- Noise measurement-front
- Ergonomy
- Failure rate
- Manufacturing cost
- Advanced Technologies
- Air filtration

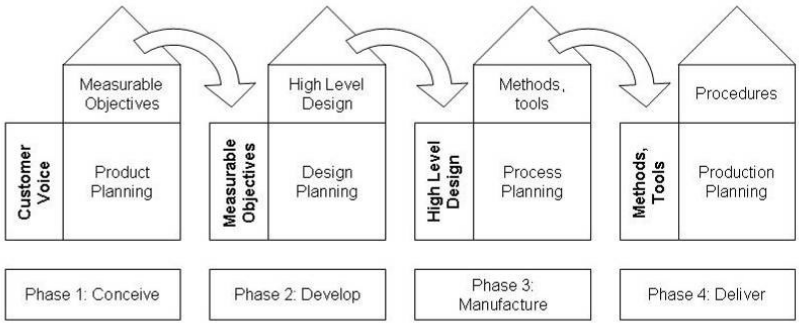

Figure 4. Adapting QFD, Based on ROI Technology Conference, 2004

In the QFD software, different phases of the QFD are simulated (see fig. 4). Each of the phases assembles critical information that forms the basis for the next phase. The most important HOWs or, those most difficult to accomplish are selected from the chart and brought into the next chart as the WHATs for that phase. In this case all of the technical requirements are used in order to build up the second phase of QFD: Design Deployment. Therefore the technical requirements of phase 1 were translated into WHATS of phase 2 (see fig. 5) and new HOWS were generated as below.

- Insulation efficiency
- Cost of advanced technologies
- Cost of engineering
- Cost of industrial design
- Accessibility of spared parts
- Compressor energy efficiency rating
- Volume efficiency (total/usable)
- Nr. of adjustable features

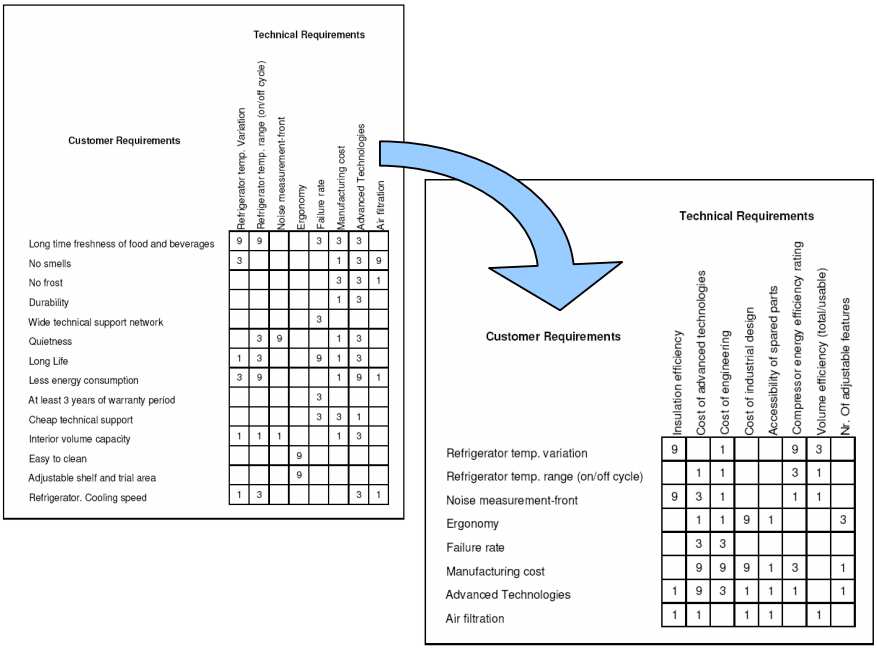

Figure 5. HOWS and WHATS of the First 2 Phases of QFD

In the HOQ, the Importance Rating shall be given in the generic QFD chart. Data for this importance rating *(I)* is based on the customer feedback that came from the customer surveys. The room is inserted with vertical orientation (values apply to WHATs) with values entered from a relative scale 1-8 with higher numbers indicating greater importance to the customer. The values for this column are determined by using the following formula applied on the survey results:

I (W) = round [10 x Mean(W) – 40]

This Importance room is the operand in the "Absolute Technical Importance" room since the values in it are usually multiplied by each symbol to create the "weighted" average of symbols in the Relationship Matrix.

When the created QFD Matrix gives the possibility to define the relationships of the customer requirements and the technical requirements (see table 4). These symbols are weighted so that they can be used in "Absolute Technical Importance" calculations. The chart has been set at 9 for "Strong", 3 for "Medium" and 1 for "Weak." For a blank matrix cell, or a cell with a symbol other than those listed above, the value 0 is assigned to it when used in a calculation.

Table 4. Matrix Symbol Set Description

Name	Symbol	Weights	Description
The Strong Symbol	◉	9	Strong relationship between HOW and WHAT
The Medium Symbol	○	3	Medium relationship between HOW and WHAT
The Weak Symbol	△	1	Weak relationship between HOW and WHAT

4.1. Results of QFD

In the first phase of QFD, the focal point has been product planning and the HOQ consists of the voice of customers and the design requirements (see fig 6). Within this phase the customer rating, which has to be based also on competitive summary is left intentionally out of the scope, because the ABC Analysis hasn't been fulfilled yet, which is going to be handled in further research.

For the determination of the interior of the QFD Matrix different sessions with experienced Engineers have been hold. At least weightings are determined in the matrix fallowed by the determination of the roof, where the dependencies of the technical requirements are given. The 8 major technical requirements in the given HOQ have to be measurable, thus the targets are determined and their difficulty level is given in figure 6.

In the final stage of first phase of QFD the software used calculates the ratings automatically and the gathered information is used to built up the second HOQ given in figure 7. Therefore it is important to mention that not only the correlation of the HOWs and WHATs is important; the organizational difficulty is also affecting the ranking of the technical requirements. In our case it can be seen that the usage of advanced technologies is the most important item, which can be also proven by the trend of today's R&D.

The second phase is aiming in fact the identification of the best design concept and determination of critical parts and its characteristics in order to determine the items for further development. Therefore the same methodology as in the first phase is applied and the reduction of cost of advanced technologies is determined as the most important point that has to be focused on, followed by cost of engineering and compressor energy efficiency rating. Another important part characteristic is the insulation efficiency, which also has to be improved. Also the cost of industrial design could be an issue, but all of the other items can be handled secondarily with respect to their rating in the HOQ far below the calculated mean value of 12.125 for the relative importance.

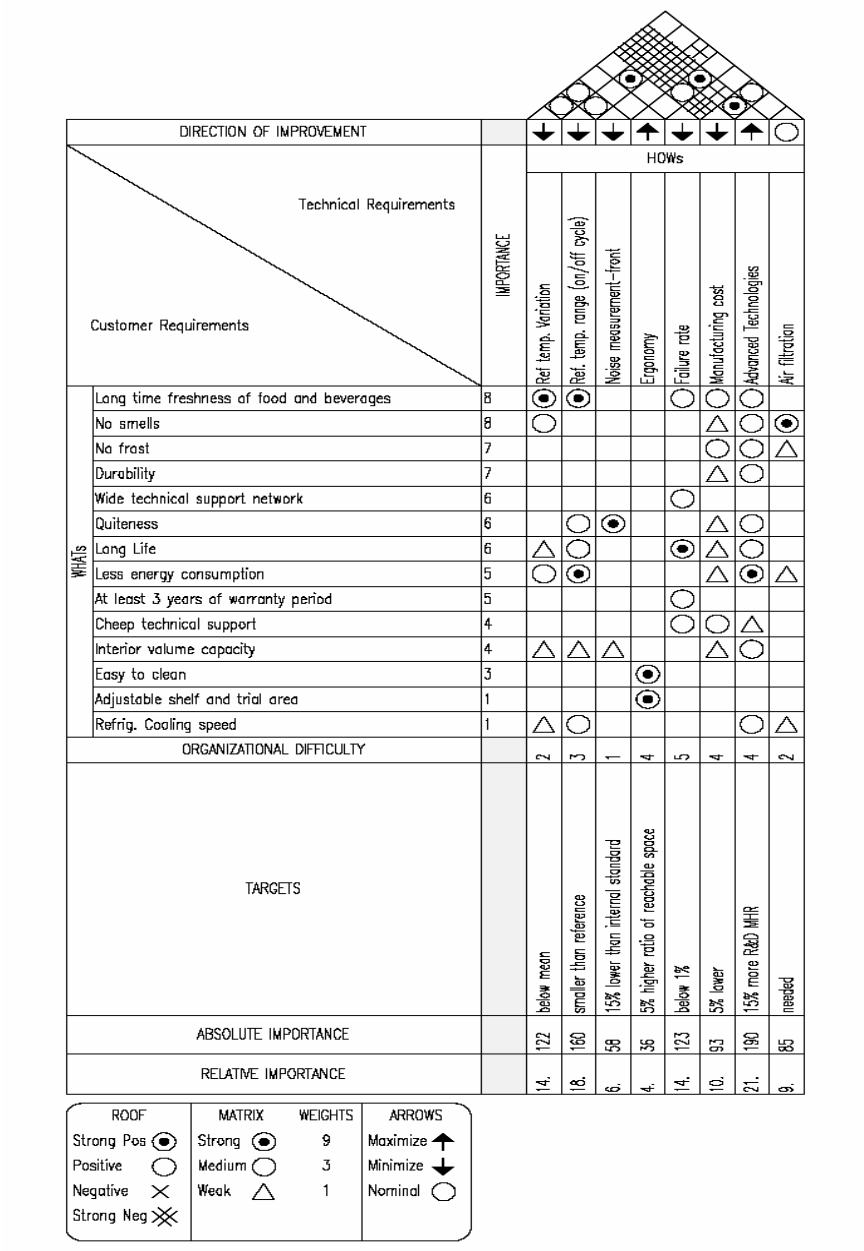

Figure 6. HOQ in the First Phase of QFD

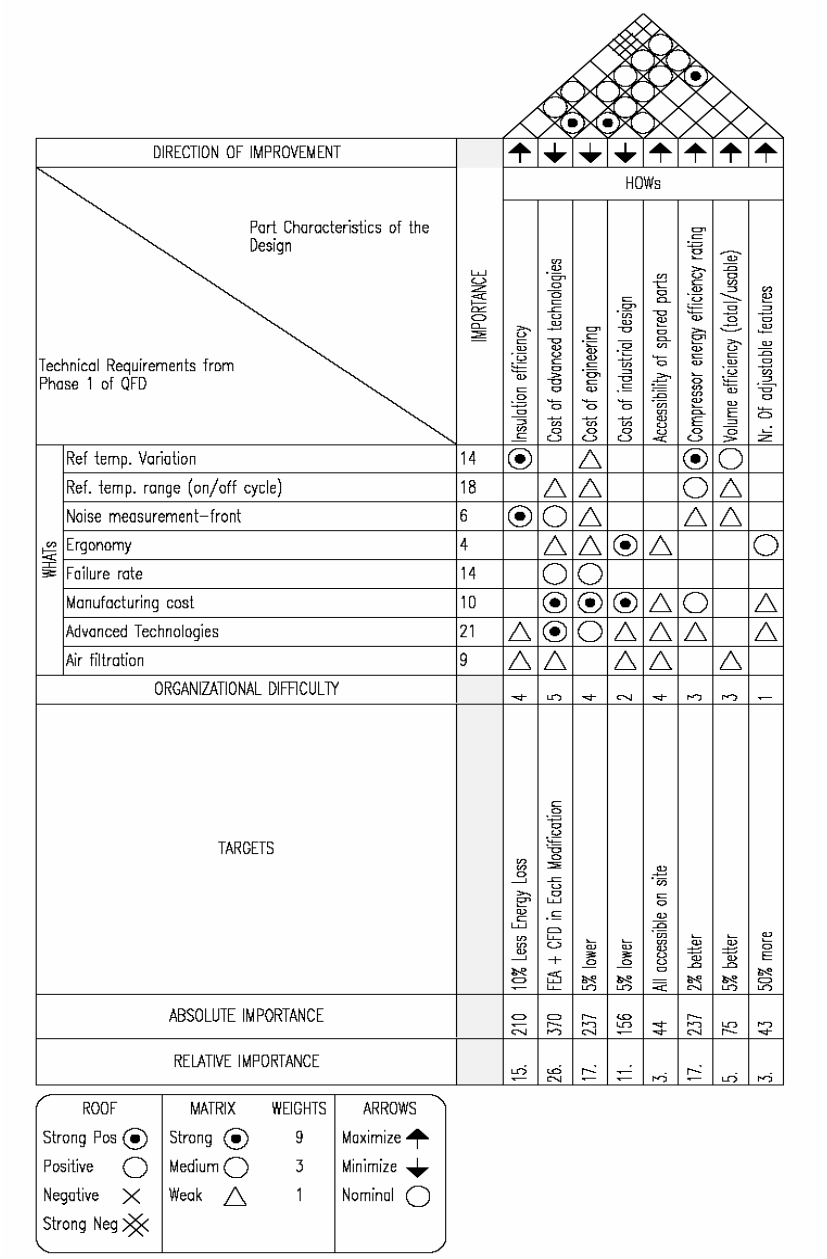

Figure 7. HOQ in the Second Phase QFD

In fact how the results of the second phase thus the usage and evaluation of the most important items are going to be used in the process and production planning is normally covered by the last two phases of QFD, which are left intentionally out of scope of this paper.

5. CONCLUSIONS AND RECOMMENDATIONS

Global competition, getting better products, shorter time to market is vitally important to a company. Linking market knowledge about customer needs to technical knowledge of engineering is a fundamental step to achieve winning product designs. Unfortunately, highly focused specialists in marketing and engineering do not always communicate. Engineering and marketing have grown apart becoming unaware of what the other area has to contribute to product creation. Decreased integration and communication between these two critical business areas can lead to the customer requirements being poorly communicated. The ability to combine skills to develop and produce successful products decreases.

Quality function deployment provides a framework for integrating marketing and engineering. Decisions made in different domains impact other domains in terms of costs, performance and ultimately the market share and overall profitability of the firm. The use of a QFD approach links customer needs to technical requirements and manufacturing decisions so that products can be designed effectively and manufactured efficiently. Quality Function Deployment (QFD) is a comprehensive quality system aimed specifically at satisfying the customer. QFD allows customers to prioritize their requirements, tells us how we are doing compared to our competitors, and then directs us to optimize those aspects of our service that will bring the greatest competitive advantage.

This paper presents a case study for customer involvement in product development in Turkish refrigerator market, of which quality function deployment is one. As a mature product, refrigerators need product modification and QFD is a useful tool for decision making for implementing customer feedback in to the development stage. The primary data collected for the study was limited for more innovative product development. More open-ended questions or unstructured questionnaire forms could have been used. This way more innovative data would have been collected. Moreover, the sample of the study was limited to high education group in Istanbul, which is not representative of the total population.

The integration of key decision areas between manufacturing and marketing is mostly performed in order to gain a competitive advantage in the marketplace. But the substantial costs associated with decision integration, such as the costs resulting from added structural and infrastructural mechanisms necessary for high levels of integration are not examined within the frame of this work.

The results of this study will be very useful in the definition and development of the next generation of the products and will have a significant spin-off for related products. Most important, the critical characteristics of the refrigerator are determined that they can be focused on during the R&D work. In fact, everything required by the customer is of great importance, but a successful product development shall choose the best alternative available within the budget. QFD enabled here a bridge between the necessities and the financial side of the work by using the interrelationship, the difficulty and the associated costs of individual requirements. It is for example very interesting to determine that the reduction of cost of advanced technologies is the most important point that has to be focused on, followed by cost of engineering and compressor energy efficiency rating.

In short QFD provided us a brief overview of the status-quo in the refrigerator market and its reflection in the production field. It enabled us to choose the best alternative for the direction of improvement, assuring a customer-focused and successful product development. We strongly believe that this study indicates companies succeed by providing superior customer value via QFD.

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