Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 158 (2019) 735–744

Procedia Computer Science

www.elsevier.com/locate/procedia

3rd World Conference on Technology, Innovation and Entrepreneurship (WOCTINE)

An Evaluation on Lifecycle of Products in Textile Industry of Turkey through Quality Function Deployment and Pareto Analysis

Ayşenur Erdil[1,*],

[1]*University of Istanbul Medeniyet, Turkey*

Abstract

Quality Function Deployment (QFD) is a quality development methodology which demonstrates right customer needs into technical solutions. The purpose of QFD methodology in this paper provides to connect customer requirements and technical characteristics in the textile-production industry. This method supports to define the customer and market-business expectations by a group of tools-house of quality and combine the expectations of the consumer to the existent system from the start of its design. This study aims to present an overview of this method, and also usage of QFD and Pareto Analysis with an application. This paper focuses on the application of these methods about the assessment of the sustainability of the lifecycle of Textile products in Textile Companies of Turkey. The results of this study are assessed on the framework of quality, robust and environment-oriented production such as green production. The study highlights an initial perception towards the development of the quality management for further investigation and scientific research.

Peer-review under responsibility of the scientific committee of the 3rd World Conference on Technology, Innovation and Entrepreneurship

Keywords: Customer requirements; House of Quality; Lifecycle; Pareto Analysis; Quality; Quality Function Deployment; Technical Characteristics; Textile.

1. Introduction

The textile industry is one of the industries where significant phases of the generation in the industrialized-technical politically organized bodies of households under a single government have been established much more or fewer parallel to this sourcing of producing. Moreover, the relative frequency by which modern householders are defined has been accumulated (so-named 'fast fashion') and the consumption of garments in the industrialized cities has become larger. The textile industry is dispersed having different constituents with a general framework in large stages of the industry, where producing and consuming perform in various locations and sometimes in various continents. This growing consumption has appeared parallel with the differences in the development policies and in

* Corresponding author.*E-mail address:* runesyalidre61@gmail.com

1877-0509
Peer-review under responsibility of the scientific committee of the 3rd World Conference on Technology, Innovation and Entrepreneurship
10.1016/j.procs.2019.09.109

in the textile sector heading to the direction of what is named 'fast fashion'[1, 2]. Textile products are thrown away when their warranty life is shortened and their hidden lifecycle is covered. Reusing textile products and giving the second life of textile products support a decline of the environmental problem for the lifespan of them [2, 3].

Green Manufacturing has to be implemented in this period in order to focus the attention also on the environmental impact and resource consumption, in addition to time, cost, and quality. Currently, the area of green manufacturing has extended into green supply chain management. Most of this research addresses issues related to evaluating current or potential suppliers' environmental practices, the environmental/economic benefits and drawbacks of establishing a green supply chain, and reverse logistics [4]. As a result of the interviews with consumers and according to the surveys, motivation (green production- green consumption) is desired in "Implementation strategy" in order to acquire and find out the assessment gathered. "Implementation Strategy" is one of the excellent and crucial methods, steps of gestating social activity and policy for the cultural framework of the country [5]. This strategy has taken periodic and regular impacts of daily practices into consideration and this method has been applied in the current research to take and provide a more effective perception to the application of second-hand purchasing and expenditure. Correspondingly, Cagliano et al. (2006) [6] focused on the durability, stability, and quality of the production policy integration over time, and resulting that the classification of the strategic combinations configured by a sector is fairly steady. The rapid change of the fashion tendency shortened the life cycle span of product in undeveloped and low-level income and the development of integrated markets have generated the common business framework of industry [7, 8]. The changing degree of the consumer needs has a significant and requirement influence in the sector, however, globalization has caused critical changes to organize and sustain the frame [8]. In the manufacturing and transportation structure of style-apparel firms, "make or buy" alternatives are proposed to be more strategic and difficult [6, 9]. Some textile products' brands have prestige and these firms follow an excellent strategy which is named "Fast Fashion". Others also support this purchase implementation in order to shorten the lifecycle time of clothes and fashion cycle time. Therefore, the producers try to coordinate with the customer for consumption. Nowadays, customers are under pressure to purchase much more clothes to follow the fast fashion and throw away after using and wearing one or two times [10].

2. Literature Review

2.1 Overview of Textile Industry in Turkey

Turkish textile sector, whose past goes to 1920s, is improved in the direction of government until 1950s. In the 1938 revitalized cellulose, after 1960s synthetic fiber production is begun. Private sector started cotton thread production in 1960s and synthetic thread production at 1970s. In the first years of Republic, Turkey was the fiber exporter, thread, fabric, and ready-made importer. This country started to be textile exporter after 1950s, ready-made exporter after 1970s [12, 13]. In 1950s textile sector and in the first years of 1970s ready-made sector began to evolve according to the internal market demand and considerations. With their cheap raw material and labor opportunities, they began to have a notable position in Turkey's economy in the 1980s. Free trade and the adoption of the right trade strategies occurred textile and ready-made sectors to the locomotive sector.

From the middle of the nineteenth century onwards, the textile industry has played a key role in early industrialization process in most countries. This is not surprising, given the combination of a large domestic demand (clothing is a basic necessity) and the early success at mechanizing textile production. This was also the case in Turkey and Turkey's textile industry has the biggest share in Turkish foreign trade. Turkey is the sixth largest producer of cotton yarn in the world. Turkey was Europe's number one supplier of textile products in 1995 [11].

Turkey's textile industry has been steadily developing with the industry integrating as one of the leading sectors with a high share of the country's economy and Gross domestic product (GDP) [14].

The county has a leadership position for a rich source of the raw materials that are used for the production. With its liberal trade strategy provided with the highly facilities in terms of labour force, the country have a well-developed business-industry that can produce quality products. Turkey maintains to invest in utilizing-applying advanced technologies to develop their industry. In terms of logistics and transportation, the country has a strategically arrangement as it is the entrance to European markets. Turkey goes along to invest in utilizing advanced technologies to develop their industry [12-15]. Textile production is 14 percent of the total manufacturing industry, 13 percent of total industrial production and 10 percent of Turkey's total production. There are 123 companies of textile products' production from among the 500 biggest industrial organisations in Turkey. As of September '96 there are 143 out of 800 foreign capitalised firms in textile products' sectors (110 textile-made, 33 textile). The strong position held by textile sectors is not only a success of modern integrated factories and firms that can market their own trade-marks but also then thousands of small and middle-sized firms. These firms with a labour force under 200 are generally located in Istanbul, Izmir, Denizli, and Adana organised under Textile and Ready-Made Exporters Unions. There are seven textile and ready-made Exporters Unions in Istanbul, Izmir, Denizli, Bursa, Antalya, Mersin, Gaziantep and they are bound to the Foreign Trade Councillor [12-15]. The development of textile industry trade is also a result of the development of transportation and communication facilities in Turkey, the education on textile and ready-made and the growth of a generation that knows at least one foreign language.

2.2. Expectations for Businesses Strategy of Textile Industry

There are recommendations for increasing the competitive capacity among companies operating and customer satisfaction in the manufacturing industry of textile products. These are indicated as below:

i. Supporting to strengthen the capital configuration.
ii. Expanding the company progression and having an improvement strategy (for instance green manufacturing etc.).
iii. Improving collaboration between SMEs (Small and medium-sized enterprises).
iv. Developing a competitive collaboration between companies.
v. Improving the relationship and integration between the centred industry and side industries.
vi. Connecting and reaching international sales and marketing departments and partnerships.
vii. Establishing textile marketing and sales media and partnerships.
ix. Providing the standard reconciliation in software and information management.
x. Increasing qualified human resources and improve the joint projects between the industry-university.
xi. Improving the capability of standards, test, measurement, and authorization approval-accreditation.
xii. Decreasing the burden on production and operation expenditure.
xiii. Supporting to the supply of intermediate inputs of the other manufacturing industry sectors and reducing them.
xiv. Diminishing the foreign-dependence in intermediate inputs and to provide investing and producing in selected intermediate inputs.
xv. For the public to apply, purchase and tender policies that support the sector.
xvi. Meeting the capital and financing needs under appropriate conditions.

The paradigm of corporate environmental responsibility has to extend beyond complying with increasingly stringent environmental regulations and also beyond the taking up of proactive initiatives by companies of the textile industry. Current researches show that the business and financial performance of companies of sectors may depend on socially, economically and environmentally responsible business practices. Thus, companies are under pressure to continuously search for new ideas and methods allowing them to achieve and maintain environmental sustainability and green perception [14, 16-18]. The environmental and ecological effects of product manufacturing and also subjected to a series of procedures are becoming more significant [19, 20]. In order to use of this issue for the textile products and household equipment designers to highlight these problems, there are three strategies as follows; raw material, resources effectiveness, product lifecycle expanding and product reusing, recycling.

However, product designers do not regularly deal with product lifecycle (by way of extending the product lifecycle, renovation and manufacturing again) and product reprocessing of waste to recover reusable material practices [20]. For example, the cost of more raw materials and resources has increased remarkably as the demand from emergent economies, markets boosted [21].

3. Methodology

3.1. Qfd-Quality Function Deployment

Quality is a dynamic concept, which in essence means to exceed the expectations. It includes a sustainable improvement since the requirements of the customer being tended to increase as those expectations are met. Continuous developments, creativity, and innovation are the fundamentals that provide the capability of organizations to deal with the changing, unforeseeable perceptions and developments [22]. Quality has become one of the most important consumer satisfaction and expectation criteria in the selection of competing products and services. Consequently, understanding and developing quality is a key impact leading to business success, growth, and providing a competitive position. There is a substantial return on investment from developed quality, and from successfully supporting quality as an integral part of the overall business strategy [23].

The American Society for Quality (ASQ) defines the quality as a subjective concept for which each person has his or her own description. In technical usage, quality can have two meanings [22, 23, 31, and 43]:

(i) -The characteristics of a product or service that focus on its ability to satisfy highlighted or applied requirements.
(ii) - A product or service free of failures-deficiencies.

The major objectives in applying Quality Function Deployment (QFD) are supporting quality, reducing production cycle time, and dropping costs. QFD methodology examines a system of matrix-like framework named as the House of Quality (HoQ) which determines collectively to determine final-absolute weightings of the technical requirements. The derivation of absolute weights of the technical requirements and their prioritization is the significant point in QFD phases. One of the main theoretical difficulties in implementing QFD is that it takes notice multidimensional classified data variables. The rating data of these categorical variables modify from person to person and case study to case study. In prioritizing the technical requirements, QFD examiners often do not be successful to fully combine the different information extractable from ordinal variables and eliminate some parts of QFD, HoQ. It is also defined that in each matrix structure of QFD, much more heuristics have been defined to prevent the variation, precariousness, and vagueness. During the QFD steps, any mistakes such as choice and simplification of rating rank, implementation of methods, or integrating of different matrices can disappoint all process [24-27]. QFD is a group of powerful product development means which were improved in Japan to transmit the conceptions of quality control from the manufacturing operations into the new product evaluation process. The basic properties of QFD are a base on collecting market requirements by applying actual customer declarations - mentioned to as the Voice of the Customer (VoC), its remarkable implementation of multidisciplinary group work and the use of an extensive matrix (called the "House of Quality") for describing information, approaches, and determination. Some of the advantages of applying QFD have been presented as [26-30]:
(i) Diminishing time to market (ii) Decreasing in design changes (iii) Reducing design and manufacturing expenditures (iv) Improved quality (v) Expanding, extending customer satisfaction

Yoji Akao [32] is widely considered as the father guru of QFD and his research conducted to its first applications at the Mitsubishi Heavy Industries Kobe Shipyard in 1972. He stated that QFD as a technique for improving a design quality purposed at providing the satisfaction of the consumer and then building the requirements of customers into design objectives and major quality confidence points to be applied throughout the production stage. The “voice of the customer” (VoC) is the term used to describe the stated and unstated requirements or needs of the consumer. The voice of the customer can be captured in a variety of methods: Direct discussion or interviews, surveys, focus groups, customer specifications, observations, warranty data, field reports, complaint logs, etc. This data is used to define the quality attributes needed for a supplies component or material to integrate in the process or product [28]. The centered features of QFD are its oriented on providing customer needs through the usage of their actual expression (referred the "voice of the customer (VoC)"), its simplifying of teamwork and the implementation of an extensive matrix for determining information, conceptions, and decisions. This matrix is generally specified as the "House of Quality" and is often realised to perform QFD in its totality [26, 44].

According to Akao, QFD is a method for developing a design quality purposed at satisfying the consumer and then applying the consumer’s demand for design objectives and major quality assurance points to be used during the production stage. QFD is a technique to confirm the design quality while the product is still in the design stage. As a very important side advantage, Akao points out that, when appropriately applied, QFD has illustrated the decreasing of development time by one-half to one-third [31, 32].

3.2. Background (History) of QFD

QFD developed and applied at the Mitsubishi Heavy Industries Kobe Shipyard in Japan in the early 1970s, is consumer-driven quality management system. This has been engaged by much more firms in the US since the mid-1980s [33, 34]. Successful application of QFD could produce many advantages, a deduction in design expenditure and time to market, the promotion of group work and so forth [35, 36]. A characteristic property of the QFD system is that the voice of the customer is deployed into the marketing, R&D, engineering, manufacturing steps of the product improvement. Each translation uses a graph called a House of Quality (HoQ) which integrates each stage’s inputs (WHATs) to the stage’s outputs (HOWs). The initial step of QFD includes information on customer requirements and their relative importance. Relationships between customer requirements and design targets (or design properties), customer’s perspective of the degree of satisfaction for the product of the company, as well as regarding its competitors and current measures of design target levels for both the product of firm and rivals [38]. Generally, in the initial stage, the information included in HoQ is applied for prioritizing the design destinations and describing destination design goal levels. Chan and Wu (1998) [37] based on prioritizing design targets and describing their relative importance ratings using methods. The determined rating can be applied as weighting factors-criteria in the multiobjective optimization problem, where multiple objectives are integrated into a single objective with the weighting factors.

In traditional QFD, destination design objective levels are specified in a subjective manner, Kim (1997-1998) and Moskowitz and Kim (1997) [37, 38] suggested similar mathematical programming perceptions to define the goal design objective levels respectively. Kim improved approximate equations representing the integration between design objectives based on the subjective judgment of the designer while Moskowitz suggested linear regression models that are convenient to the data set. This is a customer and technical competitive evaluation data. When a designed experiment is not nearly unacceptable, these perceptions can be useful. The equations are implemented as constraints for the optimization issues to discover optimal destination values for the goals of the design [37, 38]. The "House of Quality” matrix (Figure 1) is the most recognized form of QFD. It is applied by a multidisciplinary team to render a group of customer requirements, drawing upon market research and benchmarking variables, into a suitable number of prioritized engineering objectives to be built by a new product design [27, 46].

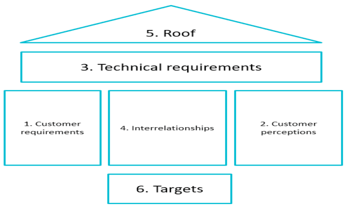

Fig. 1. Basic House of Quality Matrix [48]

The general format of the "House of Quality" is made up of six major components which are completed in the course of a QFD project: [27, 39-41, 46];

1. Customer requirements (HOWs) - a structured list of requirements derived from customer statements.
2. Technical requirements (WHATs) - a framework set of appropriate and measurable product properties.
3. Planning matrix - presents impressions of customer detected in market evaluations. involves the relative importance of customer needs, business and opponent performance in supporting these needs.
4. Interrelationship matrix - presents the QFD group’s approaches of interrelationships between technical and customer needs. A suitable scale is implemented, demonstrated using symbols or images. Filling this part of the matrix includes discussions and consensus developing within the group and can be time-consuming. Focusing on key relationships and decreasing the numbers of needs are useful methods to decrease the demands on resources.
5. Technical correlation (Roof) matrix - applied to define where technical requirements provide or hinder each other in the product design. It can emphasize innovation possibilities.
6. Technical priorities, benchmarks, and objectives - applied to determine the priorities transfer to technical needs by the matrix, measures of technical achievement supported by competitive products and the rate of difficulty included in improving each requirement.

4. Data and Methodology

4.1. QFD Application

In this part of the study, a quality function deployment was evaluated in the textile production industry of Turkey. In this application, customer requirements, customer significance level and technical characteristics were determined and scored with the experts and employee of all production industrial sectors (TUSIAD). Besides, a questionnaire was prepared for learning the opinions, perspectives of customers about the sustainability of the lifecycle of Products. This step of the study was very important to gather data and also to assist in the implementation of the research. The research was focused on a quantitative perception by means of a questionnaire-based survey determining the evaluation of the sustainability of the lifecycle of textile products for the textile industry with companies-firms in Turkey currently enrolled in the program. This survey was e-mailed to approximately a total of 143 companies of Textile Industry in Turkey with the help of the Turkish Industrialists' and Businessmen's Association (TUSIAD) and Turkey Exporters Assembly (TIM). The results of this questionnaire were assessed on the framework of environment-oriented production such as green production. The sample size was 103, returning the survey from the textile companies in Turkey, with a 72% rate of response. The questionnaire development was based on the lifecycle of textile products due to the sustainability dimensions and level of product quality of Business Textile sector. Customer requirements in the term of the lifecycle of textile products include some criteria. These are environmentally friendly Production-Green Production, Modular Design, Economic Benefit analysis-Economic Design and Long Lifecycle Product. The Technical characteristics include groupings identified according to the questionnaire on the environment which is focused on quality of product and sustainability of lifecycle of the textile product. These characteristics which were determined according to the survey questions and answers are shown in Table 1 and Table 2.

Table 1. Quality Function Deployment Table –Matrix for Textile Industry

Customer Requirements (What)	Importance of customer** / Technical characteristics (How)*	CRITERIA OF SOCIAL DIMENSION*										
		s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11
Environmentally friendly Production-Green Production	4	3	9	3	9	9	3	9	0	0	9	3
Modular Design	4	3	9	9	9	9	1	9	3	3	0	9
Economic Benefit analysis-Economic Design	4	3	3	3	3	9	3	3	1	1	1	9
Quality Product	5	1	0	3	9	9	3	0	0	0	1	1
Long Lifecycle Product	4	3	0	3	9	9	9	9	9	9	3	3
AW		53	84	87	165	189	79	120	52	52	57	101
CNW		1,62	2,57	2,66	5,05	5,79	2,42	3,67	1,59	1,59	1,74	3,09
Rank		27	22	20	4	1	23	10	28	28	26	17

Customer Requirements (What)	CRITERIA OF ENVIRONMENTAL DIMENSION*							
	en1	en2	en3	en4	en5	en6	en7	en8
Environmentally friendly Production-Green Production	9	9	3	9	3	3	3	9
Modular Design	9	9	9	9	9	9	9	9
Economic Benefit analysis-Economic Design	9	9	9	9	3	9	9	1
Quality Product	9	9	9	3	3	9	9	3
Long Lifecycle Product	9	9	9	9	9	9	9	3
AW	189	189	165	159	111	165	165	103
CNW	5,79	5,79	5,05	4,87	3,40	5,05	5,05	3,15
Rank	1	1	4	8	11	4	4	16

Customer Requirements (What)	CRITERIA OF ECONOMIC DIMENSION*										General Total
	ec1	ec2	ec3	ec4	ec5	ec6	ec7	ec8	ec9	ec10	
Environmentally friendly Production-Green Production	1	0	0	0	3	1	3	3	3	9	
Modular Design	9	3	3	9	9	3	3	3	3	9	
Economic Benefit analysis-Economic Design	9	9	9	3	9	9	3	9	9	3	
Quality Product	9	9	9	3	3	9	3	3	3	3	
Long Lifecycle Product	1	3	0	9	3	3	3	1	3	3	
AW	125	105	93	99	111	109	63	79	87	111	3267
CNW	3,83	3,21	2,85	3,03	3,40	3,34	1,93	2,42	2,66	3,40	100,00
Rank	9	15	19	18	11	14	25	23	20	11	29

Note : Strenght of relationships (Yılmaz, 2009 [42]): **Importance of customer **1-5**(1-Not important; 2-Less important; 3-not decide; 4- important; 5-Very important), **Technical characteristics*** (0-Not correlated; 9-Very strong correlate; 3-Middle correlate; 1-Weak correlate)

The quality function deployment applied from the feedbacks of surveys, reports of companies and interviews with experts of the business of textile industry in Turkey are shown in Table 1. Table 1 provides the interrelationship matrix with the type of relationships. Any cell that is empty implies no or insignificant relationship. The degrees of the strength of relationship are placed in the column of customer requirements and technical characteristics of quality function deployment matrix.

Table 2. Technical Characteristics-Requirements (TCs-TRs) for Sustainability of the lifecycle of the Product

Symbol	SOCIAL CHARACTERISTICS (CRITERIA)	Symbol	ENVIROMENTAL CHARACTERİSTİCS (CRITERIA)	Symbol	ECONOMIC CHARACTERİSTİCS (CRITERIA)
s1	INCREASING SALES FOR CULTURE, CURRENT SUSTAINABILITY	en1	DURABLE GOODS	ec1	COST REDUCTION BY USING CHEAPER PARTS
s2	CONSUMER UNDER PRESSURE TO PURCHASE AGAIN (PERCEIVED OBSOLESENCE)	en2	EXTEND THE PRODUCT LIFESPAN (Limited Useful-decreasing lifespan)	ec2	CAPITALIST SYSTEM IDEA OF FREEDOM (for a specific product)
s3	PRODUCT/SERVICE AGENCY -REPRESENTATION (solving the technical problems)	en3	LONG TIME GUARANTEE	ec3	DESIGN SERVICES,UNIQUE DESIGN
s4	CUSTOMIZATION	en4	MODULAR STRUCTURE	ec4	FREEMARKETS OVER REGULATED MARKETS
s5	CUSTOMER SATISFACTION	en5	PRODUCT LIFE SPANS THROUGH BETTER QUALITY	ec5	HIDDEN ENGINE OF ECONOMY
s6	PRODUCT/SERVICE STYLE, BRANDS, IMAGE (Media)	en6	PRODUCT LIFETIME GUARANTEE	ec6	INNOVATION OVER IMPROVEMENTS OF THREAD
s7	PRODUCT SATISFACTION	en7	PRODUCT RELIABILITY-QUALITY (creating Quality Difference)	ec7	LOCAL PRODUCTION
s8	SLOW FASHION (shortining the fashion time of products)	en8	THE SOCIAL AND ENVIROMENTAL DEGRADATION (ecological Impact)	ec8	PRIVATE ENTERPRISE OVER GOVERMENT OPERATORS
s9	FASHION TRENDS			ec9	PRODUCT/SERVICE AFFORDABILITY
s10	SOCIAL SUSTAINABILITY PROBLEM			ec10	THE MORE ADVERTISEMENT
s11	TECHNOLOGICAL ASPECTS (OBSOLESENCE)				

The QFD team determines interactions/correlations (improvement ratio) between the customer requirements for the analyzed companies products of textile industry compared with technical requirements of products. The objective of this analysis is to discover how the variation in values of some quality characteristics affects the values of the other sustainability criteria (Hows). This analysis has an important effect for designing the new product in terms of sustainability on the lifecycle of textile products as it shows the impact of actions-suggestions to develop the whole product. The results of this evaluation are recorded in the correlations matrix, which forms the quality house without the roof. Also, the relative importance (CNW) weight is calculated for each quality characteristic-criteria in part, as a share of the total relative importance of all properties-criteria. From this information, the QFD group will determine which of the quality characteristics-requirement contribute greater satisfaction to customers according to the formulated requirements and which therefore will require to be developed. The scoring-weighting and calculations in the other columns were conducted for the calculation of CNW.

Scoring and calculations were implemented for the textile product in the textile sector according to the relationship between customer requirements and technical characteristics. In the calculations, sorting was conducted from higher to lower value-weight (CNW) with the support of the statistical package program oriented on the weight of customer requirements. As a result of this sorting, 3 units of technical characteristics which are the first priority, were identified with a value of 5.8 percent; The second priority technical characteristic includes 4 units of technical characteristics which were identified with a value of 5.1 percent, the third priority technical characteristic involves 1 unit of technical characteristics which were identified with a value of 3.8 percent, so on.

The classified priority order for the Technical Requirements is listed in Table 3.

Table 3. The groups of the priority order for the Technical Requirements (Depending on the sorting (Rank) CNW -percentage value)

The priority number-importance (Rank)	CNW-percentage value	Technical Requirements
1 (1)	5,8	s5; en1 ; en2
2 (4)	5,1	s4; en3; en6; en7
3 (8)	4,9	en4
4 (9)	3,8	ec1
5 (10)	3,7	s7
6 (11)	3,4	en5; ec5; ec10
7 (14)	3,3	ec6
8 (15)	3,21	ec2
9 (16)	3,15	en8
10 (17)	3,09	s11
11 (18)	3,03	ec4
12 (19)	2,85	ec3
13 (20)	2,66	s3; ec9
14 (22)	2,57	s2
15 (23)	2,42	s6; ec8
16 (25)	1,93	ec7
17 (26)	1,74	s10
18 (27)	1,62	s1
19 (28)	1,59	s8; s9

4.2. Pareto Analysis Application

Literature research further presented that there is no suspicion that the Technical requirements (TRs) are the true alteration of requirements of customer and demands, but the current prioritization sorting-rank of TCs-TRs. TRs are not adequately and can be improved further. One TR may has priority over the other TR due to the general cause. It can also be determined that higher statistical Importance of few TRs can do a better position than all the rest TRs which might implement an application of Pareto's 80/20 principle [25].

The values of absolute weight (AW) from the quality function deployment matrix (Table 1) can be organized into a Pareto diagram to show which technical characteristics are the most important in meeting customer requirements. A Pareto chart can be constructed by segmenting the range of the data into groups (also called segments, bins or categories). The left-side vertical axis of the pareto chart is labelled 'absolute weight' (AW-the number of counts for each category), the right side vertical axis of the pareto chart is the cumulative AW percentage and the horizontal axis of the pareto chart is labelled with the group names of technical requirements. The number of data points is determined by residing within each group and construct the pareto chart but unlike the bar chart, the pareto chart is ordered in descending frequency magnitude and users define the groups [25, Figure 2].

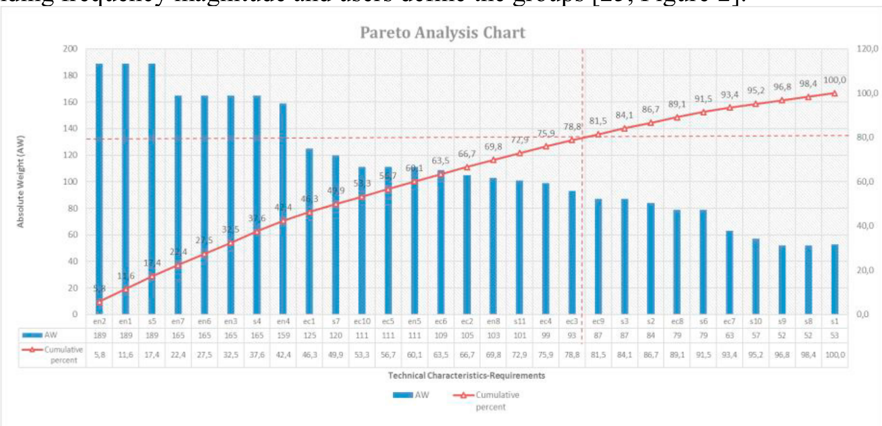

Fig. 2. Pareto Analysis for the Prioritization of Technical Requirements

In this research, a significant threshold risk variable is selected as 80% Pareto analysis (PA) presented focused on risk factors which might happen when designing and modifying quality oriented engineering researches and graded due to the severity of the risk criteria with according to the quality dimensions, and computing variables of relevant ratio % is presented [45]. In this type of studies that need team study and research, it is one of the importance of the analysis of a movement to a connected determination that supports measures against the possible failures getting, holding a high-risk level that is computed on the center of the Average weight (AW) variables table. Consequently, in order of importance when designing, producing and modifying the textile products of the business world-textile industry in Turkey based on engineering importance when the quality oriented engineering studies, determining the TR for sustainability of lifecycle of textile products pursuing orderly requirements are identified initial priority. The results of PA led to suggestions-solutions for processes and requirements that founded problems or problems with the 80/20 ratio. In prioritizing the technical requirements, PA technique supports to determine the top 20% of causes that requirements to be addressed to resolve the 80% of the problems. The AW values of the technical requirements which are calculated for each technical requirement obtained that exclude in the high weight classified. While evaluating the high-priority absolute weights supported requirements point sources between the values of these criteria in PA, conformity with 80% threshold risk variable, the initial 19 failure point sources prominence. The values of absolute weight can be organized into a Pareto diagram to show which technical characteristics are most important and the risk prioritization of requirements in meeting customer requirements. These are labelled and sorted with AW (the values of absolute weights) that are symbolised En2; en1; s5; en7; en6; en3; s4; en4; ec1; s7; ec10; ec5; en5; ec6; ec2; en8; s11; ec4; and ec3 respectively (Figure 2 and the description of the symbols in Table 2).

5. Discussions and Evaluations

When the technical requirements are compared the results of the Quality Function Deployment and Pareto Analysis methods, the general-the same-contested technical requirements should have the initial prioritization to find the solution and suggestion. For instance, s5; en1; en2; en3; en6; en7; en4; ec1 (as TRs-Technical requirements) might be taken the initial prioritization according to concluding the risk prioritization of requirements kinds. This condition is required and desired to make recommendations to improve the technical, requirement. For example, if the level of the quality-durability of textile product-production increases in the design and production phases, the lifecycle of the product extends. Thus, it will be provided to improve the consumer satisfaction, minimize the waste and also the expenditure-cost. In the event of thinking about the recommendations to improve these requirements towards the results of applied methodologies, a part of significant recommendations in this research scope is explained below;

-In the design process, all the requirements for the different phases of the life cycle should be determined. The most important aspects are maintenance and cleaning for which special requirement can take place. Failing to consider these aspects can cause a product primitively designed for a longer lifetime to be demolished or lose its functional and aesthetic property after the first cleaning. The properties of most products are modified during usage.

-In case of textile products, this change can include a worn-out and rugged surface, which is not only an aesthetical situation but also affects the mechanical properties of the product. In the case of knitted textiles, also non-expected stretching can cause a problem. This modification of the quality can be prevented by choosing the proper-convenient material and textile structure during the design stage.

-A brand supports a product to attract notice among other products by presenting it as a distinct textile product. It is the basic factor that demonstrates the quality and durability of a textile product. If the customers are gratified with the branded product, these consumers transform into dependable consumers of the brand. Depending on the marketing policy, a brand supports the consumer to acquire new products. The lifecycle of the product increases if the level of the quality-durability of product increases.

-Focusing on the available materials of products (for instance performance-durability parameters, costs, type et.) support to prevent the -risk components- failures.

-Improving and following the available technology (for example, production line, machines, usage equipment, expenditure, and resource demand of customers) can provide to eliminate the risk types during the process.

-Washing the textile products with restricted frequently and cleaning at under reducing heats and using detergents or economic cleaners and avoid the ironing where the opportunity to expand the lifecycle of the textile product.

-Extending the life cycle of textile products via the method of repairing and fixing is the one of suggestion to eliminate the risk condition.

-Purchasing minority but longer lifecycle span of textile products

-Determining of used textile products around recycling companies, centers which could recover them for derived, second-hand purchasing wherever possibility and recycling the threads or fabrics can be a major priority of the suggestions. Thus this can be to encourage, to move towards a zero waste economy and to provide waste prevention-waste reduction.

-When buying new products, choosing this made-produced with the greater values of the least energy and least toxic emissions (green production policy).

- The least energy and least toxic emissions are major risk parameters during the production process. This factor is presented for the scope of cost and health conditions for the population-customers and the economy of the country.

-The holistic view breaks down barriers between sectors and disciplines. Also, Green production is the significant strategy to support a part of the technical requirement and provide the customer satisfaction.

- Business and producer companies should force socially rational solutions involving the design and production

scope of environmentally friendly and durable products supplying the formation of a minimum amount of waste
- It is necessary to conduct a cost investigation for the use of renewable energy resources (sun panel, biomass etc.) and to ensure environment-focused production.
-The strategic plan is important for the textile firms to carry out environment-focused production. The textile should prepare its strategic plans for environment-focused production and review it on a regular basis.

6. Conclusions

Pareto analysis (PA) and QFD (Quality Function Deployment) have been widely used in the literature and also these techniques are used for the identification-determination of the most significant-dangerous failures, the removal or reduction of the most important failure modes. These are power analytical methods that can be used to estimate what sort of order should be followed for recommended action according to the calculated and determined values. It can be pointed out that the House of Quality created the opportunity to demonstrate the technical characteristics of sustainability of lifecycle of textile product around customer needs-satisfactions, setting the stage for further real-life improvements. By focusing on the strengths and weaknesses highlighted by the relationship matrix between the customer properties and the counterpart characteristics, an activity schedule for further improvement and performance improvement can develop by a joint group of representatives.

These two methods were integrated and used together to determine basic requirements, increase the quality level of the industry and voice of the customer (customer satisfaction) for this application. QFD is a systematic method of improving a new product or supporting sustainability, by which the association should guarantee that requirements of customers are translated correctly into its specifications. Therefore, achieving or exceeding customers' expectations means more than maintaining or improving customers' performances. This application supports to identify and categorize the requirements of the sustainability dimensions for the considering the lifecycle of textile products. According to the QFD, the resulting Pareto analysis led to suggestions for processes that constituted problems or problems with the 80/20 ratio. Pareto analysis technique supports to determine the top 20% of causes that requirements to be addressed to resolve the 80% of the problems [25, 45]. These techniques are used to reduce of the most important failure modes, to provide the initial requirements of the business and customer satisfaction. This issue can be applied in every industrial manufacturing and service sectors. This topic can integrate with every research areas and can be developed with other technical and customer requirements by Failure Modes and Effects Analysis and Multi-Criteria Decision Making Methods.

Acknowledgements
We would like to thank the officials of the firms in the textile industry and experts who shared for valuable information and discussions.

References

[1] Bhardwaj, V. and Fairhurst, A. (2010). "Fast fashion: response to changes in the fashion industry". *The International Review of Retail. Distribution and Consumer Research*, **20(1):** 165–173.
[2] Jørgensen, M.S., and Jensen, C.L. (2012)."The shaping of environmental impacts from Danish production and consumption of clothing", *Ecological Economics,* **83**: 164–173.
[3] Farrant, L., Olsen, S.I and Wangel, A. (2010). Environmental benefits from reusing clothes, *International Journal of Life Cycle Assessment* **15**: 726–736, DOI 10.1007/s11367-010-0197-y
[4] Fleischmann M, Beullens P, Bloemhof-Ruwaard JM, and van Wassenhove L.N. (2001)."The impact of product recovery on logistics network design". *Production and Operations Management*, **10(2) :** 156–173
[5] Reckwitz, A. (2002)."Toward a theory of social practices: a development in culturalist theorizing". *European Journal Social Theory,* **5(2):** 245–265.
[6] Cagliano, R., Caniato, F., and Spina, G. (2006)."The linkage between supply chain integration and manufacturing improvement programmes". *International Journal of Operations Production Management* **26(3):** 282–299.
[7]Abecassis-Moedas, C. (2006). "Integrating design and retail in the clothing value chain: an empirical study of the organisation of design". *International Journal of Operations and Production Management* **26(4) :** 412–428.
[8] Jin, B. (2004). "Achieving an optimal global versus domestic sourcing balance under demand uncertainty*", International Journal of Operations and Production Management*, **24(12):** 1292–1305.
[9] Buckley, P.J. and Ghauri, P.N. (2004)."Globalisation, economic geography and the strategy of multinational enterprises". *Journal of International Business Studies,* **35(2):** 81–98.
[10] Lee, M. (1997). Fast Fashion. *The Ecologist,* 37(2): 60.
[11] Turkey in Statistics, (1997). *State Institue of Statistics.*
[12] Gazanfer, S.: "Assessing the establishment of a cotton futures market in Turkey" Paper presented at the Technical seminar at the 51st

Plenary Meeting of the ICAC, Liverpool, United Kingdom, September 1992. Pp.32 https://www.icac.org/cotton_school/research_associate_prog/res_prog_04/turkey.pdf
[13] Gazanfer, S. 2004. An overview of the Turkish cotton industry with special emphasis on the available tools and techniques of price risk management. Aegean Textiles and Raw Materials Exporters Unions, Izmir.
[14] The Turkey textile industry: fast production with short delivery time, https://www.allianceexperts.com/en/knowledge/countries/europe/the-textile-industry-in-turkey/ (10.12.2017).
[15] Istanbul ready made garment and apparel exporters' association (Istanbul Tekstil Konfeksiyon Ihracatçılar Birliği), Annual Report, 1996. https://www.ihkib.org.tr/tr/kurumsal/faaliyet-raporu/k-208
[16] Istanbul ready made garment and apparel exporters' association (İstanbul Tekstil Konfeksiyon Ihracatçılar Birliği), Six Months Export Evaluation of Textile & Ready-Made Industry, Annual Report, 1997. https://www.ihkib.org.tr/tr/kurumsal/faaliyet-raporu/k-208
[17] Sarkis J. (2003). "A strategic decision framework for green supply chain management", *Journal of Cleaner Production,* **11**:397–409.
[18] Gopalakrishnan K., Yusuf Y. Y., Musa A., Abubakar T.,and Ambursa H. M. (2012). "Sustainable supply chain management: A case study of British Aerospace (BAe) Systems", *International Journal of Production Economics,* **140(1):**193–203.
[19] Allwood, J. M., Ashby, Michael F., Gutowski, T. G .,and Worrell, E. (2011)."Material efficiency: a white paper", *Resources Conservation and Recycling*, **55**: 362-381.
[20] Bakker, C., Wang, F., Huisman, J. and Hollander, M. (2014)."Products that go round: exploring product life extension through design", *Journal of Cleaner Production,* **69**: 10-16.
[21] Rosenau-Tornow, D., Buchholz, P., Riemann, A. and Wagner, M. (2009)."Assessing the long-term supply risks for mineral raw materials e a combined evaluation of past and future trends". *Resource Policy,* **34**:161-175.
[22] Yavuz, S.(2006). ''Altı sigma yaklaşımı ve bir sanayi işletmesinde uygulama'', Doktora tezi, Atatürk Üniversitesi Sosyal Bilimler Enstitüsü İşletme Anabilim Dalı, Erzurum, Türkiye, pp. 9-61.
[23] Montgomery, D.C. (2004). ''Introduction to Statistical Quality Control'', 5th Edition: *John Wiley&Sons,* Inc., New Jersey, USA, pp.2-183.
[24] Dean, E. B. (1992). Quality Function Deployment for Large Systems", Proceedings of the 1992 International Engineering Management Conference, *Eatontown, NJ*, 25-28 October.
[25] Sanders, R. (1987), "The Pareto principle: its use and abuse", *Journal of Services Marketing*, **1(2) :** 37-40.
[26] Sakao, T. (2007), "A QFD-centred design methodology for environmentally conscious product design", *International Journal of Production Research,* **45(18-19):** 4143-4162.
[27] Dikmen, I, Birgonul, M.T.,and Kiziltas, S. (2005). " Strategic use of quality function deployment (QFD) in the construction industry", *Building and Environment,* **40(2):** 245-255.
[28] Gitlow, H., Oppenheim, A., Oppenheim, R.: Quality Management: Tools and Methods for Improvement (2nd Ed.), *Richard D. Irwin Inc., Boston*, 1995.
[29] Oakland, J.S.(1993).Total Quality Management. The Route to Improving Performance. *Butterworth- Heinemann, Oxford*, 1993.
[30] Avasilcai, S. (2001): Defining performance requirements in management of technological changes, in Brudaru, O. (Ed.) "Studies in Management of Technological Changes", "Sedcom Libris" Publishing House, Iasi, 2001
[31]Learn About Quality, http://asq.org/learn-about-quality/qfd-quality-function-deployment/overview/ overview.html (25/03/2016).
[32] Akao, Y., (1990). QFD (Quality Function Deployment) Integrating Customer Requirements into Product Design.
[33] Guinta, L.R. and Praizler, N.C. (1993), The QFD Book: The Team Approach to Solving Problems and Satisfying Customers through Quality Function Deployment, New York: AMACom Publishing. 160 p, ISBN: 978-0814451397.
[34] Shillito, M.,L. (1994). Advanced QFD: Linking Technology to Market and Company Needs, New York: John Wiley & Sons Inc, 200 p., ISBN: 978-0-471-03377-6.
[35] Prasad, B. (1996). Concurrent Engineering: Fundamentals, Vol. I: Integrated Product and Process Organization, PTR Prentice Hall, *Englewood Cliffs, New Jersey*, 1996.
[36] Prasad, B. (1995). "On Influencing Agents of CE," *Concurrent Engineering: Research and Applications* (CERA), **3(2):** 78-80.
[37] Chan, L.K. and Wu, M.L. (1998)."Prioritizing the technical measures in quality function deployment", *Quality Engineering,* **10**:467-479.
[38] Moskowitz, H. and Kim, K.J. (1997). "QFD optimizer: a novice friendly quality function deployment support decision-support system for optimizing product designs", *Computers and Industrial Engineering,* **32:**641-655.
[39] Killen, C. P., Walker, M. and Hunt, R. A. (2005), "Strategic planning using QFD", *International Journal of Quality & Reliability Management*, **22(1):**17-29.
[40] Kim, J. K., Han, C. H., Choi, S. H. and Kim, S. H. (1998), "A knowledge-based approach to the quality function deployment", *Computers & industrial engineering,* **35(1-2):** 233-236.
[41] Kim, J. K, Kim, D. H. and Min, D. K. (2007), "Robust QFD: framework and a case study", *Quality and Reliability Engineering International,* **23(1):**31-44.
[42] Yılmaz H. (2009). "Optimization of The Product Design Through Quality Function Deployment (QFD) and Analytical Hierarchy Process (AHP): A Case Study in A Ceramic Washbasin", Master Thesis, Izmir.
[43] Six Sigma Market Place, https://store.isixsigma.com/productcategory/projectexamples/?utm_source=isixsigma&utm_medium=banner&utm_campaign=adlink, (10.02.2018).
[44] Cristiano, J. J., White, C. C., Liker, J.K. (2001) Application of multiattribute decision analysis to quality function deployment for target setting IEEE Transactions on Systems, *Man, and Cybernetics, Part C,* **31(3),** 10.1109/5326.971665
[45] Sankar, N.R, and Prabhu, B.S. (2001) "Modified approach for prioritization of failures in a system failure mode and effects analysis", *International Journal of Quality and Reliability Management,* **18(3):** 324-336, https://doi.org/10.1108/02656710110383733.
[46] WhatısPM, Quality Management and Process Improvement Approaches, http://www.whatispmp.com/quality-management-process-improvement-approaches/ (20.06.2018).