



ADDIS ABABA UNIVERSITY
ADDIS ABABA INSTITUTE OF TECHNOLOGY
SCHOOL OF MECHANICAL AND INDUSTRIAL ENGINEERING

CUSTOMER-ORIENTED PRODUCT DEVELOPMENT:
A CASE STUDY AT YIRGALEM ADDIS TEXTILE FACTORY PLC.

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DECLARATION

I hereby declare that the work which is being presented in this thesis entitled, “**CUSTOMER-ORIENTED PRODUCT DEVELOPMENT**” is original work of my own, has not been presented for a degree of any other university and all the resource of materials used for this thesis have been duly acknowledged.

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DEDICATION

To

Bright memory of my late brother Efreem Habtu

who taught me to trust in GOD, believe in hard work and that so much could be done with little.

My Mother

Her affection, love, encouragement and prays of day and night make me able to get such success and honor. And also for earning an honest living for us and for supporting and encouraging me to believe in myself.

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Abstract

The success of a product or service largely depends on how they meet the customers' needs and expectations. This thesis work employs Quality Function Deployment methodology to translate customer needs and requirements into the quality characteristics to improve quality for an existing product and to develop a new consumer product. Quality Function Deployment is a management tool that provides a visual connective process to help teams focus on the needs of the customers throughout the total development cycle of a product or process. It provides the means for translating customer needs into appropriate technical requirements for each stage of a product/process-development life-cycle. It helps to develop more customer-oriented, higher-quality products. The study was conducted in a case company called Yirgalem Addis Textile. The study used focus group discussion and questionnaire to identify customer needs of Yirgalem Addis Textile product of men's t-shirt and based on the result of the survey, fifteen customer needs and product technical requirement were identified. In order to identify the most prominent customer needs and product technical requirement, the data were analyzed using Quality Function Deployment approach and Pareto chart.

It was revealed in the study that Yirgalem Addis Textile failed in terms of meeting the needs of customers of men's t-shirts and so as to alleviate those problems, the study recommends to use Quality Function Deployment as a means to meet customers' need and facilitate means of communications between each department of the company.

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Glossary

CNs=Customer needs

CRs=Customer Requirements

CSFs=Critical Success Factors

ECs=Engineering Characteristics

HOQ= House of quality

NPD= New Product Development

PD=Product Development

PLC=Product Life Cycle

PTRs =Product Technical Requirements

QFD=Quality Function Deployment

SPSS=Statistical Package for Social Sciences

UCA= User-centered approach

VOC=Voice of Customer

Chapter One

Introduction

1.1 Background of the Study

Ethiopia's long history in textiles began in 1939 when, under Italian occupation, the first garment factory was established. The country's current textiles industry encompasses spinning, weaving and processing. Ethiopia has more than five public textile factories producing mostly work-wear garments for the domestic market. Numerous privately-owned factories produce shirts, suits, work clothes and uniforms for national and foreign markets (Pols,2015). But most of them falls to integrate need of customers and feed-back from the market and also design trends are weak.

The value delivered to the customer is a difference between the total value of the product and total costs which they must pay. The customer chooses these offers which maximize the delivered value. On the market this producer will get the majority which listens to the voice of the customer, knows their needs and is able quickly to react, fulfilling or even exceeding customer's expectation.

Nowadays companies face increasing competition. An increase in the significance of the function of the quality is one of the most important phenomena of all times. Customers can choose from the wide range of products and services. Sellers are forced to deliver products of acceptable quality, otherwise will lose their customers to the competition. Customers make choice on the basis of own perception of quality and values offered them (Dudek,2007).

Incorporating the customer is significant and essential at every stage of coming into existence and the life of the product. So, necessary is using the opinion of customers at the stage of the product design or of the organization of the service. It is also important in order not to leave the customer on one's own. After cashing the transaction many companies forget about their customers. The quality spiral begins on the customer and on it finishes (Roszak,2006).

The quality is the most important weapon in the market competition, international trade, is a strategic purpose. It is a good warranty of acquiring the loyalty of the customer. A quality is a notion functioning in many fields of the human activity, includes the quality of the product, the work and the life.

Yirgalem Addis Textile is one of Ethiopian integrated textile factory which was selected as a case company because it is an integrated textile factory with a capacity knitting, spinning, dying and

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garment manufacturing. In addition, also the company fell to integrate need of customer fully even if there is a product development section. The current means marketing department production order sheet of Yirgalem Addis Textile Factory which shows that the specification are not enough to address customer needs (CNs), see Appendix 1.

Quality must be designed into the product, not inspected into it. Quality can be defined as meeting CNs and providing superior value. This focus on satisfying the customer's needs places an emphasis on techniques such as Quality Function Deployment (QFD) to help understand those needs and plan a product to provide superior value (Kenneth ,2002).

To ensure success in the competitive marketplace, organizations should adopt a new product development (NPD) process that delivers products based on customers' needs. The tools and methods used in the development process determine product quality and thus demand attention. QFD is a system for translating consumer requirements (CRs) into appropriate company requirements at each stage, from research and product development to engineering and manufacturing to marketing/sales and distribution (Fisher and Schutta, 2003). Hence, QFD is not only a methodological tool but also a universal concept that provides a means of translating CRs in each stage of product/service development (Chan and Wu,2002).

Ultimately, QFD transforms CRs into technical design specifications that promote customer satisfaction. It links customers, marketers, engineers, competitors, and production methods. In addition, by facilitating the development of a detailed view of the complete design and manufacturing process, it can resolve problems in the early phases of design, thus drastically improving production (Chan and Wu,2002).

QFD is effective because it integrates the voice of customers (VOC) into the design phase, producing better products with high levels of customer satisfaction (Koksal et al., 1992). QFD aims customer satisfaction. Therefore, VOC must be understood well, QFD focuses on delivering positive value by seeking both spoken and unspoken needs, translating these into actions and designs, and communicating these throughout each organization on the value chain to the end customer.

During recent years, QFD has been recognized as an effective method for product and process development (Akao, 1997). Mallon and Mulligan (1993) defined QFD as a cross functional tool

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that assists technically oriented people, such as architects and engineers, to understand CRs sufficiently, to develop priorities for these requirements that are customer oriented and technically correct.

This thesis focused in a system capable of translating buyers and users' needs into design requirements, and changing these requirements into critical characteristics and specific parts requirements. QFD is a method for: a) developing a design quality aimed at satisfying the consumer, b) translating the consumers' demand into design targets and major quality assurance points to be used throughout the production stage (Akao ,1990). The QFD system involves constructing one or more matrices containing information related to the others. The first matrix is sometimes referred to as the "House of Quality" and contains information about customer's needs and product technical requirements (PTRs).

1.2 Product Selection

The study by Christoph & Martin (2011) shows that t-shirt have low level of risk in terms of customer empowerment in product development compared to furniture and bicycles. First, T-shirts are generally perceived to be associated with "low" overall risk, furniture with "medium" risk, and bicycles with "high" risk. Second, whereas T-shirts are perceived to involve "low" the level of engineering/technology necessary to design such products.

Furniture can be classified as involving "medium" engineering and bicycles as an example of "high" engineering. In order to remain on the market, companies need to extend the product life cycle, redesign the product, and/or develop new products.

Because of the above reason and also Yirgalem Addis Textile produce below its capacity one of the reason is lack of demand and weak relationship with customers, so the study select t-shirt because of low level risk.

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1.3 Problem Statement

Ethiopia's textiles and clothing industry is undergoing major development, aided by the presence of a cheap, skilled and highly-motivated workforce. But in most of Ethiopian textile company, the market and customer value perspectives are underestimated and/or poorly considered in many industries of the country. Limited product diversification and little sophistication offer, inefficient customs processes, inefficient production. Due to lack of experience and a sole focus on former domestic sales many fabric qualities are based on carded instead of combed cotton, have inferior quality, don't comply with international testing on chemical use, restricted substances or shrinkage and are therefore sold in local market (Pols,2015), due to this most of customer use imported textile product. In today's competitive market environment, organizations must focus on being first to market with cutting edge technology, global competition forces organization to develop innovative ideas to make their products competitive in the market. The ability to adapt to constant change is key for any successful business. With increasing globalization, all organizations must focus on customer satisfaction and needs, and they must remain open to discovery if they are to sustain their business. Diversified expectations of the customer and the augmenting competition among the companies orient the companies to search for original and easily applicable solutions.

The role of QFD method here gains significance in the meaning of simplifying the product process and increasing the sales advantages while the optimizations implemented on the products are satisfying the customer demands. So this thesis use QFD to determines Product Technical Requirements (HOWs) of men's t-shirt based on Customer needs (WHATs) and competitive analysis (WHYs), which represents a customer-driven and market-oriented process for decision-making in order to increase competitiveness Yirgalem Addis Textile which is one of Ethiopian integrated textile company.

This thesis employ QFD approach to develop an effective decision-making method to help make better decisions for planning or evaluation problems (Chin et. al., 2009). The thesis aims to answer, those research question.

How to integrate customers' needs of men t-shirt of Yirgalem Addis Textile with product technical requirements through Quality Function Deployment?

- ✓ What are the most important customers' needs and expectation from men's t-shirt of Yirgalem Addis Textile?

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- ✓ What product technical requirements fulfill those customer needs of Yirgalem Addis Textile?
- ✓ What is the current practice of Yirgalem Addis Textile in terms of satisfying those identified needs and product technical requirements men t-shirt?
- ✓ What is recommended for Yirgalem Addis Textile in addressing its customer demand and integrate it in the product development?

1.4 Objective of the Study

1.4.1 General Objective

This study aims at developing customer oriented textile product based on assessment of customer need and to integrate customer expectations and design quality into the product through Quality Function Deployment and examining its applicability.

1.4.2 Specific Objective

- ❖ To assess customer need of men t-shirt of Yirgalem Addis Textile.
- ❖ To identify Product Technical Requirements of men t-shirt.
- ❖ To suggest how to integrate need of customer with product development.
- ❖ To identify strength and weakness of the company.
- ❖ To give direction based on the assessment that help Yirgalem Addis Textile to be enough competent.

1.5 Significance of the Study

The basic thing in any company is to understand need of customer and to develop product that satisfy their customer. Quality Function Deployment is used to select the design features of a product to satisfy the expressed needs and preferences of the customer as well as to prioritize those features and select the most important features for special attention later in the design process. It helps the cross-functional team to make the key tradeoffs between the customers' needs and Product Technical Requirements so as to develop a high quality product.

1.6 Scope of the Study

The study mainly focuses on assessing need of customer of men t-shirts of Yirgalem Addis Textile and to develop customer oriented product with the application Quality Function Deployment based on customer need by considering the Product Technical Requirements.

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1.7 Limitation of the Study

In Quality Function Deployment adding competitive analysis other than the case company will make it better but since getting customer needs of competitors was difficult and time taking during the study so the study only uses the case company customer needs.

1.8 Organization of the Study

The study is organized into six chapters. The first chapter gives an overview of the introduction, problem statement, research question, and including objective of the study whereas chapter two is all about literature review about product development and Quality Function Deployment. Chapter three gives an overview of the case company profile, the fourth chapter deal with methodology to give a clear understanding the research design, data collection instrument and data analysis technique used in the study. Chapter five presents result and discussion, lastly chapter six consider conclusion, recommendation and future research.

Chapter Two

Literature Review

2.1 Product Development

Product development (PD) in broad terms may be defined as the process of conceptualizing, designing, creating, producing, introducing and delivering new products and services to consumers or improving on the old (product improvements). This process may be undertaken with a view to providing fresh user experience, addressing a need, providing solutions to problems, increasing customer base and market share as well as driving increase in sales and profit for a given company.

PD as the combination of a series of information processing, through which to transform market opportunities and demands into production knowledge.

NPD as the key in businesses and the motive of competitive advantages. In the process of NPD, a business does not simply promote new products, but has to satisfy customer demands and cope with competitors' threats. It is therefore important for businesses correctly analyzing the consumer market to draw the new product development strategies mostly suitable for the business. Since such strategies are the basis of NPD, they would affect the innovation of NPD, and valuable information should be mastered in the process of NPD (Huang et al.,2003).

Clearly defining the product concept could have the company deliberately define and evaluate the target market, product requirements, and product profits in the development process. Accordingly, market-orientation could provide businesses with necessary information in the market, such as characteristics of customer demands, market trend, and competitors' technique, and assist them in drawing the strategic model mostly suitable for the businesses (Cooper, 2003).

Moreover, product orientations of style design, brand segmentation, and good deal could enhance the product image and value. The higher product innovation requires stronger control of trade marketing that it is better to establish an autonomic marketing branch in oversea markets in order to directly acquire the first-hand information and enhance the decision-making power of trade marketing. The more direct trade marketing could result in better sales of innovative products. What is more, participating in exhibitions is a critical path to promote innovative products and acquire market responses for orders (Ulrike,2000).

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Demand-oriented or market-oriented pricing could be applied to innovative products; and, intellectual property rights are the guard of innovative products and the primary condition for industrial competition.

Extant research has provided strong arguments which indicate that customer empowerment in NPD enables firms to develop better products and at the same time to reduce costs and risks if customers in a given domain are willing and able to deliver valuable input (Christoph & Martin ,2011).

Traditionally, companies have been exclusively responsible for developing new product concepts and for deciding which concepts should be marketed zero-empowerment strategy (Christoph & Martin ,2011), see Figure 2.1.

Of course, they have listened closely to the VOC, as this has been identified as a clear prerequisite for successful NPD.

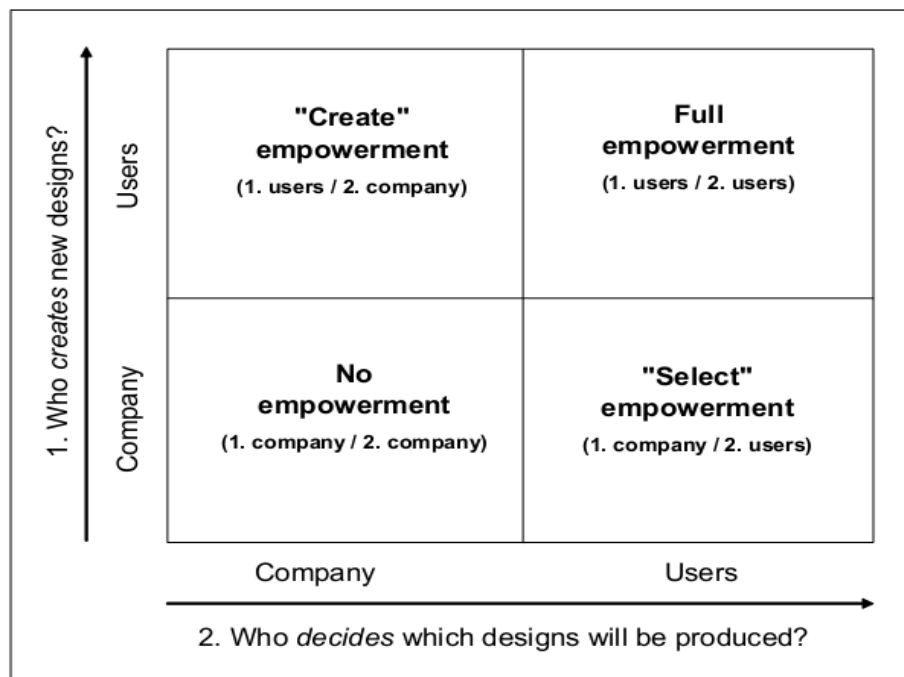


Figure 2.1 Customer Empowerment Strategies in NPD, Source: Adapted from (Christoph & Martin ,2011).

2.2 Product Development in the Textile/Apparel Industry

The sustenance and growth of the textile industry and by extension the fashion industry depends greatly in the process of product development as this is essentially its life-blood, for reasons, the least of which is the dynamic and ever changing demands and trends which are characteristic of this industry, because consumer demands are in a constant state of flux. Therefore, without the implementation of this all important process by any company in the industry, in two words: competitive sustenance, it runs the risk of its activities quickly grinding to a halt and possibly dying off.

PD strategies and processes for textile companies vary as much as the number of companies in this field, as well as the complexities and simplicities; values and visions; market share and penetration of each company. The basic steps that are essential for the actualization of any product development endeavor within the industry in focus.¹

- **Idea Generation:** This is the systematic search for new product ideas. A company typically has to generate many ideas in order to find a few good and useful ones. Product idea generation could be sourced either internally (Research and development efforts, executives, scientists, engineers, manufacturing staff, sales people) or externally (customers, competitors, distributors and suppliers). Idea generation, at individual or team level, emerges as an essential component of creativity and consequently of the innovation process. The most innovative firms usually exploit various sources of ideas from new products as well as various means to process those ideas. They also need to stimulate employees' imagination to feed the pipeline that nourishes the design and development of new products. Creative capabilities of organization are essential to their ability to innovate and survive in today's competitive environment (Galanakis, et al., 2006). The idea creation phase (creativity) is usually much less costly than the later development stages of the new product development process. It thus makes sense to maximize its output by providing a large number of ideas for further exploitation by the organization. The greater the number of ideas at the start of the new product development process, the greater the probability of ending up with successful products.

¹. www.linkedin.com/.../product-development-textileapparel-industry-

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- Idea Screening: Ideas generated in the process step mentioned above go through a procedure involving thorough screening and scaling based on the following criteria: feasibility of idea, design and development time, estimated cost of production, expected return-on-investment, benefit to consumer, competitors' market share, time to market and man-power and technological requirements This is the first evaluation of new product idea. It involves screening new-product ideas in order to spot good ideas and drop poor ones as soon as possible. In this stage, only product ideas that will turn into profitable products are adopted.
- Concept Development and Testing: Here, the product idea is drafted in verbal or pictorial form, further explaining the nature of the concept, initial ideas of impediments, materials and technologies. More so, in concept testing, new product concepts are being tested with a group of target consumers to find out if the concepts have strong consumer appeal (Fong, 2003). This step tests consumers' understanding of the product and creates an avenue for further improvement on the product. This step also samples consumer opinion on how the product will fare in comparison to alternative products in the market.
- Marketing Strategy Development: This involves the design of an initial marketing strategy for a new product based on the product concept. The marketing strategy statements consist of three parts; description of the target market, the planned product positioning, and the sales, market share, and profit goals for the first few years (Flynn, 2003).
- Business Analysis: This involves a review of the sales, costs, and profit projections for a new product to find out whether these factors satisfy the company objectives. More so, at this stage, a decision is made to ascertain the technical feasibility of the product, the products market potential and ultimately, the products financial contribution to the company (Nikolaos et al., 2004)
- PD: At this stage, the product concept is being developed into a physical and several product prototypes in order to ensure that the product idea can be turned into a workable product, everything that has been analyzed in the previous step is now put into action.
- Test Marketing: This is the stage of new product development in which the product prototype and marketing program are tested in more realistic market settings.
- Commercialization: This stage simply involves the introduction of a new product into the market through any of the promotional tool of marketing. In commercializing a product,

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such new products could be distributed intensively, exclusively or selectively. It is important at this stage that the supply chain for the company and new product(s) is maintained at its most efficient form. Monitoring of success of product in the market as well as reactions to pricing will also help the company to make adjustments for proper pricing as well as collate data for future ventures.

2.3 Critical Success Factors in Product Development

Critical success factors (CSFs) for the NPD process, based on the analysis of existing literature, is identified. Product innovation can be defined as the commercialization of a technologically distinct product, including new products whose design characteristics change to improve the service to users (Dougherty,1992). Now a day there is an agreement among the analysts in considering that a need for radical innovation of products arises when the properties, characteristics, uses, attributes, design properties and use of materials and components differ significantly from the pre-existing products. Such innovations usually rely on the introduction of new technologies or new applications of prior technologies. On the other hand, incremental innovation of a product is related to improvements to the existing product properties or functioning. This indicates that the development process of an existing product has been improved in a significant manner (Zirger and Maidique, 1990).

Ismail et al., (2012) summarize CSFs for NPD identified by previous researcher as seen in table below. In general, common factors across the three studies includes top management support for the team, structured NPD process with long term strategy and excellent quality of execution.

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Table 2.1 CSFs for NPD Identified by Previous Researchers. Source: Adapted from (Ismail et al., 2012)

References	CSFs
Cooper and Kleinschmidt (2007)	<p>A high-quality new product process that demanded up-front homework, sharp and early product definition, tough Go/Kill decision points, and quality of execution, thoroughly, yet flexible.</p> <p>A defined new product strategy with new product goals, delineated areas of focus, new product roles clearly communicated, all with a long-term thrust.</p> <p>Adequate resources of people and money</p> <p>R and D spending for NPD (as a % of sales) – by far the strongest determinant of the impact of the NPD effort.</p> <p>High-quality new product project teams</p> <p>Senior management commitment and involvement</p> <p>An innovative climate and culture</p> <p>The use of cross-functional project teams</p> <p>Senior management accountability for new product results.</p> <p>Customer focused</p>
Cooper (2005)	<p>Front-end loaded – an emphasis on homework prior to development</p> <p>Develop products superior to competitors</p> <p>Excellent quality of execution</p> <p>Tough, rigorous Go/Kill decision points</p> <p>NPD performance metrics (e.g. Net present value, sales, on-time launch)</p> <p>A Process Manager to lead the process</p>
Bender et al. (2000) Lynn et al. (1999)	<p>High-quality vision</p> <p>Adequate funding and aggressive deadlines (time factor)</p> <p>Teaming factors (skills, experience, stability)</p> <p>Information storage and processing</p> <p>Having a structured new product development process</p> <p>Having a clear and shared vision on the team</p> <p>Development NPD process</p> <p>Development and launching a product within the proper time frame</p>

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	Refining a product after launch and having a long-term view Possessing the optimal team skills Understanding the market and its dynamics Securing top management support for the team and the team's vision Applying lessons learned from past projects Securing good team chemistry ,Retaining team members with relevant experience
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2.4 Customer Oriented Product Development

Research indicates that the commercial performance of new products depends on how well the market opportunity has been identified, analyzed, and incorporated into the product's design (Dougherty,1990).

The basic condition for a product design based on CNs is to get acquainted with the expectations of the customers and the society (everyone concerned), and to translate these demands to technological terms (Vera & Márta, 2008).

Balakrishnan (1996) defined customer-orientation as the degree to which a firm analyzes its customers' needs and preferences before developing its marketing mix and also the quality of its interactions with its customers as it implements its marketing mix.

Customer orientation is the sufficient understanding of one's target buyers to be able to create superior value for them continuously (Slater et. al,1994). Consumer-oriented firm can be defined as a firm with the ability and the will to identify, to analyze, to understand, and to answer user needs.

Consumer orientation also emphasizes the identification of possible markets in the case of a technological breakthrough looking for commercial applications. Finally, a consumer orientation helps the firm to learn a large part of the market's technical issues and provides an evaluation of possible segments, of the importance of the market, and of its growth rate. Consumer oriented also called user-centered.

Nevertheless, the emergence of user-centered design has naturally clarified the scene and brought together design practice and user research activity. The contribution of user-centered practices in the design activity has augmented the understanding of 'user' needs. The emergence of user-centered design has happened by a step-by-step contribution of user-centered practices in the practice of design. The gradual convergence of user-centered practices and design practice has

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initiated by the contribution of practices from ‘biological’ and ‘social’ sciences to the practice of design and augmented the understanding of user experience (Sanders, 2001).

Sanders (2001) outlines the development of the user-centered approach in terms of step-by-step contribution of user-centered practices to the design practice as follows:

- ✓ Fit to the body was emphasized in the field of ‘ergonomics’ or ‘human factors’.
- ✓ Fit to the mind was seen in the introduction of ‘cognitive ergonomics’, leading to new fields such as information design and interaction design in the 1980’s.
- ✓ Fit to the social aspects of human behavior came with the advent of ‘applied ethnography’ and ‘contextual inquiry’ in the 1990’s.
- ✓ Fit to the emotional domain is just now receiving attention, as seen in interest areas such as ‘affective human factors’.
- ✓ Fit to the dreams and aspirations of the people who will buy and use the goods and services that we design is the next step.

User-centered approach (UCA) is not only a model providing need-related information to the design process, but also an understanding that focuses on user experience rather than the product or the design problem. Marzano (1997) emphasizes the shift from focusing on products to user experience as what consumers want is not products, but benefits. So it is to shift focus from products to customer benefits.

2.5 Methods for Assessing User Needs

In contrast, in today’s dynamic environment with enormous changes in user needs and expectations, utmost technological advancements, growing international competition and decreasing product life cycles, the only way for companies to survive is a good coupling of thoroughly understanding user needs with an awareness of technological possibilities (Crush, 2000; Holt et al., 1984). To understand the real needs of the users, it is needed to apply systematic, well-defined procedures and ‘methods’ through the process of collecting need related information.

Considering the large number of methods, Holt et al. (1984) classify these methods into three categories:

2.5.1 Utilization of Existing Knowledge: this is relatively cheap way of obtaining information about user needs. The major problems are to locate the most important sources, to train and make those involved need- conscious, and to develop and maintain a practical procedure for systematization, registration, and utilization of relevant data.

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2.5.2 Generation of New Information: this approach requires a relatively great effort and therefore a more expensive way of assessing user needs. One has to plan and implement special activities in order to provide the information. On the other hand, the information acquired in this way is usually more complete and reliable.

2.5.3 Provision of Need Information by other Methods: this group includes informal approaches, i.e. information related to user needs obtained by informal contacts with knowledgeable persons, and 'environment-related methods' such as product safety analysis, ecological analysis, and resource analysis (Holt et al., 1984).

2.6 Customer Need and Kano Model

The Kano model provides an effective way of categorizing CNs and helps understand the nature of these needs. The Kano model divides the product or service attributes as following categories each of which affects customers in a different way as following (Tan & Shen, 2000).

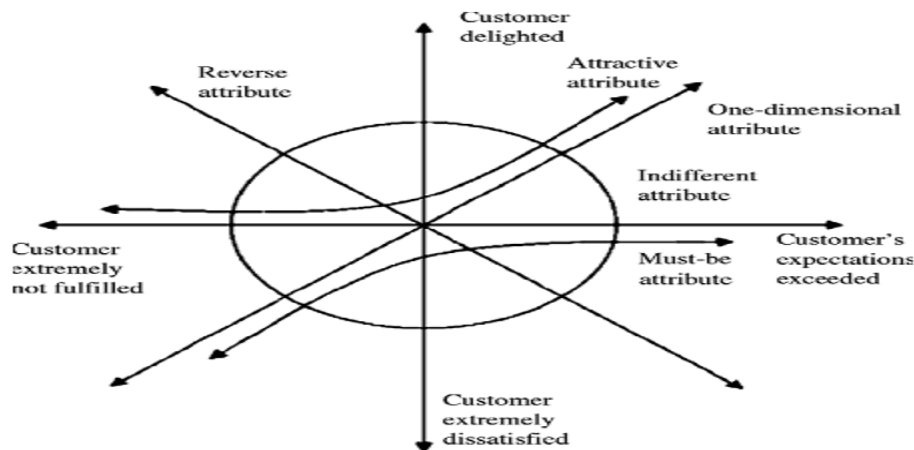


Figure 2.2 Kano Model. Source: Adapted from Cheng and Chiu (2007).

1. Must-be attributes (M). The must-be attributes fulfill the basic functions of a product. If they are not fulfilled, customers will be very dissatisfied. However, their fulfillment will not increase satisfaction since the customers take them for granted.

2. One-dimensional attributes (O). These result in customer satisfaction when fulfilled, and dissatisfaction when not fulfilled.

The higher the level of fulfillment, the higher the customer's satisfaction, and therefore, customer reaction depends linearly on the level of fulfillment only for one-dimensional attributes.

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3. Attractive attributes (A). These attributes are not expected by customers and thus fulfilling those leads to more than proportional satisfaction. On the other hand, if they are not met, there is no dissatisfaction.

4. Indifferent attributes (I). This category means that the customer is indifferent to this product attribute; that is, customers do not care whether they are fulfilled or not.

5. Reverse attributes (R). These attributes contrarily cause customer dissatisfaction when fulfilled and satisfaction when not fulfilled.

6. Questionable attributes (Q). This rating indicates that either the question was phrased incorrectly, or the customer misunderstood the question, or an illogical response was given.

2.7 Understanding Customer Choice Decisions: The Voice of the Customer

One of the essential strategies for successful functioning of any organization is delivering superior service or product quality to their customers. Understanding what exactly the customer's needs and wants, (VOC) are is a key criterion in total quality management (Griffin and Hauser, 1991). The first step towards understanding CNs is to identify attributes and customer consequences. Attributes are defined as the physical or abstract characteristics of a service or product. They are objective, measurable, and reflect the provider's perspective. Consequences are a result of using attributes; basically, an end result in what a customer "gets" from using a service or product.

Customers judge services and products based on their consequences, not their attributes. In other words, customers judge a service or product on its outcome, or effect of use on them. A service or product has many attributes, and each may have more than one consequence (Fisher and Schutta, 2003).

The VOC is a term used in business to describe the process of capturing customer s' requirements. The VOC is a product development technique that produces a detailed set of customer wants and needs which are organized into a hierarchical structure, and then prioritized in terms of relative importance and satisfaction with current alternatives (Griffin and Hauser, 1991).

The VOC process has important outputs and benefits for product developers. VOC provides:

- ❖ A detailed understanding of the customer's requirements.
- ❖ A common language for the team going forward.

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- ❖ Key input for the setting of appropriate design specifications for the new product or service.
- ❖ A highly useful springboard for product innovation.

There are four aspects of the VOC – CNs, a hierarchical structure, priorities, and customer perceptions of performance.

Customers continually want more reliable, durable products and services in a timely manner. In order to remain competitive, all organizations must become more responsive to customers, QFD has been widely used to capture the VOC and translate it into technical requirements in the development of products and services. It is a link between product or service development and technical specifications to achieve customer satisfaction. Applications of QFD range from product development, service development, and product re-projecting (Carnevalli & Miguel, 2008).

2.8 Quality Function Deployment

QFD was developed by Yoji Akao in Japan in 1966 (Akao,1997). Olhager and West (2002) described QFD method as an attempt to build a structured method to deploy flexibility related CRs in the features of various manufacturing systems. The unique approach of its ability to integrate CNs with PTRs. It helps the cross-functional team to make the key tradeoffs between the customers' needs and the technical requirements so as to develop a high quality service or product.

QFD as it is commonly known, is a process that provides structure to the development cycle. This structure 'can be' likened to the framework of a house. The foundation is customer requirements. The frame consists of the planning matrix, which includes items such as the importance rating, customer-perceived benchmarking, sales point, and scale-up factors. The second floor of the house includes the technical features. The roof is the trade-off of technical features. The walls are the interrelationship matrix between the CRs and the technical characteristics. Other parts can be built using things such as new technologies, functions, technical characteristics, processing steps, importance ratings, competitive analysis, and sales points. The components utilized are dependent upon the scope of the project (Akao & Mazur,2003).

The QFD process starts with the identification of the needs of the customers. A customer need is a description, in the customer's own words, of the benefit to be fulfilled by a product. Identifying and prioritizing CNs are extremely important for effective PD because, generally, consumers evaluate product(s) on more than one criterion. Therefore, the QFD process starts with the

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collection of qualitative and/or quantitative information from the customer about their needs and preferences (Cengiz et al., 2004).

In general, QFD facilitates organization: 1) understanding the actual requirements of customers, 2) prioritizing CRs in order of importance from the customer's point of view, 3) communicating among team members in order to ensure decision making and reducing loss of data, 4) designing the products which meet or exceed CRs, 5) planning or selecting the product design strategically (Han et al., 2001).

When the firm adopts the QFD approach it directly affects the product life cycle (PLC) and product/process development cycle (Vivianne & Hefin, 2000). It is very clear that QFD use the VOC; the CNs and requirements changes continuously and firm have to respond accordingly.

The firm introduces a new product in market and customers get satisfied with the product design and features certainly the product will move towards the growth stage. As the growth stage is going to get completed the customer's needs and requirements start changing and customer wants something new with more features. Now at this time if the organizations do not respond to the customer changing needs in a timely manner the product will eventually move to the maturity and then declining stage. So if the firm wants to remain in market it has to design product according to the customer wants. when appropriately applied, QFD has demonstrated the reduction of development time by one-half to one-third (Akao, 1990).

Figure 2.3 shows the PLC Stages before QFD implementation here as shown the gap between the stages is short so product quickly moves towards the decline stage and figure 2.4 shows the PLC Stages after QFD implementation, here can be seen that the gap between stages increased hence the product can enjoy more time in market. they are still in growth stage, reason behind this is that they quickly respond to their customers' requirements and needs and they keep on adding new features in their products as per market requirements which helps them to give new life to their existing products.

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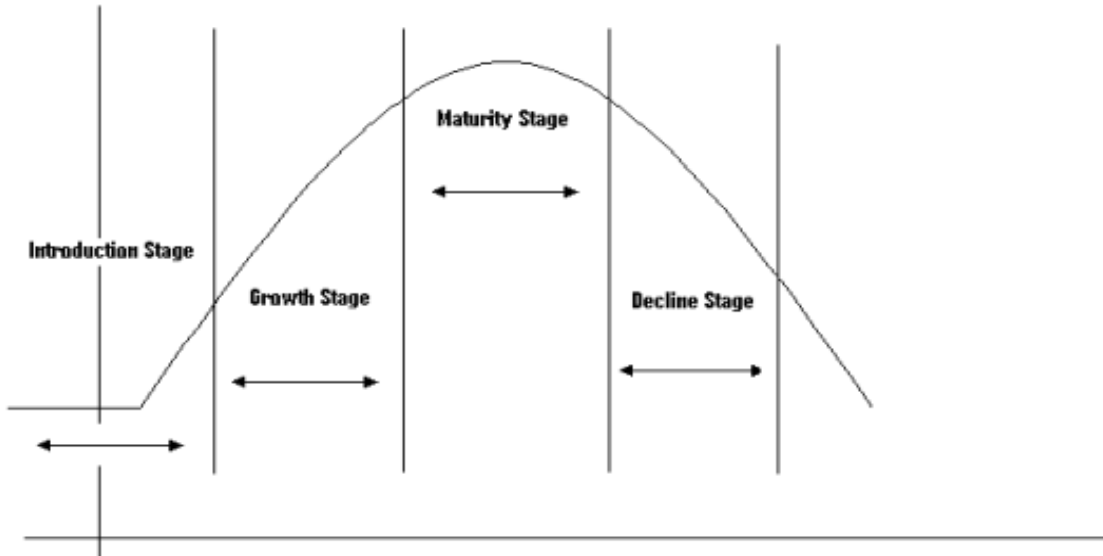


Figure 2.3 PLC Stages Before QFD Implementation. Source: adapted from (Usman & Faisal,2009).

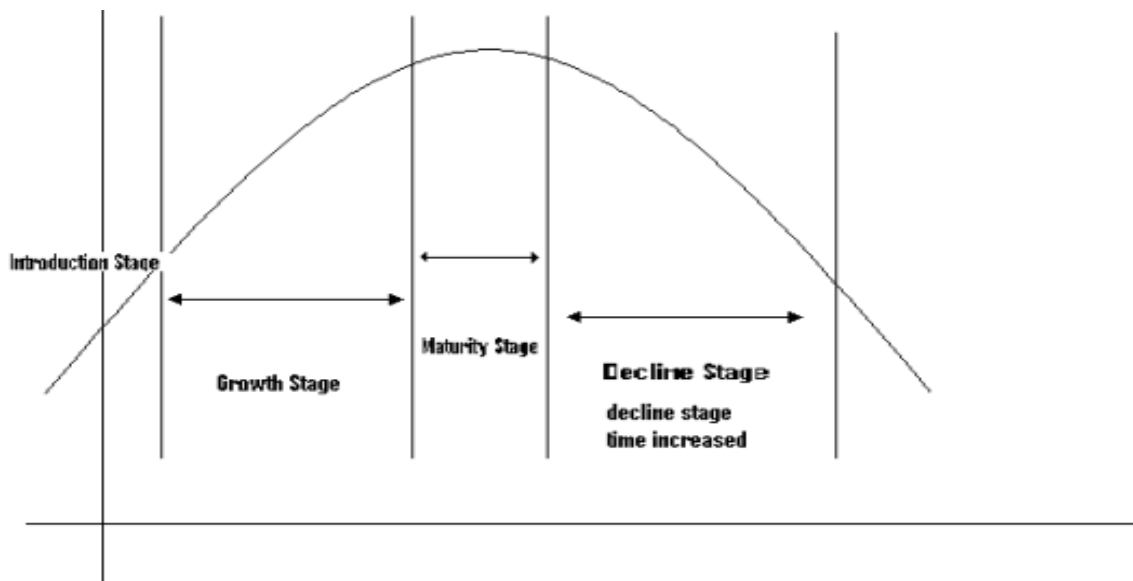


Figure 2.4 PLC Stages After QFD Implementation. Source: adapted from (Usman & Faisal,2009).

The opportunities to apply QFD in service and business sectors are rapidly expanding, QFD has been used to enhance a wide range of service aspects in healthcare, chemical and telecom industries as well as the typical product design applications. It is vital for companies to identify the exact needs of the customers and to measure their satisfaction to survive in the current competitive market. QFD focuses on designing in quality rather than inspecting in quality which reduces development times, lowers startup costs, and promotes the use of teams (Fisher and Schutta, 2003).

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2.8.1 Seven Principles of Modern QFD.

There are seven basic principles behind Modern QFD;

2.8.1.1 Focus with Priority

Each of the Management and Planning tools are used to address fundamental QFD principles. Prioritization allows the organization to focus their human and financial resources to deliver maximum value to the customer. Random improvements are replaced by aligning set efforts to what matters most to the customer.

2.8.1.2 Understand the Causes

Another fundamental principle of QFD is cause-effect relationship. Causal factors are typically the constituents of products, such as product attributes, design elements, processes, and other issues related to our product and technology. Effects are outcomes that lead to benefits to the customer.

2.8.1.3 Understand the Situation

The Japanese have a word to describe “the true source of information” Gemba. In manufacturing, Gemba refers to the shop floor. When there is a problem, the engineers go directly to the work area and use their own eyes to see, their own ears to hear, their own hands to touch, etc. They rely on direct experience to understand the relevant situation we might help them realized.

2.8.1.4 Market-in vs. Product-out

One of the most critical business process is NPD. Without new products, an organization becomes stale, isolated from its customers, and may be forced to compete by lowering process on existing products.

A fundamental QFD principle is to drive PD by beginning with the customer’s need (market-in), rather than how the product can be changed or enhanced (product-out). Any organization claiming to be customer-centered must understand.

2.8.1.5 Define the Process

Another fundamental principle of QFD is that maximum benefits to organization results from continued use of method. The learning curve can be steep, so it is best to “depreciate” this over multiple projects over time. Further, the information acquired and the charts created can be re-used, often with little more than minor revision after validating with current market conditions.

2.8.1.6 Better Communication

One of the most frequently cited reason for doing QFD is to improve communications within the organization. QFD addresses both internal and external communications at both the human level and the technique level.

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2.8.1.7 Listen to the “Voice of the Customer”

A common misunderstanding among QFD and other quality professionals concerns what the “Voice of Customer” is. In the most cases, it is necessary to go beyond the started requirements in order to build a competitive and profitable product.

Why? State or voiced requirements can be met by any competitor who has access to them. This has led to a commoditization of products that differ little within a certain price point. In such case, the way to succeed is by lowering price, which is not always a long-term strategy for everyone (Mazur,2008).

2.8.2 QFD Structure

Phase of QFD: The QFD system consists of the following four interlinked phases (Cengiz et al.,2004), as shown in figure 2.5 below.

Phase I-The first phase of QFD system is HOQ. This translates CNs (WHATs) into engineering characteristics (ECs) the HOWs.

Phase II-QFD second phase is parts deployment, which translates key ECs (new WHATs) determined in the previous phase into parts characteristics (HOWs).

Phase III- Process planning, which translates key parts characteristics (new WHATs) obtained in the previous stage into process operations (HOWs). During process planning, manufacturing processes are flowcharted and process parameters (or target values) are documented.

Phase IV-Finally, the company needs the right production plan to get the processes to run effectively and efficiently. This results in the last phase, production planning, which translate key process operations (new WHATs) into day-to-day production requirements (HOWs).

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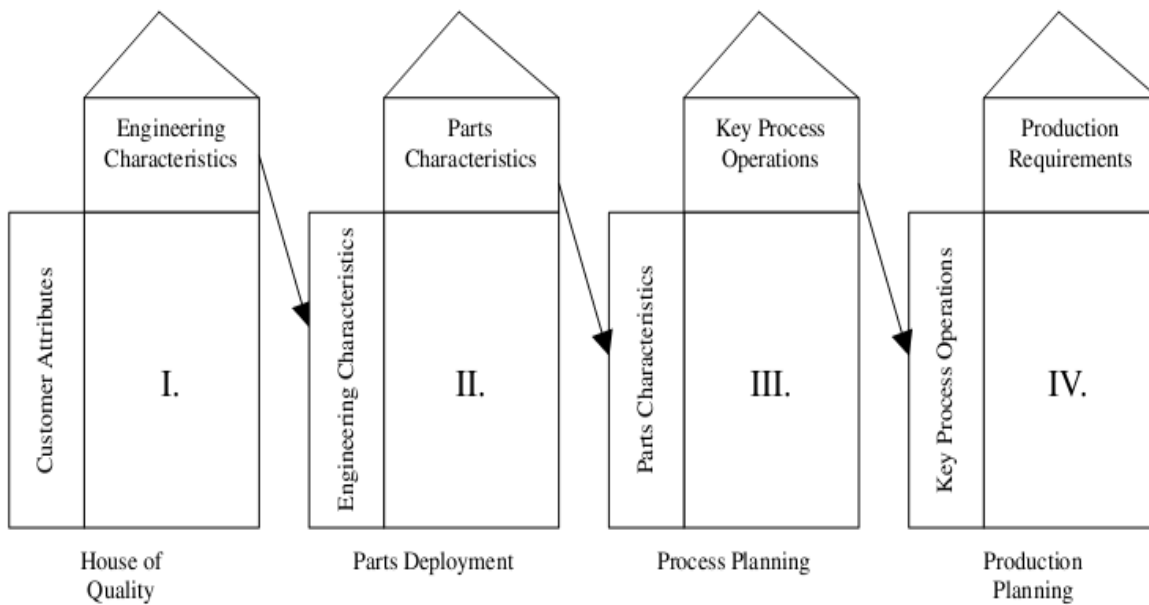


Figure 2.5 The Four Phase of Quality Function Deployment (QFD). Source: Adapted from (Cengiz K. et al.,2004).

QFD or the HOQ is the foundation to link the voice of the customers with technical design requirements of a product. HOQ is the first phase of the QFD system. The purpose of HOQ is to transform customer needs into product design specifications (referred to in QFD terms as “Engineering Characteristics”). HOQ shows what customer wants and how designer fulfils the requirements in product development phase. It provides a framework and guides the designer to set the target to improve their product quality.

QFD analysis, a matrix of HOQ is used to display the relationship between the CRs (referred to as “WHATs”) and the ECs (referred to as “HOWs”). It identifies the interrelationship matrix between CRs and ECs. This matrix summarizes information about ECs and their associated customer ranking and the correlation between the ECs parameter. Six HOQ steps are following in Figure 2.6.

Step I. Has a list of CNs and identify the degree of importance of each CNs.

Step II. Contains market data, strategic goal setting for the new product and computations for prioritizing the CNs.

Step III. Includes information to translate the CNs into the organization’s technical description or ECs.

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Step IV. Contains the relationship matrix between each CNs and each ECs.

Step V. The “roof” of HOQ assesses the correlation matrix between each ECs;

Step VI. Contains the prioritization of the ECs, information on the competitors and technical targets.

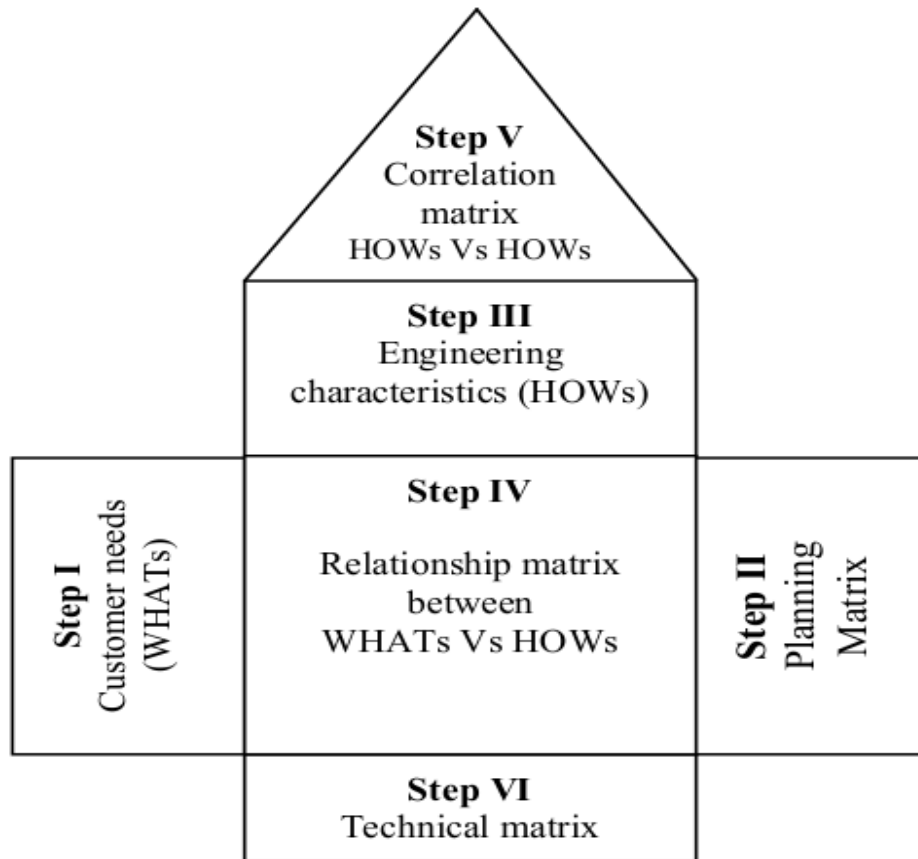


Figure 2.6 The House of Quality. Source: Adapted from (Chan L.K, &Wu M.L. 2004).

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2.8.3 Benefit and Drawbacks of QFD

Hunt and Xavier (2003) concluded the several research reports in the 1990s and tabulated the benefits of the QFD below:

- ✓ It develops collaboration between individuals and departments.
- ✓ It facilitates the developments of a sense of ownership through the involvement of many individuals, this ownership then drives the strategy implementation process.
- ✓ It identifies customers and their needs with regards to the strategic formulation process.
- ✓ It enforces a methodical and comprehensive analysis of all relevant relationships.
- ✓ The matrices provide a comprehensive document of all the data used and decisions taken in the strategic decision process.
- ✓ Emotions and politics are to a large degree removed from the strategic process.
- ✓ The completed matrices can be reused dynamically to allow a rapid refocusing of strategy if circumstances change.
- ✓ It maintains consistency with the firm's capabilities.
- ✓ The techniques lead decision-makers through complex decisions and provide a structured view of fuzzy "issues".

And Chan & Wu (2002b) cared more about the intangible benefits of the QFD model. They summarized the contents of the benefits by using a structured table to state. The table is shown below.

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Table 2.2 The Intangible benefits of the QFD model. Source: Adapted from (Chan & Wu 2002b).

QFD benefits	Enhanced customer-orientation	<ul style="list-style-type: none"> ✓ Structuring “the voice of the customer “. ✓ Creation of focus on customers need. ✓ Effective use of competitive information. ✓ Identifications of area to be acted upon. ✓ Improved customer-company relationship. ✓ More satisfied/delighted customers.
	Effective product development	<ul style="list-style-type: none"> ✓ Lower start-up and product costs. ✓ Shorter design cycles. ✓ Fewer midstream design changes. ✓ Limiting post-introduction problems. ✓ Avoiding future development redundancies. ✓ Identifying future application opportunities.
	Improved communications and team works	<ul style="list-style-type: none"> ✓ Involvement of every function and everyone. ✓ Provision of a common language. ✓ Decrease of cross-functional barriers. ✓ Provision of working procedures and focuses. ✓ Living documentations for future applications. ✓ Improved company management and culture.

Some drawbacks of QFD.

- ✓ QFD is a qualitative method. Due to the ambiguity in the voice of the customer, many of the answers that customers give are difficult to categorize as demands, the HOQ can become very large and complex, setting target values in the HOQ method is imprecise strength relationship is ill-defined (Vivianne and Hefin,2000).
- ✓ Process-related improvements more difficult to achieve than product-related ones, benefits service developers more than product developers, improvements increasingly difficult with increasing product complexity (Griffin,1992).

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2.8.4 Application of QFD in Textile

The literature about application of QFD in the textile are limited to the best of this study. They are few articles that have been published claim that QFD is a suitable and promising method to facilitate the textile product development process. However, it has been reported that QFD still needs a lot of development and understanding before the method can be applied. Their main focus is on the first matrix: The HOQ.

Table 2.3 Literature Review of the use of QFD in Textile.

Reference	Product used	Notes	More matrices used
Chutima & Sudawan (2006)	Sport bra	The Authors use QFD as a means of product development after identifying customers need in sport bra product.	Only product design matrix that combines information from marketing research with information from product technology.
Esra & Turan (2014)	-	Authors determine the factors that affect the brand loyalty of consumers by using QFD in apparel industry.	Planning matrix and house of quality.
Cezar et al.,(2014)	Men's shirt	Authors built the house of quality for men's shirt.	House of quality.
Samira et al.,(2012)	Men's shirt	Authors using house of quality they determine the most important factors impacting the customer's clothing selection.	House of quality.
Vera & Marta (2008)	Curtains	Authors developed a new, innovative design method, which considers the full life cycle of the product, they extended the widely used QFD method.	House of quality.

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2.8.5 Some Success Story of QFD

With QFD for the first time, many development teams will learn why their products or services behave in a particular way. They will understand why customers prefer some aspects of their competitor's products (Hales, 1995).

Under QFD, time is spent up front by the design team carefully defining product requirements from the customers' point of view. These requirements typically are of three types: (1) CNs, (2) customer expectations or wants, and (3) exciting features. While product definition time increases with QFD, the total design cycle time is reduced by eliminating design changes in subsequent stages. The design-to-market cycle time often can be reduced from 20 to 90 percent because technical targets planned in the early stages help designers avoid problems in later stages (Juliard, 1991).

In some organizations, while maintaining and enhancing design quality, QFD has helped reduce design time by 40% and design cost by 60 % (Hauser 1993). Toyota and NGK reported the following benefits from using QFD: engineering changes were cut by 30% - 50%, design cycled were shortened by 30-50%, start-up costs were trimmed by 20-60% and warranty claims were reduced by 20-50% (Kathawala and Motwani, 1994).

In 1990, Puritan-Bennett, a medical equipment company, successfully used QFD to help redesign its spirometry business in order to regain their market share (Hauser, 1993).

Chapter Three Company Profile

3.1 Background

Yirgalem Addis textile factory PLC is formerly Adei Ababa yarn factory which was privatized by the Government in Nov, 2010. The Company had more than 50 years' experience in spinning, knitting, weaving, dyeing, garments and blanket activities. The factory is located on a prime & accessible location in the southern part of capital city Addis Ababa on Debrezeit road, Nifas Silk Lafto sub city.

Yirgalem Addis Textile Factory plc is owned by W/o Yirgalem Asfaw, a woman entrepreneur, highly committed to transform the factory to one of the biggest textile and garment manufacturer in Ethiopia.

Currently, the factory has more than 800 employees and 90% of the employees are women. It is important to mention company is also helping HIV patients by providing them employment. Registered HIV patients in the company are 23 in numbers.

3.2 Products of the Company

Yirgalem Addis Textile Factory PLC products are categorized as below:

- ✓ Various counts of cotton yarn
- ✓ Bleached yarn
- ✓ Grieg knitted fabric in various density and constructions (Including collar and cuff)
- ✓ Stock net
- ✓ Dyed knit fabrics
- ✓ 100% cotton Knit garment such as crew neck t-shirt, polo shirt and under wears
- ✓ Sport wear
- ✓ Woven garments like work wear and Military uniforms
- ✓ Stone washed garments
- ✓ Embroidered Garments
- ✓ Woven Blanket
- ✓ Non - woven blanket

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3.3 Major International and Local Customers

The factory has been supplying its products to the following major international and local customers:

- International Red cross society
- Intra Health International
- USAID
- Goal Ethiopia
- Ethiopian Army
- KIK Textile, Germany
- Weather Proof, USA
- David payser sportswear, USA
- Champro sports, USA
- Coca Cola Company (East African bottling house)

3.4 Production Facilities and Capacity

The company is an integrated textile factory consisting of:

- Spinning
- Knitting
- Knit dyeing
- Garment stone washing
- Blanket weaving, blanket stitch bond (non-woven)
- Garment production.

Table 3.1 Production capacity with its attainable capacity of Yirgalem Addis Textile

No	Section	Units	Designed	Attainable Production		Remark
			Per day	Per day	Annual (Av.)	
1	Garment	Pcs.	7500	6000	1800000	1 shift
2	Knitting	Kg.	6500	2500-6000	1275000	3 shifts
3	Spinning	Kg.	6000	3100	1116000	3 shifts
4	Dyeing	Kg.	6000	3000-5000	1200000	3 shifts
5	Blanket	Pcs.	950	800	240	3 shifts
6	Non-woven	Pcs.	1237	1000	300000	3 shifts

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3.5 Quality Control

The company has laboratories in spinning, dyeing and blanket plants with modern laboratory equipment's to ensure customer quality requirements.

3.6 Expansion and Rehabilitation Project

The company is undergoing expansion in its blanket and garment plants and rehabilitation project in its knitting and dyeing plants that enables the company alleviate its bottle necks and be more competitive in the international market.

3.7 Mission, Vision, Core values and Principles

3.7.1 Mission

To satisfy customers who demand quality apparel and excellent service to ensure sustainable growth of the business. Our main export customers are fast moving international companies and our local customers are both organizations and final consumers who trust our brand, traditions and innovations.

3.7.2 Vision

To be one of the nation's leading apparel, knitting fabrics and blanket manufacturer that satisfies its customers' need.

3.7.3 Core value and Principles

Fairness and integrity: adhere to the principles of fairness, be honest, transparent to all stake holders.

Innovation: be oriented towards learning and continual improvement.

Excellence: be operationally and professionally excellent.

Social responsibility: build up belongingness to employees and communities.

Chapter Four
Methodology

4.1 Research Design

This study adopts both a combination explorative and conclusive research design. An explorative study is a study concerned to explore the research questions that is customer need, whereas conclusive research design is aimed to provide final findings for the study.

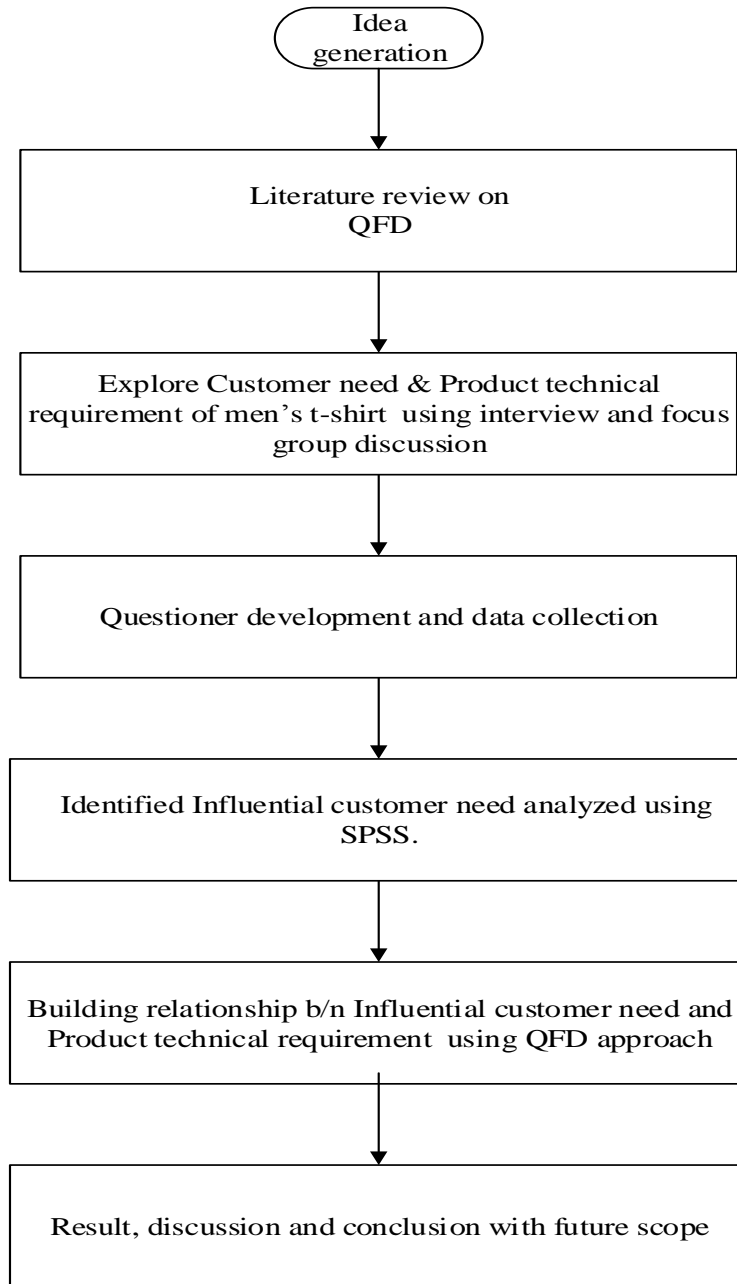


Figure 4.1 Flow of the Research Design

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4.2 Target Population

Due to the unknown number of customers, the sample size to explore the needs of customers and the rating of customer satisfaction through two questionnaires have been calculated with respect to Equation 1:

$$n = \frac{P(1 - P)Z^2}{d^2} \quad \text{Equation 1}$$

where n is the sample size, P is the expected proportion at 30%, Z is a normal random variable, and d is the margin of error in estimating P.

The confidence level corresponds to a Z-score. This is a constant value needed for this equation.

At 90% confidence interval $-Z$ score = 1.645, $d=0.1$, refer Appendix 7.

$n = \frac{0.3(1-0.3)1.645^2}{0.1^2} = 56.82$ customers are needed to be surveyed regarding to Equation 1 in order to obtain the CRs information.

The target population of this study also comprise of employees of Yirgalem Addis Textile from production and technique, knitting unit, dyeing unit, Garment unit to identify product technical requirement.

4.3 Data Collection

Primary data are collected regarding the need of customer towards Yirgalem Addis Textile t-shirts, collected using focus group discussion, the respondents for this study was employees from various functional areas in the company to identify PTRs and from end customer to assess their need. Data collected using structured questionnaires, interview and focus group discussion.

Focus group discussion can reveal a wealth of detailed information and deep insight, Griffin and Hauser (1991) suggest that interviews / Focus group discussion with 20-30 customers should identify 90% or more of the CRs in a relatively homogeneous customer segment.

The interview/ focus group discussion question includes

1. What is that as customer your needs or expectation in a men's t-shirt?
2. What do you look for when purchasing a t-shirt?

This paper focuses men who are 18 to 45 years old living in Addis because most t-shirt are wear with this age range. The company that investigated sells the products in their shopping center located inside the company and distributed 75 questionnaires and collected 60 properly filled ones. During the survey, the researcher provided accompanied surveyed people just to make sure they could fully understand the concept of the survey along with the objectives.

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The purpose of the interview process/focus group discussion is to promote the customer to talk. To elicit needs from a customer, the researcher used a probing technique repeatedly by asking "why" to determine the attributes responsible for making a specific feature appealing to them. Fifteen CNs were developed from the interview data and focus group discussion.

4.4 Survey

The next step was to obtain the importance rating and rankings of each need from the customer base. A survey was conducted of 60 customers regarding the relative importance of the needs and level of satisfaction on each regarding to Yirgaalem Addis men's t-shirt. The reason behind this was to avoid misinterpretation of the customer's overall attitude or satisfaction towards the product that could lead to poor prediction of the customer's purchase behavior.

First, the respondents were asked to identify the most important need to them and label it as 5. To prioritize CRs on a scale of 1 to 5 (1 =not important,2=not very important,3=somewhat important,4=very important and 5 = most important).

The second part of the survey the respondents are asked to evaluate the particular product (Men's T-shirt) on each CNs on a standard 5 point Likert scale. Where,

On the scale level. Extremely Satisfied 5, Satisfied 4, Indifferent 3, Unsatisfied 2, Extremely Unsatisfied 1

The reason why the researcher asks customers just to rate on scales from one to five is that it is easier for the customer to choose. Their choice is limited to top, middle, bottom, above middle or below middle. The process of averaging and rounding up then gives the increased distribution that require to make the QFD analysis easier.

In order to fulfil those customer need in men's t-shirt which is found using focus group discussion, PTRs should be identified that fulfill the customer need. So for this purpose the researcher use again focus group discussion and interview from Yirgalem Addis Textile worker from each section that is production and technique, knitting unit, Dyeing unit and Garment unit. Those PTRs identified using focus group discussion and interview mentioned below.

- Suitable design
- Anti-wrinkle action
- Appropriate sewing machine setting
- Production planning optimization
- Gloss
- Parameter setup
- Size and shape stabilization
- Range of colors and patterns
- Faber content of fabric
- Printing and packaging specification

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- Elasticity of volume
- Resistance to dye
- Ability not to form pilling
- Sizes/complying with the standard
- Type of material

The PTRs are also identified on level set out in difficulty scores from 1 to 5 (5 for extremely difficult).

4.5 Data Analysis Technique

The main idea of QFD approach is building a design strategy over the VOC. The CRs should be carefully studied and defined to take the first steps in the study before going further in the next phases. The next phases of the QFD are about converting the CRs into corresponding PTRs in order to combine both design and production issues in the same study. This methodology integrates the CRs and product specifications into the product design process so that the product will be likely to capture a reasonable customer attraction on the market.

Chapter Five
Result and Discussion

5.1 Customer Needs

The first step is to elicit and capture the basic needs and requirements of the customer - or WHAT is it that the customer wants ,as in the first phase the data obtained on CRs and needs about the respective product, information about the most important quality characteristics of the product or about the technical capacity of the organization to get those quality characteristics necessary to meet CRs in terms of efficiency, product planning is considered critical for the success of the entire QFD process.

As mentioned in methodology section the research used explorative research design to identify CNs towards men t-shirt. Focus group discussion use as a means to get CNs; those needs are mentioned below.

- ✓ Easy to wear.
- ✓ Comfortable to wear.
- ✓ T-Shirt designs.
- ✓ To be attractive.
- ✓ To be safe, resistant to wear and washing.
- ✓ Ensuring a smooth movement of the body.
- ✓ To match to as many clothes.
- ✓ To be molded on the body.
- ✓ Various style to choose and many color available.
- ✓ To have appropriate sizes.
- ✓ Not to wrinkle easily.
- ✓ Having the proper sewing.
- ✓ Dimensional stability.
- ✓ Reasonable price.
- ✓ Look trendy, fashionable.

5.1.1 Organizing Customer Needs

There are three reasons behind organizing the CNs:

- To organize the raw customer data into groups of associated data to simplify using the QFD charts at a later stage.
- Because the CNs are listed in the language of the customer, the process of organizing the data allows the study to reach a common understanding of customer wants.
- The customer research techniques by the nature of their sampling and the customer responses may not highlight all the CNs. The process of organizing listed below gives the study a chance to surface areas and requirements which the customer has not talked about.

Customer-oriented product development

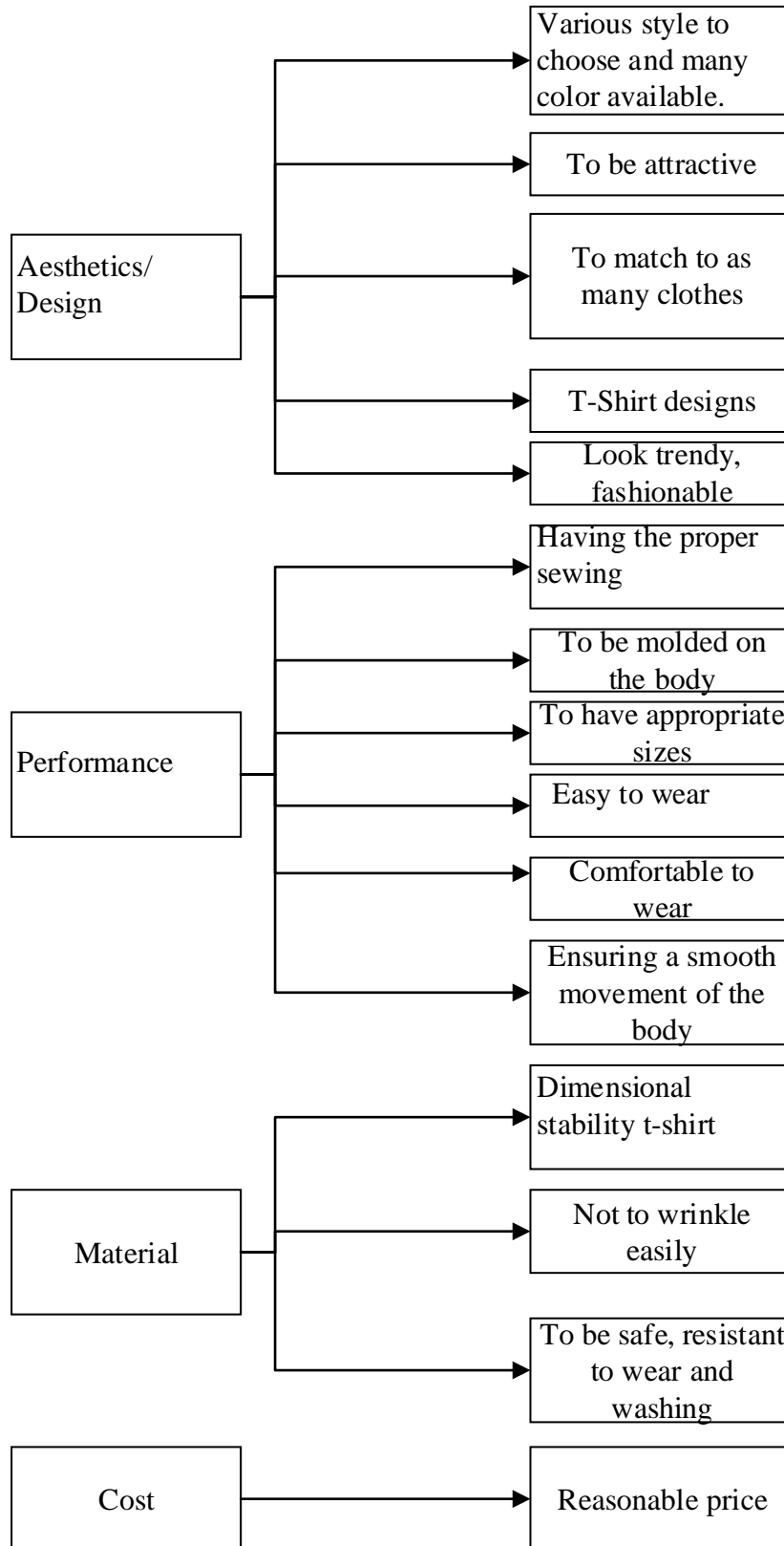


Figure 5.1 Attribute and Customers' Needs

Customer-oriented product development

Hence, the gathering and use of CRs is the foundation of QFD. It follows, therefore, that the first area that must be understood in QFD is that of CRs. As QFD is a technique for translating the CRs into a product design. Since the CRs are identified as shown in the above, the table below shows their rating on a scale on a scale of 1 to 5 (1 =not important,2=not very important,3=somewhat important,4=very important and 5 = most important). After analyzing the data with SPSS version 22 this are the result.

Table 5.1 customers' Needs with its Scale of Importance

Customers' needs	n	Mean	Std. Deviation
Easy to wear.	60	3.4500	.50169
Comfortable to wear.	60	3.4833	.50394
T-Shirt designs.	60	3.4500	.50169
To be attractive.	60	4.5000	.53678
To be safe, resistant to wear and washing.	60	4.4833	.56723
Ensuring a smooth movement of the body.	60	3.4500	.50169
To match to as many clothes.	60	2.5500	.67460
To be molded on the body.	60	2.5167	.56723
Various style to choose and many color available.	60	3.4833	.53652
To have appropriate sizes.	60	4.5500	.50169
Not to wrinkle easily.	60	4.5000	.56748
Having the proper sewing.	60	4.4833	.56723
Dimensional stability.	60	4.5000	.56748
Reasonable price.	60	4.5167	.50394
Look trendy, fashionable	60	3.4833	.50394
Valid n (list wise)	60		

As shown in the above table most of the CNs are important since most of the value is greater than the mean 3.

Customer-oriented product development

5.2 Customer Need Satisfaction

Customer voices are diverse. In consumer markets, there are a variety of different needs. Customer satisfaction can only be achieved by fulfilling the customers' needs. Regarding customers' satisfaction of Yirgalem Addis textile of men's t-shirt this are customers' response. The table below shows their rating on a scale of 1 to 5(Extremely Satisfied 5, Satisfied 4, Indifferent 3, Unsatisfied 2, Extremely Unsatisfied 1), after analyzing the data with SPSS version 22 this are the result.

Table 5.2 customers' Needs with its Satisfaction Rate

Customers' needs	n	Mean	Std. Deviation
Easy to wear.	60	3.6167	.49030
Comfortable to wear.	60	2.7333	.68561
T-Shirt designs.	60	1.8167	.46910
To be attractive.	60	2.8167	.89237
To be safe, resistant to wear and washing.	60	1.5333	.50310
Ensuring a smooth movement of the body.	60	2.6000	.49403
To match to as many clothes.	60	2.5833	.49717
To be molded on the body.	60	2.5667	.49972
Various style to choose and many color available.	60	1.5000	.50422
To have appropriate sizes.	60	2.5667	.49972
Not to wrinkle easily.	60	1.5167	.50394
Having the proper sewing.	60	2.5833	.49717
Dimensional stability.	60	1.5500	.50169
Reasonable price.	60	2.5000	.50422
Look trendy, fashionable	60	1.6000	.49403
Valid n (list wise)	60		

As shown in the above table regarding to level of customer satisfaction in most their need, the mean value is below 3 which shows customers are unsatisfied in most of their need.

Customer-oriented product development

As the CNs and expectations are expressed in terms of CRs, the QFD approach needs to come up with engineering characteristics (HOW's) that will affect one or more of the CRs. Each engineering characteristic must directly affect a customer perception (VOC) and be expressed in measurable terms.

Implementation of the CRs in design is difficult until they are translated into counterpart technical characteristics. Counterpart technical characteristics are an expression of the VOC in technical language and specifications. So as it is described in the methodology section using focus group discussions, this are the PTRs identified as a means to achieve those customers need.

- Suitable design
- Anti-wrinkle action
- Appropriate sewing machine setting
- Production planning optimization
- Gloss
- Parameter setup
- Size and shape stabilization
- Range of colors and patterns
- Fiber content of fabric
- Printing and packaging specification
- Elasticity of volume
- Resistance to dye
- Ability not to form pilling
- Sizes/complying with the standard
- Type of material

Since both customers' needs and level of satisfaction on those need are identified and calculated using SPSS, after rounding those mean number to next integer in order to increased distribution that require to make the QFD analysis easier. The PTRs as shown in the above they already identified so those will be an input in building the HOQ.

Customer-oriented product development

5.3 Development of Product Technical Requirement

After the CNs were analyzed, the next step in the construction of the HOQ was the development of PTRs. The PTRs are the design specifications that satisfy CNs. This aspect of QFD is directly in the organization's control, and focuses on designing specific, measurable design aspects that ensure the end product meets the customer wants and needs. The PTRs are called the "how's" and are placed on the top of the house. Each can have one or more PTRs.

PTRs must be within the control of the manufacturer. It must also be measurable to enable designers to determine if the customers' needs are fulfilled.

Building a HOQ is to compare the VOC with PTRs and determine their interrelationships. In this context, engineering knowledge about the product and historic evidence data can provide useful information. Common practice is to use symbols to represent the nature of relationship between CRs and PTRs.

Symbols used are:

- I. A solid circle represents a strong relationship (scored as +9).
- II. A single circle represents a medium relationship. (scored as +3).
- III. A triangle represents a weak relationship (scored as +1).
- IV. The box is left blank if there is no relationship between VOC and PTRs.

Since all customer need and PTRs were identified the next step is building the relationship b/n them using QFD capture professional edition 4-2-20 software, this software will help to build the relationship and HOQ. The input for the QFD capture professional edition 4-2-20 software related entry for customer need (WHATs) and PTRs (HOWs) are in appendix 5 and 6 respectively.

Customer-oriented product development

Direction of Improvement		
Maximize	↑	1.0
Target	●	0.0
Minimize	↓	-1.0

Direction of Improvement	1	Importance of the WHAT's														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Suitable design	Anti-wrinkle action	Appropriate sewing machine setting	Production planning optimization	Gloss	Parameter setup	Size and shape stabilization	Range of colors and patterns	Fiber content of fabric	Printing and packaging specification	Elasticity of volume	Resistance to dye	Ability not to form pilling	Sizes/complying with the standard	Type of material
Easy to wear	1	4.0	●	○	○		●	○	○	○	▽	○		▽	●	○
Comfortable to wear	2	4.0	○	○	○		○	○	○	●	▽	○			●	●
T-Shirt designs	3	4.0	●	▽	○	○	○	○	○	○	○	○	○	○	○	○
To be attractive	4	5.0	●	▽	▽	○	○	○	○	○	○	○	○	○	○	○
To be safe, resistant to wear and washing	5	5.0	○	○		○	○	○		○	▽	○	●	●		●
Ensuring a smooth movement of the body	6	4.0	○	▽	○	▽		○	●	▽	○	○		●	○	○
To match to as many clothes.	7	3.0	○			○		▽	▽	○		○				
To be molded on the body	8	3.0	○	○	▽	▽	▽	○	●	▽	○			▽	●	○
Various style to choose and many color available	9	4.0	●	▽	▽	○	○		●	○	○			▽	○	○
To have appropriate sizes	10	5.0	○		▽	○		○	●	○		○			●	○
Not to wrinkle easily	11	5.0	○	●	▽			○	○					○	▽	●
Having the proper sewing.	12	5.0	○	○	●	○		○	○	○	▽		▽	○		○
Dimensional stability	13	5.0	○	○		○		○	●		○	▽	○	○	▽	○
Reasonable price	14	5.0	○			○		○		▽	○					
Look trendy, fashionable	15	4.0	●		▽	○	▽	○		▽	○	○				▽

Standard 9-3-1		
Strong	●	9.0
Moderate	○	3.0
Weak	▽	1.0

Figure 5.2 Complete Interrelationship between VOC and Product Technical Requirements

After drafting the relationship matrix, it is evaluated for any empty row or column. An empty row indicates that a customer voice is not being addressed by any PTRs. Thus, the customer expectation is not being met. Any blank column indicates that the technical requirement is unnecessary, as it does not address any VOC. The next step is building the HOQ, the house is built and analyzed with QFD capture professional edition 4-2-20 software.

Customer-oriented product development

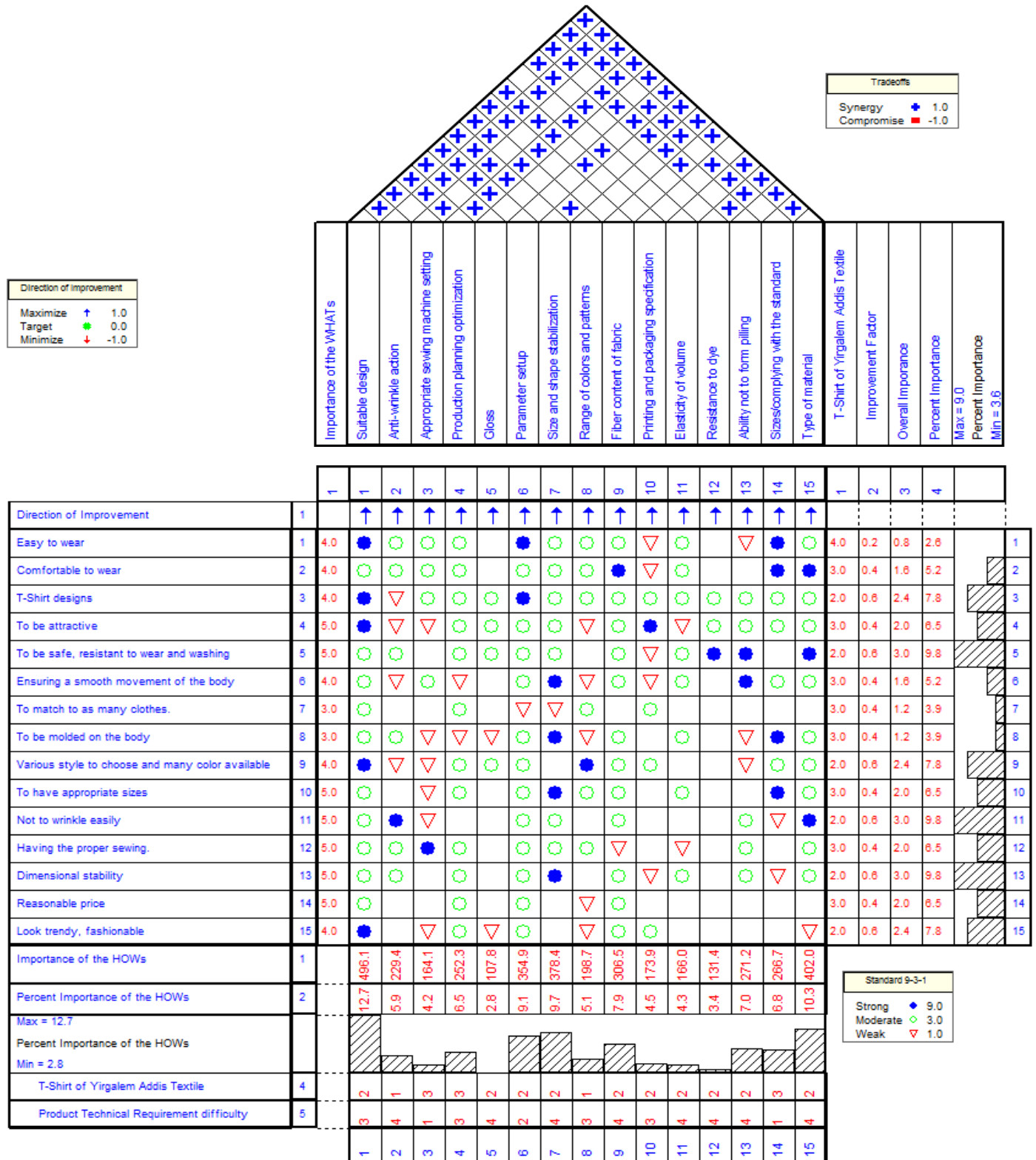


Figure 5.3 Correlation Matrix and Tradeoff between Product Technical Requirements and VOC (House of Quality)

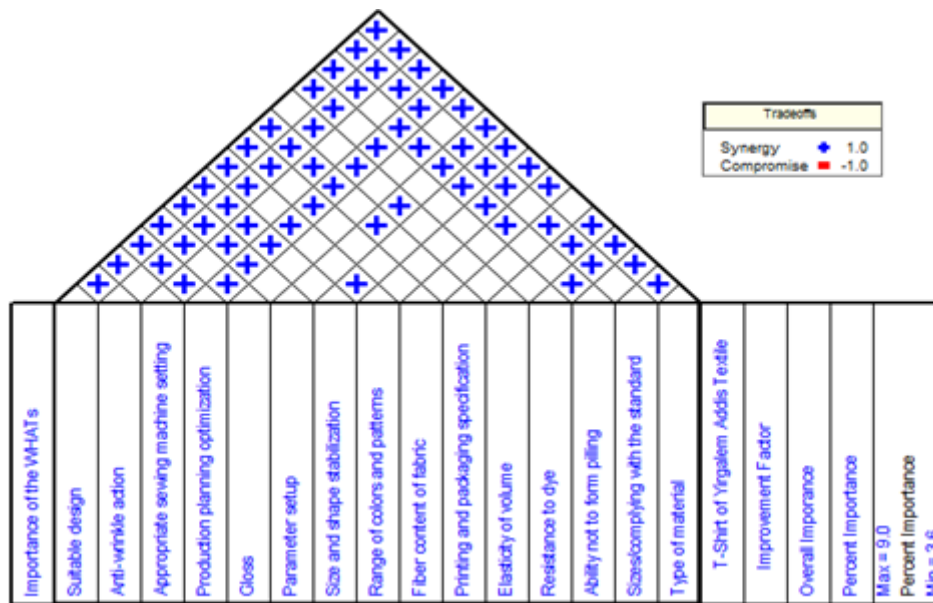


Figure 5.4 The Roof of the House

5.4 Correlation Matrix

On top of the HOQ is a triangular table the roof of the house, which is called the correlation matrix. This roof-like the above figure shows the correlations that exist between the different PTRs. A change in a particular product requirement that is related to another product requirement will usually affect both requirements. Correlations identified in the roof indicate areas where trade – off decisions and research and development are needed. Here too, symbols can be used to indicate the nature and the strength of the correlations. (+) Synergy, Strong positive correlations imply that an improvement in one product requirement supports another. This information offers the opportunity to use research funds efficiently by avoiding duplication of efforts to achieve the same result. (-) Compromise, Strong negative correlations demand attention because they represent conditions in which trade- off decisions may be needed.

The roof of the HOQ, expressed as correlation matrix, is used to identify any interrelationship between PTRs as shown in the above figure. The symbols are (-) which is compromise relationship whereas (+) is synergy which is strong relationship between PTRs meaning fulfilling one PTRs can enhance the other as it is shown in the figure most the PTRs have positive relationship.

Customer-oriented product development

Below the roof there is an improvement direction as it is shown all of the PTRs need an improvement in order to fulfill the customers need.

Based on the above result as shown above in figure 5.3. The table below shows summary of the customer's needs, after using QFD capture professional edition 4-2-20 software analysis.

Table 5.3 Customers Need with its Importance Level

Customers need	Overall Importance WHATs	Percent of importance the WHATs
To be safe, resistant to wear and washing.	3	9.8
Not to wrinkle easily.	3	9.8
Dimensional stability.	3	9.8
T-Shirt designs.	2.4	7.8
Various style to choose and many color available.	2.4	7.8
Look trendy, fashionable	2.4	7.8
To be attractive.	2	6.5
To have appropriate sizes.	2	6.5
Having the proper sewing.	2	6.5
Reasonable price.	2	6.5
Comfortable to wear.	1.6	5.2
Ensuring a smooth movement of the body.	1.6	5.2
To match to as many clothes.	1.2	3.9
To be molded on the body.	1.2	3.9
Easy to wear.	0.8	2.6

In order to identify the most prominent customers need using Pareto analysis would be important.

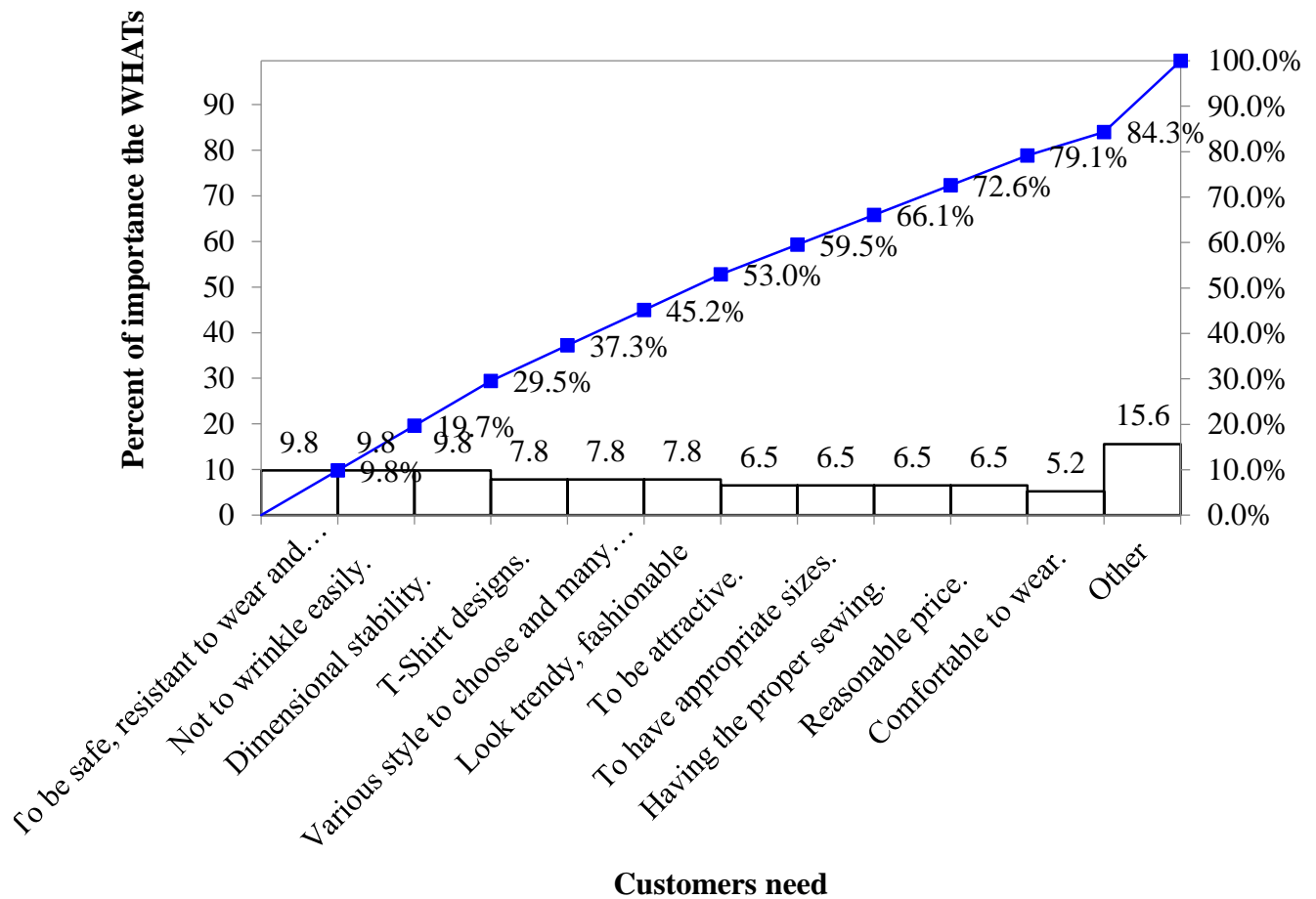


Figure 5.5 Pareto Analysis of Customers Need

Based on the Pareto chart analysis as shown in the above figure more than 80% of the Customers need are: to be safe, resistant to wear and washing, not to wrinkle easily, dimensional stability, t-shirt designs, various style to choose and many color available, look trendy, fashionable, to be attractive, to have appropriate sizes, having the proper sewing, reasonable price, comfortable to wear, so in this case addressing those that are mentioned above will solve 80% of customers need.

In order to identify the most prominent PTRs, the data analyzed using Pareto diagram to arrange information in such a way that priorities for product improvement can be established. Since resources are limited and also financial consideration so it is better to prioritize.

The table below shows summary PTRs after using QFD capture professional edition 4-2-20 software, as shown in figure 5.3, so this is an input for Pareto analysis.

Table 5.4 Product Technical Requirements with its Importance Level

Product technical requirements	Importance of the HOWs	Percent of importance the HOWs
Suitable design	496.1	12.7
Type of material	402	10.3
Size and shape stabilization	378.4	9.7
Parameter setup	354.9	9.1
Fiber content of fabric	306.5	7.9
Ability not to form pilling	272.2	7
Sizes/complying with the standard	266.7	6.8
Production planning optimization	252.2	6.5
Anti-wrinkle action	229.4	5.9
Range of colors and patterns	198.7	5.1
Printing and packaging specification	173.9	4.5
Elasticity of volume	166	4.3
Appropriate sewing machine setting	164.1	4.2
Resistance to dye	131.4	3.4
Gloss	107.8	2.8

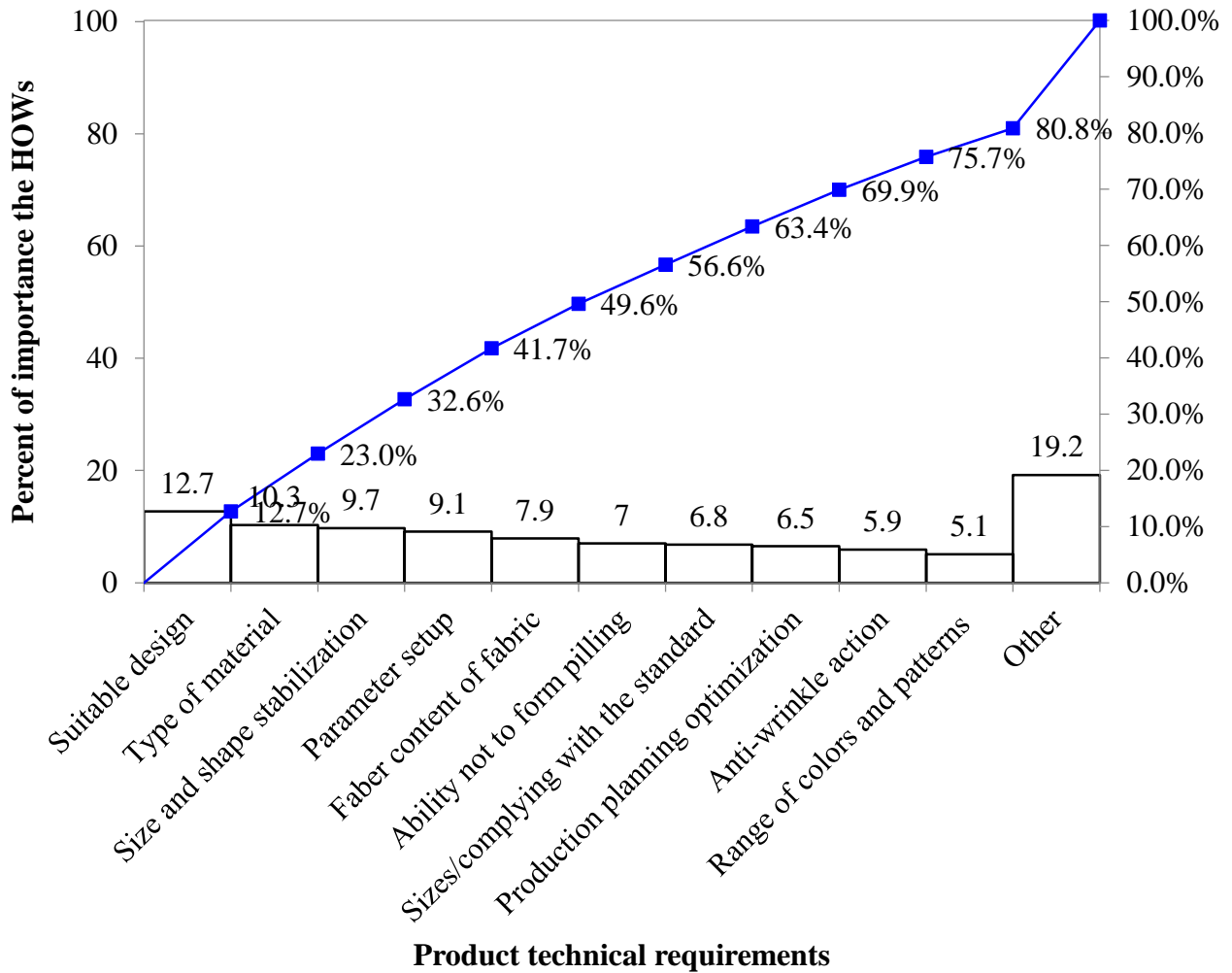


Figure 5.6 Pareto Analysis of Product Technical Requirements

Based on the Pareto chart analysis as shown in the above figure more the 80% the PTRs are: suitable design, type of material, parameter set up, size and shape stabilization, fiber content of fabric, sizes/complying with the standard, ability not to form pilling, production planning optimization, anti-wrinkle action, and range of colors and patterns this means if Yigralem Addis Textile at least meet those PTRs can solve 80 % of the CNs and also as it shown in the roof of the house of quality most of the PTRs have synergy relationship meaning positive relationship as discussed above.

Chapter six
Conclusion and Recommendation

6.1 Conclusion

In this thesis, an empirical study presents in order to identify customers need and product technical requirement of men's t-shirt of Yirgalem Addis Textile product in to develop customer oriented product. The study has gathered different characteristics influencing customer's intention on purchasing men's t-shirt and using Quality Function Deployment method provided the most important items. Based on the results, fifteen customer needs and product technical requirements of men's t-shirt were developed from the interview data and focus group discussion. Using Quality Function Deployment and Pareto analysis the major customer needs and product technical requirements were identified. In terms of customer need the result are to be safe resistant to wear and washing, not to wrinkle easily, dimensional stability, t-shirt designs, various style to choose and many color available, look trendy, fashionable, to be attractive, to have appropriate sizes, having the proper sewing, reasonable price, comfortable to wear whereas in terms product technical requirement result are suitable design, type of material, parameter set up, size and shape stabilization, fiber content of fabric, sizes/complying with the standard, ability not to form pilling, production planning optimization, anti-wrinkle action, and range of colors and patterns . Based on the results of this survey, Yirgalem Addis Textile failed in meeting most of the customer needs and PTRs, so the study conclude that increasing market sales in clothing and textile industry needs a comprehensive method to look for all-important items from customer's life style to optimization of production planning.

The Product Development is a necessity in today's highly competitive conditions. By allocating resources for research and development activities, the quality and long-term usage requirements of the customers can be fulfilled. In general, Yirgalem Addis Textile should allocate resources for Research & Development activities to produce high quality products.

It is an inevitable fact that the products which are not renovated or differentiated will not keep their places in the apparel as the industry is affected intensely by fast fashion. Therefore, by following new trends, it would be possible to meet the expectations of customers about design and product variety. So Quality Function Deployment can be an important way in terms of meeting customers need and building upstream communications within the organization.

Customer-oriented product development

6.2 Recommendation

The success of a product in any industry and especially in the textile/apparel industry is determined by the interaction and integration of value, time, cost and quality. Creativity, willingness to overcome errors and contingency planning are core requirements for product development. All departments working in product development must work in tandem and with clear set goals to maximize productivity. And also it needs a comprehensive method to look for all-important items from customer's life style to optimization of production planning.

To design a product well, a design teams needs to know what it is they are designing, and what the end-users will expect from it. Quality Function Deployment is a systematic approach to design based on a close awareness of customer desires, coupled with the integration of corporate functional groups. It consists in translating customer desires into design characteristics for each stage of the product development.

Quality Function Deployment benefits for companies seeking to improve their competitiveness and productivity through improved quality is continuously improving product reliability, improve product quality, increase customer satisfaction, shorten time to market, reduce design costs, improve communications, increase productivity and increase corporate profits.

Companies that understand this, that to be competitive they have to put an emphasis on innovation and creativity and meet the needs of their customers, will be able to grow in the global business environment of the 21st century, so the researcher recommend to use the output of this research as a means to meet customers need and to facilitate means of communication.

6.3 Future Research Work

The textiles industry has a large pollution problem worldwide. Textile processing creates many aspects of waste, these include liquid, gaseous and solid wastes, a few of these may be hazardous. The waste generated depends solely on the type of textile facility, the processes and technologies being operated, and the types of fibers and chemicals used. So any researcher can consider environmental effect and also the cost of processing those product technical requirements.

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Appendices

Appendix 1 Marketing Department Production Order Sheet

	Yirgalem Addis textile factory plc	document no.
title	marketing department production order sheet	page 1 of 1

<p>to : production and technique planning and it store</p> <p>from: marketing and sales department</p>
--

please produce and supply the following products/services to the concerned store/internal customer.

1.type of product/service:-

polo t-shirt

5.pos.no:-816/2/15

2.print/design:-

6.date:-01/10/15

3.composition:**100%**

cotton

7.ordered qty:-

4.customer:-

8.delivery date:- within 10 days

detailed specification

<i>s/n</i>	<i>product/service description</i>	<i>yarn count</i>	<i>fabric content</i>	<i>finished fabric gsm</i>	<i>finished fabric width</i>	<i>color</i>	<i>shade #</i>	<i>gross qty in kg</i>	<i>net qty in kg</i>	<i>remark</i>
	for knitting unit									
1	single jersey with 13% black stripe collar	ne 20 rf	100% cotton	to be set by dyeing	to be set by dyeing	grieger	as per sample	348.01	339.31	
2	single jersey	ne 20 rf	100% cotton	to be set by dyeing	to be set by dyeing	grieger	as per sample	140.93	137.41	

Customer-oriented product development

<i>s/n</i>	<i>product/service description</i>	<i>yarn count</i>	<i>fabric content</i>	<i>finished fabric gsm</i>	<i>finished fabric width</i>	<i>color</i>	<i>shade #</i>	<i>gross qty in kg</i>	<i>net qty in kg</i>	<i>remark</i>
for dyeing unit										
1	single jersey with 13% black stripe collar	ne 20 rf	100% cotton	180	86	red	as per sample	339.31	322.34	
2	single jersey	ne 20 rf	100% cotton	180	86	black	as per sample	137.41	130.54	

for garment unit

<i>s/n</i>	<i>item description</i>	<i>style</i>	<i>color</i>	<i>qty in set / size break down for garment</i>								<i>total</i>
				<i>s</i>	<i>m</i>	<i>l</i>	<i>xl</i>	<i>xxl</i>	<i>xxxl</i>	<i>4xl</i>	<i>5xl</i>	
1	men's polo t-shirt with collar and cuff with contrast colors	as per sample	red body with black stripe	268	411	294	234	94	11	18	2	1332
			total	268	411	294	234	94	11	18	2	1332

prepared by:

checked by:

approved by:

Customer-oriented product development

Appendix 2 Questioner



ADDIS ABABA INSTITUTE OF TECHNOLOGY
SCHOOL OF MECHANICAL AND INDUSTRIAL
ENGINEERING

Post graduate program in industrial engineering

Dear Respondent,

Am doing research on title **Customer-oriented Product Development** to determine consumers need when buying T-Shirt. One of the outcomes of this research is to integrate a consumer's need with product technical requirement of T-shirt.

I would therefore value your opinion and would appreciate it if you could find time in your busy program to help me by completing the enclosed questionnaire. There are no right or wrong answers; I am interested in your opinion and experience.

The questioner has two parts the first one is to rank the most important requirement in buying a T-shirt and to give that best indicates how well you feel Yirgalem Addis Textile satisfies each of the requirement which a questioner of customer of Yirgalem Addis Textile of men's t-shirt. Whereas the second part is to production and technique department of Yirgalem Addis Textile.

I would appreciate it very much if you could return the questionnaire, to the person who gave them to you within three days. Thank you for the courtesy of your assistance.

Sincerely.

Customer-oriented product development

1. Using focus group discussion this are the identified consequence in men's t-shirt need, so assign a number from 1 to 5 points, on a scale of 1 to 5 (1 =not important,2=not very important,3=somewhat important,4=very important and 5 = most important). You may assign the same number of points to more than one consequence.

- ✓ Easy to wear. ___
- ✓ Comfortable to wear. ___
- ✓ T-Shirt designs. ___
- ✓ To be attractive. ___
- ✓ To be safe, resistant to wear and washing. ___
- ✓ Ensuring a smooth movement of the body. ___
- ✓ To match to as many clothes. ___
- ✓ To be molded on the body. ___
- ✓ Various style to choose and many color available. ___
- ✓ To have appropriate sizes. ___
- ✓ Not to wrinkle easily. ___
- ✓ Having the proper sewing. ___
- ✓ Dimensional stability. ___
- ✓ Reasonable price. ___
- ✓ Look trendy, fashionable. ___

Customer-oriented product development

2. Please rate how well Yirgalem Addis Textile product of men's t-shirt delivers each of those needs when you use it. Circle the number below that best indicates how well you feel the men's t-shirt satisfies each of the needs. For comparison purposes, use a scale of: Extremely Satisfied 5, Satisfied 4, Indifferent 3, Unsatisfied 2, Extremely Unsatisfied 1

Customers' needs	Rating scale
Easy to wear.	1 2 3 4 5
Comfortable to wear.	1 2 3 4 5
T-Shirt designs.	1 2 3 4 5
To be attractive.	1 2 3 4 5
To be safe, resistant to wear and washing.	1 2 3 4 5
Ensuring a smooth movement of the body.	1 2 3 4 5
To match to as many clothes.	1 2 3 4 5
To be molded on the body.	1 2 3 4 5
Various style to choose and many color available	1 2 3 4 5
To have appropriate sizes.	1 2 3 4 5
Not to wrinkle easily.	1 2 3 4 5
Having the proper sewing.	1 2 3 4 5
Dimensional stability.	1 2 3 4 5
Reasonable price.	1 2 3 4 5
Look trendy, fashionable	1 2 3 4 5

Customer-oriented product development

1. Questioner for workers of Yirgalem Addis textile PLC that work more on production of t-shirt and technical department.

Using focus group discussion this are the identified product technical requirements that aimed at fulfilling need of men's t-shirt, so assign a number from 1 to 5 points to identify its difficult, on a scale of 1 to 5 (1 =not difficult,2=not very difficult ,3= difficult,4=very difficult and 5 = extremely difficult). You may assign the same number of points to more than one product technical requirement.

- Suitable design. __
- Anti-wrinkle action. __
- Appropriate sewing machine setting. __
- Production planning optimization. __
- Gloss. __
- Parameter setup. __
- Size and shape stabilization. __
- Range of colors and patterns. __
- Fiber content of fabric. __
- Printing and packaging specification. __
- Elasticity of volume. __
- Resistance to dye. __
- Ability not to form pilling. __
- Sizes/complying with the standard. __
- Type of material. __

Customer-oriented product development

2. Circle the number below that best indicates how well you feel that Yirgalem Addis Textile PLC satisfies each of the product technical requirements. For comparison purposes, use a scale of: Extremely Satisfied 5, Satisfied 4, Indifferent 3, Unsatisfied 2, Extremely Unsatisfied 1.

Technical requirement	Rating scale based on level of satisfaction
Suitable design	1 2 3 4 5
Anti-wrinkle action	1 2 3 4 5
Appropriate sewing machine setting	1 2 3 4 5
Production planning optimization	1 2 3 4 5
Gloss	1 2 3 4 5
Parameter setup	1 2 3 4 5
Size and shape stabilization	1 2 3 4 5
Range of colors and patterns	1 2 3 4 5
Fiber content of fabric	1 2 3 4 5
Printing and packaging specification	1 2 3 4 5
Elasticity of volume	1 2 3 4 5
Resistance to dye	1 2 3 4 5
Ability not to form pilling	1 2 3 4 5
Sizes/complying with the standard	1 2 3 4 5
Type of material	1 2 3 4 5

Customer-oriented product development

Appendix 3 Frequency Table of importance of WHATs

Easy to wear.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid somewhat important	33	55.0	55.0	55.0
very important	27	45.0	45.0	100.0
Total	60	100.0	100.0	

Comfortable to wear.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid somewhat important	31	51.7	51.7	51.7
very important	29	48.3	48.3	100.0
Total	60	100.0	100.0	

T-Shirt designs.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid somewhat important	33	55.0	55.0	55.0
very important	27	45.0	45.0	100.0
Total	60	100.0	100.0	

Customer-oriented product development

To be attractive.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid somewhat important	1	1.7	1.7	1.7
very important	28	46.7	46.7	48.3
most important	31	51.7	51.7	100.0
Total	60	100.0	100.0	

To be safe, resistant to wear and washing.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid somewhat important	2	3.3	3.3	3.3
very important	27	45.0	45.0	48.3
most important	31	51.7	51.7	100.0
Total	60	100.0	100.0	

Ensuring a smooth movement of the body.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid somewhat important	33	55.0	55.0	55.0
very important	27	45.0	45.0	100.0
Total	60	100.0	100.0	

Customer-oriented product development

To match to as many clothes.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid not very important	31	51.7	51.7	51.7
somewhat important	27	45.0	45.0	96.7
most important	2	3.3	3.3	100.0
Total	60	100.0	100.0	

To be molded on the body.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid not very important	31	51.7	51.7	51.7
somewhat important	27	45.0	45.0	96.7
very important	2	3.3	3.3	100.0
Total	60	100.0	100.0	

Various style to choose and many color available.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid somewhat important	32	53.3	53.3	53.3
very important	27	45.0	45.0	98.3
most important	1	1.7	1.7	100.0
Total	60	100.0	100.0	

Customer-oriented product development

To have appropriate sizes.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid very important	27	45.0	45.0	45.0
most important	33	55.0	55.0	100.0
Total	60	100.0	100.0	

Not to wrinkle easily.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid somewhat important	2	3.3	3.3	3.3
very important	26	43.3	43.3	46.7
most important	32	53.3	53.3	100.0
Total	60	100.0	100.0	

Having the proper sewing.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid somewhat important	2	3.3	3.3	3.3
very important	27	45.0	45.0	48.3
most important	31	51.7	51.7	100.0
Total	60	100.0	100.0	

Customer-oriented product development

Dimensional stability.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid somewhat important	2	3.3	3.3	3.3
very important	26	43.3	43.3	46.7
most important	32	53.3	53.3	100.0
Total	60	100.0	100.0	

Reasonable price.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid very important	29	48.3	48.3	48.3
most important	31	51.7	51.7	100.0
Total	60	100.0	100.0	

Look trendy, fashionable

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid somewhat important	31	51.7	51.7	51.7
very important	29	48.3	48.3	100.0
Total	60	100.0	100.0	

Customer-oriented product development

Appendix 4 Frequency Table of level of satisfaction of WHATs

Easy to wear.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Indifferent	23	38.3	38.3	38.3
Satisfied	37	61.7	61.7	100.0
Total	60	100.0	100.0	

Comfortable to wear.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Unsatisfied	24	40.0	40.0	40.0
Indifferent	28	46.7	46.7	86.7
Satisfied	8	13.3	13.3	100.0
Total	60	100.0	100.0	

T-Shirt designs.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Extremely Unsatisfied	13	21.7	21.7	21.7
Unsatisfied	45	75.0	75.0	96.7
Indifferent	2	3.3	3.3	100.0
Total	60	100.0	100.0	

Customer-oriented product development

To be attractive.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsatisfied	30	50.0	50.0	50.0
	Indifferent	11	18.3	18.3	68.3
	Satisfied	19	31.7	31.7	100.0
	Total	60	100.0	100.0	

To be safe, resistant to wear and washing.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extremely Unsatisfied	28	46.7	46.7	46.7
	Unsatisfied	32	53.3	53.3	100.0
	Total	60	100.0	100.0	

Ensuring a smooth movement of the body.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsatisfied	24	40.0	40.0	40.0
	Indifferent	36	60.0	60.0	100.0
	Total	60	100.0	100.0	

Customer-oriented product development

To match to as many clothes.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Unsatisfied	25	41.7	41.7	41.7
Indifferent	35	58.3	58.3	100.0
Total	60	100.0	100.0	

To be molded on the body.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Unsatisfied	26	43.3	43.3	43.3
Indifferent	34	56.7	56.7	100.0
Total	60	100.0	100.0	

Various style to choose and many color available.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Extremely Unsatisfied	30	50.0	50.0	50.0
Unsatisfied	30	50.0	50.0	100.0
Total	60	100.0	100.0	

Customer-oriented product development

To have appropriate sizes.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsatisfied	26	43.3	43.3	43.3
	Indifferent	34	56.7	56.7	100.0
	Total	60	100.0	100.0	

Not to wrinkle easily.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extremely Unsatisfied	29	48.3	48.3	48.3
	Unsatisfied	31	51.7	51.7	100.0
	Total	60	100.0	100.0	

Having the proper sewing.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsatisfied	25	41.7	41.7	41.7
	Indifferent	35	58.3	58.3	100.0
	Total	60	100.0	100.0	

Customer-oriented product development

Dimensional stability.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extremely Unsatisfied	27	45.0	45.0	45.0
	Unsatisfied	33	55.0	55.0	100.0
	Total	60	100.0	100.0	

Reasonable price.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unsatisfied	30	50.0	50.0	50.0
	Indifferent	30	50.0	50.0	100.0
	Total	60	100.0	100.0	

Look trendy, fashionable.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extremely Unsatisfied	24	40.0	40.0	40.0
	Unsatisfied	36	60.0	60.0	100.0
	Total	60	100.0	100.0	

Customer-oriented product development

Appendix 5 Related Data Entries of list of WHATs

		Related Data Entries					
		0	1	2	3	4	5
List Entries	0		Importance of the WHATs	T-Shirt of Yirgalem Addis Textile	Improvement Factor	Overall Importance	Percent Importance
	1	Easy to wear	4.0	4.0	0.2	0.8	2.6
	2	Comfortable to wear	4.0	3.0	0.4	1.6	5.2
	3	T-Shirt designs	4.0	2.0	0.6	2.4	7.8
	4	To be attractive	5.0	3.0	0.4	2.0	6.5
	5	To be safe, resistant to wear and washing	5.0	2.0	0.6	3.0	9.8
	6	Ensuring a smooth movement of the body	4.0	3.0	0.4	1.6	5.2
	7	To match to as many clothes.	3.0	3.0	0.4	1.2	3.9
	8	To be molded on the body	3.0	3.0	0.4	1.2	3.9
	9	Various style to choose and many color available	4.0	2.0	0.6	2.4	7.8
	10	To have appropriate sizes	5.0	3.0	0.4	2.0	6.5
	11	Not to wrinkle easily	5.0	2.0	0.6	3.0	9.8
	12	Having the proper sewing.	5.0	3.0	0.4	2.0	6.5
	13	Dimensional stability	5.0	2.0	0.6	3.0	9.8
	14	Reasonable price	5.0	3.0	0.4	2.0	6.5
	15	Look trendy, fashionable	4.0	2.0	0.6	2.4	7.8

Customer-oriented product development

Appendix 6 Related Data Entries of list of HOWs

Related Data Entries								
	0	1	2	3	4	5	6	
List Entries	0		Direction of Improvement	Importance of the HOWs	Percent Importance of the HOWs	Graph	T-Shirt of Yirgalem Addis	Product Technical Requirement
	1	Suitable design	↑	496.1	12.7		2	3
	2	Anti-wrinkle action	↑	229.4	5.9		1	4
	3	Appropriate sewing machine setting	↑	164.1	4.2		3	1
	4	Production planning optimization	↑	252.3	6.5		3	3
	5	Gloss	↑	107.8	2.8		2	4
	6	Parameter setup	↑	354.9	9.1		2	2
	7	Size and shape stabilization	↑	378.4	9.7		2	4
	8	Range of colors and patterns	↑	198.7	5.1		1	3
	9	Fiber content of fabric	↑	306.5	7.9		2	4
	10	Printing and packaging specification	↑	173.9	4.5		2	3
	11	Elasticity of volume	↑	166.0	4.3		2	4
	12	Resistance to dye	↑	131.4	3.4		2	4
	13	Ability not to form pilling	↑	271.2	7.0		2	4
	14	Sizes/complying with the standard	↑	266.7	6.8		3	1
	15	Type of material	↑	402.0	10.3		2	4

Appendix 7 Two tails of Z

Two tails of Z
 Entries in the table represent two-tailed *P* values for *z* statistics

tenths	hundredths									
	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	1.00000	0.99202	0.98404	0.97607	0.96809	0.96012	0.95216	0.94419	0.93624	0.92829
0.1	0.92034	0.91241	0.90448	0.89657	0.88866	0.88076	0.87288	0.86501	0.85715	0.84931
0.2	0.84148	0.83367	0.82587	0.81809	0.81033	0.80259	0.79486	0.78716	0.77948	0.77182
0.3	0.76418	0.75656	0.74897	0.74140	0.73386	0.72634	0.71885	0.71138	0.70395	0.69654
0.4	0.68916	0.68181	0.67449	0.66720	0.65994	0.65271	0.64552	0.63836	0.63123	0.62413
0.5	0.61708	0.61005	0.60306	0.59611	0.58920	0.58232	0.57548	0.56868	0.56191	0.55519
0.6	0.54851	0.54186	0.53526	0.52869	0.52217	0.51569	0.50925	0.50286	0.49650	0.49019
0.7	0.48393	0.47770	0.47152	0.46539	0.45930	0.45325	0.44725	0.44130	0.43539	0.42953
0.8	0.42371	0.41794	0.41222	0.40654	0.40091	0.39533	0.38979	0.38430	0.37886	0.37347
0.9	0.36812	0.36282	0.35757	0.35237	0.34722	0.34211	0.33706	0.33205	0.32709	0.32217
1.0	0.31731	0.31250	0.30773	0.30301	0.29834	0.29372	0.28914	0.28460	0.28014	0.27571
1.1	0.27133	0.26700	0.26271	0.25848	0.25429	0.25014	0.24605	0.24200	0.23800	0.23405
1.2	0.23014	0.22628	0.22246	0.21870	0.21498	0.21130	0.20767	0.20408	0.20055	0.19705
1.3	0.19360	0.19020	0.18684	0.18352	0.18025	0.17702	0.17383	0.17069	0.16759	0.16453
1.4	0.16151	0.15854	0.15561	0.15272	0.14987	0.14706	0.14429	0.14156	0.13887	0.13622
1.5	0.13361	0.13104	0.12851	0.12602	0.12356	0.12114	0.11876	0.11642	0.11411	0.11183
1.6	0.10960	0.10740	0.10523	0.10310	0.10101	0.09894	0.09691	0.09492	0.09296	0.09103
1.7	0.08913	0.08727	0.08543	0.08363	0.08186	0.08012	0.07841	0.07673	0.07508	0.07345
1.8	0.07186	0.07030	0.06876	0.06725	0.06577	0.06431	0.06289	0.06148	0.06011	0.05876
1.9	0.05743	0.05613	0.05486	0.05361	0.05238	0.05118	0.05000	0.04884	0.04770	0.04659
2.0	0.04550	0.04443	0.04338	0.04236	0.04135	0.04036	0.03940	0.03845	0.03753	0.03662
2.1	0.03573	0.03486	0.03401	0.03317	0.03235	0.03156	0.03077	0.03001	0.02926	0.02852
2.2	0.02781	0.02711	0.02642	0.02575	0.02509	0.02445	0.02382	0.02321	0.02261	0.02202
2.3	0.02145	0.02089	0.02034	0.01981	0.01928	0.01877	0.01827	0.01779	0.01731	0.01685
2.4	0.01640	0.01595	0.01552	0.01510	0.01469	0.01429	0.01389	0.01351	0.01314	0.01277
2.5	0.01242	0.01207	0.01174	0.01141	0.01109	0.01077	0.01047	0.01017	0.00988	0.00960
2.6	0.00932	0.00905	0.00879	0.00854	0.00829	0.00805	0.00781	0.00759	0.00736	0.00715
2.7	0.00693	0.00673	0.00653	0.00633	0.00614	0.00596	0.00578	0.00561	0.00544	0.00527
2.8	0.00511	0.00495	0.00480	0.00465	0.00451	0.00437	0.00424	0.00410	0.00398	0.00385
2.9	0.00373	0.00361	0.00350	0.00339	0.00328	0.00318	0.00308	0.00298	0.00288	0.00279
3.0	0.00270	0.00261	0.00253	0.00245	0.00237	0.00229	0.00221	0.00214	0.00207	0.00200
3.1	0.00194	0.00187	0.00181	0.00175	0.00169	0.00163	0.00158	0.00152	0.00147	0.00142
3.2	0.00137	0.00133	0.00128	0.00124	0.00120	0.00115	0.00111	0.00108	0.00104	0.00100
3.3	0.00097	0.00093	0.00090	0.00087	0.00084	0.00081	0.00078	0.00075	0.00072	0.00070
3.4	0.00067	0.00065	0.00063	0.00060	0.00058	0.00056	0.00054	0.00052	0.00050	0.00048
3.5	0.00047	0.00045	0.00043	0.00042	0.00040	0.00039	0.00037	0.00036	0.00034	0.00033
3.6	0.00032	0.00031	0.00029	0.00028	0.00027	0.00026	0.00025	0.00024	0.00023	0.00022
3.7	0.00022	0.00021	0.00020	0.00019	0.00018	0.00018	0.00017	0.00016	0.00016	0.00015
3.8	0.00014	0.00014	0.00013	0.00013	0.00012	0.00012	0.00011	0.00011	0.00010	0.00010
3.9	0.00010	0.00009	0.00009	0.00008	0.00008	0.00008	0.00007	0.00007	0.00007	0.00007