DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

BENCHMARKING AND QUALITY IMPROVEMENT -AN APPLICATION OF QUALITY FUNCTION DEPLOYMENT IN A FIRM-

by

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February, 2007

İZMİR

BENCHMARKING AND QUALITY IMPROVEMENT
-AN APPLICATION OF QUALITY FUNCTION DEPLOYMENT IN A FIRM-

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by
Alev TEZEL

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M.Sc THESIS EXAMINATION RESULT FORM

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BENCHMARKING AND QUALITY IMPROVEMENT
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ABSTRACT

Nowadays, it is nearly getting necessary to adopt fast growing industrial developments and demands for the companies in manufacturing or service market. In order to stay in competitive market, the companies try new approaches and put the successful ones into application. One of the widely used approaches is, today, Quality Function Deployment (QFD).

In this study, the basic steps of Quality Function Deployment approach is presented. Also an example of application of QFD to a television manufacturing company is given as a project.

Therefore, this research attempts to build the benchmarking from the "voice" of the customer. The comprehensive methodology I propose here is called the quality benchmarking deployment (QBD) technique. The case study findings demonstrated that QFD could be successfully applied in combo CRT television projects as a strategic tool to facilitate marketing and manufacturing decisions. As a result of extensive literature review and the case study observations; this study also points out the limitations and breakthroughs of the QFD methodology. Finally, critical success factors are proposed to improve the performance of the QFD methodology in projects.

Keywords: Benchmarking, Competitive Benchmarking, Quality Function Deployment, Quality Improvement, Voice of Customer, Customer Satisfaction, Analytic Hierarchy Process

KIYASLAMA VE KALİTE İYİLEŞTİRMESİ
KALİTE FONKSİYON GÖÇERİMİ METHODU UYGULAMASI

ÖZ

Günümüzde hızlı bir gelişme sergileyen endüstriyel yenilikler ve isteklere ayak uydurmaya çalışmak, üretim veya servis sektöründeki kuruluşlar için her geçen gün daha da artan bir zorunluluk haline gelmektedir. Herhangi bir üretim şirketi, bu rekabetçi ortamda ayakta kalabilmek için sürekli olarak yeni yaklaşımlar denemekte ve başarılı bulunanlar uygulamaya konulmaktadır. Bu konuda günümüzde yaygın olarak kullanılmakta olan yaklaşımlardan birisi Kalite Fonksiyon Yayılımı (**Q**uality **F**unction **D**eployment)'dır.

Bu çalışmada, bir ürün geliştirme süreci boyunca uygulanabilecek bir kalite tekniği olan Kalite Fonksiyon Yayılımı (QFD)'nin uygulanma aşamalarından bahsedilmekte ve televizyon üreten bir firmaya bu uygulama tatbik edilerek sonuçların nasıl değerlendirileceği gösterilmektedir.

Bu nedenle, bu araştırmada müşterinin sesinden yola çıkarak rekabetçi kıyaslama yöntemi oluşturmaya çalışmaktadır. Önerilen kapsamlı rekabetçi yöntemi *"quality benchmarking deployment (QBD) technique"* dir. DVD ve DVB özelliği olan CRT televizyon başarılı uygulama bulguları kalite fonksiyon göçeriminde gösterilmektedir ki bu da stratejik araç olarak pazarda rekabet edebilirliği ve üretilebilirliği açısından kolaylık sağlamaktadır. Sonuç olarak yayınlanan makaleler ve bu çalışmadaki gözlemler QFD'in bazı kısıtları olduğunu göstermektedir. Sonuç olarak, projelerdeki kritik başarı faktörleri QFD yöntemi uygulanarak geliştirilmesi sağlanır.

Anahtar sözcükler: Kıyaslama, Rekabetçi Kıyaslaması, Kalite Fonksiyon Göçerimi, Kalite İyileştirme, Tüketici İhtiyaçları, Müşteri Memnuniyeti, Analitik Hiyerarşi Yöntemi

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CHAPTER ONE
INTRODUCTION

Organizations and firms are under increasing pressure to do more with less, downsize their organizations, and at the same time, implement quality management practices and leverage advanced technologies. Managers must locate problem areas, identify opportunities, and determine whereto spend the scare money. Without a measurement program in place, organizations can only make a “best guess” as to problem areas and opportunities, and determine whether expenditures have been justified in terms of improved productivity and quality. Establishing a benchmarking practice can help provide an accurate picture of where an organization’s efforts stand, and it is the type of program most senior management can identify with.

Competitive Benchmarking is an exercise undertaken to define standards of performance and best method to achieve and sustain the same, while meeting of the quality and delivery requirements of the customers at competitive prices. It is conditioned by the provisions and constraints of resources available at one’s disposal.

Everyday, a great variety of new or improved products are designed and manufactured, which offer enough space for customers to become more selective in making their choices. To survive the fierce competition in the market, companies have to develop quality products and customer satisfaction becomes more and more of a concern in the product design phase. As a well-known customer-oriented approach, Quality Function Deployment (QFD) is widely used not only to make the process possible to translate the voice of customers into the language of designers, but also, it can assist in making decisions during product design and development.

Quality Function Deployment (QFD) is a system and procedures to identify, communicate, and prioritize customer requirements so that an organization can optimize its products and services to exceed customer expectations. Identification is achieved through voice of customer analysis, communication is achieved through a series of liked matrices, and prioritization is derived from the customer, competitors,

and the vision of the company. Optimizations activities are then focused on those areas that mean the most to the customer, beat the competition, and are in line with the vision of the organization. Users of QFD have reported that design costs can be reduced by one third and design time by one half. This research will show the need for QFD in today's fast paced world of new product design and development, and will demonstrate its application with a case study of new television project for OEM customers.

That is why, in this study, firstly, a detailed benchmarking describing and literature review from published articles. The first objective of this paper is to propose a tool to help the company to establish its competitive benchmarking. Then Quality Function Deployment is described, QFD is a technique to deal with customer needs and expectations more systematically for achieving the most important objective of a consumer electronics company, satisfaction of OEM (Original Equipment Manufacturer) customers. OEM customer needs and expectations are prioritized with AHP which take place in QFD. QFD is broadly a total quality management implementation technique requiring clear assessment of OEM customer/end-user expectations apart from the basic needs a project to convert them into design targets. Within the context of this research, an attempt has been made discuss QFD as a strategic tool to increase OEM customer satisfaction with a step-by-step implementation of the methodology to a low-end combo television project and to depict limitations and challenges of QFD implementations in consumer electronics industry.

The reminder of this thesis is organized as follows.

Following this introduction, Chapter 2 presents the conceptual framework of this study wherein the Benchmarking Process and Technique. This study attempts to build the benchmarking from the "voice" of the customer. Benchmarking is an operational process involving continuous learning and adaptation which enables you to improve your organization's competitive position.

Chapter 3 of this thesis presents the conceptual framework of this study wherein the “house of quality” theory and benefits are described in detail. Review the QFD from other publications and related literature researches are also in this chapter.

Analytic Hierarchy Process (AHP) is described in Chapter 4. In this thesis, AHP is utilized to prioritize the customer needs and expectations that take place in the QFD.

Chapter 5 presents an application of combo television project in the QFD process is described in detail with also limitations. Also discusses the steps of each stage of the procedure in detail.

Finally, Chapter 6 presents my conclusions and recommendations.

CHAPTER TWO
BENCHMARKING

2.1 Introduction

Intense competition in international markets requires firms to improve competitiveness. These improvements not only benefit the firms themselves, but also have a direct impact on the competitiveness of an industry as a whole. The competitiveness of the firms within a particular industry therefore, reflects the competitiveness of that industry. However, there is still debate among several disciplines regarding how the competitiveness of these firms should be measured and what factors affect competitive performance. These divergent perspectives suggest an alternative approach that would apply multiple theories to analyze competitiveness in order to better appreciate its complexity (Coates & McDermott, 2002; Hoskisson, Hitt, Wan, & Yiu, 1999).

This section will address several issues including: what benchmarking is; when it should be used; and the benefits from using it; how to approach a benchmarking initiative, and how to optimize a benchmarking project.

In this study, benchmarking process is used for achieving performance improvement. The benchmarking process is composed of four phases: planning, analysis, integration, and action phases. In the planning phase, management should reach agreement on such issues as: identifying what is to be benchmarked, identifying competitors, and developing methods for data collection. In the analysis phase, the key questions are these: what is the performance of the best competition organization? How to determine current performance and how to benefit from the "benchmark" organization? The integration phase is to develop goals and integrate them with the benchmarking approach in order to achieve performance improvement.

This phase addresses such questions as: has top management accepted this finding? Have the goals been completely communicated to all parties involved?

is crucial. In this research, I especially focus on the first two phases, planning and analysis. The integration and action phases are not the focus of this study. These two phases involve actions that are internal to the benchmarking process, which should be implemented within the organization.

The task of linking the planning and analysis phases is to measure the gap between the company's products and those of the best company in the industry. To accomplish this task, to achieve the company's objectives and missions and to make appropriate selections of benchmarking by considering the limits on capital resources and capabilities, the QBD methodology is developed from the technique of "house of quality" which is used to organize the qualitative and quantitative data that is gathered, and to identify an organization's competitive benchmarking. The conceptual framework is shown in Figure 2.1 (Chen, 2002).

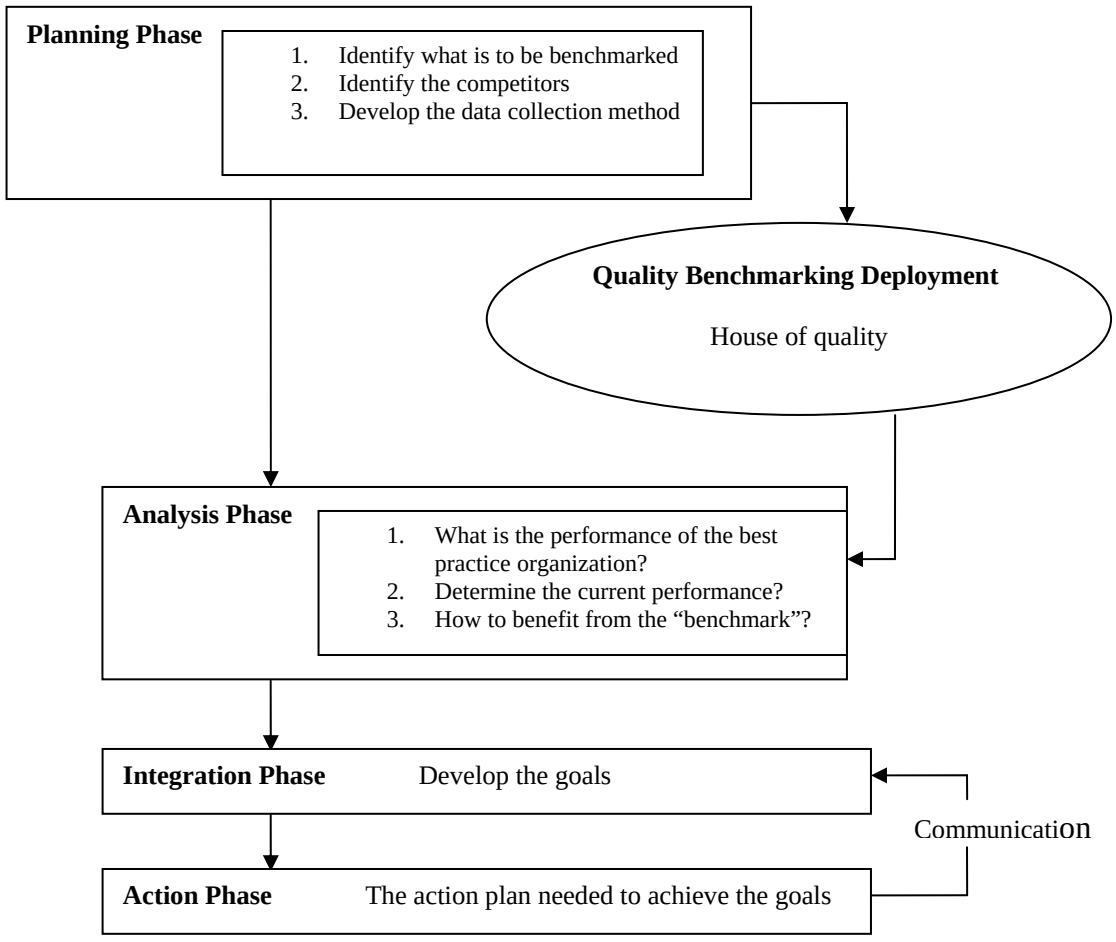


Figure 2.1 The benchmarking process model

2.2 Evolution of Benchmarking

The concept of a benchmark originates from land surveying, being a point of reference of known altitude against which other objects are assessed. Frederick Taylor adopted the term in his scientific management practices and a benchmark became the efficiency standard by which a job could be performed.

2.2.1 What is benchmarking

The term benchmark comes from surveying where it was used to denote a notch or mark representing a given altitude and against which other heights could be calibrated or 'benchmarked', since when it has come to mean any standard against which something is compared; and some of the leading exponents in business include Xerox and GE. In business terms there are numerous definitions of benchmarking, but essentially it involves learning, sharing information and adopting best practices to bring about step changes in performance. So, at its simplest, benchmarking means: "Improving by learning from others – i.e. - benchmarking is simply about making comparisons with other organizations and then learning the lessons that those comparisons throw up".

Another definition is:

"Benchmarking is the continuous process of measuring products, services and practices against the toughest competitors or those companies recognized as industry leaders (best in class)"

Robert Camp's definition:

"A positive, proactive process by which a company examines how another company performs a specific function in order to improve how it performs the same, or similar function. Operational processes must be comparative or analogous if the highest degree of knowledge transfer between benchmarking partners is to be achieved" (Camp, !989).

2.2.2 What it is not

Although benchmarking involves making comparisons of performance, it is not:

- just competitor analysis - benchmarking is best when it involves collaboration
- comparison of league tables - the aim is to learn about the circumstances and processes that underpin superior performance
- a quick fix, done once for all time - benchmarking projects may extend over a number of months or even years, and it is vital to repeat them periodically so as not to fall behind as the background environment changes
- catching up - in rapidly changing circumstances, good practices become dated very quickly and anyway you want to gain competitive, or possibly prime mover, advantage
- copying - the fact that others are doing things differently does not necessarily mean they are better
- spying or espionage - openness and honesty are vital for successful benchmarking

The underlying reason for benchmarking is to learn how to improve your business processes and thereby increase your competitiveness. Organizations choose to benchmark outstanding companies whose business processes are analogous to their own even if they are in different industries! Benchmarking allows you to identify those practices that have facilitated those successful companies' superior performance and that can be adapted to your own business. Accordingly, benchmarking is an operational process involving continuous learning and adaptation which enables you to improve your organization's competitive position.

2.3 Why Benchmark Works

Although many organizations initiate benchmarking projects because of some dubious reasons; for practical purposes the only reason to benchmark is because you recognize that somewhere, somehow you are not as efficient or as capable of

satisfying your customers as your competition – whether currently or because you have spotted a trend in the market that you need to exploit, follow or respond to.

There are two key drivers for an organization – profitability and revenue growth (the former being a function of the latter after costs) and there are many variables that impact on these. The key to maximizing both is to understand where competitors are better than you – where customers value it. It is of little value having the best process for selling insurance if what customers really want is an easy to use claims process and yours isn't! Similarly it is no good having an extremely slick sales process for commodities if the delivery is poor, patchy and unreliable.

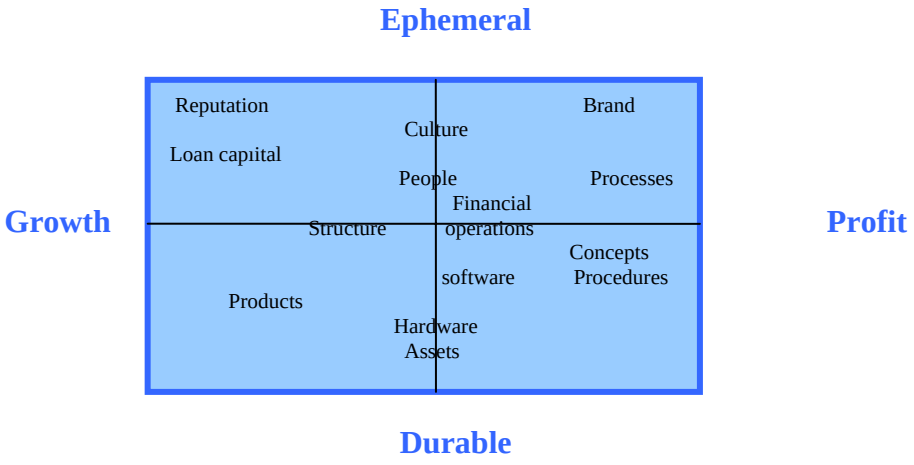


Figure 2.2 Drivers and Contribution to growth/profit

As the diagram shows (Figure 2.2), processes, although an ephemeral component of an organization (as opposed to more durable items such as hardware and fixed assets) because they change easily, are critical for profitability as delivery of products/services is crucial to customer satisfaction, payments and ultimately profit. Similarly reputation (ephemeral) is critical to growth but can be lost all too easily – especially if processes/people do not deliver.

Although benchmarking is a measurement process and does generate comparative performance measures, it also about attaining exceptional performance. The practices that lead to exceptional performance are called enablers. Thus the process of benchmarking results in two types of outputs: benchmarks, or measures of superior performance, and enablers. Process enablers are developed to meet a specific

business need within the context of a specific business environment and company culture. This is why it is of little value to ‘steal’ from others because you will not have explored whether and where their business practices are relevant or transferable to yours (Neil Jones, 2004).

2.4 Comparing benchmarking to other activities

While benchmarking is a distinct quality improvement activity, it is not intended to be a stand-alone process, but rather an integral part of a comprehensive total quality management (TQM) program. TQM programs encompass quality control tools and methods which include, but are not limited to quality function deployment, statistical quality control, and cycle time reduction (Gunn, 1992).

Benchmarking promotes proactive change in that the focus is not only on quantifiable results (metrics) but also on identifying practices and processes (enablers) that produce superior products and services (Watson, 1993). Therefore, when benchmarking is added to TQM programs, the framework for achieving total customer satisfaction and cost competitiveness is strengthened (Digital Equipment Corporation, 1992).

It is important to note that benchmarking is a distinct information gathering activity that is separate from other comparable processes which include site visits, reverse engineering, and competitive analysis, and reengineering (see Table 2.1). Site visits are often used for idea generation, but generally lack the focus required for the transfer application of new practices. Reverse engineering is concerned with the functionality and characteristics of competing products, without examining the process used to produce them. Traditional competitive analysis is generally used to influence business decisions, relying on information, and culture. Contemporary benchmarking differs from all of the these practices in that it places emphasis on processes and practices, rather than an “after the fact” analysis, although it can

include reverse engineering, site visits or competitive analysis as a subset or element of the information gathering process.

Table 2.1 Comparing Benchmarking with Other Activities

Element	**Site Visits**	**Reverse Engineering (Tear Down)**	**Competitive Analysis**	**Reengineering**	**Benchmarking**
Purpose	General Information gathering, learning new ideas	Comprasion to similar products	Influence on business decisions	Redesign of existing management process	Change leading to improvement in customer satisfaction
Focus	Usually Undefined	Characteristics and functionality	Competitive strategies and tactics	Process charts, measures, and methods	Best practices and methods
Application	May or may not directly apply	Mainly manufactured products	Markets, products, functions, and services	Organizational process redesign	Products, processes, functions, sales, and services
Information Source	Anyone	Competitors	Competitors and industry analysis	Internal sources, competitors, customers, suppliers	Best-in-class worldwide leaders and competitors

2.5 Benefits from benchmarking

Successful benchmarking, in which gaps in performance are bridged by improvements, results in significant tangible benefits that are needed in the public sector, such as:

- step changes in performance and innovation;
- improving quality and productivity; and
- improving performance measurement.

Benchmarking can also have a beneficial effect on aspects needed to support continuous improvement, such as:

- provides realistic and achievable targets
- challenges operational complacency
- confirms the belief that there is a need for change
- allows employees to visualize the improvement which can be a strong motivator for change
- raised awareness about performance and greater openness about relative strengths and weaknesses;
- learning from others and greater confidence in developing and applying new approaches;
- greater involvement and motivation of staff in change programmers;
- increase in willingness to share solutions to common problems and build consensus about what is needed to accommodate changes;
- better understanding of the ‘big picture’ and gaining a broader perspective of the interplay of the factors (or enablers) that facilitate the implementation of good practice; and
- Increasing collaboration and understanding of the interactions within and between organizations.

According to Hurmelinna *et al* (2002), although each benchmarking process and the achieved results are unique, the general advantages achieved from the benchmarking process can be summarized as analyzing the operation, knowing the best of the best (BOB), incorporating the world-class performers, and gaining superiority. A company that is using benchmarking study in developing critical areas of business should not expect any ‘‘quick fixes’’. Development in the benchmarking should follow the ‘‘thinking is out of the box’’ approach where benchmarking results take the company closer to the world class performance level, shown in Figure 2.3 The benchmarking gives an insight where the company should focus its development actions in order to reach better conditions for surviving in its business (Hurmelinna *et al*, 2002).

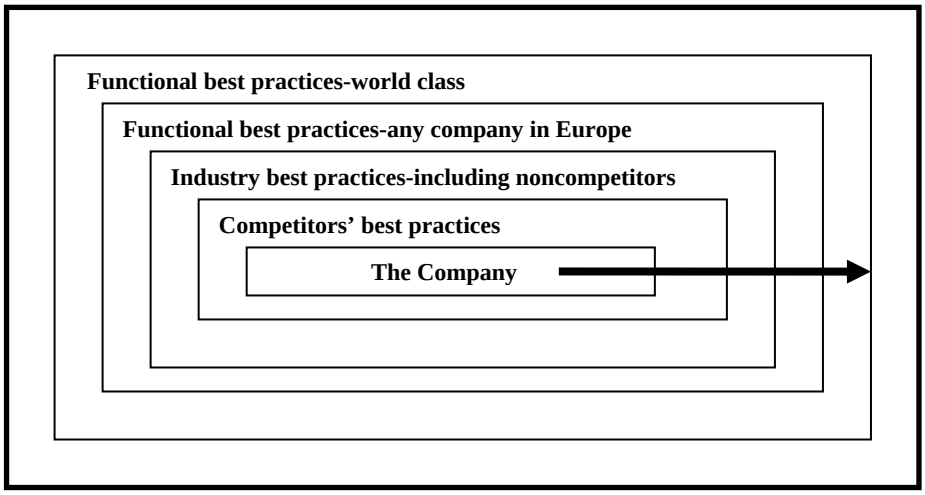


Figure 2.3 Thinking is ‘‘out of the box’’

2.6 Disadvantages of benchmarking

- Might be difficult in persuading partners to discuss their strategy
- Although benchmarking projects can be completed quickly, quantifiable results may take much longer, depending on the scope and nature of the changes that are introduced.
- Weakness in planning and implementation can lead to failure of the process
- Communication failure between partners can occur
- Process may not be successful if the goal is too ambitious.

- Some organizations do not benchmark because their weaknesses are exposed.

There might be cultural difficulties in transferring “best practices” in multilateral organizations

2.7 Types of benchmarking

The Figure 2.4 below shows the benchmarking concept and the various parameters that an organization has to consider when embarking for a benchmarking exercise.

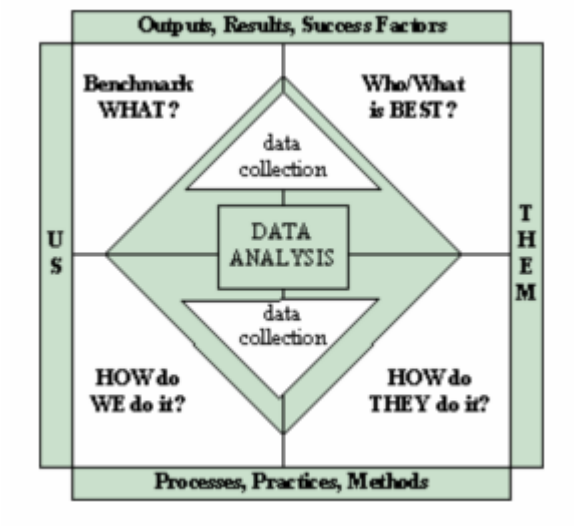


Figure 2.4 Concept of Benchmarking

Different types of benchmarking can be defined based on: (Spendolini, 1991)

- What is compared?
- Against whom is it being compared?

2.7.1 What is compared?

Organizations can benchmark any of the parameters that seem most relevant/critical to them. You can benchmark key performance results, key processes or even the strategic planning areas of your organization.

2.7.1.1 Performance Benchmarking

Performance benchmarking is the comparison of specific performance measures (financial, operational, and functional) for determining how good one's organization is compared to others.

2.7.1.2 Process Benchmarking

Process Benchmarking is the comparison of methods and practices for performing business processes with the best to improve one's own processes.

2.7.1.3 Strategic Benchmarking

Strategic Benchmarking is the comparison of the strategic choices and dispositions made by other companies for collecting information and improving one is own strategic planning and positioning.

2.7.2 Against whom is it compared?

Organizations need to define the domains and scope of their benchmarking endeavors. Comparisons can be made within the organization or with other organizations.

2.7.2.1 Internal Benchmarking

Internal Benchmarking is comparison between departments, units, subsidiary or countries within the same company or organization. It's mainly used within large corporations where different units are evaluated and compared to each other. If one unit performs better than the other, practices can be easily transferred internally for improvement. Internal benchmarking offers various benefits in that it is often easy to define comparable processes, data and information, very often on a standard format.

Many organizations begin their benchmarking practices by comparing business practices internally. The company does not assume that it will discover that it will find the best business practices in this effort; it's merely a starting point to begin to identify the best internal practices in the organization.

Advantages

- Data is often easy to collect.
- Internal Benchmarking has often produced great results for diversified companies.
- The internal knowledge gained as a result of internal benchmarking becomes the baseline for all subsequent investigation and measurement involving external benchmark partners

Disadvantages

- Information collected internally often represents a limited focus on the issue being benchmarked.
- Organizational bias often permeates the findings.

2.7.2.2 Competitive benchmarking

Competitive Benchmarking involves the identification of the products, services and work processes of your organization's direct competitors. The chief objective is to identify specific information about competitors' products, processes and business results and then make comparisons with those of your own organization. It's an extension of competitor analysis where instead of focusing on the industry average, the focus is on the best competitors. However due to problems regarding sharing of sensitive information between competitors and the legal and ethical limitations connected to this type of benchmarking, competitive benchmarking is often considered superficial and focused on key figures.

In this study, competitive benchmarking process is used for where the company is in the sector and for achieving quality improvement continuously.

Advantages

- The information from competitive benchmarking is very important since competitors practices affect the perceptions of customers, suppliers, shareholders, potential customers and "industry watchers" –all of which have a direct effect on the eventual business success.
- Very often due to highly similar business practices, the lessons learnt from competitors can be applied to the organizing without a lot of translation.
- Another possible advantage is the fact that very often competitors have very often performed their own benchmarking studies and are willing to trade information.
- In some cases competitors may actually join forces to participate in joint benchmarking efforts in nonproprietary areas.

Disadvantages

- The issue of competitive benchmarking must be addressed with sensitivity and caution. Benchmark partners must be approached in an up-front manner with no hidden agendas. If you approach your competitor as an enemy you will end up eliciting the predictable reaction of suspicion.
- Data-collection difficulties.
- Ethical issues.
- Antagonistic attitudes.

2.7.2.3 Functional Benchmarking

In functional benchmarking, benchmarking partners can be customers, suppliers or other companies within the same industry or technological area. It is often easy to get in touch with such companies and the problems facing these companies are often similar. Many of the standard reference books actually combine functional and

generic benchmarking under the same name. However one way to distinguish them is that all functional benchmarking need not be generic but all generic benchmarking will most often be functional.

2.7.2.4 Generic benchmarking

Generic benchmarking is a comparison of own processes against the best processes around regardless of the industry. The objective is to identify the best practices in any type of organization that has established a reputation for excellence in the specific area being benchmarked. It's often referred to as functional benchmarking because benchmarking at this level most often involves specific business activities within a given functional area such as manufacturing marketing, engineering or human resources.

Generic benchmarking is often referred to as an exercise in creativity. This is because finding companies in totally unrelated areas that perform similar processes as one self might require a solid portion of creativity. The same goes for transferring knowledge from one industry to another. Still the potential for identifying the new technologies or practices that will lead to breakthroughs is highest in generic benchmarking.

Advantages

- High potential for discovering innovative practices. Generic benchmarking offers the highest potential for leading to breakthroughs. One of the most popular examples is the spread of bar coding from one industry to another. The advantages can be described in the context of paradigm shifts, which often involve radical alterations in an organizations approach to certain issues or problems. There have been many cases where breakthroughs achieved could have come only from outside the industry.
- Development of professional networks.
- Access to relevant databases.

- Stimulating results.

Disadvantages

- Difficulty transferring practices into different environment.
- Some information not transferable.
- Time-consuming.

If we want to type benchmarking as a developing tool, we can build Figure 2.5 given below;

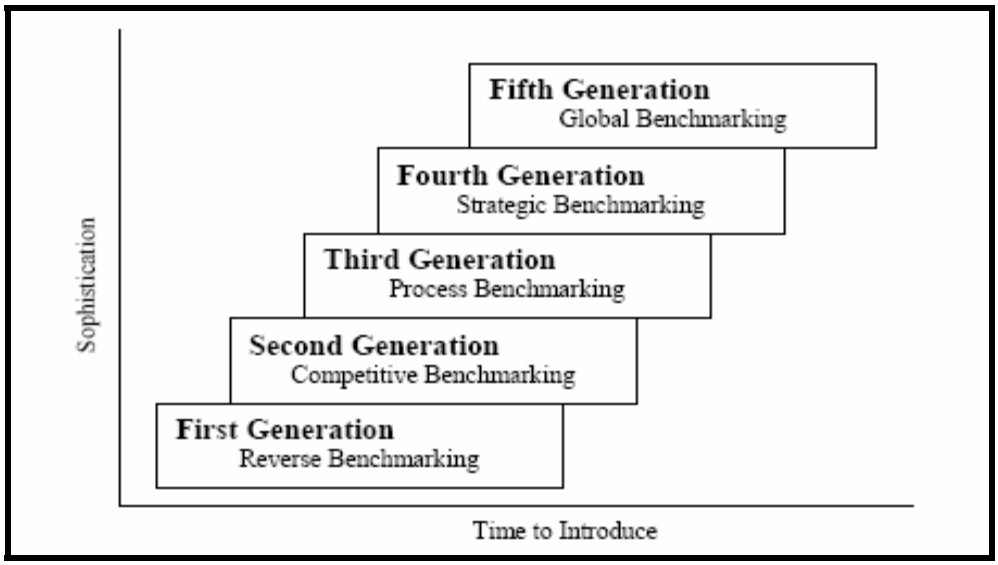


Figure 2.5 Benchmarking as a developing evaluation tool (Barber, 2003)

- **First Generation** of benchmarking as evolving in the early nineties. It was an evaluation/comparison with similar products.
- **Second Generation** of benchmarking evolved when product comparisons expanded to evaluating similar processes with competitors. This occurred in the mid-nineties.
- **Third Generation** of evaluation implied comparisons occurred outside the same industry.
- **Fourth Generation** is referred to as strategic benchmarking. It is a systematic process of evaluating alternatives, implementing strategies and improving performance by understanding and adapting successful strategies

from external partners who participate in an ongoing business alliance. This generation of benchmarking differs from process benchmarking in terms of the scope and depth of commitment among the sharing companies. Strategic benchmarking is comparing a competitor's strategy to one's own in the same market and product benchmarking compares the features and performance of actual products.

- **Fifth Generation** is referred to global benchmarking which should help such organizations identify and link with the best in class (Barber, 2003).

2.8 Benchmarking Methodology

To support this continuous process, APQC uses a four-phased methodology that has proved successful for more than 25 years. The phases are: **plan, collect, analyze, and adapt** shown in the Figure 2.6 given below (APQC, 2003).

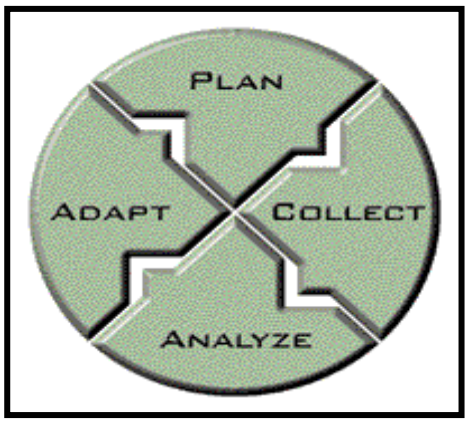


Figure 2.6 Steps of benchmarking

2.8.1 Plan

During this phase, the study focus area, key measures, and definitions are established and clearly documented. Additionally, the data collection tools are refined and finalized, and research is conducted to identify the best-practice organizations to study. Representatives from the sponsoring organizations select the best-practice organizations to be visited.

2.8.2 Collect

This phase has two distinct objectives: 1) collect qualitative data and 2) learn from the best. The study questionnaire is administered to all participants, and the site visits are conducted at the best-practice organizations selected in phase one.

2.8.3 Analyze

Key activities during this phase include analyzing trends and identifying practices that enable and hinder superior performance. The study team presents a final report containing key findings and insights at a knowledge transfer session. At this concluding meeting, the sponsors discuss the key findings and have an opportunity to interact with each other and the best-practice organizations.

2.8.4 Adapt

Adaptation and improvement resulting from the best practices identified throughout a consortium benchmarking study occur after the participants take the findings back to their organizations. For an additional fee, APQC staff is available to help study participants create action plans tailored to their organizations based on the study findings.

2.8.5 Refining the Process

Organizations refine this model to meet their needs as they become more experienced in benchmarking. The number and names of steps are not as important as the use of an integrated, systematic approach to benchmarking. The time frame for each phase is typically:

- 30 percent - Planning the study,
- 50 percent - Collecting information, and
- 20 percent - Analyzing performance gaps.

2.9 Review of the literature

This section will review and present various user process models and theories in order satisfy and extract the key success factors that characterize a successful benchmarking process. I utilized literature reviews from articles and publications because the main subject and application is Quality Function Deployment. Benchmarking is only one step in the QFD.

It appears that even though the body of literature on benchmarking articles, papers and publications is growing, majority of this literature reiterates the same concepts and ideas, providing minimum value-added to the managers wanting to go beyond the benchmarking basics. The value of this research is intended to be in its empirical approach; to use the existing benchmarking practices across the industries and provide direction to firms wanting to implement the process. A summary of the reviewed research literature is presented in Table 2.2 (Afshan Sadeghi, 1999).

Table 2.2 Literature review

Date	Authur(s)	Study	Summary and conclusions
1996	Arldt, Brian K.	Development of a Benchmarking Model for Quality Improvement in Health care	Describes two benchmarking pilot studies performed in two hospitals to improve the quality and performance their operations.
1996	Ellot, Stephen N	An Evaluation of the Benchmarking Incentive Regulation (IR) Scheme	Defines characteristics of incentive Regulation, and develop a qualitative benchmarking evaluation scheme and applies it to eight specific IR case examples to draw policy implications.
1996	Gannaway, Jerry N.	Analysis of the Benchmarking Process as a Potential Tool to Enchance Organizational Competitiveness	Describes four phases of benchmarking Planning, Analysis, Integration, and Action at Lockheed Fort Worth Company. It determines the costs and savings from the pilot to identify benchmarking's benefits to Lockheed.
1996	Hernandez, Emillio	A methodology For the Design of Parallel Benchmarks	Three benchmarking techniques are presented to evaluate program and data transformations, to design more efficient programs, define new benchmarks to evaluate software performance, and to obtain performance results.
1996	Ramabadran, Ramamurti	Cooperative Benchmarking: An Empirical Investigation of the Impact of Team and Partner Characteristics in Project Outcomes	Studies the impact of Benchmarking Team and Partner characteristics on the benchmarking team members satisfaction

Table 2.2 Literature review cont…

Date	Authur(s)	Study	Summary and conclusions
1997	Birk, Thomas A	Benchmarking Decision-Making strategies for Distance Education t Four- Year Colleges and Universities in the United States	Suggests a “best practices” methodology for determining whether a program or course should be offered through distance education by benchmarking three major public universities.
1997	Emhjellen, Kjetilli	Adapting Benchmarking to Project Management Processes, Metrics, And Benchmarking process Models	Indicates areas or processes of project management where improvement techniques such as benchmarking should be focused. Also suggest metrics for project management processes.
1997	Hollingsworth, Keith B.	A Warehouse Benchmarking Model Utilizing Frontier Production Functions	Proposes a warehouse-specific benchmarking model consisting of all basic areas of a warehouse: receiving, storage, broken case item selection, full case selection, pallet selection, and shipping. This model was used to identify those warehouses with superior performance.
1997	Ikenberrry, Kevin D.	Establishment of Benchmarks for Aquatic Facilities, Programs, and Personnel of the Southern University Group	Creates ten benchmarks for the aquatic facilities, programs, and personnel of the SUG through a survey. Each subject institution then evaluates their data against the benchmarks.
1997	Jackson, Andrew E.	Analytical Process Desegregations Procedure Supporting Competitive Benchmarking Initiatives	Develops a methodology to use in Process benchmarking between willing participants in two or more organizations, used to identify mutually beneficial processes to benchmark.
1997	Pohl, Martha J.	A Total Quality Management Perspective with Specific Reference to the Software Industry	Presents perspectives on measurements issues in organizations that aim for quality improvement through TQM.
1997	Rux, Paul P.	Benchmarking Total Quality Management Databases For Higher Education	Provides a guide for how to, and how not to use benchmarking, to design database tools for TQM in education.

Table 2.2 Literature review cont…

Date	Authur(s)	Study	Summary and conclusions
1998	Burns, Gerald D.	Benchmarking Rule-Based Expert System Shells	Presents a quantitative way to evaluate the performance of rule-based expert system shells. Marks this as a benchmark in the knowledge engineering field.
1998	Harris, David T.	Educators Attitudes Towards the Appropriateness of Total Quality Management	Develops ten constructs essential to TQM based on commonalities of Deming, Juran, Crosby, and the Baldrige Award criteria. Using a survey, these constructs are tested for resistance among K-12, higher education, and student bodies in education system. Little resistance to implementation of TQM was observed.
1998	Johnson, bonnie C.	Benchmarking in Food Service Operations	Identifies and rates food service performance measures, important activities in food service benchmarking attitudes, beliefs and usage.
1998	Keiser,Arthur E.	Benchmarking in Private Career Schools: A Preliminary Empirical Investigation in the Establishment of Quantitative Strategic Indicators in this Specialization Postsecondary Education Sector	Analyses certain operations of private career institutions and determines a list of preliminary metrics for each operation in successful institutions
1998	Morrow, Tommy K.	Effects of Selected Practices on Project Cost Performance (team Building, Constructability, Organization Strategies, Change Management)	Investigates the effect of selected construction performance. The data utilized is from the Construction Industry Institute Benchmarking and Metrics database
1998	Ouimet, Judith A.	The Freshman Experience: Benchmarking Student Perceptions of Quality of Life	Determine the contributing factors that influence Quality of Student Life in three large public universities. Results show factors lead to improved satisfaction in personnel domain and less satisfaction in academic domain.
1998	Plemmons, James K.	Materials Management Process Measures and Benchmarking in the Industrial Construction Industry	Identifies 35 key effectiveness measures oh the material management process. To facilities their implementation within the construction industry, a mechanism for benchmarking these measures is proposed and evaluated.

CHAPTER THREE
QUALITY FUNCTION DEPLOYMENT (QFD)

3.1 Introduction

In recent years, industry practices have evolved their strategic and operational decisions taking customer orientation into account. Specifically, for each stage of product development and production, the company requires greater details on customer needs than provided by the traditional market research.

Once a product plan is established which defines the target market and customers, the next step is to plan how to capture these customer's needs for each development project. This includes determining how to identify target customers, which customers to contact in order to capture there needs, what mechanisms to use to collect their needs, and a schedule and estimate of resources to capture the voice of the customer (project plan for product definition phase).

As mentioned earlier, the central theme of establishing benchmarking is built upon customer needs, the house of quality technique is considered to be the most useful quantitative tool to translate directly the “voice” of the customer into product development and improvement elements. Mizuno and Akao (1996) noted that the so-called “quality function” is an activity of continuing quality improvement. Therefore, from product design and development to product disposal, product quality function is clearly established in each stage. As such, the quality function of deployment (QFD) technique systematically works to fulfill this purpose. In contrast with QFD, the Quality Benchmarking Deployment (QBD) puts emphasis on competitor’s analysis and reveals our own position with respect to competitors.

3.2 The Definition and Content of QFD

Hauser and Clausing (1988) describe QFD with a different emphasis, “quality function deployment focuses and coordinates skills within an organization, first to design, then to manufacture and market goods that customers want to purchase and will continue to purchase.” That is, they are concerned more with teamwork and organization-wide communications. This was, in fact, Akao’s original intention (Pardee, 1996).

The QFD founder Akao (1990) describes QFD as “a method for developing a design quality aimed at satisfying the customer and then translating the customer’s demand into design targets and major quality assurance points to be used throughout the production phase”. Sullivan (1986) defines QFD more concisely as “a system to assure that customer needs drive the product design and production process”. See also similar description by Eureka and Ryan (1994). That is, QFD is a “customer-driven planning process” (Day, 1993).

This definition also emphasizes the broad use of QFD in phases beyond requirements elicitation, specifically mentioning "to be used throughout the production phase." Both of these definitions include the term "consumer" or "customer." This emphasizes how important the customer is to the QFD process. The customer plays a central role in QFD. For us in the early 2000's, this is hardly a revolutionary idea, but back in the 1960's, this was a novel and intriguing concept. Much of today's customer awareness comes from the quality movement, and QFD was one of the techniques that lead this movement into North America.

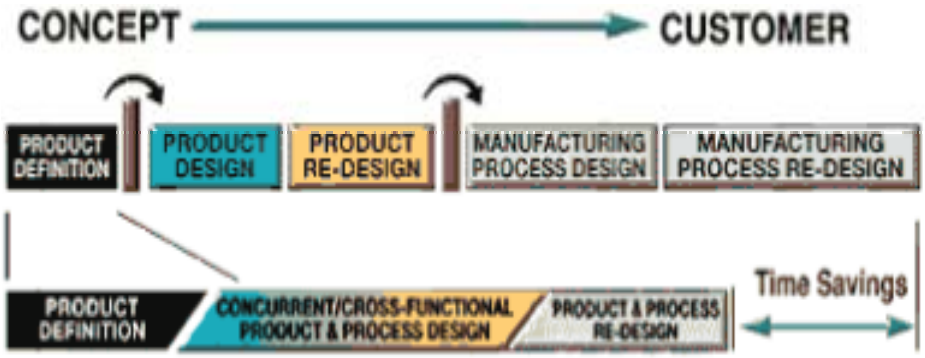


Figure 3.1 From concept to customer (ASI, 1994)

The diagram in Figure 3.1 illustrates the distinction between traditional product engineering processes and a QFD product engineering process. The top set of process elements represents the traditional process and the bottom set represents the QFD process. Not that while the initial product definition step is longer with QFD, the overall process is faster since there is a cross-functional team that facilitates concurrent engineering. The overall time savings turns into a faster-time-to-market, a great benefit to a company in many markets. Table 3.1 summarizes the "before QFD" and "after QFD" perspectives.

Table 3.1. "Before QFD" versus "After QFD" (ASI, 1994)

Before QFD	After QFD
Individual work	Cross-functional teams
Some customer focus	Intense customer focus
"Over the wall" development	Supports simultaneous engineering
Poor documentation	Supports integrated product development
Poor communication	Better communication/documentation

3.2.1 History

There are several ideas that Akao merged and evolved together to form QFD. Akao describes at least three core techniques that he combined into QFD: statistical process control, design quality, and value engineering. The approximate time-line for QFD's development and integration into manufacturing is in Table 3.2

Table 3.2 QFD Time-line (Akao, 1996)

Year	Activity
1966	Bridgestone Tire Corporation uses a "process assurance items" table
1967	Akoa writes about QFD
1972	Mitsubishi's heavy Industries Kobe Shipyard uses a "quality chart" (House of Quality)
1978	Toyota Auto body uses QFD
1983	First QFD Seminar in Japan
1990's	American automotive industry adopts QFD
1996	Survey indicates that QFD is used more in the US than in Japan, based on a survey of companies that participated in QFD seminars and conferences

3.2.2 QFD models

There are two dominant QFD models: (i) the Four-Phase Model as described by Hauser and Clausing (1988) and Sullivan (1986), also known as the Clausing model or the ASI (American Supplier Institute) model, (Eureka and Ryan, 1994) and (ii) Akao's Matrix of Matrices Model (Akao, 1990). As Cohen (1995) explains, the Four-Phase Model is a blueprint for product development and covers basic product

development steps, while the Matrix of Matrices Model is also designed for Total Quality Management (TQM) and covers a host of activities such as reliability planning, value engineering, cost analysis, and manufacturing quality control that are implicit or optional in the Four-Phase Model. Even though, in practice, the two models differ more in style than in content, and it seems that the simpler Four-Phase Model is more widely described and used, especially in the U.S. Therefore, they will mainly focus on the Four-Phase Model. As for the Matrix of Matrices Model (Akao, 1990; Cohen,1995; King, 1987) that may be the most accessible English-language source for the model in which QFD is presented as a system of as many as thirty matrices or other diagrams, and the tutorial presented by King (1989) in the First QFD Symposium.

3.2.2.1 The Four-Phase Model

As widely used, the Four-Phase Model divides a product development process into four phases or steps using four matrices. The first phase is to collect customer needs for the product (or customer requirements, customer attributes) called WHATs and then to transform these needs into technical measures (or technical requirements, product design specifications, engineering characteristics, performance measures, substitute quality characteristics) called HOWs. This phase is so fundamental in product development that the corresponding QFD matrix is given a special name called the HOQ. The HOQ links customer needs to the development team's technical responses to meet these needs, which may also be called Product Planning (Cohen, 1995) or Customer Requirement Planning (Sullivan, 1986). The second phase transforms the prioritized technical measures in the first phase into part characteristics, called Part Deployment. Key part characteristics are transformed in the third phase, called Process Planning, into process parameters or operations that are finally transformed in the fourth phase called Production Planning into production requirements or operations. The Four-Phase Model is usually depicted in a conceptual form as shown in Figure 3.2 (Hauser and Clausing, 1988; Cohen, 1995).

The described QFD process can be well illustrated by the famous car door example given in literature by Hauser and Clausing (1988). ". . . Suppose that our team decides that doors closing easily are a critical attribute and that a relevant engineering characteristic is closing energy. Setting a target value for closing energy gives us a goal, but it does not give us a door. To get a door, team need the right parts (frame, sheet metal, weather stripping, hinges, etc.), the right processes to manufacture the parts and assemble the product, and the right production plan to get it built".

This example can be depicted by a typical Four-Phase Model as shown in Figure 3.3. For other complete QFD examples with all the four phases, the readers are referred to (Day, 1993, Chapters 7–10 and Sullivan, 1986).

The QFD idea is not complex. It provides a formal linkage between objectives (WHATs) and responses (HOWs), a systematic method for developing or deploying the HOWs from the WHATs and for setting priorities, and a convenient repository of all the information (Cohen, 1995). In fact, the Four-Phase Model breaks down QFD into four inter-linked phases to fully deploy the customer needs phase by phase in such a convenient way that each phase is described by a matrix of WHATs and HOWs and that each phase's important outputs (HOWs), generated from the phase's inputs (WHATs), are converted into the next phase as its inputs (newWHATs). However, as Hauser and Clausing (1988) indicate, successfully implementing QFD is not simple at all since "an elegant idea ultimately decays into process, and processes will be confounding as long as human beings are involved." They point out that QFD's principal benefit is getting people thinking together in the right directions.

Although a complete QFD process contains four phases, "most organizations that use QFD stop after developing their customized version of the House of Quality" (Cohen, 1995). This is quite understandable, partly due to the lack of specificity in the literature as how to develop downstream QFD phases, partly due to the fact that the structures and analyzing methods of the other three QFD phases are more or less

the same as those of the HOQ phase. In fact, the HOQ phase is of fundamental and strategic importance in the QFD system, since it is in this phase that the customer needs for the product are identified and then, by incorporating the producing company's competitive priorities, are transformed into technical measures for the needs. In other words, HOQ links the voice of the customer to the voice of the development team through which detailed process and production plans can be developed in the other phases of the QFD system.

I have described above the complete QFD process and given a full QFD example for possible reference. In what follows I will give a detailed presentation of the HOQ phase due to its importance in the theory and applications of QFD.

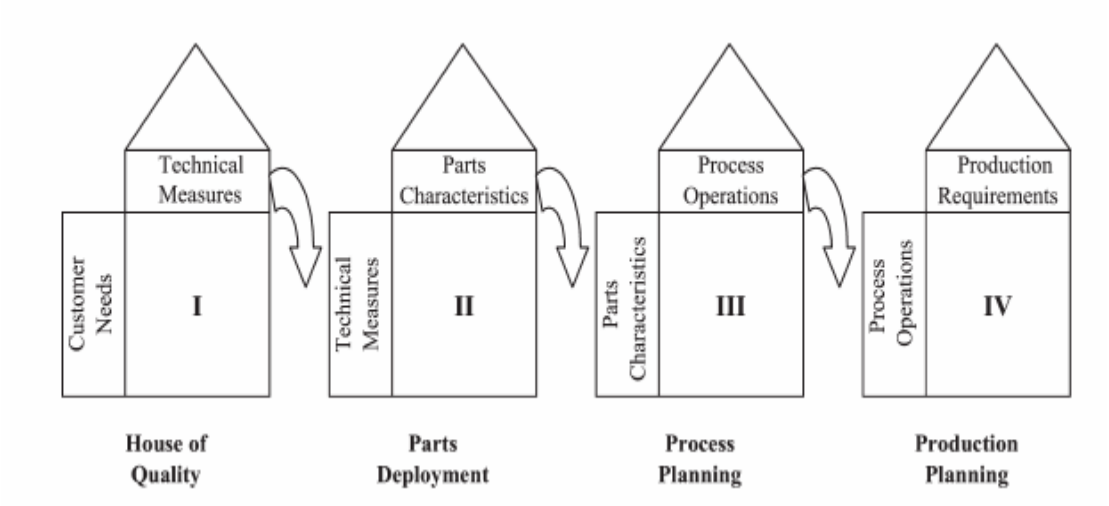


Figure 3.2 The four-phase model of QFD

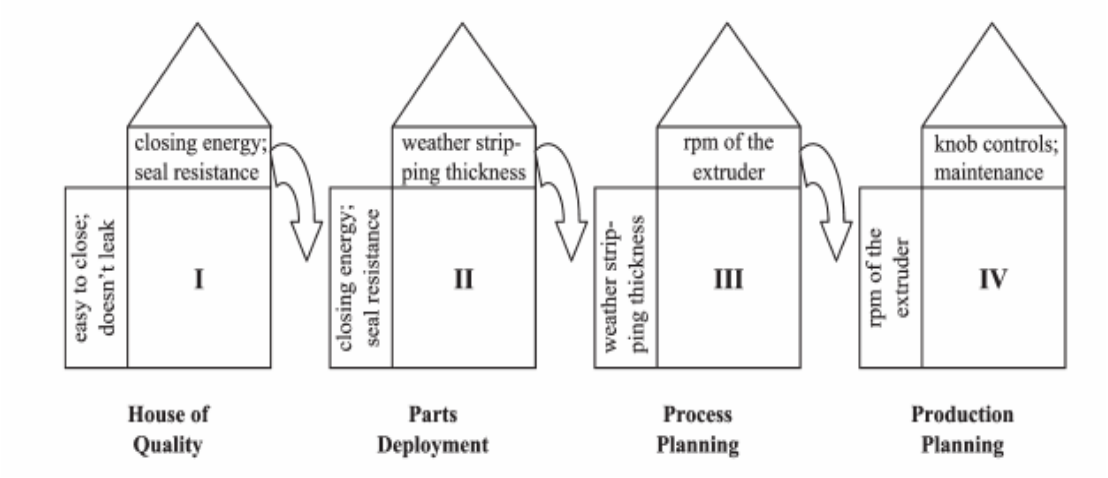


Figure 3.3 The four-phase model of QFD: A car door example

3.3 House of Quality : Concepts and Methods

A typical HOQ comprises six main parts, as shown in Figure 3.4. It is a structured and systematic way to transform the customers' needs for a product into prioritized technical measures that can be further deployed to develop process and production plans. Although the HOQ's contents are different in various presentations, more detailed description through "sub-parts" in Figure 3.5 provides a nearly full account of HOQ's key elements addressed by various authors. As they are well recognized by both researchers and practitioners, it is felt that their concepts and methods could be regarded as standards for facilitating communications among people interested in QFD.

The methodology used in the project presented in this research is shown in Figure 3.7.

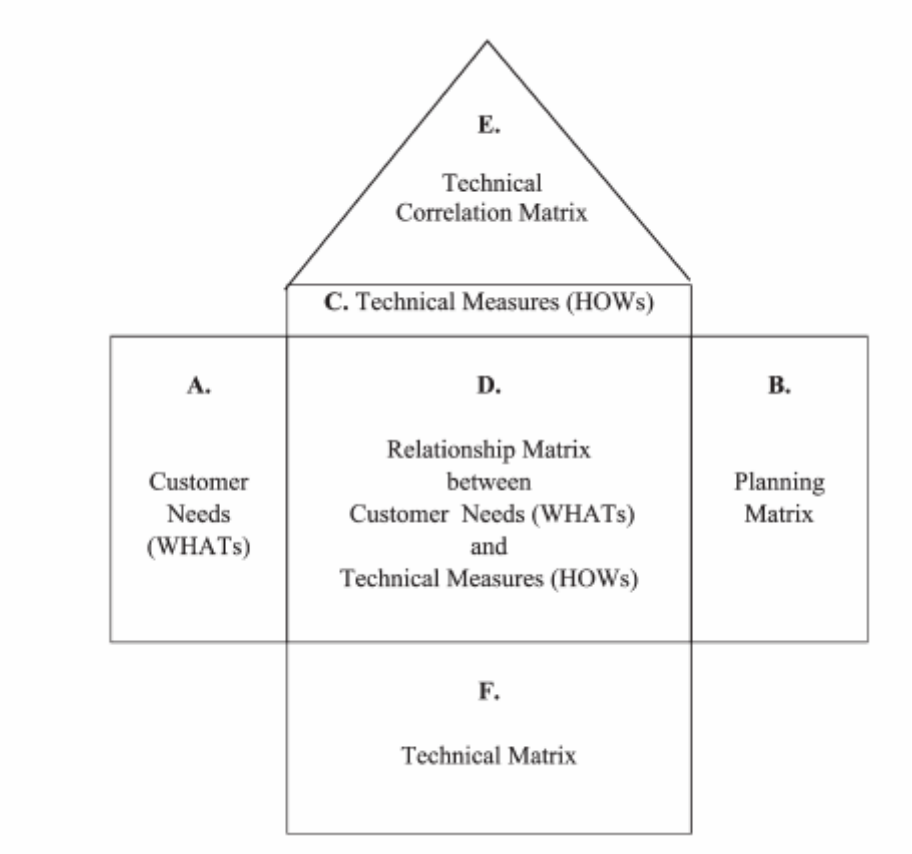


Figure 3.4 House of quality (HOQ): brief description.

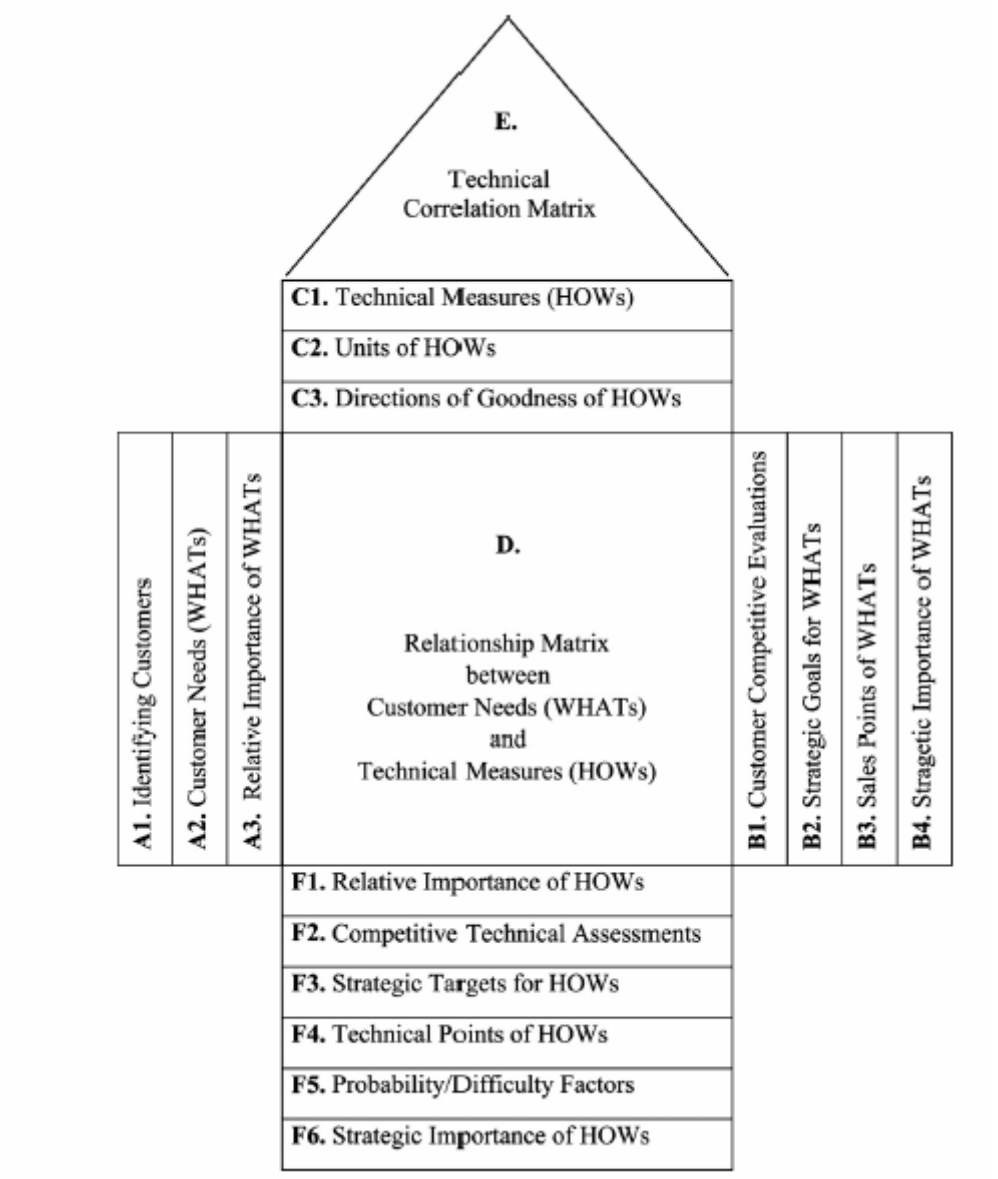


Figure 3.5 House of quality (HOQ): detailed description.

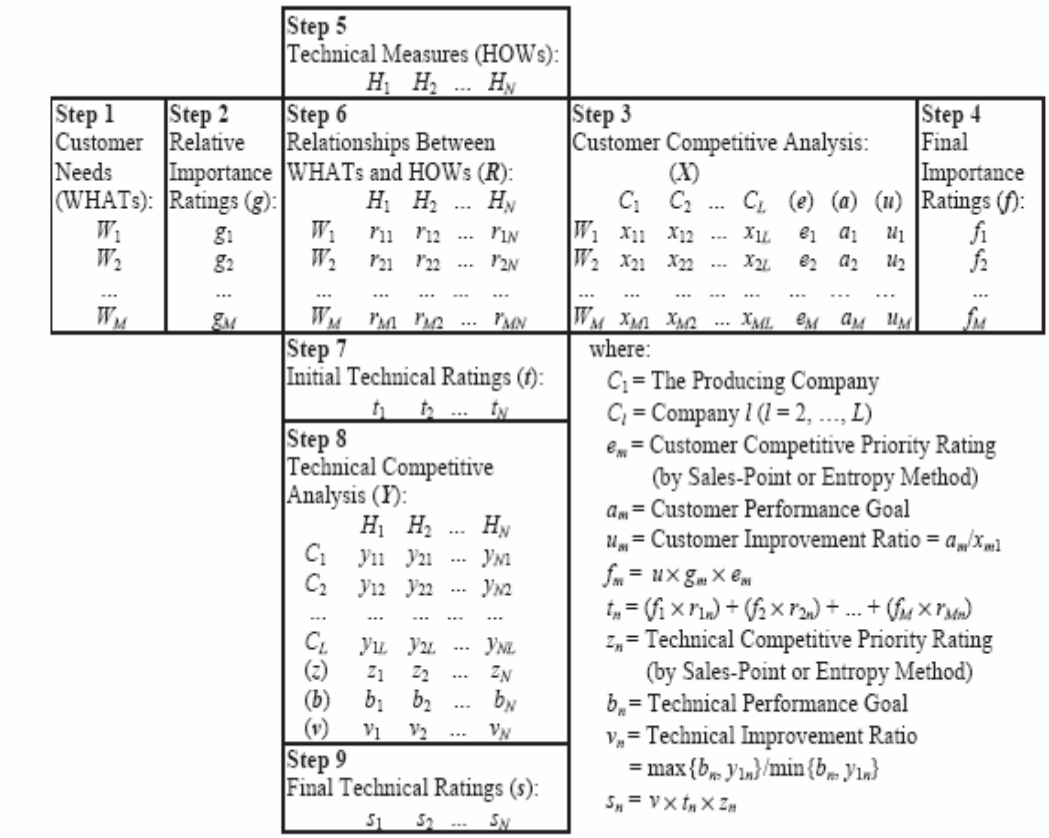


Figure 3.6 HOQ model: quantitative descriptions.

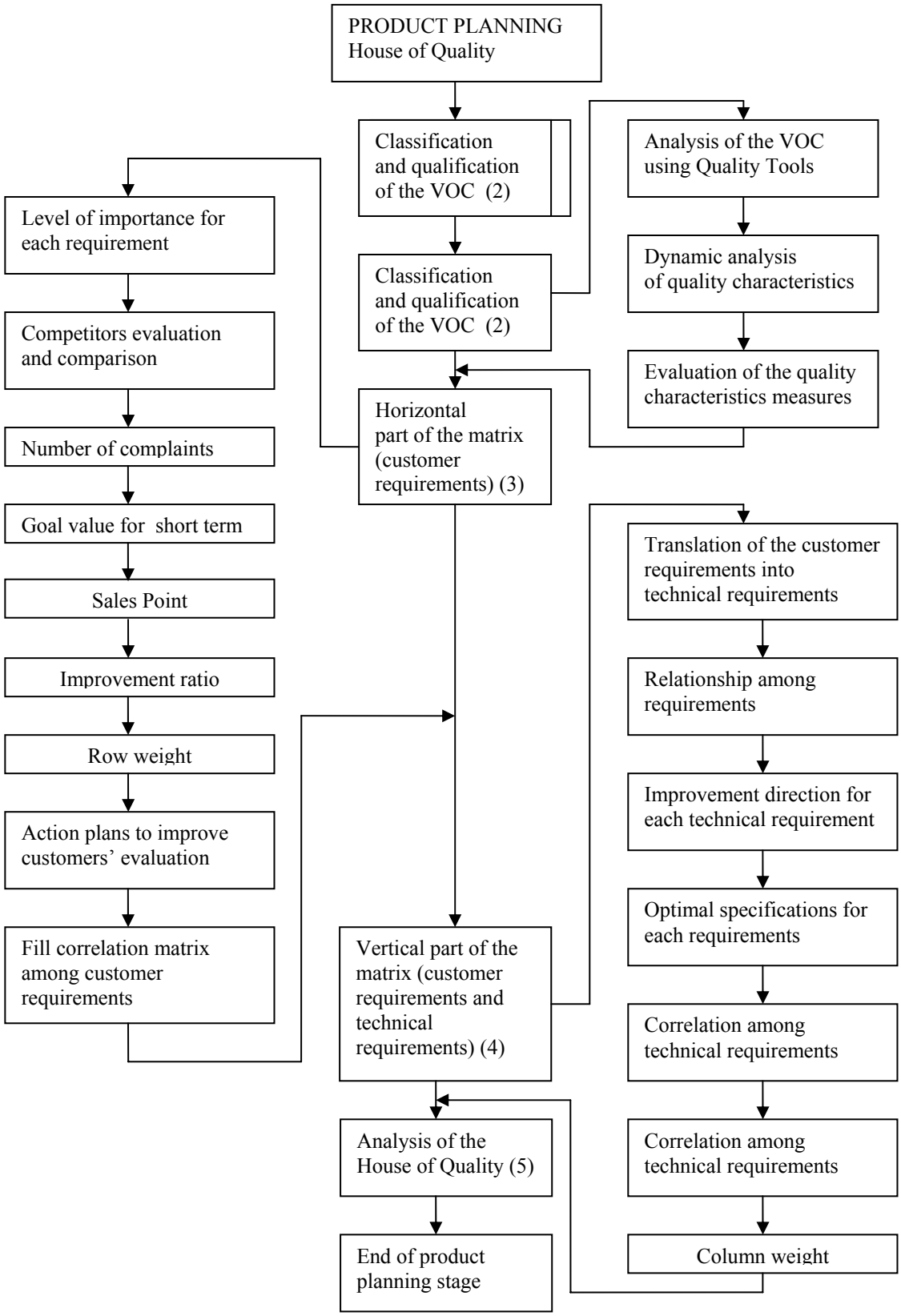


Figure 3.7. The house of quality methodology (Gonzalez, Quesada ,2003)

3.3.1 Part A. Customer Needs (WHATs)

Quality function deployment starts with the customers. The first step for a development team of a company to build an HOQ is to identify the customers of the product, collect their needs for the product (and, if necessary, organize these needs in the form of a tree diagram and reveal the needs' relative importance perceived by the customers.

A1. Identifying Customers

At first, the customers should be identified according to the nature of the product. There are generally three types of customers (ASI ,1994 and Guinta, 1993) internal customers such as shareholders, managers, and employees; intermediate customers such as wholesale people and retailers; and ultimate customers such as recipients of service, purchasers, and institutional purchasers. Usually the main focus is on the ultimate customers, who could be identified through previous information and marketing research.

A2. Customer Needs (WHATs)

After the customers are identified, the next step is to determine what are the needs of the customers for the product concerned. Customer needs are usually expressed in customers' words that can be collected by various methods by the company's marketing department, or by an outside marketing or information gathering agency. According to American Supplier Institute (ASI, 1994) methods for collecting customer needs include:

- **Survey:** mail/telephone; comment card; questionnaires.
- **Focus groups:** facilitator guides a small group of 8–12 randomly selected customers for a free- flowing discussion of the product.
- **Individual interviews:** focus group may tend to reinforce the vocal members' ideas while the quiet members' needs may be lost in the process. Individual interviews can overcome this weakness and are very

effective in getting at the emotional side of the customers' purchasing decision.

- Product in use: displays; clinics.
- Listening and observing: managers, engineers, and "mystery shoppers" can be stationed at trade shows and retail outlets to listen to people's comments and conversations. By observing customers, one can see where they are confused, frustrated, or "lost," and then find potential "excitement" opportunities.
- Natural field contact: sales meetings; service calls; trade shows.
- Feedback: employees and customers discuss competitors' products.
- Complaints: letters; cards; hot lines.
- Warranty data: service records; cards; letters.
- Sales records: monthly; reports; parts sales.
- Publications: government; independent labs; trade journals; consumer magazines.

According to Griffin and Hauser (1993) individual face to face interviews may be more cost effective than focus groups, and 20–30 customers should be interviewed to obtain 90–95% of all the possible customer needs. It should also be noticed that mail/telephone surveys may be unsuitable for collecting qualitative data such as customer needs due to the difficulties in controlling the scope of responses and the inadequacy of the response rate.

On the other hand, customers' words are usually too general and/or too detailed to be directly used as formal customer needs. To facilitate analysis and application, the words collected are usually organized as a tree-like hierarchical structure to form various levels of customer needs and, according to the situation, those at a specific level are chosen as the final customer needs. As Griffin and Hauser (1993) describe, customer needs can usually be structured into a hierarchy of primary, secondary, and tertiary needs. The primary or strategic needs are the 5–10 top level needs that are used to set the strategic directions for the product, secondary or tactical needs indicate more specifically what must be done to fulfill the strategic directions

implied by the primary needs, and tertiary or operational needs provide details so that engineering solutions can be developed to satisfy the secondary needs. An example for making fried vegetable as shown in Figure 3.8 can illustrate this type of hierarchical structure. An Affinity Diagram, a method of organizing qualitative information into natural and logical groups, can be used for this purpose (ASI, 1994 and Cohen, 1995). Other techniques, such as cluster analysis, may also be used to form and structure customer needs (Griffin, 1993).

Primary Needs	Secondary Needs	Tertiary Needs
Good taste	Appropriate ingredients	Not too salty
		Not greasy
		Moderately spicy
		Appetizing
	Good smell	Hot
		Fresh
		Sweet smell
Good appearance	Good color	Not overcooked
		Freshness
		Jade color
	Good shape	Good-looking plate
		Not too full
		tasteful arrangement

Figure 3.8 Hierarchical structure of customer needs:
A fried vegetable example.

A3. Relative Importance of WHATs

Customer needs are of different priorities for the customers, and the next QFD step is to reveal the relative importance of the customer needs identified. The company would work on the most important customer needs and disregard the unimportant customer needs to make best use of its resources. Conventionally, customers are asked to give relative importance ratings for each WHAT using five-, seven- or nine-point scales. More elaborate scales, such as the 1–10 scale and anchored scale, are also used (Griffin, 1993). A common and appropriate way of obtaining this information is mail/telephone surveys. Since a sufficient number of customers should be surveyed to provide statistical significance, focus groups and individual interviews are usually not suitable for collecting quantitative information about the relative importance of customer needs due to their high costs. Additionally,

fuzzy methods can be applied to address the vagueness and subjectivity in people's assessment.

3.3.1.1 Kano's Model of Customer Satisfaction

In his model, Kano *et al*. (1984) distinguish three types of product requirements which influence customer satisfaction in different ways when met (Figure 3.9).

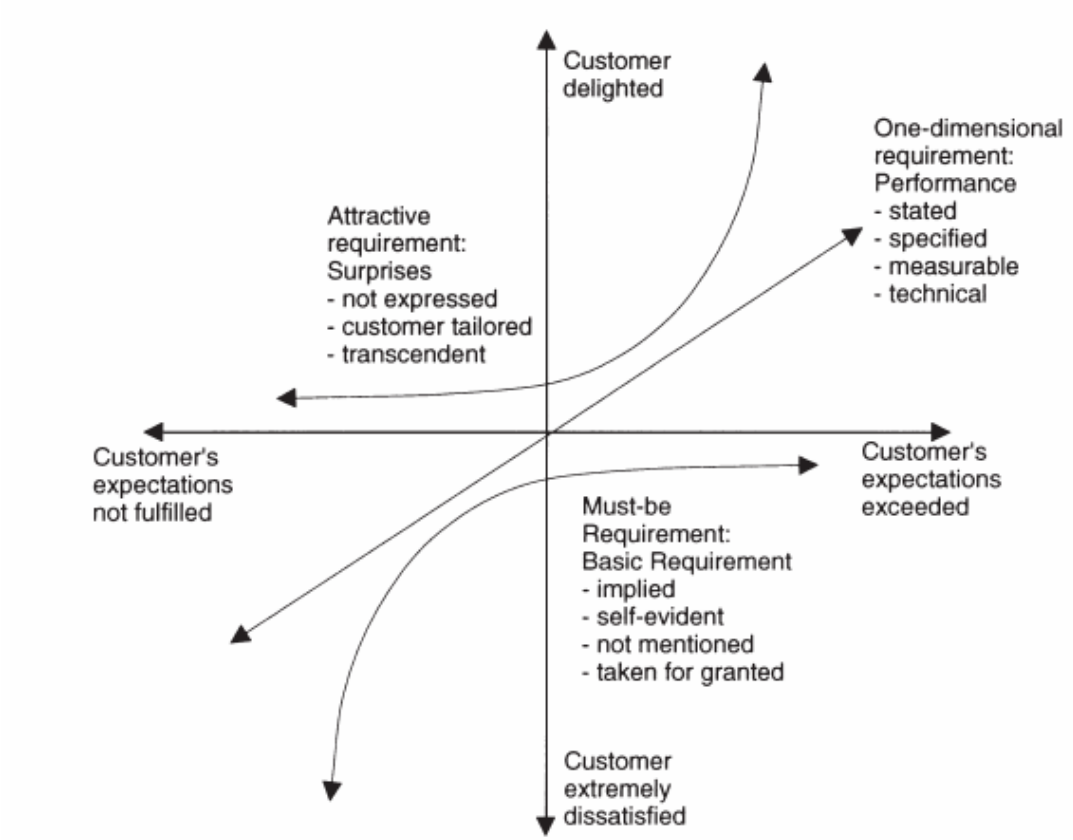


Figure 3.9 Kano's model of customer satisfaction (Maltzer, Hinterhuber ,1998)

'Must-Be' requirements: The 'must-be' requirements are basic criteria of a product. If these requirements are not fulfilled, the customer will be extremely dissatisfied. On the other hand, as the customer takes these requirements for granted, their fulfilment will not increase his satisfaction.

Fulfilling the must-be requirements will only lead to a state of ‘not dissatisfied’. The customer regards the must-be requirements as prerequisites; he takes them for granted and therefore does not explicitly demand them. Must-be requirements are in any case a decisive competitive factor, and if they are not fulfilled, the customer will not be interested in the product at all.

For instance, British Rail found through extensive market research that when the average punctuality exceeds a certain level there is no increase in customer satisfaction. But if punctuality does not meet customers’ expectations it causes a high level of dissatisfaction. Punctuality is a must-be requirement. For fulfilling this minimum requirement Bristish Rail does not get ‘bonus points’.

One-Dimensional requirements: With regard to these requirements, customer satisfaction is proportional to the level of fulfillment — the higher the level of fulfillment, the higher the customer’s satisfaction, and vice versa. One-dimensional requirements are usually explicitly demanded by the customer.

A good example of a one-dimensional requirement is the gas mileage (petrol consumption) of a car. The better it is, the more satisfied the customer is, and vice verca.

Attractive requirements: These requirements are the product criteria which have the greatest influence on how satisfied a customer will be with a given product. Attractive requirements are neither explicitly expressed nor expected by the customer. Fulfilling these requirements leads to more than proportional satisfaction. If they are not met, however, there is no feeling of dissatisfaction.

Product or service elements that exceed customers’ expectations and are classified as attractive requirements enhance customers’ perceived value and their satisfaction. For instance, an airline that offers an in flight telephone service may provide a value enhancement to business travelers who otherwise lose opportunities to communicate

with their respective customers and/or home offices. Yet the absence of this service will not necessarily result in customer dissatisfaction or loss of passengers.

The advantages of classifying customer requirements by means of the Kano method are very clear:

- Product requirements are better understood. The product criteria which have the greatest influence on the customer's satisfaction can be identified. Classifying product requirements into must-be, one-dimensional and attractive dimensions can be used to focus on priorities for product development. It is, for example, not very useful to invest in improving must-be requirements which are already at a satisfactory level, but better to improve one-dimensional or attractive requirements as they have a greater influence on perceived product quality and consequently on the customer's level of satisfaction.
- Kano's method provides valuable help in trade-off situations in the product development stage. If two product requirements cannot be met simultaneously due to technical or financial reasons, the criterion which has the greatest influence on customer satisfaction can be identified.
- Must-be, one-dimensional and attractive requirements differ, as a rule, in the utility expectations of different customer segments. From this starting point, customer-tailored solutions for special problems can be elaborated, which guarantees an optimal level of satisfaction in the different customer segments.
- Discovering and fulfilling attractive requirements creates a wide range of possibilities for differentiation. A product which merely satisfies the must be and one-dimensional requirements is perceived as average and therefore interchangeable.
- Kano's model of customer satisfaction can be optimally combined with quality function deployment. A prerequisite is to identify customer needs, their hierarchy and priorities (Griffin and Hauser, 1993). Kano's model is used to establish the importance of individual product features for the

customer's satisfaction, and thus it creates the optimal prerequisite for process-oriented product development activities (Maltzer, Hinterhuber, 1998).

3.2.2 Part B. Planning Matrix

The previous part is a repository for qualitative customer needs, while the current Planning Matrix part is the repository for important quantitative data about the needs (Cohen, 1995). This part is customer competitive evaluations of the company's product compared with its main competitors' similar products in terms of the products' performance on customer needs. From these comparative evaluations the company may set strategic goals for its product to better satisfy the customer needs. Sales points may also be derived to indicate the company's competitive positions and opportunities. The final rank order of the customer needs' strategic importance can be computed from the above information in Parts A and B. Part B is also referred to as WHYs since it indicates why you should work on some WHATs through customer competitive evaluations of the WHATs, strategic goals and sales points assigned to the WHATs, and strategic importance derived for the WHATs.

B1. Customer Competitive Evaluations

First, competitors who produce the similar products should be identified by the company under study. Knowing the company's strengths and constraints in all aspects of a product and in comparison with its main competitors is essential for a company if it wishes to improve its competitiveness in the relevant markets. This kind of evaluative information can be obtained by asking the customers to rate the relative performance of the company and its competitors on each WHAT and then to aggregate the customers' ratings. As in Part A3, the performance may be rated on a suitable numerical scale, and a useful way to obtain this kind of information remains to be mail/telephone surveys, and focus groups and individual interviews are still not suitable here. It should also be noticed that customers can and should only rate the

product(s) they use and are quite familiar with. Thus, many more customers should be sampled to retain statistical significance.

B2. Strategic Goals for WHATs

After knowing your company's performance and your competitors' performance on each customer need through customer competitive evaluations, the next QFD step is to set goals for each WHAT. These goals are numerical and should be consistent with the rating scale already established. The goals must be set realistically taking into account program timing, resources, cost objectives, and available technology. The goal-setting strategy reflects the type of activity a company will pursue to better satisfy the customer needs, and such activities include (ASI, 1994):

- Improve through QFD implementation,
- Hold (i.e., retain your current position),
- Copy a competitor (this is a weak option),
- Degrade (dangerous, since you may overkill a customer need).

B3. Sales Points of WHATs

The next step is to determine the company's sales points for the customer needs according to the previous information. A sales point contains such information that characterizes the company's ability to sell the product based on how well each customer need is met (Cohen, 1995). In other words, a sales point indicates the possibility that will give the company a unique selling proposition: when the company and its competitors are all doing poorly at a WHAT, one can assume the reason for this is a bottleneck in technology and the company needs a technological breakthrough to improve its product (ASI, 1994). Usually, a "strong" sales point is reserved for important WHAT where each comparing company is rated poorly, a "moderate" sales point means the importance rating or competitive opportunity is not so great, and a "no" sales point means no business opportunity. Numerically, 1.5, 1.25, and 1 are assigned to strong, moderate, and no sales point respectively (Cohen, 1995). To be more objective, entropy methods for obtaining the important weights of

a set of decision attributes can be adopted to reveal the WHATs' competitive priorities (Chan *et all*, 1999).

B4. Strategic Importance of WHATs

From the afore information, final or strategic importance rating (or row total, planning weight, as some people call it) can be obtained for each customer need by the following formula (Cohen, 1995):

Final importance = (goal - current position) x relative importance x sales point

Customer needs with high final importance ratings indicate high potential business benefit to the company and thus should be prioritized.

3.3.3 Part C. Technical Measures (HOWs)

This part lists and structures the technical measures (HOWs) identified by the product development team. The units and directions of goodness or improvement of these HOWs are also determined to facilitate further analysis and deployment.

C1. Technical Measures (HOWs)

After the information collection and analysis in the previous parts, customer needs are transformed into technical measures (HOWs) in this step. HOWs are methods, company measures, design requirements, substitute quality characteristics, and engineering characteristics, which can be related to and measure the customer needs (WHATs). According to American Supplier Institute (ASI, 1994), good HOWs should be measurable, global, and proactive. In practice, technical measures can usually be generated from current product standards. Methodologically, proper HOWs may be selected by creating a cause-and-effect diagram or a tree diagram and ensuring through cause-effect analysis that the HOWs are the first order causes for

the WHATs (ASI, 1994). As in Part A2 for dealing with customer needs, it is also useful to use the Affinity Diagram method to organize the selected HOWs into appropriate hierarchy structure to facilitate analysis and implementation (Cohen, 1995).

C2. Units of HOWs

To be properly defined, any measure should be associated with a unit and a direction, which are the next two QFD steps. Although it should not be a problem to define the units of the HOWs, it is better to give these units explicitly in the QFD matrices for both clarity and completeness. Such examples would be voltage in volts, time in minutes, length in feet, weight and force in pounds, capacity in gallons, energy in foot-pounds, resistance in pounds per square foot, process complexity in number of steps, quality in defects per thousand pieces or defects per million, and so on.

C3. Directions of Goodness of HOWs

As for improvement directions, three possible definitions may be adopted for different HOWs: the more the better (to increase), the less the better (to decrease), and target is best (to close to) (Cohen, 1995).

3.3.4 Part D. Relationship Matrix Between Customer Needs (WHATs) and Technical Measures (HOWs)

The Relationship Matrix of WHATs vs. HOWs is a systematic means for identifying the degree of relationship or linkage between each WHAT and each HOW. Completing this Relationship Matrix is a vital step in the QFD process since the final analysis stage relies heavily on the relationship symbols or numbers at the intersections of this matrix of WHATs vs. HOWs.

Filling in the Relationship Matrix in a column- or HOW-wise fashion works better, since usually the development team defines the HOW once and then establishes if it helps to satisfy each of the WHATs. Sometimes one may also examine the impact of each HOW on each WHAT and then define the degree of this impact as the relationship.

Usually there are four relationship levels, i.e., no relationship, weak/possible relationship, medium/moderate relationship, and strong relationship. Two sets of measurement scales may be employed to quantify the said relationships: (0, 1, 3, 9) (ASI, 1994 and Cohen, 1995) and (0, 1, 3, 5) (Hauser and Clausing, 1988 & Guinta, 1993). The former scale is more frequently used and seems more suitable since it assigns a much higher weight to the strong relationship that is indeed much more important in the product development process. QFD experts also like to use symbols to intuitively describe the relationships between HOWs and WHATs, and authors suggest the use of the following set of simple symbols to represent the four degrees of relationships: <blank> for "no relationship", Δ for "weak relationship", O for "moderate relationship", and ⊗ for "strong relationship".

3.3.5 Part E. Technical Correlation Matrix

The Technical Correlation Matrix is the development team's assessments of which HOWs are interrelated and how strong these relationships are, which can be obtained through engineering analysis and experience. This part, as Cohen (1995) points out, is probably the most underexploited part of QFD, yet its potential benefits are great. Usually, after the HOWs have been determined, the development team will be able to see that as one HOW is changed, the others will be influenced. The degrees and directions of these influences have serious impacts on the development effort. Especially, negative impacts of one HOW on the others represent bottlenecks in the design that call for special planning or breakthrough attempts. In other words, the Technical Correlation Matrix will show us which technical areas need close communication and collaboration and which areas do not (Cohen, 1995)

Usually five types of technical correlations or impacts are identified in QFD: strong positive impact, moderate positive impact, no impact, moderate negative impact, and strong negative impact. A set of symbols, e.g., √√, √, <blankl>, x, x, x are usually used to intuitively represent the said impacts. As indicated above, few QFD studies use the Technical Correlation Matrix and, not surprisingly, even fewer quantify the technical impacts. Exceptions convert the impact symbols into appropriate numerical scales and explicitly involve the technical impacts into the QFD analysis.

Consisting of the elements above its diagonal, the Technical Correlation Matrix graphically resembles the roof of a house, so comes the term "House of Quality."

3.3.6 Part F. Technical Matrix

The Technical Matrix contains much technical information that is linked to both customer needs and parts characteristics in QFD's second phase. It provides the initial rank ordering of the technical measures' relative importance based on the information in the previous parts. Competitive technical assessments are conducted here to compare the company's performance and its competitors' performance on the HOWs. Then, technical performance or strategic targets on the HOWs can be set to be competitive and probabilities (Guinta, 1993) or technical difficulties (Hauser and Clausing, 1988) to achieve these targets can be determined, and the strategic or final importance of the HOWs can be computed from the above information and the more important HOWs are selected to enter into the next phase of QFD for further analysis and deployment.

F1. Relative Importance of HOWs

The relative importance rating of each HOW is a comprehensive measure indicating the degree to which the HOW is related to all the WHATs. These ratings reflect the basic importance of the HOWs developed in relation with the WHATs,

and are decided by two factors: the final importance ratings of the WHATs and the relationships between the HOWs and the WHATs. They are usually computed using the following simple additive weighting formula: (Guinta, 1993 and Cohen, 1995)

Relative importance of a HOW =

$$\sum_{\text{WHAT}} \left[\text{final importance rating of WHAT x relationship value between WHAT and the HOW}\right]$$

That is, a HOW's relative importance rating is computed as the average over its relationship values with all the WHATs weighted by their final importance ratings.

In addition, other more elaborate decision-making and performance measurement methods can also be used to compute the HOWs' relative importance ratings (Chan and Wu, 2005).

F2. Competitive Technical Assessments

After determining the HOWs' relative importance, the next step is to conduct competitive technical assessments to compare your product's technical performance and the performance of your competitors' similar products on the HOWs. This step can be done through marketing but is a difficult task in applying QFD since not all technical parameters and know-hows of the competitors' products can be easily obtained, and some may even be kept highly confidential. It may be necessary to purchase and test the competitors' products for comparative analysis. The development team should make every effort to acquire this comparative information. Failing to do so may result in an unfavorable position for the company in the market places. In case of extreme difficulty in obtaining the technical parameters of the competitors' products on some HOWs, careful technical assessments and comparisons should be made to give reliable scores (in a suitable scale consistent with that used in customer competitive evaluations) representing the technical performance of competitors' products on the said HOWs.

F3. Strategic Targets for HOWs

Once the HOWs have been initially prioritized as in Part F1 and competitive technical assessments have been conducted as in Part F2, the next step is to set performance targets for the HOWs (sometimes these targets are called HOW MUCHes. It should be noted that performance targets are different from design specifications. Essentially, target for a HOW represents a level of performance on the HOW that the company believes is required for its product to be competitive in the relevant markets in comparison with its competitors' products. Intuitively, the target set for a HOW should be high if the HOW has high initial relative importance (implying high impact on the customer needs) and/or if the relative performance of the company's product is not good compared with the performance of its competitors' products. The targets should also be set to be reachable according to the company's technical resources, as in the setting of strategic goals for satisfying customer needs in Part B2.

F4. Technical Points of HOWs

Although the above competitive technical assessments are important, it seems, unfortunately, that few QFD studies explicitly use this information to examine the HOWs' final strategic importance as done in the customer competitive evaluations. Intuitively, similar sales points as derived for the WHATs (see Part B3) should also be obtainable for the HOWs using competitive technical assessments and the HOWs' relative importance. These sales points should also be incorporated into the determination of the HOWs' final strategic importance. For convenience and discrimination, they may call these sales points for HOWs technical points.

F5. Probability/Difficulty Factors

For each HOW's performance target, the development team could determine a factor of probability (or difficulty) to achieve it through engineering and cost

analysis. Usually, the probability (difficulty) factor is low (high) for an aggressive target to be more competitive and profitable, and is high (low) for a conservative target. A suitable scale that is consistent with the scales used in the previous parts, such as a five-, seven-, or nine-point scale with large number indicating high probability, should be adopted to measure these probability factors.

F6. Strategic Importance of HOWs

The HOWs' relative importance ratings as obtained in Part F1 only take into account their relationships with the prioritized WHATs and involve no information about the competitive technical assessments of the HOWs, the HOWs' targets, and the related probability factors, as examined in the above parts (Parts F2–F5). The ratings obtained in Part F1 can be thought of as reflecting the HOWs' basic importance. Authors suggest this additional HOQ step (i.e., Part F6) to compute the final importance rating of each HOW that is a comprehensive measure for the HOW's priority. They are not aware of any QFD studies considering the HOWs' final importance as in this Part F6. Such final importance may be obtained by using ideas similar to those in Part B (for obtaining the WHATs' final importance). Intuitively, HOWs with higher initial relative importance ratings (implying higher relationships with the important WHATs), higher competitive priorities as determined by the technical points (or equivalently by the competitive technical assessments), larger differences between current performance levels and target levels, and lower probabilities should have higher strategic importance, indicating working focuses and market opportunities for the company. Thus, suggestion the following formula to compute for each HOW it's final importance rating:

$$\textit{Final importance} = (\textit{target} - \textit{current position}) \times \textit{relative importance} \times \textit{technical point} \div \textit{probability factor}$$

Those HOWs of higher final importance are moved to Phase II of QFD, Parts Deployment, as new WHATs and then are translated into parts characteristics (new HOWs), and then analyses can also be done to complete the new phase as done in the above Parts C–F, using the similar methods as just described for HOQ, QFD's first phase. For a full account of QFD's other three phases.

3.4 The Benefits of QFD

3.4.1 Qualitative Benefits

QFD has been well recognized and applied so it is natural to ask what the benefits of using QFD are. In other words, why should a company use QFD for product development? Various applications and studies have shown many benefits of QFD. In earlier QFD researches, Sullivan (1986) emphasizes that QFD can bring tremendous efficiency to companies because misinterpretation (of product objectives, marketing strategies, and important production control points) and need for changes are minimized. Later, Burrows (1991) states that although only about 20% of QFD users realize identifiable short-term advantages in the marketplace, over 80% get strategic benefits such as increased understanding of the customer, increased communication, and faster decision making. Brown (1991) indicates that the benefits of QFD include superior product design, the potential for breakthrough innovations, shorter design cycles with fewer engineering changes, lower project and product costs, and, most importantly, satisfied customers. Bossert (1991) also gives a detailed account of QFD's benefits that are grouped into four areas: customer orientation, reduction of implementation time, promotion of teamwork, and provision of documentation. Furthermore, customer satisfaction may also be replaced with customer delight that leads to customer loyalty that results in future businesses and recommendations to others (Chan, Wu, 2005).

More recently, Hill (1994) outlines 11 benefits arising from the use of QFD such as customer-orientated companies and market-driven products, fewer design changes, reduction in start-up costs, shorter design cycles, and multifunctional teamwork. Also listed QFD's benefits that include "better systematic documentation of engineering knowledge and business operations procedures", "more competitive pricing due to lower development and start up costs," "more satisfied customers," and seven others.

Overall, I summarize the intangible benefits of QFD as shown in Figure 3.10.

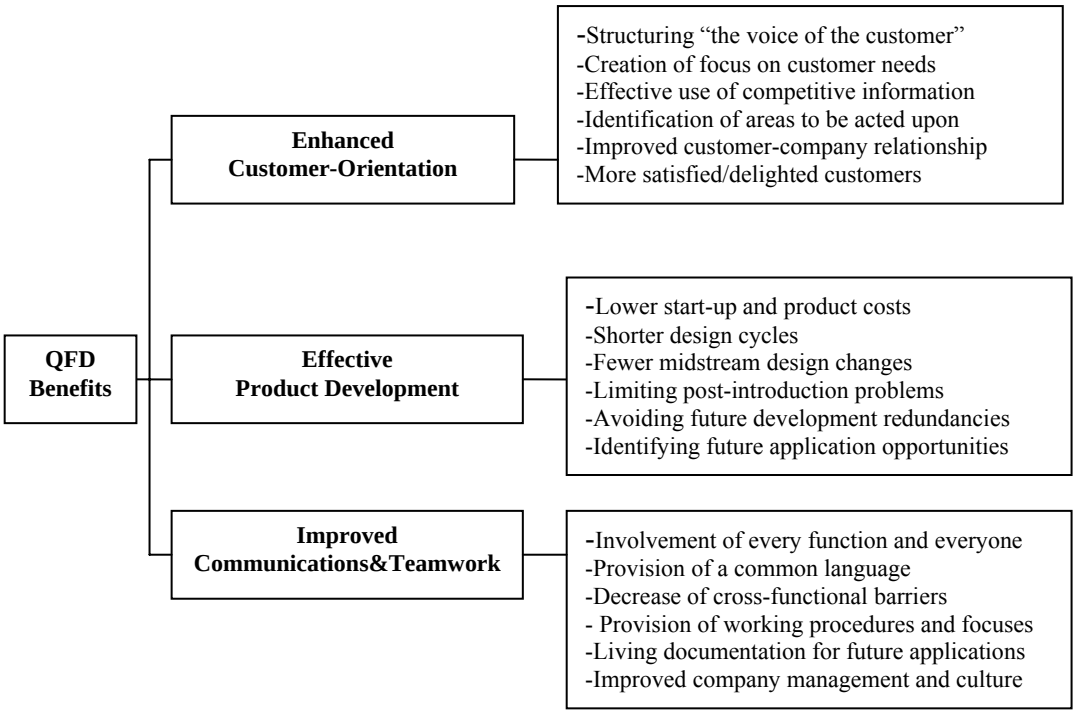


Figure 3.10 The qualitative benefits of using QFD.

3.4.2 Quantitative Benefits

Chan L.K., Wu Ming-Lu, (2005) outline the tangible benefits that are common when QFD is properly used: 30–50% reduction in engineering changes, 30–50% shorter design cycles, 20–60% lower start up costs, and 20–50% fewer warranty

claims. They especially draw a table to show the direct and impressive benefits some companies have achieved after using QFD, and explain that “the vast amount of improvement in design cycle, production cycle time, and lower start-up costs comes as a result of the ability of QFD to anticipate design conflicts and problems before production is started or before prototyping.”

An impressive quantitative example comes from Toyota, who adopted QFD as early as 1977 and achieved very good results. “Between January 1977 and April 1984, Toyota Autobody introduced four new van-type vehicles. Using 1977 as a base, Toyota reported a 20% reduction in start-up costs on the launch of the new van in October 1979; a 38% reduction in November 1982; and a cumulative 61% reduction in April 1984. During this period, the product development cycle (time to market) was reduced by one third with a corresponding improvement in quality because of a reduction in the number of engineering changes” (Cohen, 1995).

The wide adoption and noticeable benefits of QFD may be further illustrated from the following source from Europe. In a 10-year study of the Global Manufacturing Futures Project indicate that “the improved performance of manufacturing in Europe has resulted from the successful implementation of a number of action programs”. Through a large-scale survey, they identify “10 action programs that received the most attention and the top 10 programs that had the greatest pay-offs.” QFD is on both top 10 lists. As expected, “QFD is also on the Japanese list of high-pay-off programs” (Chan L.K., Wu Ming-Lu, 2005).

3.5 Strengths and weaknesses of QFD

The strengths and the weaknesses of QFD for product development have been analyzed based on the available literature and our own experience (Table 3.3). This table indicates that QFD is only suitable for product improvements at this stage and not for the development of truly innovative products. The QFD approach ensures that the product is developed according to the wishes of the target group. It takes a large

effort and a lot of time to conduct QFD for the first time. However, once it has been executed it will speed up the time-to-market and enable the company to improve the product at less cost. Moreover, the QFD approach will enable the company to produce a better product with a higher chance of success once the right consumer wishes have been determined (Chan L.K., Wu Ming-Lu, 2005).

Table 3.3 Strengths and weaknesses of QFD (Chan L.K., Wu Ming-Lu, 2005)

Strengths	Weaknesses
Improves communication.	Customer involvement only in the initial phase of the development process. Feedback from customers in the latter stages is not explicitly supported.
Provides a link between consumer wishes and product(ion) characteristics.	Customer wants can be very diverse and variable. This can result in very large lists of WHAT's and HOW's which are difficult to capture in a very precise target value.
Matrices permit very complex relationships to be documented and facilitate interpretation.	natural variation that may require continuous adaptation based on their specifications.
Helps NPD teams to set targets for product characteristics.	interactions and affect the way processes should be designed and optimized. This gives rise to a very large and complicated relationship matrix.
Helps NPD teams to make trade-off decisions.	It is very time consuming to complete the matrices.
Helps NPD teams to gather and structure all the relevant information for the development of a successful product.	Process-related improvements are more difficult to achieve than product-related ones.
Makes decisions explicit and it documents why certain decisions have been made.	Benefits service developers more than product developers.
Helps a company to get rid of the over the wall approach.	Improvements increasingly difficult with increasing product complexity.
Allows simultaneous development across functions and all functions participate from the start.	Improvements more difficult to achieve in projects concerning true innovations.

Cont….	
Enables to compare a product with competing products on relevant consumer wishes.	More suitable for products which are assemblies of individual components.
Reduces the final production cost because of the high degree of conceptual research.	It can be very hard to establish (and interpret) the consumer wishes. Once you have the wrong consumer wishes, your product will not be successful.
Increases the potential market share at the moment of launch because of the consumer segmentation and the consumer analysis.	It is very hard to approach the functional properties of products as detached from each other. Neither can a product be divided in parts (except into packing and content of the packing).
Empowers the NPD team to make decisions.	By putting the emphasis on the 'Voice of the consumer', the interests of the company (policy and profitability) are getting less importance.
	Development of QFD usually involves communication of information about skills and resources, future strategies, costs and current production approaches and, therefore, the company may not be willing or even able to afford the whole QFD process.
	It demands a whole new line of thinking and corporate structure.
	A lot of product requirements, as mentioned by the consumer, are sensory requirements. Although a lot of research has been conducted in this field it is still difficult to measure them. Besides it is difficult to control them, since they are dependent of multiple variables related to product, production process, consumer, or the surroundings.

3.6 Review of Literature

Since the aim of this study is examined the applicability of QFD as a strategic decision-tool, to make comparison between the performance of different competitors and transfer the experience gained from the current Project to the forthcoming projects. In this section, a review of previous studies on application in industrial or service sector is presented.

Although there have been many QFD studies and applications in the literature during the past three decades, different authors use different terms and methods and they also focus on different parts of the QFD system. There have been no consistent or unified accounts of the QFD concepts and procedures, which is uncommon for such a popular methodology and may be quite confusing for non specialists. This research attempts to present a comprehensive description of the QFD concepts and methods to facilitate a clearer reference of the basis of QFD.

Examples of the successful use of QFD can be seen in many different types of industries and services to include: automobile manufacturing, power plant operations, service providers, software design, and even in theme park design. Ginn and Zairi (2005) neatly proposes that based on a benchmarking exercise involving some 164 QFD practitioners within Ford Motor Company and 27 selected external QFD companies. The predominant response "cell" was from Vehicle Centre 1, Power-Train Systems Engineering, although there was both a US and non-power-train response content. The benchmarking focused on four parts: (1) criteria of success; (2) learning experience; (3) teamwork; and (4) future of QFD.

Maltzer and Hinterhuber's (1998) paper begins with a brief discussion of the strategic importance of customer satisfaction, then Kano's model and its combination with quality function deployment is demonstrated, using a case study from the ski industry. The paper closes with a brief discussion of the managerial implications and the consequences of the application of these tools.

Another application is performed by Dimsey and Mazur (2002) at Hayes Brake. In the design of a new braking system, used QFD to determine the importance of various braking functions and performance levels to users, and then subsequently design both a lower-cost alternative as well as a high performance model. Their paper will describe the customer evaluation process including a web-based questionnaire, the deployment through the House of Quality to a Function Analysis,

multiple cost modeling studies, and the design concepts that were created and proposed to the OEM. The product is still waiting approval from the OEM.

Carpinetti and Melo (2002) proposed an approach for systematically defining the object of study of benchmarking based on deriving improvement actions from customer expectations and strategic decisions through business processes, and prioritizing improvement actions that will most contribute to strategic objectives. Finally, two cases of application are presented to illustrate the validity as well as to make some considerations based on the potential benefits and limitations of this proposal. A first application of the steps proposed was performed in a middle-sized company located in the State of Sao Paulo, Brazil. It develops, manufactures and markets residential steel doors and windows, with a daily production volume of about 8,000 pieces, comprising nearly 600 different catalogue items. It works on an assembly to order scheme. A second case of application was developed in a small company located in the State of Sao Paulo that develops, manufactures and commercializes a full range of equipment for tuning electronic fuel injection. It employs about 160 people and has an annual income of around US$2 million. Although it is the only company that manufactures such products in Brazil, it has been facing competition from abroad. Therefore the owners of the company welcomed our proposal to identify improvement needs to be tackled by a benchmarking project. An improvement team was formed, comprising in this case one member of the company staff (sales manager) and a graduate student, to guide the deployment process.

Birgonul, Dikmen *et al* (2005) by considering the QFD methodology has been applied to a real construction project and its applicability in the wider construction sector has been discussed. According to the case study implementation, it has been observed that QFD can be utilized to determine the right marketing strategy, to make a comparison with the competing alternatives and to collect data which could increase client satisfaction level in upcoming projects. Thus, using QFD during the marketing stage as an uncovered application area has been demonstrated.

The organization of Gonzalez and Quesada (2003) study is as follows. First, they describe the general problem of the school furniture in Costa Rica. After this, they explain the methodology used in the present study along with general concepts of quality function deployment (QFD), followed by a literature review that will help theoretically support our practical results. Then, they describe the QFD application in the school furniture problem. The purpose of their project is to address the school furniture problem in the areas of functionality, material, structure, production, ergonomics, and aesthetics. The specific objective of the project is identifying the most important variables in order to create designs that are ergonomically correct, strong, durable, low maintenance, low cost, and can be made by local industries from locally available materials.

Min Hua lu, Madu, Christian N (1994) proposed a model that integrates AHP, QFD, and Benchmarking is presented, and discussed in detail. The comprehensive, formal an analytical approach is the key to the formulation of successful long-range planning.

Chan Lai-Kow, Ming-LuWu (2005) studied fully illustrate HOQ model, a full example for a fried Chinese vegetable to illustrate step by step all the relevant details with the purpose of facilitating the understanding and application of the QFD process. Their article presents a systematic and operational approach to quality function deployment (QFD), a customer-driven quality management system for product development.

Herrmann A. et al. (2000) studied about market-driven product and service design at German Rail. German Rail is to implement this concept in three steps, which are described taking the example of the already competing Inter City links on the route between Frankfurt and Paris: first of all, the wishes of potential and actual customers with regard to the quality of service on the Inter City trains in question must be determined. Various methods, such as the repertory grid approach, the laddering interview, the content analysis and the laddering method are used for this purpose. The next step is to transform these abstract customer conceptions into concrete

quality attributes. This task can best be accomplished by means of a conjoint analysis on the basis of the information acquired as described above. Finally, the fitness of the offered services for their intended purpose is examined, with particular emphasis on satisfaction measurement.

Akbaba (2000) studied QFD system in service sector and also mentioned QFD procedures in detail to identify, communicate, and prioritize customer requirements so that an organization can optimize services to exceed customer expectations.

Wang and Xie (1998) compare two methods which are prioritization matrix method and analytic hierarchy process (AHP) for prioritizing the customer voice and also technical responses in HOQ. The AHP method is offered a more precise analysis, but requires more time and resource. It is easier to use the prioritization matrix method, but the results might not be as accurate as the AHP method can provide. In regard to which one is better for a particular industry or company, specific considerations based on the decision-makers' needs are required.

Chou (2004) applies quality function deployment (QFD) techniques to evaluate the quality of service of undergraduate nursing education in Taiwan from the perspective of nursing students.

Partovi and Corredoira (2002) present a model for prioritizing and designing rule changes for the game of soccer in order to make it more attractive to soccer enthusiasts. The model, which is loosely based on QFD, incorporates spectators' interests and relates them to activities on the soccer field and the corresponding regulations. They have used AHP to determine the intensity of relation between variables of the model, and incorporated ANP to consider the influence of various columns on other columns and prioritize various columns in QFD matrices.

Costa and Dekker *et al.* (2001) presents a detailed literature review on the topic of the application of QFD in food industry. The review is extended with a thorough

description of the methodologies involved in the practices of QFD within food companies, exemplified with the help of a case study on ketchup quality improvement.

Another service application is studied by Jeong and Oh (1998). Their research on service quality and customer satisfaction has become significant in the hospitality industry. Their study provides an overview of the QFD process and develops a hypothetical application in the lodging industry in order to illustrate future application and analysis strategies. Some benefits and disadvantages of the QFD process are compared to extant service quality and customer satisfaction paradigms.

Chen (2002) examined the CKS International Airport and found that the "convenience of transport facilities connecting to the outside", the "interior design and layout", and the "information service of the airport" should be priorities to be improved in performing benchmarking activities. Airport benchmarking could provide the CKS International Airport authority with a long-term vision and a valuable strategic planning tool in airport service.

Earlier reviews of the documented accounts of QFD-based approaches to strategy were presented at the 7th Symposium on QFD in Tokyo in 2001, and at the 8th Symposium on QFD in Munich in 2002. Hunt and Xavier (2003) updated reviews, identifying the parallels and contrasts evident in the cases with the techniques of policy deployment.

Table 3.4 and 3.5 currently offers a brief review of the majority of applications (Hunt and Xavier, 2003). The Table 3.4 below documents authors who have described QFD strategic applications utilizing a single matrix.

Table 3.4 Brief review of the majority of applications

Authors	**Description of application**
Maddux, Amos & Wyskida (1991)	Used QFD to facilitate strategic planning decisions at the Production Engineering Division of the U.S. Army Missile Command.
Philips, Sander & Govers (1994)	Describe a QFD procedure to formulate annual policy and demonstrate their approach by comparing it to policy formulation at Philips EBEI-IC in Taiwan.
Hummel (1996)	Detail the use of QFD by a consulting organization for strategic planning and describe the application of a five-step approach within the University of Vermont to build a single HOQ type matrix.
Ferrell & Ferrell Jr. (1994)	Describe the use of a single QFD matrix applied to business planning within a small U.S. appraisal firm to translate customer requirements into targets for relevant controllable business parameters.
Cohen (1995)	Describe the application of QFD to strategic product planning in which a matrix is used to set strategic goals, prioritize product family members, highlight products that fail to meet market needs and those needs which currently are not satisfied.
Guinta & Praizler (1993)	Detail three case studies of strategic applications of QFD, identifying key new customers, highlighting the most important requests for quotation and the design of an employee training program.
Prasad (1995)	Highlights the problems of incompatible tactics in the application of Just-in-Time techniques and advocates the use of a JIT quality matrix developed from the HOQ.
Lu, Madu, Kuei & Winokur (1994)	Describe a method to integrate the techniques of the Analytical Hierarchy Process (see Saaty, 1990 for a description of AHP), QFD and benchmarking in a single matrix tool to analyze strategic marketing policy.

The Table 3.5 summarizes a review of multiple matrix examples of cases that have used a multi-matrix method.

Table 3.5 Brief review of the multiple matrix strategic QFD applications

Authors	**Description of application**
Atkins & Crisafi (1995)	Describe McDonnell Douglas Technologies Inc. use of a three-phase QFD matrix approach within an "Integrated Strategic Planning Process".
Lu & Kuei (1995)	Explore the application of a four-phase QFD procedure to strategic marketing planning. Gathered customer requirements are used in a series of matrices to generate long term corporate goals, marketing-related objectives, marketing strategies and finally marketing tactics.
Day (1991)	Describes the application of QFD matrices to business planning using a four-phase approach, which converts company vision into individual responsibilities and action plans.
Chen & Bullington (1993)	Describe the use of QFD in developing a strategic planning process for the research activities of an academic department at Mississippi State University. They utilized a four-phase approach and used the needs of appropriate funding agencies to drive the process.
Lowe & Ridgway (1998)	Applied a two-phase approach based upon QFD techniques for the identification and interpretation of an organization's core competencies.
Barnard (1992)	Describes a strategic planning approach that involves nine steps to develop a series of five appropriate HOQ type matrices.
Lyman, Buesinger & Keating (1994)	Describe the application of six QFD matrices as a decision-making tool for focusing product development efforts within Chevron Chemical Co.'s Specialty Polymers Strategic Business Unit.
Hales (1995) & (1997)	Describes two QFD based approaches to strategic decision-making and project selection used by a consulting agency.

CHAPTER FOUR
ANALYTIC HIERARCHY PROCESS

4.1 Introduction

Recently, the analytic hierarchy process (AHP) has been proposed for application to the HOQ to generate the relative importance of the “voice of the customer”. First developed by Saaty (1980), AHP is a powerful tool for problem-solving and decision-making in a complex environment. Instead of weighting the alternatives according to one criterion in only one level as in the prioritization matrix method, the AHP method structures a complex, multicriteria problem hierarchically. It organizes the basic rationality by breaking down a problem into smaller and smaller constituent parts, then guides the decision-maker through a series of pairwise comparison judgements to express the relative strength or intensity of impact of the elements in the hierarchy. Recently, AHP has been used by many authors to identify and prioritize customer requirements in the HOQ (see Akao, 1990; Armacost *et al.*, 1994; Aswad, 1989; Doukas *et al.*, 1995; Fukuda & Matsuura, 1993; Xie *et al.*, 1995).

AHP is an effective technique for analyzing a complex problem because it facilitates step-by-step cause–effect explanations and systematically accommodates the use of expert judgment.

AHP is used in this study to be shown to be useful in prioritizing alternative customer needs and expectations, these advantages make AHP the appropriate method for an analysis of competitiveness. In addition, proper pairwise comparison questions are important to AHP methodology because they lead to sensible and reliable results.

Expert Choice is a Decision Support System (DSS) designed to facilitate the use of Analytical Hierarchy Process, is used to generate the overall weights for each criterion

The AHP and Expert Choice software engage decision makers in structuring a decision into smaller parts, proceeding from the goal to objectives to sub-objectives down to the alternative courses of action. Decision makers then make simple pairwise comparison judgments throughout the hierarchy to arrive at overall priorities for the alternatives. The decision problem may involve social, political, technical, and economic factors.

4.2 Definition of AHP

Analytical Hierarchy Process is a decision making technique for managing problems that involve the consideration of multiple criteria simultaneously (Saaty, 1980). Since the development and introduction of AHP, it has been used in various areas such as economics, social sciences, politics, and industry as a decision making tool. Applications in those areas include business administration, cost-benefit analysis, future planning, resolution of conflicts, determining requirements, allocating resources, measuring performance, designing systems and ensuring system stability.

In one of the first applications of AHP in technological areas, Roper-Lowe and Sharp (1990) supported AHP as a valuable tool for selecting information technology (IT) in MCDM situations. They not only selected IT as one of the MCDM problems to which AHP can be applied, but they also indicated that AHP could provide documentation regarding how and why a particular decision was made. Furthermore, the process was easy to understand and their decision makers felt comfortable with the method. Additionally, several human factors researchers attempted to use AHP in ergonomic analysis and user interface evaluation and found it a useful method for their studies.

AHP is viewed as “a flexible model that allows individuals or groups to shape ideas and define problems by making their own assumptions and deriving the desired solution from them” (Saaty, 1996). Because of its flexibility, ease of use, and ability to provide a

built-in measure of the consistency of the decision maker's judgment, AHP has been widely studied and applied across various fields (Saaty, 1994).

AHP uses a multi-level hierarchical structure of objectives, criteria, sub-criteria, and alternatives, and provides a quantitative computational method for generating priorities based on pairwise judgment of the criteria. Thus, a decision-maker can choose among the alternatives based on the relative worth of each alternative. In this way, AHP organizes multiple factors to be considered in a systematic way and provides a structured solution to decision making problems.

4.3 The analytic hierarchy process for prioritization in QFD

Recently, AHP with some modifications has been used to assess the relative importance of user quality factor requirements in the HOQ. As a powerful and robust decision analysis methodology for problem-solving and decision-making in a complex environment, AHP is very simple and appealing for solving large-scale real-world problems. Prioritization in the HOQ is a complex, multi-criteria decision-making problem. The weight analysis of customer requirements and technical responses in the HOQ is difficult but important to the decision-maker. Therefore, the AHP method is a particularly suitable alternative for weighting customer requirements and technical responses in the HOQ. Most of the research on the application of AHP to the HOQ in the past has been focused on using AHP to weight only the customer requirements.

The AHP method can in fact be directly used in the prioritization of the technical responses. In this manner, the overall HOQ analysis becomes more complete. The AHP method itself requires the alternatives and the criteria in the same level of the hierarchy to be independent. Within the HOQ, the customer requirements can be independent, but the technical responses may not be independent since they may have relationships as shown in the roof of the HOQ. The technical responses can be divided into more

detailed descriptors, and with the related part taken as a new technical response, the technical responses can become independent of each other based on some appropriate assumptions.

4.4 How AHP Works

AHP is based on the principles of decomposition, comparative judgments, and synthesis of priorities. The three principles of the AHP described by Saaty (1980) are as follows:

1. Hierarchic representation and decomposition, which is called hierarchic structuring – that is, breaking down the problem into separate elements;
2. Priority discrimination and synthesis, which is called priority setting – that is, ranking the elements by relative importance; and
3. Logical consistency – that is, ensuring that elements are grounded logically and ranked consistently according to logical criteria. (Saaty, 1980)

The typical steps of applying AHP can be summarized as follows:

1. Define the problem or decision issues and determine their scope and goal.
2. Identify the criteria that affect the behavior of the problem.
3. Structure a hierarchy of the factors contributing to a decision from the highest to the lowest level. This step allows a complex decision to be structured into a hierarchy from an overall objective to various criteria, sub-criteria, and so on until the lowest level. According to Saaty (1996), creative thinking, recollection, and various perspectives should be used to construct a hierarchy.
4. Given that the hierarchy has been structured, construct pairwise comparison matrices for each level using relative scale measurements the pairwise comparisons are performed in terms of how much more important element A is than element B. When a group participates in the judgment process, the

group may need to reach consensus on issues. However, when they do not reach an agreement, a geometric mean of their judgment is recommended for use (Saaty, 1980).

5. Calculate the relative worth of each element using the eigenvector method. Priorities of alternatives and weights of criteria are synthesized into an overall rating.
6. Perform a consistency check on the completed hierarchy of weights.

The casting process having the highest priority weight is selected. Various steps of the casting process selection are described in Figure 4.1.

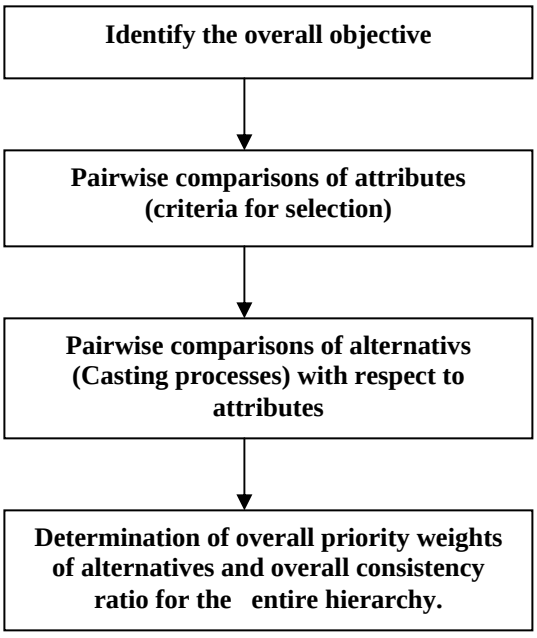


Figure 4.1. Process of casting process selection using AHP.

4.5 Scales for Pairwise Comparison

In terms of the scales for quantifying pairwise comparisons, several approaches are available, although Saaty's (1980) linear scale (Table 4.1) was the first proposed and has been used pervasively. Based on the fact that most humans cannot simultaneously compare more than seven objects (plus or minus two), Saaty (1980) established 9 as the upper limit of the scale and 1 as the lower limit.

Table 4.1 Linear scale for quantifying pairwise comparison (Saaty, 1980)

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgment slightly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Demonstrated importance	An activity is strongly favored and its dominance demonstrated in practice
9	Absolute importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent judgments	When compromise is needed
Reciprocals of above nonzero	If activity *i* has one of the above nonzero numbers assigned to it when compared with activity *j*, then *j* has the reciprocal value when compared with *i*.	

Another approach, namely the exponential scale based on different observations in psychology about stimulus perception (denoted as e_i).

According to the measurement theory, the difference $e_{n+1} - e_n$ should be greater than or equal to the smallest perceptible difference, which is proportional to e_n. These exponential scales are recommended for psychophysics problems relating to sensory systems regarding the perception of taste, smells, touch, sound, size, and lights that follows the power law with exponents.

The most distinct steps of using the AHP that distinguishes it from other MCDM methods are building the hierarchy of elements and computing their relative weights. To explain the process effectively, a simple example is introduced in the following sections.

4.6 Hierarchical Structures

Suppose there is a hierarchical structure (Figure 4.2). Nodes in the hierarchy represent criteria, sub-criteria, or alternatives to be prioritized, and arcs reflect relationships between the nodes in different levels. Each relationship (arc) represents a relative weight or importance of a node at Level L relating to a node at Level L-1, where L = 2, 3, …, N-1, N. The nodes at Level L do not necessarily connect to all the nodes at Level L-1, where L = 2, 3, …, N-1, N.

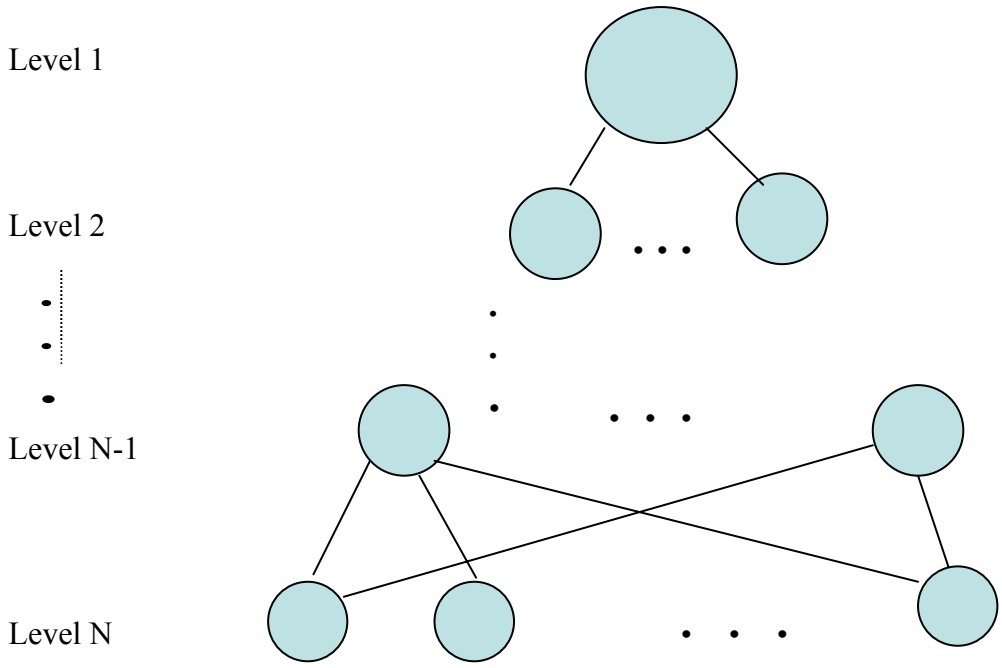


Figure 4.2 A hierarchical structure representation

The computation of weights is performed in the following way. Suppose there is a set of *n* criteria $\mathbf{C} = \{C_{L,1}, C_{L,2}, \ldots, C_{L,n}\}$ located at a hierarchical Level L. Assuming that all the criteria at Level L are comparable with each other, $n(n-1)/2$ paired comparisons of the *n* criteria at Level L are performed. For each pair of comparisons, a decision maker (individual or group) uses the nine-point scale described in Table 4.1 to reflect the degree of preference. The final AHP result is an assignment of weights to the criteria or alternatives at the lowest Level N.

4.7 Data Analysis

Using any of the scales discussed in section 4.5, the preference or dominance measures of paired comparisons are placed in a matrix form in the following manner:

$$M=\begin{bmatrix} 1 & m_{12} & \dots & m_{1n} \\ 1/m_{12} & 1 & \dots & m_{2n} \\ . & . & \dots & . \\ . & . & \dots & . \\ . & . & \dots & . \\ 1/m_{1n} & 1/m_{2n} & \dots & 1 \end{bmatrix}$$

Each m_{ij} of the matrix represents the ratio by which criteria i dominates criteria j. As mentioned in the previous section, criteria can be usability dimensions, sub-dimensions, or questionnaire items. Since **M** is a reciprocal matrix, in which each element of the lower-left diagonal part is the inverse of each element of upper-right diagonal part, each m_{ij} follows the specifications such as

$m_{ij} = 1/m_{ij}$, for $m_{ij} \neq 0$

$m_{ij} = 1$, for $i = j$ and $i, j = 1, 2, \dots, n$.

To calculate weights based on the pairwise judgments, it is assumed that exact measurement was made so that each element can be decomposed into a ratio of weights as follows:

$$m_{ij} = \frac{w_i}{w_j}$$

Then the matrix **M** is expressed as

$$\mathbf{M}=\begin{bmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ . & . & \cdots & . \\ . & . & \cdots & . \\ . & . & \cdots & . \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{bmatrix}$$

Since $m_{ij}=\frac{w_i}{w_j}$ as defined above, $w_i = m_{ij}\ w_j$. For all j, w_i can take the general form of

$w_i=\frac{1}{n}\sum_{j=1}^{n} m_{ij}\ w_j$, which leads to $n\ w_i=\sum_{j=1}^{n} m_{ij}\ w_j$. This expression can be denoted in matrix form as

$nw_i = A\ w_j$ (or $Ax = \lambda x$),

where n (or λ) is the eigenvalue and w is the eigenvectors. However, this is not solvable since there exist multiple eigenvalues and eigenvectors. Since m_{ii} =1 for all i, then $\sum_{i=1}^{n}\lambda_i = n$. If **M** is a consistent matrix (see the next paragraph), small variations of m_{ij} keep the largest eigenvalue close to n, and the remaining eigenvalues close to zero. Therefore, the priority vector can be obtained from a vector w that satisfies

$Aw = \lambda_{max}\ w$

The vector w is the eigenvector corresponding to the maximum eigenvalue. To obtain relative weights, the sum of which is equal to one, the eigenvector should be normalized in the following manner:

$$w' = \left(\frac{1}{\sum_{i=1}^{n} w_i} \right) w$$

Since the pairwise comparison judgments are subjective, there is a concern regarding consistency. For example, if A is twice as preferable as B and B is three times preferable to C, then A should be six times more preferable than C. This is perfectly consistent according to logic but it is likely that the judgment matrix is not consistent in some level because of human nature. Thus, the Consistency Index (*C.I.*) was suggested to see what degree of inconsistency the AHP model can tolerate such that the judgment is still useful.

When the decision maker's judgment is perfectly consistent in each comparison, $m_{ij} = m_{ki}\, m_{kj}$ for all i, j, and k. In this case, the matrix **M** is referred to as a consistent matrix. If M is perfectly consistent, then max $\lambda = n$. Thus, the algebraic difference between max λ and n is a measure of consistency, and Saaty (1980) suggests the following *C.I.*, Random Index (*R.I.*), and consistency ratio (*C.R.*):

$$C.I. = \frac{\lambda_{max} - n}{n - 1}, \text{ and}$$

$$C.R. = \frac{C.I.}{R.I.},$$

in which *R.I.* is obtained from Table 4.2 based on the *C.I.* of a randomly generated reciprocal matrix from the scale 1 to 9, using a sample size of 100. If the *C.R.* is less than 0.1, the judgments are reasonably consistent and therefore acceptable. If the *C.R.* is greater than 0.10, then the judgments should be revised.

Table 4.2 Random Index values according to matrix size (Saaty, 1980)

Matrix Size	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R.I.	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

4.8 Group decision making

The AHP allows group decision making, where group members can use their experience, values and knowledge to break down a problem into a hierarchy and solve it by the AHP steps. Brainstorming and sharing ideas and insights (inherent in the use of Expert Choice in a group setting) often leads to a more complete representation and understanding of the issues. The following suggestions and recommendations are suggested in the Expert Choice software manual.

1. Group decisions involving participants with common interests are typical of many organizational decisions. Even if we assume a group with common interests, individual group members will each have their own motivations and, hence, will be in conflict on certain issues. Nevertheless, since the group members are “supposed” to be striving for the same goal and have more in common than in conflict, it is usually best to work as a group and attempt to achieve consensus. This mode maximizes communication as well as each group member's stake in the decision.

2. An interesting aspect of using Expert Choice is that it minimizes the difficult problem of “group think” or dominance by a strong member of the group. This occurs because attention is focused on a specific aspect of the problem as judgments are being made, eliminating drift from topic to topic as so often happens in group discussions. As a result, a person who may be shy and hesitant to speak up when a group's discussion drifts from topic to topic will feel more comfortable in speaking up when the discussion is organized and attention turns to his area of expertise. Since Expert Choice reduces the

influences of group think and dominance, other decision processes such as the well known Delphi technique may no longer be attractive. The Delphi technique was designed to alleviate group think and dominance problems. However, it also inhibits communication between members of the group. If desired, Expert Choice could be used within the Delphi context.

3. When Expert Choice is used in a group session, the group can be shown a hierarchy that has been prepared in advance. They can modify it to suit their understanding of the problem. The group defines the issues to be examined and alters the prepared hierarchy or constructs a new hierarchy to cover all the important issues. A group with widely varying perspectives can feel comfortable with a complex issue, when the issue is broken down into different levels. Each member can present his own concerns and definitions. Then, the group can cooperate in identifying the overall structure of the issue. In this way, agreement can be reached on the higher-order and lower-order objectives of the problem by including all the concerns that members have expressed. The group would then provide the judgments. If the group has achieved consensus on some judgment, input only that judgment. If during the process it is impossible to arrive at a consensus on a judgment, the group may use some voting technique, or may choose to take the "average" of the judgments. The group may decide to give all group members equal weight, or the group members could give them different weights that reflect their position in the project. All calculations are done automatically on the computer screen.

4. The Group Meeting: While Expert Choice is an ideal tool for generating group decisions through a cohesive, rigorous process, the software does not replace the components necessary for good group facilitation. There are a number of different approaches to group decision-making, some better than others. Above all, it is important to have a meeting in which everyone is engaged, and there is buy-in and consensus with the result.

Expert Choice is intuitive, graphically based and structured in a user-friendly fashion so as to be valuable for conceptual and analytical thinkers, novices and category experts. Because the criteria are presented in a hierarchical structure, decision makers are able to drill down to their level of expertise, and apply judgments to the objectives deemed important to achieving their goals. At the end of the process, decision makers are fully cognizant of how and why the decision was made, with results that are meaningful, easy to communicate, and actionable.

4.9 Limitations of the AHP

In order to apply AHP effectively to the research, criticisms of the method should be identified and discussed. A number of limitations of AHP have been indicated and discussed by various researchers (Mobolurin and Bryson,1993; Wedley, 1993; Perez, 1995) since Saaty's (1980) introduction of it, which is discussed briefly below.

In terms of the formulation of the decision hierarchy, it is obvious that as the number of levels increases, the amount of data to be obtained also increases. In addition to that, as the number of levels increases, the aggregation of paired comparison data becomes more complex. It also increases the number of alternatives to be compared so that it becomes very difficult for decision makers to distinguish among and compare the alternatives. According Mitta (1993), a maximum of seven alternatives can be considered at a time. To overcome this limitation for the current dissertation research, absolute measurement AHP (Saaty, 1996) was used in the event that there are too many—more than seven—alternatives to be compared at the lower level of the hierarchy. Absolute measurement AHP is comprised of indicator categories (e.g., excellent, good, poor, etc) or grades (e.g., A, B, C, etc.) at the lowest level for each criterion (e.g., individual questionnaire item) so that each criterion is assigned as one of the values of indicator categories or grades. To convert these values into the relative

weights for each criterion, pairwise comparisons were performed using the eigenvector approach.

Another criticism focuses on Saaty's nine-point linear scale. Saaty insisted that the scale appropriately captures individual preferences documented by experiments (Saaty, 1980). However, Mitta (1993) proposed that the scale could be modified to include an unbounded scale rather than placing an upper limit on the scale. In contrast, Harker and Vargas (1987) advised that as concepts of infinity and infinite preference are so abstract that the abstract nature can confuse decision makers, limit their abilities to comprehend the paired comparison procedure, and prevent them from providing appropriate estimates of preference strength.

The most controversial issue of AHP is referred to as rank reversal, presented by Belton and Gear (1983) and Dyer (1990a; 1990b). According to them, the AHP may reverse the ranking of the alternatives when an alternative seeming identical to one of the existing alternatives is introduced. To solve this problem, they suggested a revised AHP. However, the issue of rank reversal is not a concern in this research, unless new criteria or nodes in the levels other than the lowest level are introduced into the hierarchy. In the original AHP, the alternatives are placed on the lowest level of the hierarchy and the scores for alternatives are calculated as relative weights based on pairwise comparisons. The alternatives were excluded from the hierarchy and the score for each product was based on the users' subjective rating of the questionnaire items, which was the input to the sets of relative weights from the AHP model. In other words, the AHP model constitutes only the sets of coefficients to be applied to the scores from questionnaire items so that the introduction of new alternatives would not affect the AHP hierarchy or model.

CHAPTER SIX
QUALITY FUNCTION DEPLOYMENT APPLICATION IN A FIRM

5.1 Company presentation

Vestel Group of Companies has been carrying out activities in product development, production and local-international sales in the fields of consumer electronics, white goods and digital products since 1984.

Vestel Electronics, one of the biggest electronic household goods manufacturers in Turkiye, joined the Zorlu Group in 1994.

Vestel Electronics, having realized a great step forward within the last 10 years is the fifth biggest private industrial institution in Turkiye, and the biggest television producer company in Europe controlling 5% of the world television market acording to the ISO data.

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Today, the Vestel Group is comprised of seventeen companies operating in manufacturing, technology development, marketing, and distribution fields in the consumer electronics, digital technologies, and white goods. The Group's products include; LCD TVs, Plasma TVs, conventional TVs, IDTVs, digital terrestrial and satellite receivers, notebooks, wireless products, built-in and freestanding refrigerators, air conditioners, washing machines, and cooking appliances. The product groups are differentiated in order to provide customers a wide selection range.

secure its position as a first class OEM Company, meeting a wide range of specialized needs and ensuring consistent high quality products.

Vestel's research and design teams are the first in Turkey to develop proprietary product designs and Vestel is the only developer of micro-controller software for use in its production processes. In order to follow up the new technologies, the Group established Vestel USA in 1998, and acquired Cabot Communications in the UK, which develops and offers broadcast TV technology solutions.

Subsidiary companies of the Group located in various countries in Europe play an important role in penetrating the European market and expanding Vestel's export markets.

Vestel Electronics, having a good reputation globally by its superior technology, has been manufacturing the products of the global electronic giants such as JVC, Hitachi, Sharp, Sanyo, Thomson, LG and Toshiba in its facilities together with its own trade marks for the last four years.

The High-End television factory, which was opened in Vestel City has the biggest production capacity under a single roof in Europe in the production of plasma TV and TFT-LCD TV, which is the ultimate point reached by the global display technology, besides the advanced technology TV production of 4 million a year. Vestel High-End television factory is foreseen to create an export volume of 2 billion Dollars annually.

Vestel sees Research & Development as the guaranty of its growth and future. It gives a great importance to the new product development to be able to follow global developments quickly.

Vestel invested in Research & Development in Manisa, İzmir and İstanbul in Turkey, and San Diego (USA), Honk Kong, Shangai (China), and Taipei (Taiwan) abroad.

These investments symbolize the passion of Vestel to create products of higher than the world quailty for the people all over the world. Thanks to this strategy, Vestel Electronics makes its competitive position in the sector stronger and approaches its target “to become the leader production and technology company in the sector” as defined in its vision.

Total selling figures of Vestel Electronic in 2004 reached 4,4 billion YTL by a 24% increase from 3,6 billion YTL. The share of the sales oriented towards the foreign market in the total selling was recorded as over 90%.

Vestel Electronics was the export champion in Turkey in the years of 1998, 1999, 2000, 2002 and 2003, and became the leader in its sector by increasing its market share to 54% in the television export in the year of 2004. This big success of Vestel is also a proof of the added value it creates for the country. Vestel Electronics, getting a share of 26% from the European television market, with its production of 10,5 millions pieces has the position of the biggest television manufacturer in Europe. Vestel Electronics, which carries out exportations to 108 countries mainly exports to EU countries.

Sale of the Vestel Electronics products is carried out by Vestel Dayanıklı Tüketim Malları Pazarlama A.Ş. (Vestel Durable Consumables Marketing Corporation) in the country and by Vestel Dış Ticaret A.Ş. (Vestel Foreign Trading Corporation) in the foreign markets.

It has been documented by TSE (Turkish Standards Institute) that all of the products by Vestel Electronics are manufactured under the controlled conditions as required by the ISO Quality Management System and ISO 14001 Environment Management System.

Vestel Electronics targets to grow, to increase its market share in Europe to 30%, and become one of the 3 biggest television manufacturer companies in the world in the year of 2006.

5.1.1 Object and scope

The object of the Company is to produce electronic devices, equipment, hardware, spare parts, elements, components, videos, and televisions.

5.1.1.1 Mission and Vision

Our Mission is "Conquering the world with technological products".

To be the most powerful technology and production group in our sector, they should work with *'dynamism and knowledge'*, preserving our core values *'spirit of competition, productivity and honour'*.

"Customer satisfaction" is our continuous commitment and concern.

Therefore, commit ourselves to achieve the following objectives of our Quality Policy,

- To conform our customer's requirements in international standards, we should design *"innovative products and services"* and supply them to our customers with *"competitive prices"*.
- Our *"Suppliers"* are our partners; we should support them for their continuous improvement, and definitely explain our customers' expectations.
- We should provide our *"employees"* confidence to management and always keep training them for being a customer oriented team member. Employees are our most valuable assets to reach our targets.
- We should fulfill all *"Quality System"* requirements stated in our Quality Manual, designed according to *ISO-9001: 2000 Standard*, and continuously improve.

Europe will remain Vestel's principal market and the Company intends to remain involved in that market in order to keep abreast of and respond to new trends and to add new products to its existing portfolio.

In order to defend its superior market position, Vestel plans to invest still more in research and development. The Company intends to increase the overall share of "A" brands in its product portfolio.

Vestel plans to make geographical expansion the main engine of its future growth and development. Its sights will be set initially on Russia and former Community of Independent States countries and subsequently on Central Asia and India.

Vestel will be giving increasingly more importance to original design manufacturer activities and services.

The Turkish domestic market will continue to play an important role in all of the Company's business activities.

The areas identified by Vestel as its most important avenues of future development are consumer electronics and white goods. Vestel will focus on growth in these two areas in the Turkish domestic market as well as in exports.

Vision: To be the world's most powerful technology and production group in the sector (Strength).

Mission: To conquer the world with technology products (Technology).

5.1.2 Perfectionism

Vestel keeps a close watch on new technological developments and strives for perfection in its business and reputation.

5.1.3 Teamwork

In keeping with the wisdom that the best companies are the ones with happy employees, Vestel's performance is the result of the combined efforts of its people. Employee satisfaction is a matter of importance to Vestel and the Company seeks to achieve it.

5.1.4 A seamless whole

Vestel establishes and maintains cordial relations with its employees, shareholders, customers, and suppliers and it acts in unison with them all.

5.1.5 Customer satisfaction

Vestel takes a customer-focused approach and strives to increase customer satisfaction. Vestel gives its customers reasons to have confidence in it as a company.

5.1.6 Commitment to corporate mission, vision, and values

Vestel acts consistently in line with its clearly defined and publicly disclosed corporate mission, vision, and value statements.

5.1.7 Commitment to ethical values

Vestel employees have high moral values, do their jobs well, and identify with and adhere to the Company's ethical values.

5.1.8 Continuity

Vestel develops its strategies in keeping with the principle of continuity and strives to achieve continuity in all its actions.

5.2 Problem Definition

In technology era of "faster, cheaper and better", companies are focusing on improving the product development process. New business strategies, new organizational approaches, new business processes and new enabling technology are being used by many forward-thinking companies to continually improve their product development process. How does a company keep up with these fast-paced changes? Some of the improvement opportunities are obvious to personnel within an organization. Other opportunities may not be obvious, or there are so many things to do that it becomes a question of where to start. Management will typically have a number of questions on their minds: How do we compare with the rest of industry? With the best in industry? What are our strengths and weaknesses? Is our development process aligned with our strategic objectives? What improvements need to be made? Where do we start? What are our priorities given the resources that we

have available? What benefits can we expect? How can we figure this out quickly so that we can get started?

5.3 Aim of the study

The goal is to achieve controlled and continuous increases in revenues and profitability by focusing on its core business activity of producing high-quality consumer goods.

This research attempts to present a comprehensive description of the quality function deployment (QFD) process to facilitate a clearer reference of the basis of QFD.

The purpose of this research is:

1. Determination of a marketing strategy by identification of expectations of the target customer groups (OEM customers) and comparing the strengths/weaknesses of the television technology complex with those of alternative television projects available in the market;
2. AHP has been shown to be useful in prioritizing alternative variables which are OEM customers' needs and demands.
3. using the current QFD exercise findings to facilitate decision-making in forthcoming projects;
4. formulation of a systematic procedure which may guide the decision makers in all stages of the technological products including feasibility analysis and design so that the company may create a competitive advantage within the market by 'quality differentiation'.
5. competitive benchmarking to the development of quality improvement.

This research is integrated Analytic Hierarchy Process (AHP), Quality Function Deployment (QFD) and Benchmarking; use them for quality improvement, product development at the firm level. This study applies the principles and techniques of QFD to the development of CRT combo Television design operations.

AHP is used for multi-criteria decision making in a group set-up. AHP has been shown to be useful in prioritizing OEM customers' needs and demands. AHP is an effective technique for analyzing a complex problem because it facilitates step-by-step cause–effect explanations and systematically accommodates the use of expert judgment (Saaty, 1990); these advantages make AHP the appropriate method for an analysis of competitiveness.

QFD, on the other hand, is used in translating customers' needs into the specific organizational actions. Creative inputs, consensus management, and group members' commitment are the most important advantages when using either AHP or QFD.

QFD can be described as an approach to product quality design, which attempts to translate the voice of the customer into the language of the engineers.

Whether in industry, project group continually need to reference our own performance against others. Competitive benchmarking is where group wish to discover what company's performance is compared with an immediate competitor. The organization must assess its strengths and weaknesses. And priorities can be set for making improvements.

5.4 An Application of the Quality Function Deployment Methodology

5.4.1 Model Development

In the previous chapters, proposed competitive benchmarking, QFD in details and brief explanations about AHP. In the current section, application QFD for 20'' Combo Television (convergence devices DVD and DVB) which is competitive QFD. Priorization customers' needs and expectations by using AHP.

Comprehensive QFD model to the unique considerations of the CRT (Cathode Ray Tube) combo television (combo is playability DVD) project. This project will show some of the key steps as well as excerpts of some of the analyses and charts.

For confidential reasons, I can not reveal much about the OEM customers and competitors in competitive assessments, their needs in details of this study.

I hope, however, that readers can get a feel for the power QFD, the need to fit QFD to the CRT combo television project, and the focus and clarity that QFD can bring to a new product development or projects.

In this research, 20 inch CRT (Cathode Ray Tube) Television which is digital convergence device DVD and DVB-s /DVB-t is classified low end. The product is The Toshiba MD20F52 FST PURE Flat Tube TV/DVD combines a Full-Featured DVD Player with a Stereo TV in one convenient, compact design. The FST PURE Flat tube improves viewing angle and picture linearity over conventional tube televisions. The Digital Comb Filter eliminates detail noise in intricate scenes and reduces dot crawl and color bleed. The combination of a Stereo TV with double baffle speaker system delivers the best sound by keeping the sonic image widely separated within the cabinet. The StableSound feature eliminates drastic volume changes by maintaining volume within a preset range.



Toshiba FST PURE® MD20F52 20" TV/DVD Combo

5.4.2 The QFD Team

Team is a group of individuals representing various disciplines and functions that meets together for the purpose of problem solving or decision making.

QFD team's performance is the result of the combined efforts of its people. Vestel began by training 10 engineers from across the company as QFD. The group included sales engineers, R&D engineers (both software and hardware engineers), and quality engineers. From this group training to focus on the project. See Figure 5.1.

Team members are all engineers; mechanical engineers for mechanical and industrial design and ergonomics, electrical and/or electronic engineers for reliability, hardware and software development and industrial engineers for manufacturing. Team is important for all stages in this research. They analyze the customer needs and wants. This analysis helps the QFD team expand their understanding of OEM customers and end users needs beyond the obvious into areas where hidden needs may emerge in the future.

Team is important for the projects.

Why:

• Teams allow the people who are the most knowledgeable about a process to pool their skills, talents, and expertise for the improvement process.

• Communication between affected organizations is improved, more ideas can be generated, and ultimately, decisions are of higher quality in a team environment than when a task is undertaken by an individual.

• Members of a team are much more willing to take ownership in the resultant decisions and to actively pursue their successful implementation.

When:

A team should be used whenever a decision, problem, or task affects more than one person, organization, or company. The tools described in this document are most effective when applied by teams. Examples of when to use teams include

• Identifying improvement opportunities.

• Developing new product or process designs.

• Determining key characteristics.
• Identifying sources of variation.
• Doing a key characteristic flow down.
• Conducting a designed experiment.
• Performing a root-cause analysis.

How:

• Determine those organizations, disciplines, and individuals having some involvement in the problem, process, decision, or task under consideration.
• Request representation from each of the affected groups to act as members of the team. Provide training as necessary.
• Establish a schedule for the team meetings.
• Develop meeting agenda. Conduct team meetings. Define the problem, establish objectives, and apply appropriate problem-solving tools such as described in this document. Attempt to reach consensus decisions whenever possible; the emphasis is on reaching a common goal.

Problem-solving and decision-making teams often flounder because the problem and objectives are not well defined or understood by the team. Teams often leap to providing solutions without taking the time to define the problem and establish the objectives.

In addition, boundaries are often not defined which would help focus team activities and responsibilities. Issues which arise and are outside of the boundaries should be noted and communicated to the responsible personnel.

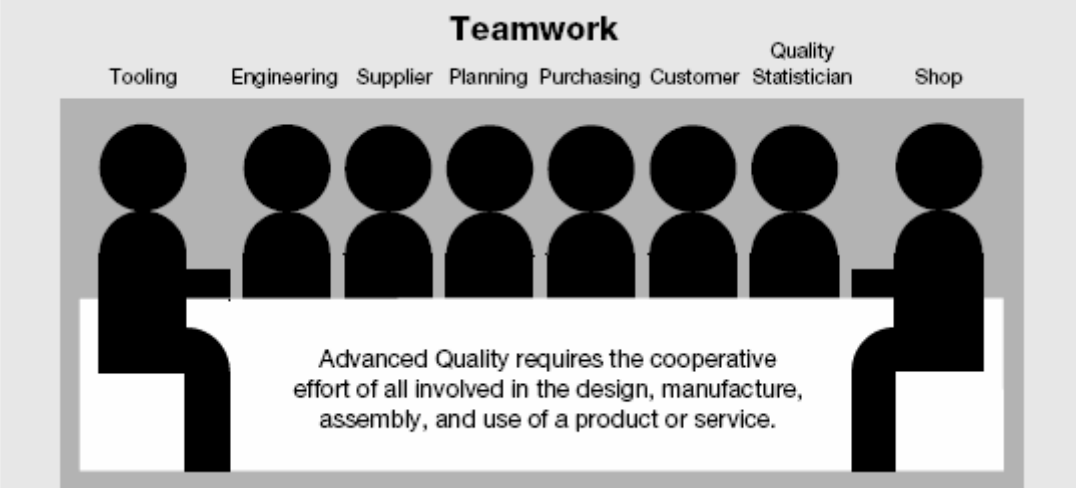


Figure 5.1 Teamwork

5.4.3 Original Equipment Manufacturer (OEM) and Our Customers

Vestel Electronics has developed its own brand name of Vestel. As well as this brand Vestel is the one of the producers of brand names of JVC, Hitachi, Toshiba, Sanyo etc.

Vestel Group is a leading manufacturer, on an own name and original equipment manufacturer (OEM) basis, of consumer electronics (principally televisions, various digital-based technologies and monitors for personal computers) and a number of higher quality electronic products for the information technology sector.

Vestel has exported 96% of its annual television production. The rest of production is made based on orders coming from the above OEM customers.

5.4.3.1 Original Equipment Manufacturer (OEM)

Originally, an OEM (original equipment manufacturer) was a company that supplied equipment to other companies to resell or incorporate into another product using the reseller's brand name. For example, a maker of refrigerators like Frigidaire might sell its refrigerators to a retailer like Sears to resell under a brand name owned

by Sears. A number of companies, both equipment suppliers and equipment resellers, still use this meaning.

More recently, OEM is used to refer to the company that acquires a product or component and reuses or incorporates it into a new product with its own brand name.

Business To Business - B To B, Business conducted between companies, rather than between a company and individual consumers.

5.4.3.2 Customers

Vestel is hoping to continue expanding, and aims to achieve sustained and controlled growth in revenues and profitability in its core activities by producing high-quality electronic consumer goods, principally televisions (both digital and analogue) and increasingly digital video products (including Digital Video Discs-DVDs and Digital Video Broadcasting-DVBs) for sale both in Turkey and overseas.

Until the beginning of 2000, Vestel's production for exports was on an OEM basis, under which it paid a license fee for each manufactured electronic device and B branded product. It served mainly large retailers, mail-order companies, wholesalers; electronic distributors, other manufacturers and some A brand customers (since 1998). The product mix was geared towards the low-end of the market, with only 30% of output aimed at the high-end.

However, from the beginning of 2000, management looked to position Vestel as a manufacturer for brand customers. The pricing pressures in the market and the high cost of manufacturing in Europe prompted the A brand Japanese manufacturers in Europe (that is Hitachi, Mitsubishi, Sanyo, JVC, Toshiba) to outsource their European production to Vestel. The first Japanese manufacturer (Mitsubishi) spent one year examining the manufacturing process, quality of products and made proper due diligence meetings before giving its orders.

Currently, management is moving to transform the company from an OEM into an original design manufacturer (ODM) and to position the Vestel Group as a major distributor and supplier of low-cost information systems, appliances and display devices.

Management continues to seek ways to broaden the value-added product range and to achieve geographic expansion into new (mainly non-EU) markets and further increase their presence in existing markets through local partnerships. In the long term, management has set its sights on becoming one of the world's three largest television manufacturers.

Vestel's historical OEM strategy, which is based on increasing the scale of operations and presence in Europe without causing brand conflicts, has stimulated growth and has been successful in capturing market share. Expects the new strategy, that is to shift production into higher-margin products (high quality CTVs, DVDs and DVBs) and information technology-based products (internet TV), to contribute to the company's results positively in the medium-term and enhance product diversification.

Vestel's core products could be characterized as having a short commercial life and exposed to technology cycles in consumer electronics. Meeting changing customer demands, efforts and success in developing new products will be among Vestel's challenges in the future.

5.4.3.3 Key Customers

It is important to capture the "voice" of those customers that can directly and directly lead to project success. QFD forced team to look not only at the OEM engineers, but also at the end consumer who uses television. Television performance and functions are important for end customers.

For the OEM customer, team are interested in spending the most time with those who would most influence the decision to use system and could spend time with us at his early stage. To get our team members to reach agreement on which OEM

customer would be most influential, QFD team first examined how the OEM made their decisions and who were the key drivers of the process.

5.4.4 Constructing the HOQ matrix

This research presents a systematic and operational approach to quality function deployment (QFD), a customer-driven quality management system for product development. After a comprehensive description of the relevant elements in house of quality (HOQ), the first and most influential phase of the QFD system. Thorough explanation is given to address the concepts, computations and implementations in the proposed HOQ model, followed by a full example for a combo television to illustrate step by step all the relevant details with the purpose of facilitating the understanding and application of the QFD process.

The steps followed during the research for applying QFD methodology to this project are mentioned in details in Chapter 3. The methodology used in the project presented in this research is shown in Figure 3.7.

As stated before, the first step in the application is to identify the expectations of the target customer groups from the project. To achieve this purpose, the database owned by the company has been investigated to extract customer expectations for quality improvement.

5.4.4.1 Identifying customer needs

Quality can be defined as meeting customer needs and providing superior value. Meeting customer needs requires that those needs be understood. The "voice of the customer" is the term to describe the stated and unstated customer needs or requirements. The voice of the customer can capture in a variety of ways: direct discussion or interviews, surveys, focus groups, customer specifications, observation, warranty data, field reports, etc.

In consumer behavior, there have been several studies (Kano, 1984) that purport that spoken words are not necessarily a complete or accurate portrayal of all issues or concerns. In QFD, extensive voice of customer analysis is done through a series of tools that attempt to discover, uncover, structure, and then prioritize these into a set of customer needs or Demanded Quality. These tools include the Management and Planning tools, the AHP, as well as specialty voice of customer tables (Mazur, 1997). In this research, AHP is used for priorization of OEM customer needs and demands. The Voice of Customer Table 5.1 takes the verbatims of the customer in the context of actual or possible scenarios of use and rewords them into additional unspoken data. This analysis helps the team expand their understanding of customer needs beyond the obvious into areas where hidden needs may emerge in the future.

Customer satisfaction is one of the most fundamental metrics that measures company success at their key customers.

Vestel is commitment to every customer's success and values effective partnersips with customers, OEM customers' comments and response to the survey will help the QFD team achieve beneficial results for both. The survey is included below specifications. Survey is in Appendix A.

Survey format:

The survey is comprised of five sections distributed across one General and four functional areas:

-General
-Product planning/Marketing
-Engineering/Development
-Purchasing/Operations
-Quality and Reliability

Also web-based OEM customer satisfaction questionnaires in Appendix B which is for increase product quality. In addition, each section of survey and questionnaire includes an expanded Comments field at the conclusion to provide additional space for OEM customers' and end users' feedback.

Once customer needs are gathered, QFD team then has to be organized. The mass of interview notes, requirements documents, market research, and customer data needs to be distilled into a handful of statements that express key customer needs. Affinity diagramming is a useful tool to assist with this effort. Brief statements which capture key customer needs are transcribed onto cards. A data dictionary which describes these statements of need is prepared to avoid any misinterpretation. These cards are organized into logical groupings or related needs. This will make it easier to identify any redundancy and serves as a basis for organizing the customer needs.

First, the benchmarking company should identify and structure its customers' needs; these are called the "requirement qualities". This is the most critical part of the benchmarking process. Generally, customer needs may come in various forms, such as basic needs, articulated needs, and surprise needs. It is difficult for the product development team to deal with a list of 100-300 customer needs, examining them item by item. Therefore, QFD team structures the customer needs into a hierarchy of primary, secondary, and tertiary needs. In doing so, QFD team is able to work out the requirement quality deployment table.

The affinity or tree diagrams show the needs (primary, secondary, and tertiary levels, etc.) organized into groups. These will be aligned on the left side of the preplanning chart for the House of Quality. In this study, five requirements are primary needs which are cosmetic requirements, product specifications, storage and shipment, quality and cost.

Secondary level of cosmetic requirements is industrial design, plastic quality, paint quality, logo, carton box, silk painting, remote control, and artwork/IB.

Secondary level of product specifications are picture and sound quality, extra features, easy of use, compatible interface to other products and low energy consumption.

Container loading quantity is the secondary level of storage and shipment.

Reliability, service and guarantee period is the secondary needs of quality.

Low cost is the most important for both end users and OEM customers to buy the qualified television. The key element of Vestel's marketing strategy is to supply "value for money" products at internationally competitive prices, beneficial payment terms and shorter delivery times.

Web-based survey, questionnaire and customer complaints are resulted in Table 5.1.

Table 5.1 Voice of customers of QFD matrix

CUSTOMER REQUIREMENTS
1. Cosmetic Requirements
a. Industrial Design (Form aesthetics)
b. Plastic Quality (Touch quality)
c. Paint Quality
d. Logo
e. Packing (Carton Box)
f. Silk Printing
g. Remote Control
h. Artwork/IB
2. Product Specifications
a. Picture Quality
b. Sound Quality
c. Extra Features
d. Ease of Use (OSD, RC, etc.)
e. Compatible interface to other products
f. Low Energy Consumption
3. Storage and Shipment
a. Container Loading Quantity
4. Quality
a. Reliability (long life)
b. Easy and Low Cost Service
c. Guarantee Period
5. Cost
a. Low Price

Results of customer surveys, questionnaires, face-to-face interviews with OEM customers and also OEM engineers and complaints received from previous projects have constituted the entries of the database. An alternative way of determining VOC

related to the housing project under investigation is to form an interdisciplinary QFD team responsible for providing expert opinions/judgments. This joint QFD team comprised of 10 members, 2 of which is the project manager and senior engineer of the hardware and software department. After conducting a series of brainstorming sessions and utilizing QFD tools like affinity diagrams, tree diagrams and matrix diagrams, the joint research team managed to determine the 19 most important criteria that would satisfy the customers of CRT combo television (convergence DVD and DVB). The determined customer needs are presented in Table 5.1.

5.4.4.2 Customer Requirements in details

Cosmetic Requirements:

Industrial Design (Form aesthetics)

Industrial design is an applied art whereby the aesthetics and usability of products may be improved. Design aspects specified by the industrial designer may include the overall shape of the object, the location of details with respect to one another, colors, texture, sounds, and aspects concerning the use of the product ergonomics. Additionally the industrial designer may specify aspects concerning the production process, choice of materials and the way the product is presented to the consumer at the point of sale. Industrial design has a focus on concepts, products and processes. In addition to considering aesthetics, usability, and ergonomics, it can also encompass the engineering of objects, usefulness as well as usability, market placement, and other concerns.

Plastic Quality (Touch quality)

Plastic covers a range of synthetic or semi synthetic polymerization products. They are composed of organic condensation or addition polymers and may contain other substances to improve performance or economics. Plastics can be formed into objects or films or fibers. Their name is derived from the fact that many are malleable, having the property of plasticity.

Manufacturers use plastics because they are durable, lightweight, flexible, cost-effective, corrosion-resistant, and have excellent insulation properties. These properties allow manufacturers to produce highly functioning electronic products while also responding to changing consumer demands.

Paint Quality

One of important requirement of cosmetics is paint quality. If the paint quality is good, it will be is to bring the customer satisfaction.

Also color is important to the brand recognition, but should not be an integral component to the logo design, which would conflict with its functionality. Some colors are associated with certain emotions that the designer wants to convey.

Logo

A logo is a graphic element, symbol, or icon of a trademark or brand and together with its logotype, which is set in a unique typeface or arranged in a particular way. A typical logo is designed to cause immediate recognition by the viewer. The logo is one aspect of the brand of a company or economic entity, and the shapes, colors, fonts and images are usually different from others in a similar market.

OEM customers have a brand. Brand serigraphy is on every product. So that end users and guests always see this brand or logo. Logo or brand is advertisement for potential buyers.

Packing (Carton Box)

Packing is important for end users and OEM customers. If the carton box is the finest quality and best selection of products as well as the quickest service with accuracy. Drop tests are applied every box type for every product. Customers' expectations and ship every order of moving boxes and moving supplies with speed and accuracy.

Silk Printing

Silk Screen printing, sometimes called silk screening or serigraphy, has long proved its worth as a fine arts and commercial medium. While Silk Screen Printing Materials meet the high quality standards of professionals, hope is to bring the satisfaction to the OEM customers as well.

Remote Control

Remote controls come in several different types, but among the most common are the standard remote, which only works on your TV, and the universal remote, which allows you to control not only your TV, but other video and audio components.

Artwork/IB

Artwork includes designing carton box, gift box, users' manual (Instruction Book, IB), guarantee card, quick start guide (QSG), labels on box, barcodes.

Product Specifications:

Product specifications have become one of the most effective, most pervasive, and most popular features for televisions.

Picture Quality

Picture quality is the most preferred features for end users and potential buyers, so that OEM customers want their television with high quality picture.

Televisions have several types of comb filters. In all cases, the comb filter helps to separate the color signals from the black and white, providing a higher resolution, or sharper, picture. Of the three types, the 3DYC provides the sharpest picture, then the digital comb filter, then analog.

Picture specifications are described in briefly, below:
Contrast is the difference between the light and dark areas of the picture.
Color adjusts the richness of the color.
Tint is the balance between the red and green levels.

Black Level is the brightness of the picture.
Sharpness is the crispness of the edges in the picture.

Sound Quality

There are various types of audio capabilities that may come with television:
Mono: Single-channel sound, usually using a single speaker.
Stereo: Dual-channel sound, usually using two speakers.
Surround: Multiple-channel sound, using multiple speakers (usually six) for greater audio depth. There are many types of surround sound, and audio systems vary in the number of speakers and technologies used to produce surround sound.
Virtual Surround: Simulated multiple-channel sound with fewer (two or three) speakers.

Extra Features

Extra features are important for end users to select the television from others. End users want to select the best television. Extra features are headphone, aspect ratio, child lock, DVD & VDC playing, sleep timer, pip, different languages vocalization support, different languages subtitle support, different angle to watch possibility, superiors disk lock, Audio-CD CD-R CD-RW MP3 stealing, portable media device support , dual tuner, multi picture function; USB and SD slot etc.

Ease of Use (OSD, RC etc.)

Design, delivery, installation, programming and system set up/calibration tasks are the most critical aspects of end users' selection. If the menu of television is easy, end users adjust all technical features, settings and controls easily. OSD is screen command. Remote control which is preferred ergonomic is an important item for usability.

Compatible interface to other products

Compatible is the ability of one device or program to work with another device or program. The term *compatible* implies different degrees of partnership. For example, a DVD player and a television are said to be compatible if they can be connected to each other.

Today there are many television add-ons including Video Game Consoles, VCRs, Set-top boxes for Cable, Satellite and DVB-T compliant Digital Television reception, DVD players, or Digital Video Recorders (including personal video recorders, PVRs). The add-on market continues to grow as new technologies are developed. Televisions are compatible with above VCRs, set-top boxes etc.

Low Energy Consumption

Power consumption refers to the electrical energy over time that must be supplied to an electrical appliance to maintain its operation.

The power consumption is usually a result of power used to perform the intended function of the device plus additional "wasted" power that is dissipated as heat and/or light. Power consumption is usually measured in units of watts. OEM customers prefer low energy consumption devices because of economically feasible.

Storage and Shipment:

Container Loading Quantity

Product Arrangement is optimized by enforcing product stacking limits, orientation, sequence by drop location, and priority loading rules.

Advanced loading system delivers computerized load planning. Load any size or shape of container (20 or 40 ft): trailer, van, aircraft and railcar. The position of every product on the pallet and in the container is important for shipment.

Actual item dimensions and weight are used to calculate accurate load results. Product stacking rules (top load, bottom load, stacking limit) and payload weight limits are some of the information in the item and container databases.

Quality:

Reliability (Long Life)

In general, reliability (systemic def.) is the ability of a system to perform and maintain its functions in routine circumstances, as well as hostile or unexpected circumstances.

Easy and Low Cost Service

The services offered are designed to give you peace of mind by protecting your investment against hardware malfunction and making product ownership as easy as possible.

The end user will be responsible for any costs associated with non-warranty conditions. OEM customers reserve the right to make final decisions regarding problem determination and the appropriate service option.

Service Program for each OEM customers is unsurpassed in the industry in ensuring the highest levels of support, service and responsiveness to our customers and dealers. The lots of services are a strategic network of specially qualified service centers, which receive priority support and up-to-date information from our service headquarters, while providing world class repair turnaround time.

.

Guarantee Period

The warranty period begins on the original date of purchase, applies to the original purchaser, and covers defects in material or workmanship.

If the product is found to be defective within the warranty period, OEM customers will repair or replace defective parts at no charge to the original owner. Such repair and replacement services shall be rendered by OEM customers during regular business hours at OEM customers authorized service centers.

Parts used for replacement are warranted only for the remainder of this Warranty Period. All products and parts thereof may be brought to OEM customers authorized service center on a carry-in basis.

Cost:

Low Price

End users don’t pay more for the same television. In competition market, price is the most important to select the television. End users select the television with fitting their budget and lifestyle. Quite possibly, individuals who have made the decision to

buy the cheapest models are suffering from the pit falls and maladies that we all hear so much about.

In economics, business, and accounting, a cost is the value of inputs that have been used up to produce something, and hence are not available for use anymore. In business, the cost may be one of acquisition, in which case the amount of money expended to acquire it is counted as cost. In this case, money is the input that is gone in order to acquire the thing. This acquisition cost may be the sum of the cost of production as incurred by the original producer, and further costs of transaction as incurred by the acquirer over and above the price paid to the producer. Usually, the price also includes a mark-up for profit over the cost of production.

"How much will television cost to manufacture?" – That is among the first questions asked about a new product or invention. Answering it is a never ending exercise because production estimates are not one time events. Even long after they are in business, companies continue to find new ways to refine their production methods and reduce costs.

5.4.4.3 Structuring the needs and prioritizing them

Customer needs should be structured into a hierarchy of basic requirements, one-dimensional requirements and attractive requirements, which means assessing their strategic importance. Basic requirements have to be fulfilled; a product should be competitive with one-dimensional requirements and stand out regarding attractive requirements. As can be seen, 'good edge grip on hard pistes' is a must-be requirement as it causes very high dissatisfaction if it is not fulfilled but is not able to lead to a high level of satisfaction if it is fulfilled. To increase customer satisfaction, those product attributes should be improved which have a more than proportional effect on customer satisfaction, i.e. attractive requirements. To make effective improvements in terms of increasing the level of customer satisfaction it is necessary to know how the quality of competitive products is perceived by the customers.

Before starting to identify customer needs and filling the 1st section of the HOQ matrix, the customer profile of the project has to be defined in section 5.4.3.3. The targeted customer group as defined by the company professionals (QFD team) cover middle and low income people who are seeking differentiation in technological device CRT combo television through income, quality, features.

Benchmark TVs are classified three groups: Low Range, Mid Range and High Range. Also groups are changed for CRT and LCD/PDP televisions. Table 5.2 is shows benchmark television classification. Cost is the most important for customers for ability to buy. Low range TVs are lower price and also less qualification from others.

High end refers to the best and generally most expensive of a class of goods or services. For example, high-end audio refers to audio equipment that is designed to be the best it can be, regardless of price.

The opposite of high end is usually called "low end", usually in a derogatory manner, but sometimes connected with particular lifestyles or even artistic movements. The low-end market consists of lower-priced products suitable for customers who are not willing or able to spend large amounts of money.

Table 5.2 Classified Televisions

CRT		**LCD/PDP**	
Low Range	14" --- 21"	Low Range	15" .... 23"
Mid Range	21" RF/SLIM... 29"RF	Mid Range	26" .... 32"
High Range	28"&32" 16:9 SF/RF 33" SF , 34" RF	High Range	≥ 37"

SF: super flat

RF: real flat

PDP: plasma

After analysis of market surveys, questionnaires and complaints, team is classified the attributes of customer requirements. Table 5.3 shows customer requirements for low- end, mid-end and high-end with priority (0-100 points) which is AHP procedure applied.

In this research, Analytic Hierarchy Process (AHP) is used for prioritizing the customer voice in QFD. By following the AHP procedure is described in the Chapter 4.

Then the priority weights of each main attribute, sub-attribute were calculated using AHP method. As an example, the calculation of the priority weights of the main attributes will be explained in detail below.

Then, the AHP procedure can be done manually or automatically by the AHP software, Expert Choice. Figure 5.2 is showed evaluation of customers' satisfaction variables (customer needs). Figure 5.3 shows the hierarchical structure of the target construct.

Expert Choice, a Decision Support System (DSS) designed to facilitate the use of Analytic Hierarchy Process, is used to generate the overall weights for each criterion. The Expert Choice software can do the rest automatically, or manually combine the criterion priorities.

The AHP rating of the OEM customer satisfaction variables are presented in Figure 5.2 and Figure5.3. This is done using a 0-low and 100-high point scale to show the team judgments or preferences of one criterion over the other. Their orders of importance are as follows: low cost (70 point), Cosmetic requirements (10 point), Shipment (10 point), Quality (5 point), Product Specifications (5 point) for low end users. Secondary levels of all attributes are listed in Table 5.3 for low-end, mid-end and high-end customers.

These results show the degree of the importance to which these features influence OEM customer satisfaction. For example, it can be seen that the cost is the most important features of the television that influence customer satisfaction. The realized results from these AHP applications are presented on the left hand side of the QFD matrix. (See Figure 5.6)

We can conclude that the most important attribute in the product planning is low cost attribute because it has the highest priority weight. Cosmetic and storage/shipment attributes are the next preferred attributes.

The calculations for these items will be explained next for illustration purposes. Synthesizing the pair-wise comparison matrix is performed by dividing each element of the matrix by its column total.

The same calculations were applied to the other pair wise comparison matrices and the priority weights of each main attribute, sub-attribute were calculated. The priority weights of each main attribute, sub-attribute can be found in Table 5.3.

Expert Choice does provide facilities for performing sensitivity analysis, where the decision maker can check the sensitivity of the judgments on the overall priorities of television by trying different values for comparison judgments. Sensitivity analysis is showed in Figure 5.5. In Expert Choice, Differences of all attributes (customer needs and expectations), Gradient, 2-D plot, performance and dynamic are provided automatically.

The sensitivity analysis identifies the pair-wise comparison weights that the overall decision is the most sensitive too. These weights are the one s that must be assigned with the greatest accuracy and the AHP results should be qualified by referring to these high sensitive.

In this application overall consistency index = 0.00 less than 0.1. As the value of CR is less than 0.1, the judgments are acceptable. Similarly, the pair-wise comparison matrices and priority vectors for the remaining criteria can be found as shown in Figure 5.4, respectively. The sensitivity analyses are necessary because changing the importance of attributes may alter the QFD team.

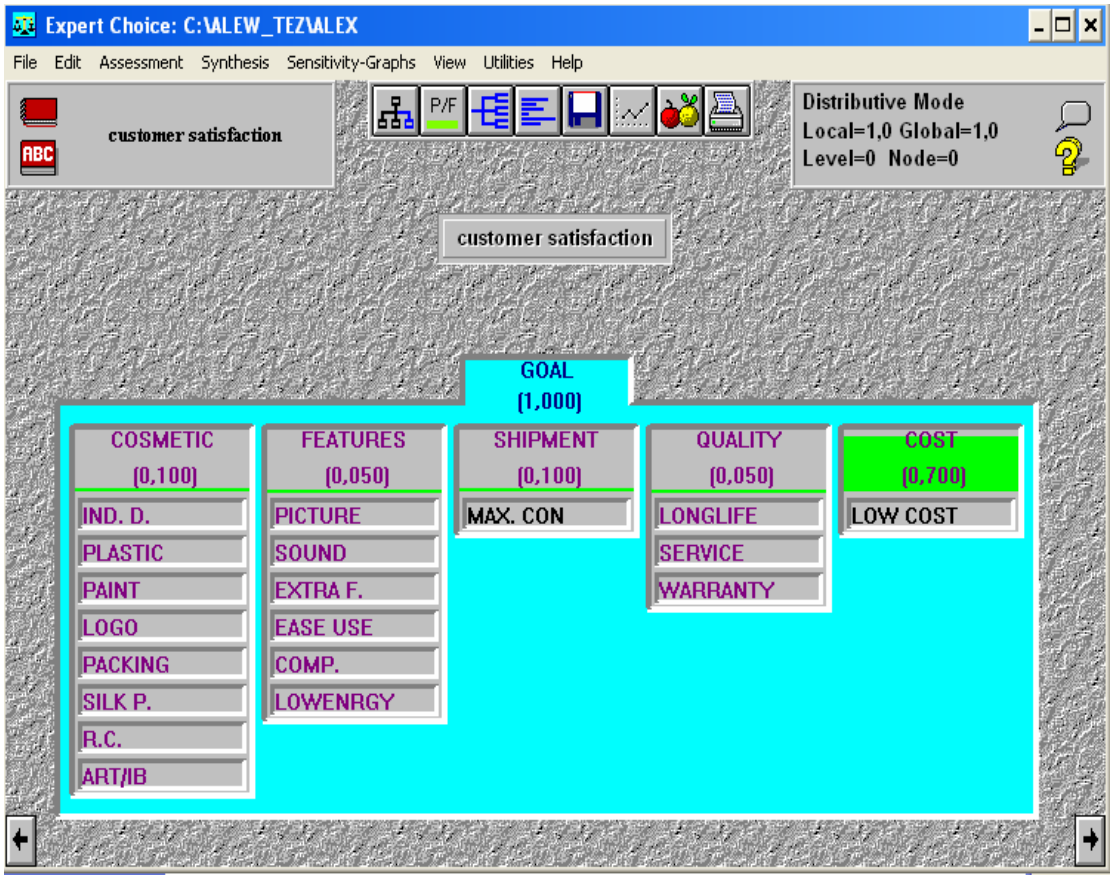
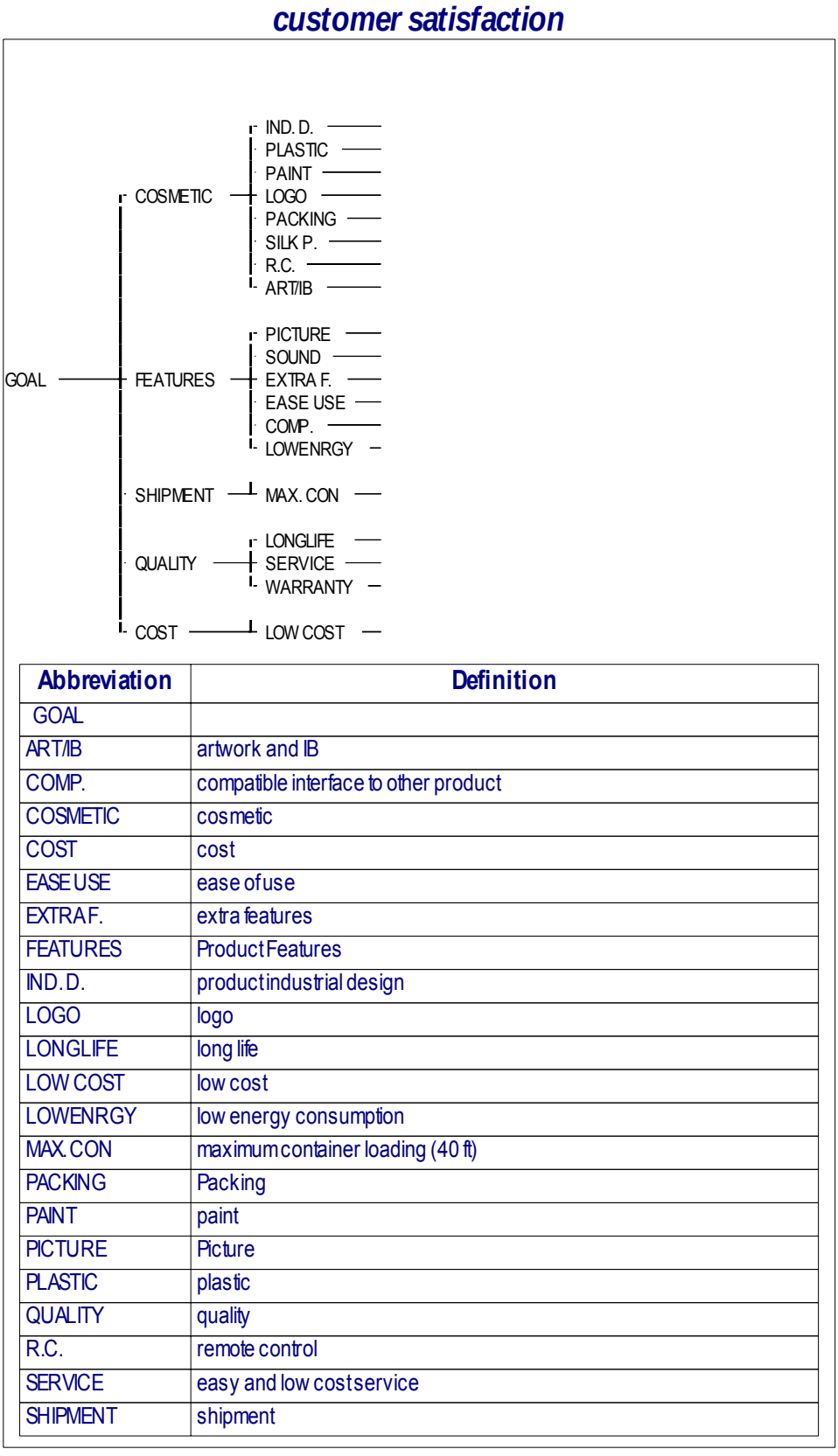
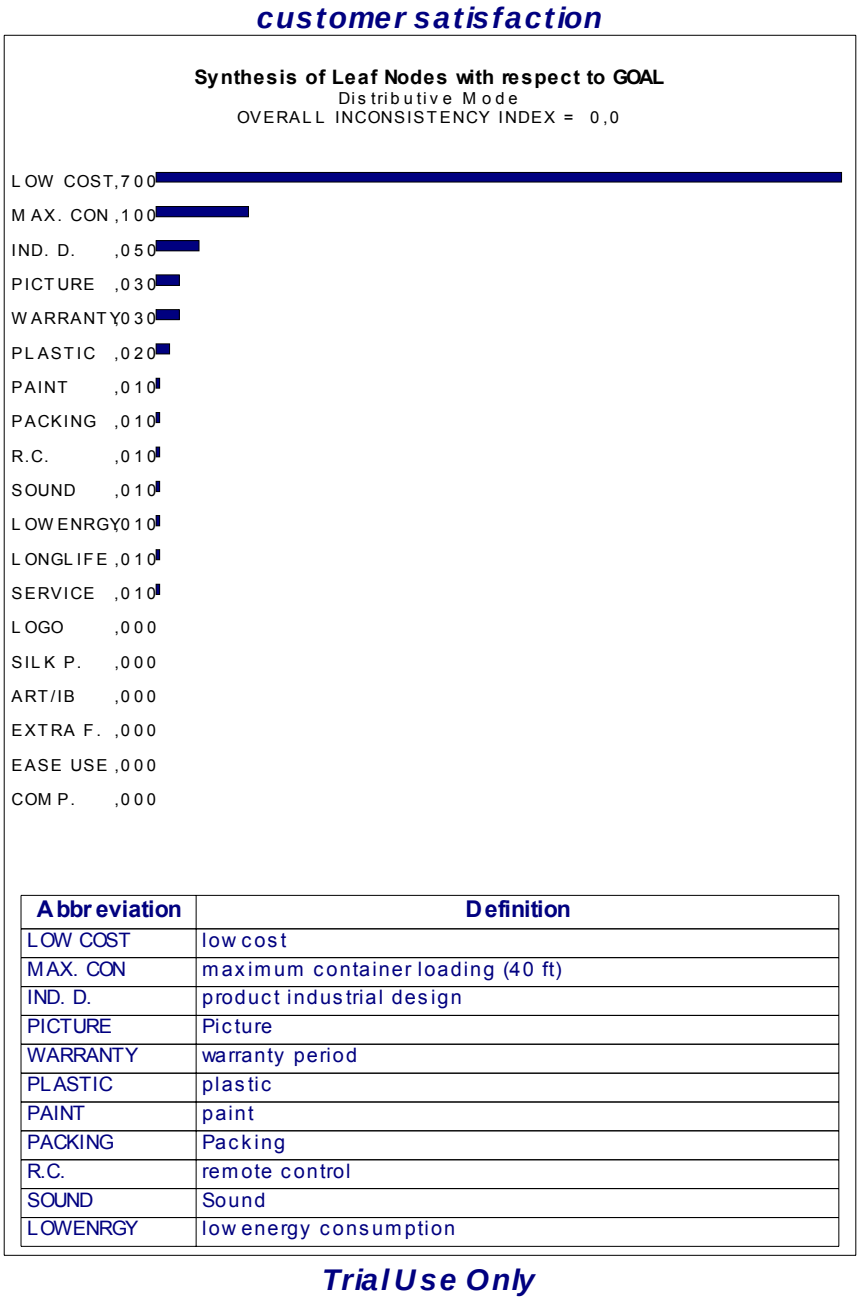


Figure 5.2 Evaluation of customers' satisfaction variables (Expert choice-trial use only)



Abbreviation	Definition
GOAL	
ART/IB	artwork and IB
COMP.	compatible interface to other product
COSMETIC	cosmetic
COST	cost
EASE USE	ease of use
EXTRA F.	extra features
FEATURES	Product Features
IND. D.	product industrial design
LOGO	logo
LONGLIFE	long life
LOW COST	low cost
LOWENRGY	low energy consumption
MAX. CON	maximum container loading (40 ft)
PACKING	Packing
PAINT	paint
PICTURE	Picture
PLASTIC	plastic
QUALITY	quality
R.C.	remote control
SERVICE	easy and low cost service
SHIPMENT	shipment

Figure 5.3 the hierarchical structure of customer needs (Expert Choice)



Abbreviation	Definition
LOW COST	low cost
MAX. CON	maximum container loading (40 ft)
IND. D.	product industrial design
PICTURE	Picture
WARRANTY	warranty period
PLASTIC	plastic
PAINT	paint
PACKING	Packing
R.C.	remote control
SOUND	Sound
LOWENRGY	low energy consumption

Figure 5.4 Evaluation of customers' satisfaction variables

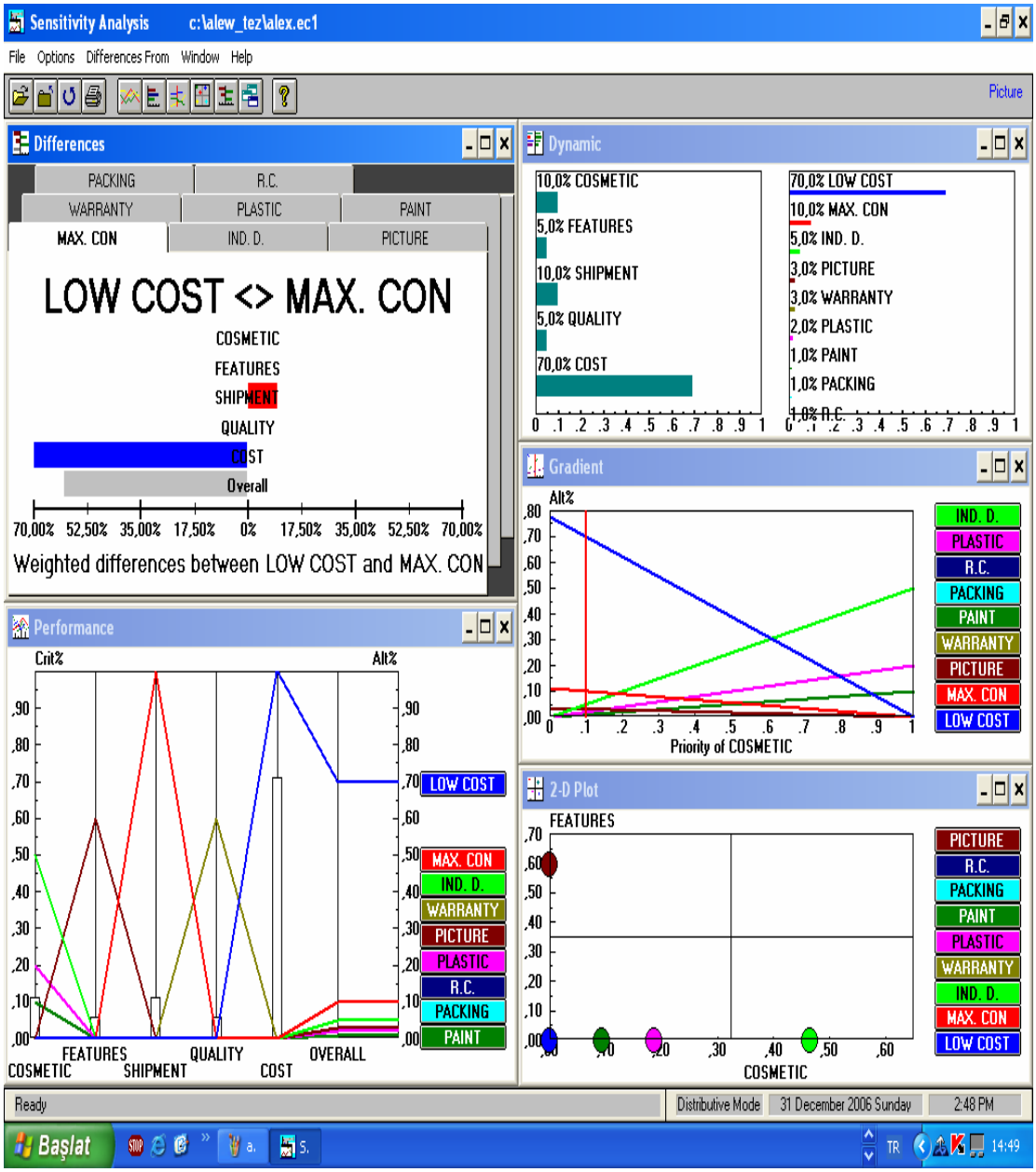


Figure 5.5 Sensitivity Analyses (Expert Choice)

Table 5.3 Customer requirements and priorities for each category

CUSTOMER REQUIREMENTS	Low End	Mid End	High End
1. Cosmetic Requirements			
a. Industrial Design (Form aesthetics)	5	5	8
b. Plastic Quality (Touch quality)	2	3	3
c. Paint Quality	1	2	5
d. Logo	0	1	5
e. Packing (Carton Box)	1	1	2
f. Silk Printing	0	1	1
g. Remote Control	1	1	4
h. Artwork/IB	0	1	2
TOTAL	**10**	**15**	**30**
2. Product Specifications			
a. Picture Quality	3	5	8
b. Sound Quality	1	4	6
c. Extra Features	0	3	5
d. Ease of Use (OSD, RC, etc.)	0	2	4
e. Compatible interface to other products	0	1	2
f. Low Energy Consumption	1	1	1
TOTAL	**5**	**15**	**25**
3. Storage and Shipment			
a. Container Loading Quantity	10	10	0
TOTAL	**10**	**10**	**0**
4. Quality			
a. Reliability (long life)	1	5	8
b. Easy and Low Cost Service	1	2	2
c. Guarantee Period	3	3	5
TOTAL	**5**	**10**	**15**
5. Cost			
a. Low Price	70	50	30
TOTAL	**70**	**50**	**30**
GRAND TOTAL	**100**	**100**	**100**

5.4.4.4 Comparing customers' perceptions

In order to know whether an improvement of certain product attributes leads to a competitive advantage it is necessary to compare the customers' perceived product quality with that of products of competitors. This evaluation should be based on scientific market research. It can be seen that an improvement of the edge grip on hard pistes has priority, because the competitor's product is perceived to be better.

To further focus improvement activities, the web survey will ask customers which of the competing models best satisfy their needs.

Once the customer requirement quality deployment table is completed, the downstream steps will be determined more and more specifically. On the right hand side of the "house" is the competitive benchmarking which comes from the customers' perceptions of performance.

In this step, QFD team use benchmarking process model which is early mentioned in detail in Chapter 2. The conceptual framework is shown in Figure 2.1.

QFD team first collect customers' satisfaction of the products amongst competitive brands and obtain the difference in value of the performance measures between our product and the best one in the industry. Besides, some customer needs have higher priorities for customers than do other needs; therefore, the relative importance of various requirements should be ranked. These priorities will help the company to make decisions, which balance costs of fulfilling a customer need, with the desirability of fulfilling that need.

The Customer Competitive Assessment measures the customer perception of the product relative to the competitor's product. Data collected from other customer is used as a basis for comparison. The data is presented graphically in Figure 5.6.

In the study, benchmarking benefits which is described in detailed in Chapter 2 helps the QFD team. The result of this benchmarking is given below.

The customer competitive assessment helps the QFD team to:

1. verify that the list of requirements is important to the customer population using AHP.
2. capture additional customer requirements.
3. discover the strengths and weaknesses of the product.
4. identify weaknesses in competitors' products.

Identifying the competitor: From the reports of companies and market surveys and questionnaires. In this study, TV_DVD 1 is our benchmarked television which is 20'' CRT Combo Television for the OEM customer. In this QFD application, two other competitors are evaluated which are TV_DVD 2, TV_DVD 3. For confidential reasons, I can not reveal the brands of competitors. Table 5.4 shows the symbols and explanations.

Table 5.4 corresponding explanation of symbols

symbol	***Meaning***
Δ	TV_DVD 1 ….benchmarked TV
O	TV_DVD 2….competitor 1
۞	TV_DVD 3….competitor 2

In this study, the rating scale is between 1-low to 5-high.

Furthermore, since the commonly used sales point concept is quite subjective so that in this application sales point is not used.

Finally, QFD team is able to design a target quality level (improvement goal) to be referenced by the company to redesign or improve their products or service. According to our position with respect to the competitors, in this step, establish the quality planning table.

To further focus improvement activities, the web surveys, questionnaires ask OEM customers which of the competing products best satisfy their needs.

The performance of the company on meeting each customer need has been compared with its major competitor performance. As a result of this comparison, the customer requirements necessitating improvements have been identified and goals have been set for better meeting each of them. The goals have been set by considering the best alternative for each customer expectation as compared to major competitors.

Improvement ratios for each customer need, which are found by dividing the goal to the current performance, are calculated. For instance, “product industrial design” has an initial importance level of 5. The performance of the current company in satisfying this need is given a score of 3 whereas the competitors have a corresponding performance score of 5. Thus, the target performance level is decided to be 5 and the improvement ratio is found by dividing the target level (5) to the current performance level (3). The improvement ratio is calculated as 1.67. Furthermore, the revised weight of the customer expectation is found by multiplying the improvement ratio (1.67) with the original importance weight (5). Thus, the revised weight is approximately 8.5. The purpose of this calculation is to increase the weight of the customer needs where the company is unsuccessful in meeting so far and to bring these issues to the attention of the QFD team.

For industrial design attribute, the improvement ratio (goal/current performance) is 5/3=1,67. Improvement ratio for all customer needs is calculated in Figure 5.6.

Improvement ratio= (goal / current performance)

*Weight= (importance*improvement ratio)*

Normalized weight= (weight of the any row / total weights)

For industrial design attribute, normalized weight is 8.33/125.6 and equal to 0.066.

The same calculations have been applied to the sub-attributes of cosmetic requirements, product specifications, quality, shipment and cost attribute with respect to product performance have been calculated. The weights and normalized weights can be seen in Table 5.5.

Table 5.5 Improvement ratio, weights and normalized weights for each attribute

	Cost	Quality			Shipment	Product Specifications						Cosmetic								
	Low Price	Warranty period	Easy and low cost service	Reliability (Long life)	Maximum container loading (40ft)	Low energy consumption	Compatible interface to other product	Ease to use (OSD, RC, etc.)	Extra Features	Sound	Picture	Artwork/IB	Remote Control	Side Painting	Packing (Carton Box)	Logo	Paint Quality	Plastic Quality (Touch quality)	Product Industrial Design (Form aesthetics)	
	70	3	1	1	10	1	0	0	0	1	3	0	1	0	1	0	1	2	5	◄Customer priority (0-to-100) (importance)
	5	5	5	5	4	4	5	5	5	5	5	5	5	4	5	4	5	5	5	Improvement Goal
TopLAM	1,25	1,25	1,25	1,25	1	1	1,25	1,666667	1,25	1,666667	1,25	1	1,666667	1,333333	1,666667	1	1,25	1,25	1,666667	Improvement Ratio (goal/current performance)
125,6	87,5	3,75	1,25	1,25	10	1	0	0	0	1,666667	3,75	0	1,666667	0	1,666667	0	1,25	2,5	8,333333	Weights (importance*improvement ratio)
1	0,696656	0,029857	0,009952	0,009952	0,07961783	0,007962	0	0	0	0,01327	0,029857	0	0,01327	0	0,01327	0	0,009952	0,019904	0,066348	Normalized weights (weight/Σweight)

Weights and normalized weights are calculated for all customer needs and in order to fill the appropriate section of the QFD matrix (See Figure 5.6).

The result of these, low price is the most important for OEM customers with %69.96. Then shipment, industrial design, picture quality, warranty period is the priorized customer needs from others.

5.4.4.5 Identifying design attributes

In this step the product development team translates customer needs into engineering concerns. The question is: How can we change the product? The team has to identify those design attributes which fulfill customers' needs. They help the different disciplines working on the project, to understand customer requirements in the same meaning and avoid confusions that can be faced while interpreting the customer needs. The corresponding technical indicator of each customer requirement listed in the HOQ matrix has been found in order to reach the correct targets that would mostly satisfy the customers. Technical measures, which have been identified as a result of brainstorming sessions, are listed in Table 5.6.

There are lots of technical specifications which are listed Table 5.6. Important technical specifications are mentioned briefly. Also for confidential reasons, I can not reveal much about all technical specifications.

Table 5.6 Technical measures of QFD matrix

Technical specifications
Plastic material
Plastic weight
Paint material
Number of Paint area
Carton box (Gravity,density,type)
Packing bag (Naylon=0, Plastozoid/naylon=1,Plastozoid=2)
Number of Label
Logo difference (silkprint=1,Logobatch=2,Metal=3)
Number of silkprint (color,number)
Remote Control
Artwork/IB (number of lang., contents, size)
Aesthetic/Appeal
Ergonomy
Design diversity
Picture brightness
Picture contrast
Picture motion parameter (Madi,Spatial,Eddı,MotionComp)
Picture resolution
Picture visible angle
Picture geometry
Extra picture features (TEXT,PIP,CTI,CompF,LTI,NR)
Sound deep noise
Sound exit power
Sound frequency performance (audio power and headphone)
Sound extra features (Dolby,SRS,BBE)
Sound THD (total harmonic distortion)
Acoustic performance
Max. Power consumption (ON,St-By)
TV size and versatility
Extra connectors,sockets (Analog-Scart,AV,SVHS,HP,YUV)
Warranty period
Electromagnetic Compatibility (EMC)
Safety
Accessorize box or nylon bag (cable, scart to scart cable, power)
Manufacturing cost

5.4.4.6 Developing the relationship matrix

The product development team has to judge how strongly the different design attributes influence individual customer needs. The influence should be measured for the following reasons: first, to determine priorities and directions for improvements to the design attributes; second, to provide an objective means of ensuring that customer requirements have been met; and third, to provide targets for further detailed development.

In order to fill the appropriate section of the HOQ matrix, the relationships between customer needs and technical measures have to be identified subjectively by the QFD team. This step is essential to understand the contribution of each technical measure in overall customer satisfaction level as well as to see how the technical measures are helpful to satisfy each customer expectations and needs. The scoring scale and the corresponding explanation of relations utilized within the study are shown in Table 5.7. QFD team members must determine if the HOW can help achieve the WHAT, if the answer is no, a zero is entered in the matrix. If the answer is yes, then the relationship must be categorized as strong, medium or weak.

All of the relationships are defined in Figure 5.6

Table 5.7 Scoring scale and corresponding explanation of relations

symbol	***score***	***Meaning of relation/linkage***
S	**9** points	**S**trong relationship
M	**3** points	**M**oderate relationship
W	**1** points	**W**eak relationship
No symbol	**0** points	No relationship

For example, industrial design is effected plastic material, logo difference moderately. The interrelationship matrix shows that there is a strong correlation between industrial design and paint material and area, aesthetic/appeal, ergonomy, design diversity, acoustic performance and also safety.

Another example for this study, there is a strong relationship between picture quality and paint material, picture brightness, contrast, motion parameter, resolution, geometry. And there is a weak relationship between picture quality and extra picture features (text, PIP, CTI etc.).

Low price have many strong relationships with technical specifications.

5.4.4.7 Developing the roof matrix

The roof matrix should quantify the physical relationships between the design attributes. Sometimes the improvement of one design attribute leads to a degradation of other design attributes. The roof matrix is very helpful when trade-offs have to be made.

The following symbols are customarily used in QFD to denote the four possible relationships. It is shown in Table5.8.

Table 5.8 Scoring scale and corresponding explanation of relations

symbol	***Meaning of relation/linkage***
	Strong positive
	Moderate positive
	Moderate negative
	Strong negative

A positive relationship where improving one requirement automatically leads to an improvement in the other requirement indicates that two HOWs may complement each other. Conversly, a negative relationship indicates that two hows may have an adverse effect on each other. Negative correlations often suggest that tradeoffs may be required. Tradeoffs should always be made in favor of the customer.

For example, a strong positive relationship exists between design attributes “sound total harmonic distortion” and “sound exit power”. A moderate positive

relationship exists between “sound total harmonic distortion” and “sound frequency performance”.

Also ergonomy and remote control have moderate relationship. If the Remote Control can use easily, the end user will be satisfied.

At this time the QFD team establishes a direction of improvement for every technical design requirement (how). For every technical design requirement there is a direction that is most favorable for customers and which will maximize customers’ satisfaction. This information will be helpful when examining the co-relationships between technical design requirements (correlation matrix) and later on when target goals must be established. Directional improvement indicators can relate if an increase or decrease in a HOW can improve customer satisfaction. It can also show if the How itself can achieve this.

The symbols shown in Table 5.9 are used to represent the directional improvement indicators. The up arrow represents an increase, the down arrow represents a decrease, and the bull’s-eye represents a target value.

Table 5.9 Target Goal symbols

symbol	***meaning***
▲	increase
▼	decrease
●	target value

For example, plastic weight must be decreased; the target value (1.6 kg) is less than benchmarked television (2.07 kg). Improvement is required for the plastic weight. The directional improvement indicator show a down arrow in this case indicating that the less weight of plastic the more satisfied the customer would be.

Directional improvement indicators for all technical specifications are filled in QFD.

The information recorded in the roof matrix is useful to the QFD team in several ways. It highlights where a focused design improvement could lead to a range of benefits to the product. It also focuses attention on the negative relationship in the design. These can represent opportunities for innovative solutions to be developed.

5.4.4.8 Estimation of costs, feasibility and technical difficulty

The product development team should try to quantify costs, feasibility and technical difficulty of each design attribute, which is necessary if reasonable choices are to be made.

The interactions between technical measures have been examined and assigned in the roof of the matrix as shown in Figure 5.6. Finally, the weights of the technical measures have been calculated by multiplying each customer need's revised weight with the relationship score on the same row and adding them column-wise. After these calculations have been made for each technical measure, the weights have been analyzed and the most important ones have been identified. This identification process has also showed the order of measures needing improvements to provide the customers with what they mostly want to see in the final stage of the project.

In order to decide on the specific targets for technical measures, the other companies' performances with respect to each technical measure have been evaluated and the best performance has been determined as the target level. The final weights of technical measures and selected targets for the project are shown in Figure 5.6.

Upon completion of competitive benchmarking in the process is to set the objective values or targets. Target goals are sometimes referred as the how muchs. Target goals represent how much must be done to be competitive in the marketplace and to what extent each How must be improved. The objective is to ensure that the next generation product will be competitive and will satisfy the customer's wants and needs. Targets are created according to industry and company standards. The QFD

team evaluates what the OEM customer want and what the competition offer and then decides on a standard.

For example, “plastic material” weights are calculated.
Weights=Σ ((8.33*3)+(2.50*9) +(1.25*9) +(1.67*3) +(0*1) +(1.67*3) +(10*9) +(1.25*1) +(87.50*9))=947.6
Normalized importance rating = 947.6/14414.93=0.06673

The same calculations were applied to the other technical measures. Importance rating and normalized importance rating for each technical attribute are calculated.

As a result of this calculations, manufacturing cost, plastic weight, ergonomy, paint material, aesthetic/appeal and design diversity are high importance from others.

If the manufacturing cost is decreased, the OEM customer will be satisfied because they pay low price to purchase. Decreasing the manufacturing cost with the optimization of loading container for shipment, also industrial design and plastic material will be changed.

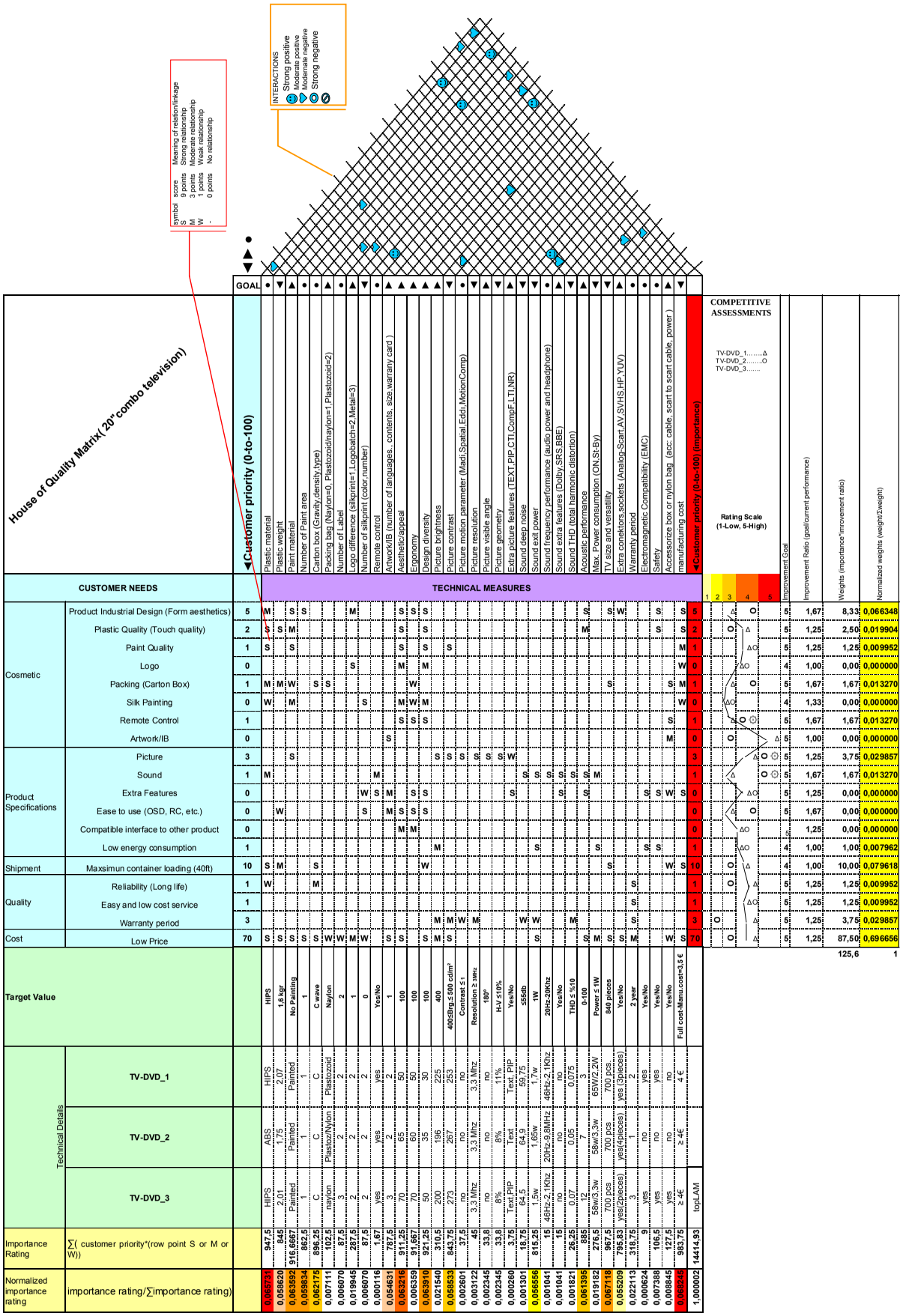


Figure 5.6 House of Quality Matrix

5.5 Analysis and Improvement

The major output of the analysis is the HOQ shown in Figure 5.6. The results achieved in Figure 5.6 demonstrated that, the ten most important technical measures which contributed to the success of the project were; Manufacturing cost, plastic weight and material, ergonomy, paint material, aesthetic/appeal and design diversity, picture contrast, sound, acoustic performance. Those points should be highlighted during the marketing efforts as these points are most valued by the end users and OEM customers. The better the customer satisfaction, the more successful will be the selling of the units in the short run. In the long run, the improved customer satisfaction will bring good reputation meaning increased competitive advantage within the market.

The calculations performed to find the weights of customer needs are important to highlight the needs that require improvements. The initial importance levels reflect the importance of each need in the eyes of customers. In this study, the three most important customer demands were listed as; low price, cosmetic and shipment. After the strategic decision making process, goals have been set which in the end affected the revised weights of the needs. When the revised weights, which show the order of importance of company decided to use the QFD methodology in forthcoming projects and establish an information infrastructure within the company to manage quality.

It seems that the bottom line of QFD is lower cost, higher quality, shorter timing with the maximum shipment, and a substantial marketing advantage.

The company professionals are satisfied with the results of the QFD application, as it helped them to identify OEM customer needs and carry out competitive benchmarking in a structured way. Databases about customer expectations, complaints etc. facilitates the data collection phase significantly. Also, a competitor intelligence system is an imperative as in order to set accurate and reliable goals, the company show know the properties and technical solutions proposed by the competitor companies working on similar projects. As a result of the QFD exercise,

the company decided to use QFD methodology in forthcoming projects and establish an information infrastructure within the company to manage quality.

After the QFD implementation, follow-up interviews have been conducted with the same OEM customer, OEM engineers and QFD team. They note that the company used the outputs of the QFD exercise in a new product project which has a very similar target customer group.

5.5.1 Application-specific limitations

One of the major problems faced in the QFD applications is poor definition of the customers. In the television industry, the customer is usually known at the beginning of the project. Therefore the seriousness of the problem may not be significant for the technological devices in general. In the study, as the project type was ‘‘produce and sell’’, the definition of the customer was a critical activity which could significantly affect the outcome of the QFD exercise.

Another point is the application process itself. The process is lengthy requiring great time, resource and effort to perform. The size of the matrices in HOQ matrix may vary according to the project but generally speaking, large and complex matrices are formed in the implementation of QFD. This sometimes leads to misunderstandings and miscalculations in the matrix formations as also experienced in the study example. As a remedy, the process can be computerized but this would incur capital investments for the formation of the necessary infrastructure.

Formation of the team for QFD implementation is another challenge faced during the implementation of the methodology. One of the most important tasks is the team formation phase since their experience and intuition determine the necessary design attributes and solve conflicts among them. The better the team is formed, the more accurate will be the completion of the matrices. Inadequacy of the professionals having knowledge on QFD, quality standards or design attributes will also hinder the successful implementation of the methodology.

Apart from these, during implementation of QFD, trying to reduce the wide variety of OEM customer needs and wants into a manageable number, choosing the right technical measures for each VOC, deciding on the correct relations between the VOC and technical measures, finding the optimum design targets are observed as other challenges faced by the authors.

In addition to the performance rating against each best practice and for each higher level category, an overall performance rating is developed by again assigning a weighting factor to each category based on their importance given the nature of the business and the product. This performance rating, when compared to that of other companies, gives an indication of the urgency of improving the development process.

Gap analysis is then employed to focus attention on the improvement opportunities that will yield the highest payoff. The categories with high weighting factors (indicating their importance to your product development success) and relatively low performance ratings yield the largest gaps between what is important to the organization and what it does well. These are the areas that require the highest priority in improving the development process and will likely have the largest payoff. On the other hand, categories with low importance ratings and relatively high performance ratings indicate low priority areas not deserving as much attention.

The strategic alignment analysis and gap analysis become the basis for identifying implementation actions and priorities.

Once the large gap categories are identified, an examination of the individual best practices with lower performance ratings will help identify the specific areas that require attention. In addition, identify and focus on the strategic levers that have low performance ratings and that are associated with the organization's intended strategy. Therefore, as a prerequisite, executive management must define a vision for product development and determine the competitive strategy as a basis for aligning product development practices and developing implementation priorities. This analysis becomes the basis for developing priorities and, eventually, an improvement or implementation plan.

CHAPTER SIX
CONCLUSION

6.1 Conclusion

Today, many companies are facing rapid transformations simulated by technological innovations and changing customer demands. These companies realize that the effort to rapidly develop new products that customer want and continue to purchase is crucial for their survival. New product development is a complex process involving multiple functional groups, each with a different perspective.

The benchmarking process is one part of total quality management, and can be described as a four-phase continuum: planning, analysis, integration and action. There is much literature on the future of the benchmarking process; however, a technical instrument for specifying benchmarking for a company has yet to be developed. In this study, we develop such an instrument, which team call “the quality benchmarking deployment” (QBD) method to help management compare the product with the best in the technology industry.

Bridging the gap between a firm's internal quality improvements and external measures of customer needs and satisfaction is an important yet complex translation process. The process has traditionally been studied within two very different domains. An external focus on customers has been the domain of marketers. Manufacturing and engineering based approaches to quality management and improvement have traditionally taken a more internal, process improvement focus. Both areas have recognized the need to broaden their focus and bridge the gap between internal quality and external customers’ needs and satisfaction. A study is presented to demonstrate the usefulness of an integrated approach.

Long range market planning is essential in order to change corporate culture, and to meet or exceed customers’ needs while making a profit. A formal analytical planning approach must be adopted by the company in order to minimize the risks

associated with the development of new products/services, better allocate the corporation’s limited resources and obtain group commitment on the company’s visions, and policies. In this research, the planning framework and discuss its major components. A model that integrates AHP, QFD and Benchmarking is presented, and discussed in detail. This comprehensive, formal and analytical approach is the key to the formulation of successful long- range planning.

In this research, an attempt has been made to examine the applicability of QFD as a strategic decision-making tool to determine the best production in the market, to make a comparison between the performances of different competitors and to transfer the experience gained from the current project to the forthcoming projects.

For this purpose, QFD team has been formed to collect and verify the expectations, needs of the customer profile of the sample project, which is a low-end (low-income) combo television project. QFD team categorized OEM customer needs and wants with end users’ income. Web-based OEM customer satisfaction questionnaires and surveys are gathered, QFD team then have to be organized. The main attributes and sub-attributes for customer needs are defined and the hierarchy is structured. And five primary customer needs are aligned on the left side of the preplanning chart for the House of Quality.

AHP methodology is used for identify and prioritize OEM customers attributes which influence the customer's perception of product quality. We can conclude that the most important attribute in the product planning of 20” combo CRT television is low cost attribute (%70) because it has the highest priority weight. Cosmetic (%10) and shipment (%10) attributes are the next preferred attributes. In this application overall consistency index = 0.00 less than 0.1. Then the judgments are acceptable. The sales point is not used because it is subjective. An advantage of AHP is that it is designed to handle situations such as this, in which the subjective judgments of individual constitute an important part of the decision process. Where accuracy is the major requirement, the AHP method would be a better choice.

QFD team collected customers' satisfaction of the products amongst competitive brands and obtain the difference in value of the performance measures between our product and the best one in the industry. Besides, some customer needs have higher priorities for customers than do other needs; therefore, the relative importance of various requirements should be ranked. The result of these, low price is the most important for OEM customers with %69.96. Then shipment, industrial design, picture quality, warranty period is the priorized customer needs from others.

After the technical measures aligned in the roof, the competitors' technical details and technical targets are determined by the QFD team. After the calculations, manufacturing cost, plastic material, paint material, aesthetic/appeal, design diversity, TV size and versatility are highlighted because we need to improve these attributes for competition in the market.

Manufacturing cost will be reduced if the number of print area reduced, plastic material will be changed, it will less cost with the same quality (HIPS). Also number of silk print (color, number) on the product and number of label and artwork/IB (number of languages) will be reduced. All of these attributes increase the manufacturing cost. Additional cost for labor and manufacturing will be minimized.

The case study findings demonstrated that QFD could be successfully applied in the design of new projects or product planning as a strategic tool to facilitate marketing decisions. As a result of extensive literature review and the case study observations; the research also points out the limitations and breakthroughs of the QFD methodology. Finally, critical success factors are proposed to improve the performance of the QFD methodology in projects.

After the QFD application to the combo TV project, follow-up interviews, comments and surveys have been conducted with the same OEM customer, OEM engineers and QFD team. They note that the company used the outputs of the QFD exercise in a new product project or ongoing projects which has a very similar target customer group. To conclude this research, it may also be meaningful to point out some other practical problems associated with QFD for future applications.

Application time is another important success criterion for QFD. Application of the methodology at earlier stages of the projects as soon as possible to avoid late engineering changes redesigns and omission of the client requirements is strongly recommended.

6.2 Recommendations

In the further steps of this study, target levels can be changed. New solutions can be generated based on different target levels. These solutions can be compared with each other according to their performances of units accepted, on-time and costs. The effect of target increase/decrease on the performance of the product can be analyzed.

The customer needs and expectations, target values, competitors and technical measures should be updated periodically and the QFD model should be reanalyzed. In order to make this procedure easier, a decision support system can be incorporated. This system can be integrated into the Expert Choice and QFD software program in the Vestel. In this way, the proposed approach in this thesis will consume less time. Hence the planning phase of product will both be more effective and efficient.

The lengthy process can be easier to handle if computer applications like QFD software are utilized. Similarly, knowledge of QFD has to be maintained by the professionals responsible for the implementations. On the job training, seminars from outsiders, etc. can be helpful for this purpose.

Potential features and functions critical to customer satisfaction can be designed in, potential failures can be anticipated and designed out, and savings in time and money can be realized by minimizing last minute design changes, product introduction delays, and market failures.

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APPENDIX A

TV Questionnaire

Please note that this survey is opened to the owners
A BRAND COMBO CRT TELEVISION

Section 1 - Corporate

Overall how would you rate the A Brand?

Excellent ☐ Good ☐ Average ☐ Poor ☐ Very Poor ☐ Don't Know ☐

How many Samsung Products do you currently own?

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6+ ☐

Section 2 - Product Specific Questions

When did you buy your New A brand CRT TV? Please Choose

Overall how would you rate the performance of your New A brand CRT TV ?

Excellent ☐ Good ☐ Average ☐ Poor ☐ Very Poor ☐ Don't Know ☐

How would you rate the following features of your New A brand CRT TV:

Design:

Overall Appearance	Excellent ☐	Good ☐	Average ☐	Poor ☐	Very Poor ☐	Don't Know ☐
Design fit with home	Excellent ☐	Good ☐	Average ☐	Poor ☐	Very Poor ☐	Don't Know ☐
Design/Materials quality	Excellent ☐	Good ☐	Average ☐	Poor ☐	Very Poor ☐	Don't Know ☐
Size	Excellent ☐	Good ☐	Average ☐	Poor ☐	Very Poor ☐	Don't Know ☐

Weight	Excellent ☐	Good ☐	Average ☐	Poor ☐	Very Poor ☐	Don't Know ☐
Screen size	Excellent ☐	Good ☐	Average ☐	Poor ☐	Very Poor ☐	Don't Know ☐

Features:

Picture Quality	Excellent ☐	Good ☐	Average ☐	Poor ☐	Very Poor ☐	Don't Know ☐
Contrast Level	Excellent ☐	Good ☐	Average ☐	Poor ☐	Very Poor ☐	Don't Know ☐
Remote Control quality	Excellent ☐	Good ☐	Average ☐	Poor ☐	Very Poor ☐	Don't Know ☐
Sound Quality	Excellent ☐	Good ☐	Average ☐	Poor ☐	Very Poor ☐	Don't Know ☐
Menu Style/Usability	Excellent ☐	Good ☐	Average ☐	Poor ☐	Very Poor ☐	Don't Know ☐
Ease of initial set up	Excellent ☐	Good ☐	Average ☐	Poor ☐	Very Poor ☐	Don't Know ☐
Connectivity	Excellent ☐	Good ☐	Average ☐	Poor ☐	Very Poor ☐	Don't Know ☐

Which factor mainly influenced your purchase? Please Choose

Section 2.2 - More about your New A brand CRT TV

What size is your model?

19 Inches ☐ 23 Inches ☐ 26 Inches ☐ 32 Inches ☐ 37 Inches ☐ 40 Inches ☐

What colour is your New CRT TV?

Black ☐ White ☐

In which room have you placed your New CRT TV? Please Choose

How have you displayed your New CRT TV? Please Choose

Section 2.3 - Advertising

What advertising have you recently seen or heard regarding the New CRT TV?

Radio ☐ In Shop ☐ Internet ☐ Poster ☐ TV ☐ None ☐

Overall how do you rate the advertising you have seen for the New LCD TV?

Excellent ☐ Good ☐ Average ☐ Poor ☐ Very Poor ☐ Don't Know ☐

Section 2.4

Do you have any other comments about the New CRT TV such as modifications, problems or just something you really like that you wish to share with us?

Section 3 - Demographics

Age Please Choose

Gender Please Choose

What was the last TV you owned before you bought the A brand CRT TV ? Please Choose

What type of TV was it? Please Choose



A BRAND COMBO CRT TV

Roughly where do you live? Please Choose

What is your working status? Please Choose

APPENDIX B

	CUSTOMER SATISFACTION QUESTIONNAIRE	DATE :

Questions hereunder will light the way for us to increase product quality, to measure customer satisfaction.
We would ask you to grade the test given below and send us by e-mail please.
We thank you for your concern and support.

COMPANY : .....

NAME & SURNAME : .....

POSITION : .....

	5	4	3	2	1
					
1. Our efficiency of handling your complaint	☐	☐	☐	☐	☐
2.Taking corrective actions concerning claimed products	☐	☐	☐	☐	☐
3. General overview of our product quality	☐	☐	☐	☐	☐
4. Advantage of our product quality to your company's competition	☐	☐	☐	☐	☐
5. Our product innovation	☐	☐	☐	☐	☐
6. Our R&D ability for your customized need	☐	☐	☐	☐	☐
7. Conformity to delivery time	☐	☐	☐	☐	☐
8. The protection level during our products transportation	☐	☐	☐	☐	☐
9. The product packaging quality of our shipments	☐	☐	☐	☐	☐
10. Our service tecnicians' professional knowledge	☐	☐	☐	☐	☐
11. Your departments can communicate easily & effectively with Vestelkom	☐	☐	☐	☐	☐
12. Vestelkom can communicate easily and often with your departments	☐	☐	☐	☐	☐
13. Advantage of our pricing to your company's competition	☐	☐	☐	☐	☐
14. General satisfaction towards Vestelkom sales, prices , products, support for technical services and transportation	☐	☐	☐	☐	☐
15. Based on your customer service experiences , satisfaction of end users towards our products	☐	☐	☐	☐	☐

Your general opinions , suggestions and expectations related to future.

VESTEL EVALUATION (QSP):