Ευρωπαϊκό Μεταπτυχιακό Πρόγραμμα στη Διοίκηση Ολικής Ποιότητας

Διπλωματική Εργασία

An Evaluation and Prioritisation System for Improvement Suggestions

- A QFD application -

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CONTENTS

ABSTRACT

The success of a Suggestion System is mainly based on the participation of the employees and on a continuous flow of submitted Improvement Suggestions. However, a large volume of Ideas doesn't automatically equal the desired result for the company.
Problems such as the choice of evaluation criteria (i.e. profit, cost, technical difficulty), or the decision of which Suggestion to implement first, frequently occur. On top of all that, there is always the main issue of keeping the raisers of the Idea satisfied, by seeing their approved Suggestions been implemented in a reasonable period.

The subject of this thesis is to develop an evaluation and prioritisation tool for Improvement Suggestions.

Based on the QFD method, the tool built consists of two main parts. One calculates the impact of the Idea on the organisation's Core Processes and the other calculates the Suggestion's implementation ease. The aim was not to produce another arithmetic tool, but a decision making method, which would satisfy a set of criteria such as flexibility, user friendliness, dynamism, support of both KAIZEN and Innovative Ideas, etc. The developed tool was designed to be applicable with different volumes of Suggestions and in different kind of organisations.
A pilot project was run at the Division of Quality Technology and Management Suggestion Box Scheme with satisfactory and reliable results produced.

ACKNOWLEDGEMENTS

Writing this thesis abroad was one the most memorable experiences in my life. It has changed me as a student, a professional, a person, as well. Hopefully, to the better.

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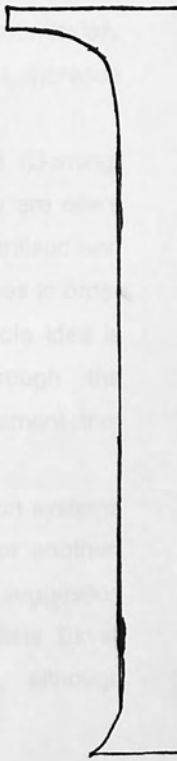
CHAPTER



CHAPTER I: INTRODUCTION

An employee suggestion system is a management tool for the submission, evaluation and implementation of an employee's idea to save cost, increase quality, or improve other elements of work, such as safety.

A suggestion system integrates all three basic principles of TQM (Deming, 1986); It *focuses on the Customer*, internal and external, since they are one's needs and suggestions, which are being considered (evaluated, prioritised and implemented). Its success requires *Total Involvement* of the employees in order for them to care and actually, submit suggestions. Finally, the whole idea is based on *Continuous Improvement*, which is achieved through the implementation of employees' incoming Opportunities for Improvement that usually suggest minor changes (KAIZEN).

The idea of a Suggestion Box is not a new one. Employee suggestion systems have been in existence for over one hundred years in one form or another, ranging from the proverbial suggestion box to fully-developed suggestion systems overseen by administrators, evaluators and idea specialists Ekvall (1976). Like most successful quality improvement programs, although

originated in the west, it was refined and flourished in Japan Muse and Finster (1989). Nowadays, an average of 25 suggestions per employee per year is reported, which results to savings of £2,600 per employee.
The benefits however, are not measured only in terms of savings. Employee suggestion programs can offer any organisation a distinct competitive advantage with their many benefits that vary and include cost savings, increased revenues, decreased waste, improved quality, safety, customer service and employee satisfaction Heath (1994).

1.1 The problem

Engaging employees in submitting Suggestions for Improvement is, definitely, the desired achievement and the key to the success of the whole scheme. However, it doesn't necessarily lead to the maximisation of the benefits that the system could provide.

The limited amount of resources (money, time, and people) has a catalytic role on the decisions that are made. It obliges the evaluation team to face the dilemma of which submitted suggestion to implement and when. The dilemma of where to invest the limited and therefore, extremely valuable resources, in order for the greatest benefit to occur (Ekvall, 1976, Heath, 1994).

If an organisation had unlimited resources, the evaluation team could indeed aim to have a product or service be perfect in all aspects. But no organisations ever do have unlimited resources. Evaluation teams must always make choices regarding where they will place special emphasis or extra resources and where they won't. Trade offs must be made in all cases (Cohen, 1996).

Deciding though, which suggestions to implement and which to reject is not enough. The next step to be taken is to decide when to implement them according to the available resources and to their importance. This is estimated according to a set of predefined criteria.

On top of all that, the human factor should not be overlooked. A considerable delay in implementing the Ideas or the choice of only Innovative ideas can affect

negatively the flow of Suggestions, and consequently the function of the Suggestion Box Scheme.

Company X for example, which is the largest company in the Greek olive oil-related industry, with a dominant presence in the food sector as well, has successfully integrated a Suggestion Scheme. Their "Opportunity for improvement" (O.F.I.) suggestion system was primarily implemented in 1992, with the purpose of empowering employees to be a part of the ongoing improvement process.
In order to boost employee participation in the first years that the system was launched, the company adopted the policy of publishing in its quarterly magazine the suggestions, which lead to a great profit. The result was a decline in the submission flow of O.F.Is, as the employees considered that the system aimed only to Innovative Ideas.
However, thanks to the top management's belief in the scheme, the system flourished. Until today, the O.F.I. system has lead to more than 21,5 million Euro in cost reduction (1 Euro = 350 drcs). Also, the percentage of the employees, who participated in the O.F.I. system at least once, raised to 74% in 1999. The O.F.Is' implementation rate though, was only 64%.
At the moment, the company is looking for a way to faster and better evaluate the Suggestions, which are submitted by the employees. Furthermore, a way that will lead to a fast implementation of the Suggestions in the context of the available resources.

What is needed is a method that will facilitate management in evaluating the submitted Suggestions for Improvement and then prioritise them.

1.2 The objectives

The objective of this thesis is to *develop a system that will evaluate and prioritise the submitted Suggestions for Improvement.* However, the goal is not to develop another strictly technical (numerical) tool, which compares the suggestions that were submitted at the time point X among them. What is needed and aimed to develop is a system that:

a) will best reflect the voice of the customer,
b) will take into consideration the specific needs, abilities and planning of the organisation,
c) will take into consideration the human factor (the raiser of the idea),
d) will be dynamic (in terms of time, of adjusting to organisational changes and of not handling predefined set of Ideas)
e) will be flexible (applicable in different kind of organisations and different volumes of Improvement Suggestions)
f) will promote both Innovative and KAIZEN Ideas

The system will be based on QFD, the function of which will be slightly altered to fit the set problem. After the development of the system, a pilot will be run in order to test the applicability of the system, as well as its drawbacks and areas for improvement. For that purpose, the Suggestion Scheme of the Division of Quality Technology and Management, University of Linköping, will be used. A team of people, who work in the Department and are trained in the use of QFD, will use the new tool to evaluate and then prioritise already submitted Suggestions for Improvement. The results and their comments on the tool will be recorded and analysed.

1.3 What makes it so important?

The limited resources of any organisation and the need to invest them in the most beneficial ideas stress the significance of the topic. As it was explained above, it is of utmost importance that neither the resources of a company are misallocated, nor the ideas that arise are mistreated.

To decide is useless, if decision cannot be carried out (Flowering Wilderness, Ch. 27)

Furthermore, it is important to keep the tank of suggestions, that is the employees, happy. They need to be encouraged and supported in submitting more and more ideas. That can only happen if they are notified about the progress of their suggestion (approved, rejected and why), but most importantly, if they see their suggestion been implemented in a reasonable time after its submission and approval.

As James Harrington says in his book Business Process Improvement (1995, p. 256), management must set proper priorities, communicate them to employees and then follow up to ensure that these priorities are lived up to. It is often a big temptation to first complete the simple little jobs, the ones that a friend wants worked on, and the ones somebody called about and let the important ones slip. It's the old "squeaky wheel" message. As a result, projects slip, money is lost and other activities are delayed. Set priorities and live by them.

1.4 Brief description of the approach

As it was stated before, the whole approach will be based on the Quality Function Deployment method, especially on the House of Quality. This specific management tool was chosen as it gives, according to the author's opinion, the most satisfying answers to the questions that were posed above and were used as criteria for choosing a tool, in comparison to other known evaluation and prioritisation methods.

In specific, the proposed House of Quality will be structured in the following manner: the organisation's core processes will be the " WHATs " of the matrix and the submitted ideas for Improvement will be the " HOWs ". The evaluation team will assign importance weights to the "WHATs" and will also define the technical difficulty of implementing the "HOWs". The current and the future importance of the suggestions for the organisation will also be taken into consideration, together with the time that the idea has been submitted. Through an algorithm, which will assign credits to each suggestion according to the set criteria, the suggestion will finally take its place on the ranking until it is implemented.

1.5 Reading instructions

The whole thesis is structured in 5 chapters including the current one.

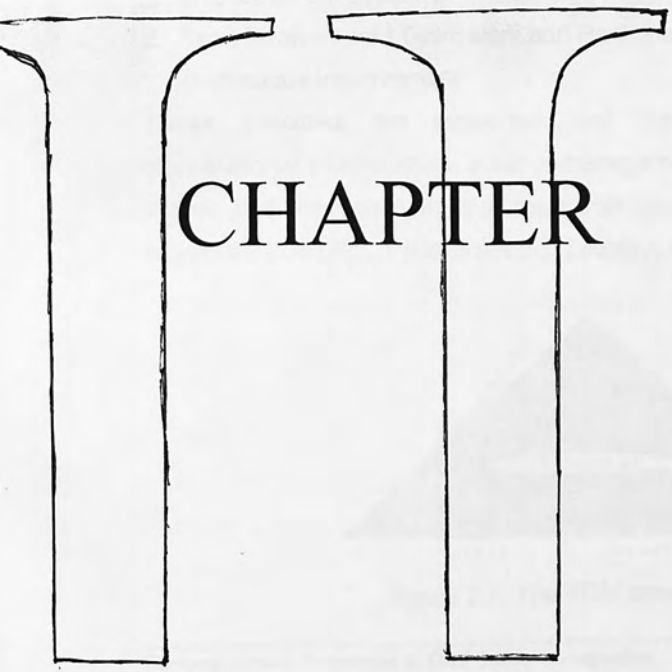
The first chapter briefly introduces the reader to the problem, the objectives of the thesis and to the approach, which will be adopted in order to come to results and conclusions.

In Chapter II there is an introduction to the Suggestion Systems. Moreover, there it is depicted the link between the Suggestion Systems and the principles of Total Quality Management. At the end of the chapter follows the definition of the problem, which will be studied.

Chapter III starts with describing the characteristics of the desired method for evaluating and prioritising the suggestions for improvement. These characteristics will serve as criteria in the selection of the most appropriate method. Then, follows a brief introduction and description of some candidate methods for evaluating and prioritising suggestions for improvement. However, the best part of the chapter is devoted to the introduction of QFD as an evaluation tool, the way it is structured, how it functions etc. An illustrative example depicts the way QFD works. Finally, it is explained why this particular management tool was chosen as the foundation of the system.

Chapter IV is the most important chapter of the thesis. There it is analysed step by step the development of the evaluation and prioritisation system. Every choice is being thoroughly justified. Moreover, there are the results of the case study that was conducted in the Division of Quality Management and Technology at the University of Linköping in order to test the developed system.

The final chapter hosts the conclusions of the study and the suggestions for further work.


CHAPTER

CHAPTER II: THEORETICAL FRAMEWORK

2.1 FOUNDATIONS OF TOTAL QUALITY MANAGEMENT

Total Quality Management is a philosophy grounded on three core principles (Deming, 1986):

1. A focus on the customer
2. Total Involvement / Team work and Participation and
3. Continuous Improvement

These principles are supported and implemented by an integrated organisational infrastructure, a set of management practices and a wide variety of tools and techniques which all must work together and support each other as suggested in the figure below (Evans, Lindsay, 1996)

Figure 2.1: The TQM core principles

Here follows a brief analysis of the three cornerstones of the Total Quality Management philosophy.

2.1.1 Focus on the customer – Customer satisfaction

One of the most popular and often met definitions of quality is the one that describes it as *the meeting or the exceeding of customer expectations* (Dahlgaard, et al., 1994). This simple and laconic, yet powerful definition makes utterly obvious how important the customer is for a company, which strives for quality and excellence. Customer's satisfaction is the key element for the company's well being and long term survival.

In order to elaborate this point further, it would be interesting to look at the results of some studies. Customer satisfaction translates directly into increased profits. Loyal customers spend more, refer new clients (one hundred satisfied customers generate 25 new customers) and are less costly to do business with (the cost of acquiring a new customer is five times as great as the cost of keeping a satisfied customer) (Evans & Lindsay, 1996)
On the other hand, poor quality products and services lead to customer dissatisfaction in the form of complaints, returns and unfavourable word-of-mouth publicity. For every complaint received, there are 20 other customers who feel the same way, but don't bother to complain. However, they will tell several of their friends and colleagues about their unpleasant experience, fact that will lead to the loss of 200 potential customers per stated complaint (Bergman & Klefsjö, 1994).
What derives from all these, is the message that satisfied customers improve business and dissatisfied customers impair business (Rydbrink 1995). Therefore, it is the industry that is dependent on the customer, not vice versa.

Japanese were long ago aware of the importance of the customer and one's satisfaction. Even in their language, the same word – OKYASUMA- means both "customer" and "honourable guest" (Evans, Lindsay, 1996) Quality as customer satisfaction has been fundamental to Japanese business approaches.

Fortunately, the importance of customer focus and satisfaction has grown fast in the western industry in the recent years (Eureka, 1988). This growing awareness of the customer's key role reflects, for example, on the Home Depot's (a retail organisation in USA) service philosophy where it is stated that "Every customer has to be treated like your mother, your father, your sister or your brother".

One of the firsts to stress the importance of the customer was W. Edwards Deming. At a conference in Japan in August 1950, Deming (1986) presented a flow diagram, which viewed production as a system. The flow was initialised with *Customer Research* and the outcome was *Distribution to Customers*. The customer thus, was identified as essential for the mere existence of this system.
The importance of the customer is also reflected on the quality awards all over the world. Both the Malcolm Baldrige National Quality Award and the European Quality Award have assigned 30% of the score on how well the company focuses on its customers and on achieving customer and people satisfaction.
All in all, if a company wants to compete and get acknowledgement of achievements in total quality management, it must have a well-developed customer satisfaction programme (Rydbrink, 1995).

In the strive of business to satisfy their customers by fulfilling their needs and expectations, the first step is to trace them down (Gordon,1993). That is, define who the customer is.
Most people and enterprises think of the "customer" as the ultimate purchaser of a product or service. These customers are more precisely referred as consumers. Clearly, meeting the expectations of consumers is the ultimate goal of any business. However, consumers are not the only customer group of concern to a business. According to the TQM philosophy, as customers are considered the employees of the company, as well as its suppliers. In a broader sense, also the environment and the community. All these are the so-called stakeholders of a company to whom the latter has to address in order to sustain a successful existence.
The stakeholders can be divided in two categories: the external and the internal customers. In the first category, there belong the consumers, the suppliers, as

well as the environment and the community. The latter category however, where the employees belong, is one of the innovative contributions of TQM philosophy. Employees are seen as internal customers and suppliers in the organisation. In general, it is easier to perceive the concept and identify the customers when thinking in terms of customer-supplier relationships. As it is shown in the AT&T customer – supplier model below (Evans, Lindsay, 1996), every process receives inputs from the suppliers and creates outputs for the customers. When the model is applied to all the levels of a company, that is the organisation, the process and the performer level, then its utility becomes apparent.

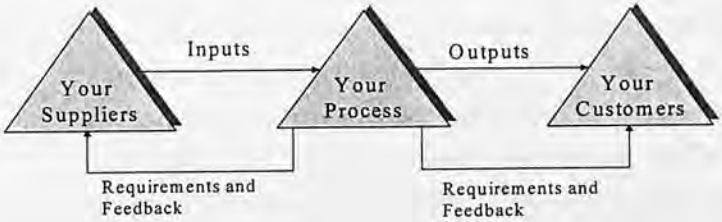


Figure 2.2: The AT&T's Customer – Supplier model

As individuals, departments and functions develop their customer-supplier models, natural linkages become evident. These linkages build up the "chain of customers" throughout the company that connect every individual and function to the external customers and consumers.

2.1.2 Total Involvement

It is common field these days that a company's most precious asset is human capital. Many global competitors, such as Japan, Taiwan, Singapore and Switzerland have few natural resources, but have managed to excel by

developing their competitive edge primarily through the human resource (Muse & Finster, 1989).

The way though, that organisations perceived and treated their employees differed in different times and places. Ever since the Industrial Revolution and until recently, most of the enterprises where managed according to the philosophy Frederick W. Taylor introduced. The Taylor system philosophy assumes that (1) people are part of the process; (2) the process needs to be controlled externally to be productive; and (3) managers have to control carefully what people do (Evans, Lindsay 1996). In other words, the workforce should be "managed" or -put in a less formal way- the brains should be left at the door!
What the Tailor system had failed at was to make use of an organisation's most important asset – the knowledge and creativity of the work force.

On the other hand, Juran credits Japan's rapid quality achievements on that actual fact. On the fact that very early they have shifted from a "control" philosophy of management to a "commitment" philosophy. The new thinking was that (1) people design and improve process; (2) workers who run the process must control it and (3) managers must obtain the commitment of people to design, control and improve processes so that they can remain productive (Evans, Lindsay, 1996). Konosuke Matsushita told a group of U.S. executives in 1988 (Shores, 1990)

> *We will win, and you will lose. You cannot do anything about it because your failure is an internal disease. Your companies are based on Taylor's principles. Worse, your heads are Taylorized too. You firmly believe that good management means executives on one side and workers on the other; on one side, men who think, and on the other side, men who can only work. For you, management is the art of smoothly transferring the executive's ideas to the worker's hands.*
>
> *We have passed the Taylor stage... For us, management is the entire work force's intellectual commitment at the service of the company...*

without self-imposed functional class barriers... Only the intellects of all employees can permit a company to live with the ups and downs and requirements of its new environment. Yes, we will win and you will lose. For you are not able to rid your minds of the obsolete Taylorisms that we never had.

Fortunately, nowadays there has been a profound shift in philosophy and very many organisations of the Western industry have or are about to pass the Taylor stage (Dahlgaard et al.1994). Employee involvement is gaining increased acceptance as an important component of modern quality management. In a TQM culture, employees are encouraged to challenge ineffective company policies and bring quality concerns directly to top management. The contributions can be substantial, as who can better understand the job and how to improve both the product and the process but the one who performs it? When managers give employees tools to make good decisions and the freedom and the encouragement to make contributions, they virtually guarantee that better quality products and production processes will result.

2.1.3 Continuous Improvement

We are living in a constantly changing world. Even though Darwin was the one who introduced the theory of evolution and claimed that in order for an organisation to survive one had to transform and adjust, he would have been astonished by today's pace of change. What is valid today might not apply tomorrow. Technology changes, business changes, customers' needs and requirements change, the whole world is changing. Fast! Therefore, there is a growing need for everyone and, business in specific, to adjust in order to survive in this context. The only way to do so is by improving continuously with respect to environmental changes.

"Our customers are intelligent; they expect us to continuously evolve to meet their ever changing needs. They can't afford to have a thousand mediocre suppliers in today's competitive environment. They want a few exceptional

ones." President and CEO of the Fujitsu Network Transmission Systems, a US subsidiary of Fujitsu Ltd.

Continuous improvement is an integral part of the management of all systems and processes. Deming introduced the notion of continuous improvement in his diagram of a production system and ingrained this thinking into Japanese management. Juran suggested that companies develop annual improvement targets and engage in hundreds of quality improvement projects continuously. Crosby's 14-point improvement plan ended with "Do it over again".

Improvements may take anyone of several forms: (1) Enhancing value to the customer through new and improved products and services, (2) Reducing errors, defects and waste, (3) Improving productivity and effectiveness in the use of all resources, (4) Improving responsiveness and cycle time performance.

In order for an organisation to progress, one may follow two different approaches. Imai (1986) defines them as: KAIZEN and Innovation.
KAIZEN is a Japanese word and it means ongoing changes to the better. It is a continuous small-step approach, while Innovation is the great-leap forward approach. The first requires simple standard techniques and common sense, whereas the latter involves high investments and, often, sophisticated technology. Imai has illustrated the difference between the two concepts by liken them to the shape of a slope and a staircase, respectively. The slope corresponds to continuous small changes and the steps to the dramatic changes of Innovation. A successful business should think in terms of combining the two approaches in order to maximise the benefit of them. Every Innovation should be followed by KAIZEN efforts in order to maintain and further improve the innovation (Imai, 1986).

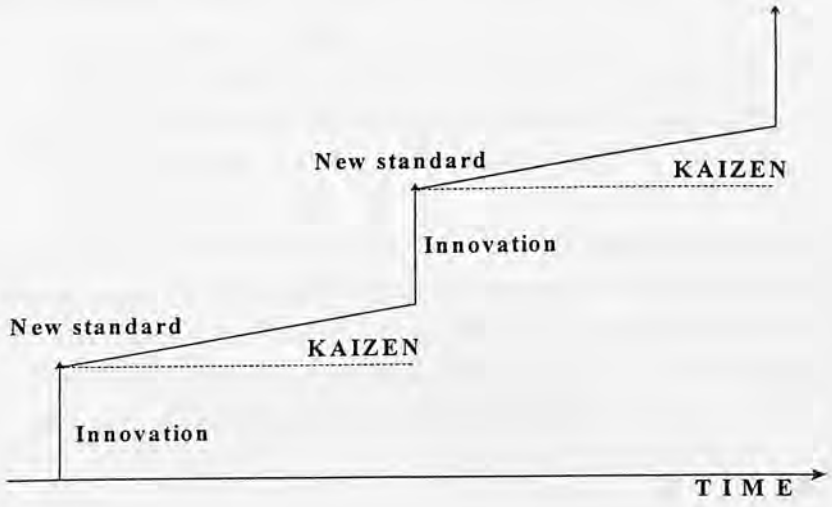


Figure 2.3: Innovation and KAIZEN Improvements

Even though, the concept of continuous improvement was conceived and developed in the States, yet it is often cited as the most important difference between Japanese and Western management. Prior to TQM, most US managers simply maintained products and processes until they could be replaced by new technology. Japanese managers, on the other hand, focused on continually improving products and processes. A huge difference lays in the perception of job functions, as well. The traditional western perception is that only top management comes up with improvements –which in this case are synonymous with Innovation. All the other employees are busy maintaining the standards. Consequently, there is no place for KAIZEN. In Japan, the idea is that ALL employees are involved in improvements. Furthermore, western companies commonly consider KAIZEN as an improvement system only. However, in Japan KAIZEN is seen as (1) an incentive and motivation system, (2) an educational system and (3) as an improvement system (Berger, 1995). The goal is to achieve everyone's commitment in the continuous improvement philosophy. If you achieve employee commitment, improvements will follow. Moreover, it is not in the interest of most Japanese companies to compare "bottom line" figures, contrary to the result-oriented focus that most western

companies adopt. Nevertheless, even in that case the MIT Commission on Industrial Productivity stated that:
"The cumulative effect of successive incremental improvements and modifications to established products and processes can be very large and may outpace efforts to achieve technological breakthroughs".

A management tool that combines the notion of the three above-mentioned core principles of the TQM philosophy is that of the Suggestion System. Its function derives from Customer Focus and Satisfaction, Total Involvement and mostly, from Continuous Improvement. In the following subchapter, the concept of the Suggestion System is defined and furtherly discussed.

2.2 SUGGESTION SYSTEMS

2.2.1 *Introduction*

Involving employees on an individual basis and increasing employee participation in quality improvement can be accomplished by many methods, such as mentoring systems, company newsletters, open-door policies of senior executives, employee surveys etc. Perhaps the most refined form of individual participation for quality improvement is the suggestion system (Ekvall, 1976, Heath, 1994).

The classic suggestion programs take employees ideas and pass them on to an expert (evaluator) for review. If the idea is feasible, it is then passed on for final review and implementation. The employee then often receives a cash award for one's efforts, based on actual savings calculations. More modern idea processes directly involve the employee(s) with the solution and implementation process. The method of rewarding their efforts may be based more on recognition than actual on cash awards (Muse & Finster, 1989).

An employee suggestion system is a management tool for the submission, evaluation and implementation of an employee's idea to save cost, increase

quality, or improve other elements of work, such as safety. Companies, typically, reward employees for implemented suggestions.

Suggestions can refer to everything, from organisation of the workplace, through product improvement to changes in machinery and processes, plus a lot of minor suggestions, which -though not terribly significant- are no doubt good solutions to daily irritants.

2.2.2 *Suggestion Systems as part of a TQM strategy*

Suggestion Systems is one of the tools that best integrate the ideas of Total Quality Management, which were briefly described above. Its foundations, its whole concept is based on the three core principles of Quality philosophy; Customer Focus, Total Involvement and finally, Continuous Improvement.

CUSTOMER SATISFACTION- FOCUS

Both the internal and the external customers of an organisation are benefited, therefore satisfied, by the implementation of a Suggestion Scheme. The first witness improvement in the products and services the company provides to them. The latter experience changes in their working environment, which pleasantly affect them. Moreover, they feel that their opinion is valued since asked through the Suggestion Box.

Thus, Suggestion systems undoubtedly help to increase both the external and internal customer's satisfaction and should therefore be considered as an important part of a TQM strategy (Rydbrink, 1995).

TOTAL INVOLVEMENT

Members of an organisation, in the main, want to see that organisation flourish and when given the opportunity will endeavour to contribute to that goal. Participating in the Suggestion System of the company gives them that exact opportunity. Employees from all levels of hierarchy can submit improving ideas that concern all organisational matters. If however, their perception is that their Suggestions, Good Ideas and Opportunities for Improvement are not heeded,

then their drive to contribute will wane dramatically. In even a small organisation the volume of Suggestions can be large, but it is vital that the raiser of each one is regularly notified of its progress (Gordon, 1993).

CONTINUOUS IMPROVEMENT

A Suggestion System, by definition, is based on the idea of Continuous Improvement. The incoming Opportunities for Improvement, Issues and Good Ideas is quite simply the fuel for Continuous Improvement, a major goal for Business Quality enhancement.

The suggestion system is an integral part of KAIZEN. Achieving everyone's commitment in continuous improvements is a goal both for KAIZEN and for the suggestion system. The vast majority of submitted Opportunities for Improvement usually consist of ideas, which suggest minor changes. However, it is thanks to these minor changes (Kaizen) that costs are cut, products and customer service enhance and the operating environment of the organisation improves to optimise productivity.

The following diagram depicts the link between a Suggestion Scheme and Total Quality Management philosophy.

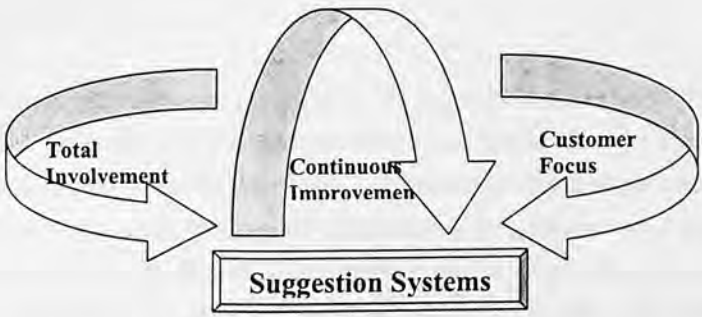


Figure 2.4: The link between Suggestion Systems and the TQM principles

2.2.3 The history of Suggestion Systems

The process of obtaining ideas from employees is not a new one. Kodak started such a program around the turn of the century in the United States. The British Royal Navy had a suggestion scheme in 1772. Back in 1894, the National Cash Register Company in the United States instituted a program for soliciting suggestions from factory workers, after the return of a shipment of defective cash registers. By the 1940s, the company was receiving an average of 3.000 suggestions each year. Suggestions Systems have gone through significant evolution ever since (Heath, 1994, Ekvall, 1976).

Suggestion systems, like most successful quality improvement methods, originated in the West, but were refined and they flourished in Japan. It was brought to Japan from the USA by TWI (Training Within Industries) and the US Air Force in the post-war years (Imai, 1986). Soon, Japan scored higher than any other country in the world in matters of submitted suggestions. In specific, an average of 25 suggestion per employee and per year was reported, which resulted to savings of £2,600 per employee (Swedish Institute for Suggestion Systems). Most large Japanese firms and about half of the small and medium-sized firms have employee suggestion systems, which appear to be more extensive than those in the United States (Muse & Finster, 1989). In fact, many U.S. plans have met with failure. One study found that about 90 percent of the suggestion plans begun in U.S. firms before 1977 have been abandoned (Sharma, 1997).

The relatively poor rates of participation in suggestion systems in the United States (0.1 suggestions per employee and year in the automobile industry) are due to a variety of reasons. Most U.S. suggestion systems emphasise in cost savings; it is the primary criterion for evaluation. U.S. systems favour significant, innovative ideas. Muse and Finster suggest that this focus effectively excludes fair consideration of suggestions that promise quality or productivity improvements over a longer period. Many employees perhaps feel they are unable to generate ideas that will save significant sums of money. Also, many managers typically take a passive approach, waiting for suggestions to be submitted. Additionally, many companies do not provide time for employees to

develop suggestions during the regular workday and employees are often unable to find time outside of their regular work schedules to develop ideas. A Swedish study found that the most common cause for withholding ideas is fear of a new time study and consequent loss of earnings or job security (Rydbrink, 1995).
Additionally to these reasons, the failure of many programs has also been attributed to (1) unclear policies, (2) lack of continuous and enthusiastic promotion, (3) poor administration and (4) lack of management support (Sharma, 1977).

Suggestions systems in Japan are quite different. The Japanese modified U.S. suggestion systems to fit in their own culture, stressing participation and employee motivation over economic benefits. Japanese suggestion systems are similar to the KAIZEN concept: small, gradual, but continuous improvements. As stated before, the number of suggestions per employee per year rose from about 5 to over 25 by 1987. In contrast, the average number of suggestions per employee in the United States was slightly more than one. The overall participation rate in Japan exceeds 70%, and many companies, such as Toyota, have participation rates above 90%, while that of typical U.S. firms is about 8%.

Differences in suggestion systems between the United States and Japan have been attributed to several reasons (Evans, Lindsay, 1996). First, the suggestion process in Japan is included in formal training sessions and involves continual guidance from supervisors. Most U.S. systems revolve around a few posters or suggestion boxes. Second, management support in the United States is generally less than enthusiastic, in direct contrast to that in Japan. Third, American unions have not supported programs, especially if some jobs are at risk. In Japan, however, unions are company-based; thus, any activity that is good for the company is good for the union and its employees. Finally, the group-centred culture in Japan facilitates co-operation rather than individual competition.
All in all, everything melts down to the different approaches Japan and western enterprises adopt and were discussed when analysing the core principles of TQM.

Konosuke Matsushita, founder of Matsushita Electric Trading Co (Panasonic, Technics, etc.) once said to a group of western managers (Dalgaard, Kristensen, Kanji (1994):

"For us, the core of management is precisely this art of mobilising and pulling together the intellectual resources of all employees in the service of the firm. Because we have measured better than you the scope of the new technological and economic challenges, we know that the intelligence of a handful of technocrats, however brilliant and smart they may be, is no longer enough to take them up with a real chance of success. Only by drawing on the combined brain power of all its employees, can a firm face up to the turbulence and constraints of today's environment".

2.2.4 *Benefits from and resistance to the implementation of Suggestion Systems*

Fostering employee creativity has many benefits.

First of all, there exists direct economic impact by the implementation of the suggestions for improvement. Its financial value might vary; it can be very little, however, it can be substantial, as well. The quality of the products or services improves, employees' productivity increases, cycle time decreases etc. Additional benefits occur by the increasing satisfaction of the customer towards the company and its products/ services. That leads to a constantly growing demand for the products and thus, to increasing revenues and profits.

Apart from the purely economic benefits that occur, the working environment for the employee enhances i.e. there is a reduction of accidents, there are extra benefits for the employees (kindergarten at the plant, flexible working hours etc). as a result, the employees' satisfaction towards one's object of work, working environment and the company itself, gradually reaches higher levels. That leads to the increase of one's productivity (which equals to even more profit for the company), but –most importantly- to the empowerment of the employee.

Finally, the volume of the already existing suggestions for improvement might work as an inspiration tank for new ones (Evans& Lindsay, 1996).

As it was stated before, the positive effects of the submitted suggestions are diffused on the employee, as well. The benefit might be direct and "tangible". A change in the production line might, for example, lead to less physical effort for the employee or to the reduction of the required time to execute the process, or to the increase of safety. Apart from that though, the employee feels that he/she can actively participate in the development of the organisation where one works. He/she has the opportunity to affect in a small or a larger extent the course of the company and one's working environment through these suggestions for improvement. Moreover, he/she is integrated as a professional being, since one is no longer only a tool in a phase of the production. One becomes an associate to the company (Milliken, Denmark). Thinking makes even routine work enjoyable; writing down the suggestions improves workers' reasoning ability and writing skills. Satisfaction is the by-product of an implemented idea and a job made easier, safer, or better. Recognition for suggestions leads to higher levels of motivation, peer recognition and possible monetary rewards. Workers gain an increasing understanding of their work, which may lead to promotions and better interpersonal relationships in the workplace.

By supporting such a scheme, the culture both of the company and the employees' changes gradually and adjusts to the KAIZEN approach. The result is the constant flow of suggestions for improvement, the continuous reduction of costs and increase of benefits, the continuous improvement and development of the organisation.

Summing it all up, the suggested opportunities for improvement can lead the company to benefits, included in one, of the following categories (Elais, 1999):

- Impact on society and environment
- Consumer Satisfaction
- Customer Satisfaction
- Cost Reduction
- Improvement of Machinery Efficiency
- Improvement of working Conditions - Hygiene
- Safety

Even though the advantages of employee involvement are clear to the enlightened, many individuals resist change (Sharma, 1977). Apart from the reasons, which lay behind the western and the Japanese philosophy, there are others as well. Managers will not allow participation because it entails sharing power with employees. Low-level supervisors, whose interests tend to be ignored in Employee Involvement, often fight it. Worker resistance is often fostered by past management credibility problems and the "fad of the month" syndrome. Resistance, is –among other reasons- fairly driven by fear. Fear of reprisal of management, fear of providing info, fear of change, fear of failure, fear of giving up control. Fear limits the potential of people and hence, restricts the products and productivity of an organisation (Gordon, 1993).

Management at Milliken believes that the OFI system is in the interest of all employees, ensuring a strong firm, giving them greater job security and the chance to earn more. This belief also reflects their conviction of employees' collective responsibility for the continuing existence of the firm. Milliken realises that not all employees share this belief, but it is also realised that it is management's responsibility to help them appreciate this.

2.2.5 *Suggestion Systems implementation strategies*

A successful suggestion system can be develop in three different stages, according to Kenjiro Yamada, managing director of the Japan Human Relations Association (Imai, 1986). Each stage corresponds to the development of both the employees and the company.

During the first stage, the management supports the employees to submit suggestions, no matter how primitive, for improvements in the daily work and their working environment. The objective in this stage is to achieve everyone's commitment in the suggestion system, not to get a flow of sophisticated suggestions.

The second stage is very crucial for the future success of the suggestion system, since it involves educating the employees in problem solving, in the seven QC tools, simple statistical methods etc.

After having engaged the employees interest in the suggestion system and enhanced their abilities by educating them, third stage's objective becomes finally, to achieve suggestions with economic impact.

The key behind this idea is to be patient and progress gradually. The time frame after all, ranges from one to five years in order for an organisation to pass through all these stages. Japanese firms exercising the KAIZEN approach, respect that order. Western companies, on the other hand, tend to skip the first two.

Muse and Finster (1989) have summarised the strategies that can foster the success of suggestion systems, as follows:

1. Ensure that management, first and foremost, is involved in the program. Involvement should begin at the top and filter down through all levels until all employees participate
2. Push decision making regarding suggestion evaluation to lower levels
3. Gain union support by pledging no layoffs due to productivity gains from adopted suggestions
4. Train everyone in all facets of the suggestion system. Improve problem-solving capability by promoting creative problem solving through the use of the seven basic statistical tools
5. Resolve all suggestions within one month
6. Encourage all suggestions to personally describe their idea to a supervisor, engineer, or manager
7. Promote pride in work and quality and productivity gains from suggestions, rather than the big cash awards possible
8. Remove ceilings on intangible suggestion awards. Revise evaluations of intangible suggestions to value them more on par with tangible suggestions
9. Eliminate restrictions prohibiting suggestions program, especially through supervisor support
10. Continuously promote the suggestion program, especially through supervisor support
11. Trust employees enough to make allowances for generation, discussion and submittal of suggestions during work hours
12. Keep the program simple

On the other hand, James A. Heath (1994) is briefer and defines five basic rules that can help make a suggestion system work:

Heath (1994), taking into consideration that the most important step is to achieve and increase employee participation, he suggested the following three stages, which will lead to the enhancement of the quality of ideas and to the turn of idea generation into a daily activity:

Stage 1: Individual task analysis

- Have employees use flowcharts to understand their tasks in term of process
- Use brainstorming to identify opportunities for process improvements
- Regularly review improvement ideas with contributing employee's supervisors
- Make small process improvements incremental personal goals

Stage 2: Departmental task analysis

- Direct functional groups of employees to schedule time to review process performance
- Generate process improvement ideas using structured approaches such as brainstorming and cause-effect analysis
- Identify customer and supplier metrics to measure long term improvement gains

Stage 3: Cross-functional task analysis

- Apply idea-generation techniques to cross-functional business processes that cut across the entire organisation
- Identify macro-metrics for major business processes that reflect total organisation performance.

2.3 PROBLEM DEFINITION

Engaging employees in submitting Suggestions for Improvement is, definitely, the desired achievement and the key to the success of the whole scheme. However, it doesn't necessary lead to the maximisation of the benefits that the system could provide. What happens when the volume of the suggestions is too large for the available resources (time, money, people etc) of the organisation? In which Suggestion's for Improvement implementation should those resources be invested, in order for the greater benefit to occur? Like in any other system, the quality of the "product" is directly relevant to that of the "input"; however it is of great importance the way one works the process. In this specific occasion, a catalytic role has the evaluation of the suggested Opportunities for Improvement according to the criteria set by the enterprise.

Nevertheless, even after the evaluation of the submitted Suggestions and their characterisation as accepted or rejected, which is the one that should be implemented first? The one that was submitted first? The one that is aligned with the company's long-term strategy and leads to the increase of the market share? Or the one that results in greater short/medium-term profit? How can the Suggestions for Improvement be prioritised in a way that their implementation will benefit the organisation in the most desirable way?

An unsuccessful evaluation and prioritisation of the submitted Opportunities for Improvement might lead to an unsuccessful distribution of the limited resources the enterprise has. Moreover, the implementation of suggestions that were wrongly evaluated (in terms of their absolute and relative importance), results in not respecting the customer's voice (internal and external) and therefore, doesn't satisfy one's needs.

Furthermore, the fact that there usually is a great delay between the submission and evaluation of a suggestion and its implementation, discourages the employee to come up with and submit more ideas for the following reasons:

- He/she assumes that the company ignores him/her
- He/she assumes that the company is in favour of suggestions, which lead to drastic changes (Innovations) and to huge profits. Thus, it is useless to submit ideas that are less sophisticated and less profitable.

In that way, the company experiences more than one losses; it loses the large volume of suggestions that were submitted and which improved, even slightly, different features and aspects of the organisation. At the same time though, it loses the few but extremely important ideas (Innovations) that were submitted together with the others. Furthermore, the human resource gradually grows dissatisfaction. Moreover, the organisation faces all the problems that the bad management – investment of the limited, thus valuable, resources results in.

In summary, the key to a highly effective Suggestions Scheme is the ability to combine the following two features:

a) to manage large volumes of suggestions in a way that ensures that every Raiser feels they are receiving a "personal service".
b) to assure that the organisation's limited resources are invested in the worthiest ideas.

In a way that ensures that no suggestion is overlooked or "lost in confusion" and can readily provide up-to-date Management Information.

CHAPTER

CHAPTER III:
EVALUATION AND PRIORITISATION METHODS

3.1 INTRODUCTION

Striving for employees' participation in a Suggestion Scheme requires adequate methods and tools to handle the ideas once they are submitted. Its final success lies on how efficient and effective will these methods be. As it was discussed in the above chapter, what is needed is an evaluation and prioritisation tool for the Improvement Suggestions that will handle them in a way the organisation will benefit most.

However, what qualities should the chosen method have? Karlsson (1997) claims that a process for prioritising must, on one hand, be simple and fast, and, on the other, yield accurate and trustworthy results. Also, it must hold stakeholder satisfaction as both the ultimate goal and the guiding theme (Karlsson, 1997). Shoji Shiba and his colleagues (1993) argue that there are three main factors in stakeholder satisfaction: quality, cost and delivery.
According to the author's opinion, the above mentioned criteria are not enough, or at least, not enough specified.

First of all, the method should be *user friendly* in terms of *time* and *ease of handling*. That means that it should be rather fast and that it shouldn't require knowledge that is difficult to acquire and, therefore, "accessible" only to an elite.
Additionally, it should *reflect the voice of the customer* (internal and external), as that is the organisation's ultimate goal to be satisfied. However, the *organisation's needs*, abilities and planning should not be ignored either.
Another crucial feature that the evaluation and prioritisation method should have, would be its relative *independence* of the user's personal opinion, when he/she applies the method. In other words, all the suggestions should be evaluated against a set of predefined and known to all users (communicated) criteria, which will be independent of the subjective judgement of the individual.
Of utmost importance is that the method is *dynamic*. Even though the criteria should be accepted and not changed while actually performing the evaluation, change should be generally allowed according to the current needs and the goals of the organisation. Furthermore, it would be interesting to carry out the evaluation not among a predefined set of suggestions, which were submitted in a specific time period (static). Instead, it should be possible for each suggestion to be evaluated and placed in the prioritisation rank right after its submission. The dynamism of the method should also foster the ability to project the importance of the suggestion now and in a future time.
Additionally, it should be understood and integrated in the system, that the *criteria are not of equal importance.* Therefore, when the suggestions are evaluated against the former, they should be assigned different scores, according to the direction and the extent they satisfy different criteria.
Lastly, the method should, of course, provide the organisation with *reliable results*.

Clear, unambiguous knowledge about suggestion priorities helps to make acceptable trade-offs among sometimes-conflicting goals such as quality, cost (Curtis et al., 1988) etc. and allocate resources based on the suggestion's importance to the organisation as a whole.

3.2 CANDIDATE METHODS

There are many methods for evaluating and prioritising features of any kind. A selection of widely known ones is briefly presented:

3.2.1 Concept selection

Concept selection is a strictly non-numeric method for prioritising that has been developed by Stuart Pugh (1981). According to the latter, the conceptual weakness in any design usually manifests itself in two ways: a) the final chosen concept is weak due to lack of thoroughness or b) it is strong but the reasons for its strength are not known or fully understood. This approach has been formulated in order to eliminate or at least minimise such weaknesses. It consists of a concept comparison and evaluation matrix in which columns are the solutions to the set problem in sketch form. In the rows there are the criteria against which the solutions will be evaluated. Each solution is assigned with +, - or S according to the result of its comparison to a predefined datum. The best solution is the one with the biggest positive difference.

3.2.2 Numerical assignment technique

It is based on the principle that each suggestion is assigned a symbol representing the suggestion's perceived importance. This approach is common in QFD where prioritising of candidate suggestions is required, see e.g. (Hauser and Clausing, 1988, Sullivan, 1986). An approach using finer granularity is to assign each suggestions a number on a scale ranging from 1 to 5, where 5 is mandatory and 1 does not matter (Karlsson, 1995).

3.2.3 Cost – value approach

The cost-value approach involves pairwise comparisons of the candidate suggestions according to their value for customer and their cost of implementation. Based on the comparisons, the value and cost distributions are calculated and plotted in a cost-value diagram.

It is visible, robust and easy to use. However, the method takes no account of interdependencies between suggestions, leaving managers to deal with them.

More suggestions will also raise the problem of complexity, since the number of pairwise comparisons is O (n2).

3.2.4 Analytical Hierarchy Process

The Analytic Hierarchy Process (AHP) is a decision-making method (Saaty, 1980). Using AHP to prioritize suggestions involves comparing all unique pairs of suggestions to determine which of the two is of higher priority and to what extent. On the one hand, AHP is a demanding method due to the dramatically increasing number of required pairwise comparisons when the number of suggestions grows. On the other hand, another important issue is the redundancy of the pairwise comparisons, which make AHP much less sensitive to judgmental errors (Millet and Harker, 1990). That is an error like the following: A more important than B, B more important than C and C more important than A cannot occur. Another advantage is that the resulting priorities are relative and based on a ratio scale, which allows for useful assessments of suggestions.

3.2.5 Hierarchy AHP

Hierarchy AHP is almost the same as AHP, only that the suggestions are placed either on top or lower at a hierarchy according to their level of generalization. They possess similar characteristics. Using a hierarchical structure reduces the required number of decisions, but also the amount of redundancy. Thus, it is more sensitive to judgmental errors than AHP.

3.2.6 Pairwise comparison technique

It is a technique based on the analytic hierarchy process (Saaty, 1980). In this technique the features are compared pairwise to estimate their relative importance. The person thus, has to decide which suggestion is more important and to what extent.

The fundamental scale used for pairwise comparisons in the AHP is from 1 to 9, where 1 means that the suggestions compared are of equal importance and 9 means that one suggestion is extremely more important that the other. It is difficult to establish the difference in importance of the three candidate suggestions more precisely.

Just like in AHP, the resulting priorities of the requirements are relative and based on a ratio scale. That is, the requirement's priorities always add up to 100% and a requirement with a priority of 30% consequently represents 30% of the total importance. Moreover, it is 3 times as important as a suggestion with a priority of 10%. In conclusion, the pairwise comparison technique is favourable. It is easy to carry out and yields informative results for the participants to discuss and consider. The pairwise comparison technique also seems to be deemed more trustworthy than the numerical assignment technique and also appears to be less time-consuming.

3.2.7 *Binary Search Tree*

A binary tree is a tree in which each node has at most two children. A special case of a binary tree is a binary search tree where the nodes are labelled with elements of a set (Aho et al., 1993). Consider the elements of the set as the candidate requirements.

3.2.8 *Bubblesort*

It is one of the simplest and most basic methods for sorting elements with respect to a criterion (Aho et al., 1993). It is also a candidate method for prioritising suggestions since the actual prioritising process can be viewed as sorting suggestions according to their priorities (i.e., the criterion). Bubblesort is closely related to AHP. However, the decision-maker only has to determine which of the two requirements is of higher priority, not to what extent. The results of a bubblesort are suggestions ranked according to their priority on an ordinal scale.

3.2.9 *Priority groups*

In some cases, one set of suggestions can clearly be of a different kind of importance that another set. One way to reduce the required effort is therefore not to compare the requirements in these distinct sets. Thus, another candidate method is to initiate the prioritising process by dividing the requirements into separate groups based on a rough prioritisation. The primary gain is that one does not have to compare high priority suggestions with low priority suggestions, since they are placed in different groups.

3.2.10 Quality Function Deployment

Quality Function Deployment is an approach that was developed in the TQM framework and was initially used to meet customer's requirements throughout the design process and also in the design of production systems (Evans & Lindsay, 1996).

QFD has been extended to apply to any planning process where a team has decided systematically to prioritise their possible responses to a given set of objectives. The objectives are called the "Whats" and the responses are called the "Hows". QFD provides a method of "How" a team should best accomplish the "Whats" (Cohen, 1995, p.2).

It uses a type of matrix diagram to present data and information. The evaluation and the final selection of the ideas derives through a process, which utilises matrices that depict the relationships among the Whats and the Hows. Also, it uses assigned weight variables, which reflect the customer's preferences, benchmarking results, the technical difficulty of implementing the Hows, their technical importance etc.

3.3 EVALUATION OF THE METHODS

Karlsson et al. (1998) carried out an experiment where they evaluated the above mentioned methods for prioritising software requirements (apart from the one of concept selection and QFD). They were evaluated against the following objective and subjective criteria: a) Required number of decisions, b) Total time consumption, c) Time consumption per decision, d) Ease of use, e) Reliability results, f) Fault tolerance.

After carrying out the experiment, Karlsson came to the following conclusions: AHP and Binary Search needed the longest time to execute, while Hierarchy AHP was the fastest method. AHP and Bubble Sort were, on average, fastest per decision. The subjective evaluation also, resulted in good marks for AHP and Bubblesort, with respect to ease of use, reliability of results and fault tolerance. Priority groups were given the lowest ranking.

However, if all the above mentioned methods are evaluated against the criteria that were set by the author, the result is different. That comparison is presented in the following table:

		CRITERIA									
	METHODS	Fast	*Easy to handle*	*Reflect customer voice*	*Reflect organisation's needs*	*Independence of user/ Predefined criteria*	*Dynamic/ change criteria*	*Dynamic/ no predefined set of suggestions*	*Dynamic/ current and future importance*	*Criteria of different importance*	*Provide trustworthy results*
1	Concept selection	✓	✓								
2	Numerical assignment technique		✓								
3	Cost – value approach		✓								
4	Analytical Hierarchy Process		✓								✓
5	Hierarchy AHP	✓	✓								
6	Pairwise comparison technique		✓								✓
7	Binary Search Tree										
8	Bubblesort	✓	✓								
9	Priority groups										
10	Quality Function Deployment		✓	✓	✓	✓	✓	✓	✓	✓	✓

Figure 3.1: The evaluation of prioritisation methods

As the table clearly illustrates, the most suitable method for evaluating and prioritizing the Suggestions for Improvement according to the defined criteria is that of Quality Function Deployment.

It is the only one (according to the author's opinion) that can support a dynamic system of evaluating and prioritising ideas. Moreover, it reflects better than any other of the candidate methods, the customer's and the organisation's voice. Additionally, it is the only method where the criteria (Whats) -against, which the Suggestions will be compared-, are always visible to the user. Moreover, thanks to its weighting factors, the different importance of the criteria can be mirrored on the system.

It is more demanding in terms of time and skills for carrying it out compared to other methods, but not in an inhibiting way.

Therefore, QFD is chosen as the tool where the system for evaluating and prioritising the submitted Opportunities for Improvement will be based on.

In the next subchapter follows a brief description about Quality Function Deployment. There will be depicted the way the method works and, out of that, the advantages and disadvantages of its use.

3.4 QUALITY FUNCTION DEPLOYMENT

3.4.1 Introduction

The basic problems of product design are universal: Customers have needs that relate to using products. The needs must be addressed by designers who have to make hundreds of technical decisions. And there are never enough people, time and money to put everything that could be imagined into a product or service (Cohen, 1995).

Furthermore, customers and engineers speak different languages. The actual intended message can be lost in the translation and subsequent interpretation by design or production personnel (Evans & Lindsay, 1996).

The Japanese developed an approach called Quality Function Deployment (QFD) to meet customer's requirements through the design process. It has extended to apply to any planning process where a team has decided systematically to prioritise their possible responses to a given set of objectives.

3.4.2 Definition

The Japanese characters for QFD are phonetically (Cohen, 1995, p. 17, Akao, 1995):
Hinshitsu, meaning quality, features, attributes or qualities
Kino, meaning function or mechanisation
Tenkai, meaning deployment, diffusion, development, evolution

The definitions for QFD are as many as the people who have discussed about it:

QFD converts the consumer's demands into "quality characteristics" and developing a design quality for the finished product by systematically deploying the relationships between the demands and the characteristics, starting with the quality of each functional component and extending the deployment to the quality of each part. The overall quality of the product will be formed through this network of relationships (Akao, 1991, p. 5)

QFD is a method for structured product planning and development that enables a development team to specify clearly the customers wants and needs, and then to evaluate each proposed product or service capability systematically in terms of its impact on meeting those needs (Cohen, 1995).

QFD is a customer driven planning process to guide the design, manufacturing and marketing of goods. Through QFD every design, manufacturing and control decision is made to meet the expressed needs of customers. It uses a type of matrix diagram to present data and information. (Evans & Lindsay, 1996, p.248)

3.4.3 History of QFD

QFD originated in 1972 at Mitsubishi's Kobe shipyard site. Toyota began to develop the concept shortly thereafter, and has used it since 1977 with impressive results. They started using QFD because they had serious rust problems. Between January 1977 and October 1979, Toyota realised a 20% reduction in start-up costs on the launch of a new van. By 1982, start-up costs fell 38% from the 1977 baseline, and by 1984, were reduced by 61%. In addition, development time fell by one-third, at the same time quality improved. Xerox and Ford initiated the use of QFD in the United States in 1986.

Today, QFD is used successfully by manufacturers of electronics, appliances, clothing and construction equipment, by firms such as General Motors, Ford, Mazda, Motorola, Xerox, Kodak, IBM, Procter & Gamble, Hewlett- Packard, and AT&T. The 1992 model Cadillac, for example, was planned and designed entirely with the help of QFD. Two organisations, the American Supplier Institute, Inc., a non-profit organisation, and GOAL/QPC, a Massachusetts consulting firm, have publicised and developed the concept in the United States (Cohen, 1995, Evans & Lindsay, 1996).

3.4.4 Brief Explanation

In QFD there is a sequence of matrices (and other tools), which comprise a visible means to address and communicate key project concerns, such as reliability, throughout the life of a project. These deployments of central issues are a structured way of relating, for example, high-priority customer needs to the work of everyone on the project. QFD provides a basis of linking these concerns into an integrated framework, so that they receive appropriate attention throughout the development process.

The QFD process involves constructing one or more matrices called "quality tables". The first of these matrices is called the House of Quality (HOQ) (see figure 3.2). It displays the customer's wants and needs (Voice of the customer) along the left, and the development team's technical response to meeting those wants and needs along the top. The matrix consists of several sections or

submatrices joined together in various ways, each containing information related to the others (Cohen, 1995)

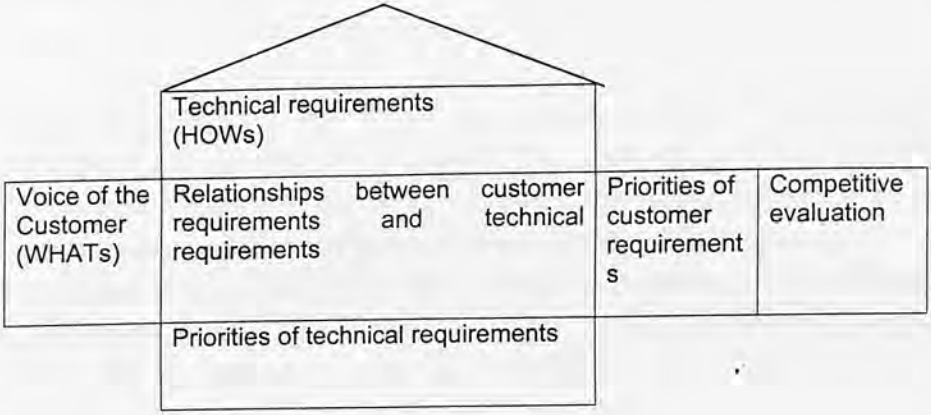


Figure 3.2: The House of Quality

WHAT is a term often used to denote benefits or objectives we want to achieve. Most commonly, the WHATs are the customer needs, or the Voice of the Customer, but the development team's own objectives could also be presented as WHATs.

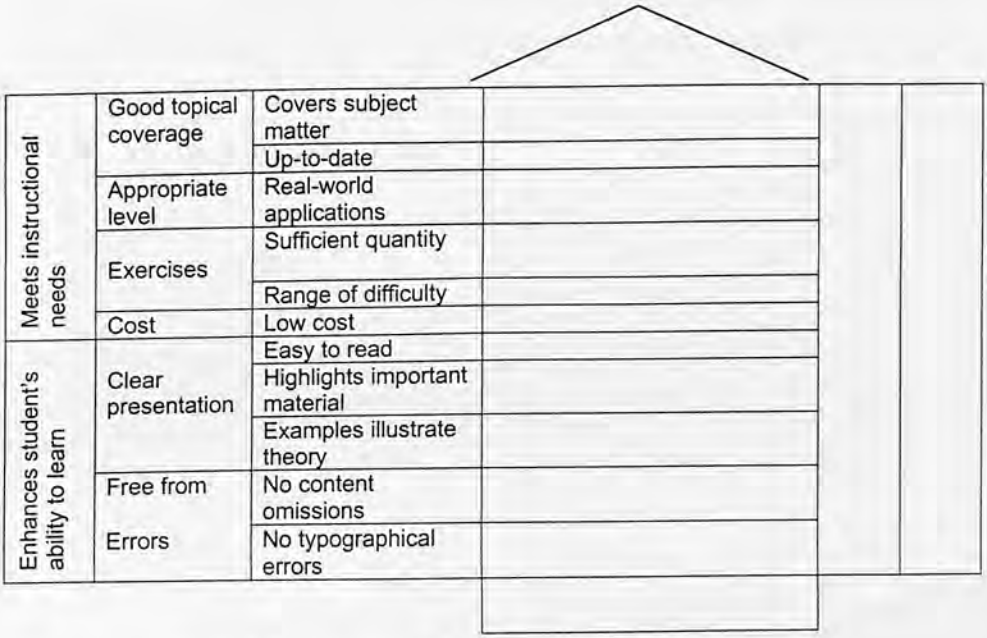
HOWs is any set of potential responses aimed at achieving the WHATs. Most commonly, the HOWs are technical measures of performance of the proposed product or service.

QFD provides a formal linkage between objectives (WHATs) and response (HOWs). It also assists developers in developing or deploying the HOWs. For the WHATs, it provides a systematic method of setting priorities, and it provides a convenient repository of the information.

3.4.5 Illustrative example

In order to illustrate the development of the House of Quality and the QFD process, the task of designing and developing a new textbook is presented (based on an example in Evans & Lindsay, 1996).

First, it is important to specify who the customer is and then, identify the customer's requirements. In the case of the developing of a textbook the customers are two; the teacher and the student. Their two primary requirements might be "meet instructional needs" and "enhance student ability to learn".
It is important to be understood that these two descriptions are not technical specifications, but they only represent the customer's voice, which is the primary input to the QFD process. The customer's actual words are vitally important in preventing misinterpretation by designers and engineers.
The above mentioned requirements can expand into secondary and tertiary requirements. "Good exercises", "Appropriate level of course", "Good topic coverage" could be some secondary requirements which derive from the original one "Meet instructional needs". The division of the requirements can be continued on more sublevels. For example, "Good topical coverage" can be divided in "Covers subject matter" and "up-to-date". The requirements are then placed in the left column of the HOQ, like the next figure shows.



Meets instructional needs	Good topical coverage	Covers subject matter			
		Up-to-date			
	Appropriate level	Real-world applications			
	Exercises	Sufficient quantity			
		Range of difficulty			
	Cost	Low cost			
Enhances student's ability to learn	Clear presentation	Easy to read			
		Highlights important material			
		Examples illustrate theory			
	Free from Errors	No content omissions			
		No typographical errors			

Figure 3.3: The voice of the customer in a House of Quality

The next step is to list the HOWs, which are the product's technical requirements, to the WHATs, which are the customer's requirements. It is the translation of the language of the customer to the language of the engineer.
In the example, the developers of the textbook have to consider issues like the number of the numerical and open-ended exercises to include, the amount of research literature to cite, the use of figures and tables, the size of the book.

After the completion of the HOWs' columns, the next component to be discussed is the roof of the HOQ. It reflects the interrelationships among the technical requirements of the product. They indicate answers to the question "How does the change of one product characteristic affects the others?" Furthermore, those relationships indicate an assessment of the trade-offs between characteristics. For example, by adding more exercises, the desired size of the book might be

exceeded. The relationships are denoted with various symbols; ▣ denotes very strong relationship, o denotes strong relationship and Δ denotes a weak relationship.

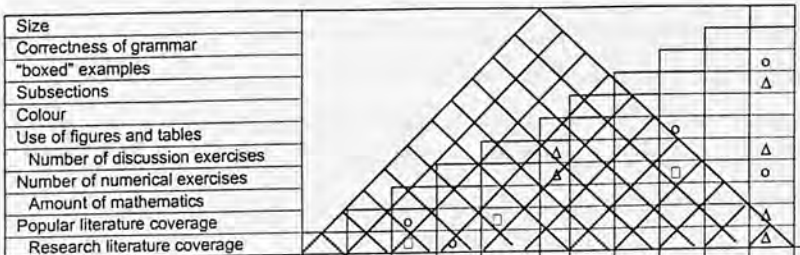
			Research literature coverage	Popular literature coverage	Amount of mathematics	Number of numerical exercises	Number of discussion exercises	Use of figures and tables	Colour	Subsections	"boxed" examples	Correctness of grammar	Size
Meets instructional needs	Good topical coverage	Covers subject matter	▣	▣							Δ		o
		Up-to-date	▣	▣									o
	Appropriate level	Real-world applications		▣			o						
	Exercises	Sufficient quantity				▣	▣						Δ
		Range of difficulty			▣	o	o						
	Cost	Low cost	o	o	o			Δ	▣	o	o		▣
Enhances student's ability to learn	Clear presentation	Easy to read	▣	Δ	▣			Δ	Δ	o	o	▣	
		Highlights important material						▣	o	Δ	▣		
		Examples illustrate theory	Δ	Δ							▣		
	Free from errors	No content omissions	▣	▣									
		No typographical errors			o			o					▣

Figure 3.4: The technical requirements & relationship matrix

The sum of the cells, where the customer requirements intersect the technical requirements, comprises the relationship matrix of HOQ. There, with symbols similar to those used on the roof, the degree of the relationship between the WHATs and the HOWs is denoted. The purpose of the matrix is to show whether the final technical requirements adequately address customer requirements. In the example, the amount of research literature referenced in a textbook bears a strong relationship (either positive or negative) to the customer requirements of "covers subject matter", "up-to-date", "no content omissions", "real world applications" and "easy to read". (see figure 3.4)

The next step in building the HOQ is to identify the importance ratings for each customer requirement. That represents areas of great interest and highest expectations as expressed by the customer. Furthermore, a competitive evaluation is conducted for each customer requirement, which highlights the absolute strengths and weaknesses in competing products. Also, it discovers opportunities for improvement and links QFD to the company's strategic vision and indicates priorities for the design process.

If, during the design of the textbook, the author finds two major competing textbooks weak in applications, whereas customer surveys reveal applications to be a highly desirable attribute, one should focus to that and use it as a competitive advantage.



			Research literature coverage	Popular literature coverage	Amount of mathematics	Number of numerical exercises	Number of discussion exercises	Use of figures and tables	Colour	Subsections	"boxed" examples	Correctness of grammar	Size	Importance	Competitive evaluation
Meets instructional needs	Good topical coverage	Covers subject matter	□	□							Δ		o	5	A (4) B(5)
		Up-to-date	□	□									o	4	A (4) B(3)
	Appropriate level	Real-world applications		□			o							5	A (2) B(3)
	Exercises	Sufficient quantity				□	□						Δ	4	A (5) B(4)
		Range of difficulty			□	o	o							3	A (2) B(3)
	Cost	Low cost	o	o	o			Δ	□	o	o		□	3	A (3) B(3)
Enhances student's ability to learn	Clear presentation	Easy to read	□	Δ	□			Δ	Δ	o	o	□		5	A (3) B(3)
		Highlights important material						□	o	Δ	□			4	A (3) B(4)
		Examples illustrate theory	Δ	Δ							□			4	A (4) B(1)
	Free from errors	No content omissions	□	□										5	A (5) B(5)
		No typographical errors			o			o					□	5	A (5) B(4)
	Competitive evaluation A		3	4	3	4	5	3	3	2	4	5	4		
		B	5	2	3	3	4	3	4	4	2	5	4		
		Targets	4	5	2	4	4	5	4	5	5	5	3		
		Deployment		*			*	*		*	*	*			

Figure 3.5: Completed House of Quality

The lower part of the HOQ focuses on the evaluation of the technical requirements of competitive products and to the target developing.

The last step in developing the HOQ refers to the selection of which technical requirements to be deployed in the remainder of the process. Those are requirements, which have a strong relationship to customer needs, have poor

competitive performance, or are at strong selling points. They have the highest priority and need to be "deployed" in order to maintain responsiveness to the voice of the customer. For example, if the attributes of "covers subject matter" and "up-to-date" are considered highly important, then the size of the book is of little concern. Furthermore, if "important material stands out" is important to the customer, then the author should focus on the chapter layout –the use of figures, tables, colours etc.

3.4.6 Prerequisites for applying QFD

Karlsson (1998), in a joint research programme carried out by Ericsson Radio Systems AB and the Department of Computer and Information Science at Linköping University, applied QFD in order to cope with the upcoming problems. After one year of working with the project, he and the rest of the researchers identified the prerequisites for applying QFD and came up with some negative and positive experiences.

The prerequisites identified for applying QFD were the following four:

1. The development project must have a *distinct and agreed-upon purpose*: a clear and for everyone understandable purpose is essential for the successful application of QFD. It saves time spent otherwise on non-value adding discussions and assures the correct executing of the method.
2. *Customers and users should be visible*: the implementers should carefully capture the voice of the customer, i.e. discover the candidate customer and user requirements.
3. *Forming a cross-functional team* adequately trained in QFD: the reason for using a cross-functional team in QFD is to provide input to the development process from sources where input is seldom or never received.
4. *Allowing time* for a first application: completing a QFD process is likely to take more time than initially planned

3.4.7 Positives experiences using QFD

A better focus on customers and users: by using the QFD approach, all issues that are not relevant to customer and user satisfaction are ignored. The evaluating team is driven by one single question: "are we now actively contributing to customer and user satisfaction or not?". In that way, the emerging result is to speed up work, since the discussions tend to be much more effective with the questions in mind and the criteria on the QFD matrix.

Prioritising Criteria: QFD recognises the different importance of the set criteria against which the Ideas will be evaluated. In fact, they must be accurately prioritised. However, as an ordinal scale (1 to 5) of absolute numbers is used to assign priorities to the criteria, there might be slightly problematic, since it is not always easy to clearly distinguish between the numbers. In that case, the AHP method could be used and pairwise compare the criteria among them (Karlsson, 1997).

QFD benefits companies through improved communication and teamwork between all constituencies in the production process, such as between marketing and design, between design and manufacturing, and between purchasing and suppliers. Product objectives are better understood and interpreted during the production process. Use of QFD determines the causes of customer dissatisfaction, making it a useful tool for competitive analysis of product quality by top management. Productivity as well as quality improvements generally follow QFD. Perhaps, most significant though, QFD reduces the time for new product development. QFD allows companies to simulate the effects of new design ideas and concepts. Through this benefit, companies can reduce product development time and bring new products into the market sooner, thus gaining competitive advantage (Evans & Lindsay, 1996).

Moreover, QFD forces the development teams to consider all the issues in a systematic fashion. It covers more ground faster than other less structured methods. It also acts as a communication tool as it effectively translates the

language of one phase of development into the language of the next. In that direction helps the standard format that it fosters of translating WHATs to HOWs. It helps people focus on facts rather than feelings. Finally, the decision process is recorded in the matrices and can be re-examined and even modified at any time (Akao, 1994, Cohen, 1995, Bossert, 1991).

3.4.8 Issues not fully supported by QFD

Level of abstraction (suggestions): the submitted suggestions for Improvement for the forthcoming system should be stated in a similar level of abstraction. They should not be stated neither too abstractly nor too detailed. Otherwise, problems in the cost estimating and in selecting the correct Ideas might occur (Karlsson, 1997). QFD doesn't provide any guidelines for specifying the Opportunities for Improvement at the right level of detail or a metric to ensure that they are stated in the same level of detail.

Handling temporal relationships among suggestions: in some cases, the implementation of a suggestion might prerequisite the implementation of another one. There is no straightforward and visible way of expressing such relationships in the QFD approach.

Initiating new development projects: a major problem that occurred when applying QFD in the United States (King, 1989) was that it was hard to prioritise customer and user requirements, when introducing a new product. Important inputs of the QFD approach, thus, could not appear any more, such as competitive assessments etc.

Managing functional requirements: it is not always feasible to find measurements for certain submitted suggestions. For example, "the button must flash when pressed" can be either done or not. No degree of achievement exists. Therefore, another essential part of the QFD tool disappears (Karlsson, 1997).

The size of the HOQ (House of Quality): the use of a HOQ that has a relationship matrix larger than 30 x 30 might turn out to be problematic. That is a crucial issue in many projects (Hunter and Van Landingham, 1994). A possible restriction of the size might lead to the adaptation of certain level of abstraction, in order to fit the desired size of the matrix.

QFD is explicitly time – consuming. It makes obvious and visible the need for several long meetings, attending by quite a few people (Cohen, p. 31).

3.4.9 Conclusions

According to the author's opinion, QFD is the only method, which can support a dynamic system of evaluating and prioritising Ideas. Moreover, it reflects better than any other of the candidate methods, the customer's and the organisation's voice. Additionally, it is the only method where the criteria (WHATs) -against which the Suggestions will be compared- are always visible to the user. Moreover, thanks to its weighting factors, the different importance of the criteria can be mirrored on the system.

It is true, that it is more demanding in terms of time and skills for carrying it out compared to other methods, but not in an inhibiting way.

What is attractive is to evaluate QFD and carefully pick the concepts found useful, and then tailor the QFD framework to fit the particular needs of one's own organisation.

CHAPTER V

CHAPTER IV
THE SUGGESTED SYSTEM FOR EVALUATING AND PRIORITISING OPPORTUNITIES FOR IMPROVEMENT

4.1 Introduction

A common pursuit in TQM is finding a cost-effective way to link or align the organisation's activities to best meet the needs of the customer (Cohen, 1995, p.320). In that way, the service and product provided to the customer will improve, together with the way the organisation functions.

Deming said that help towards improvement may come from outside the company, combined with knowledge already possessed by people within the company, but not being yet utilised (Kanjii, p. 345). Companies need to understand the means within the own organisations than in the end contribute to creating customer satisfaction (Ekdahl, p. 22). One effective way to collect and integrate that help into the organisation is by using a Suggestion Scheme.

Paraphrasing Ekdahl (1997, p.22) and adjusting his words in the Suggestion Scheme context, understanding the needs of the customer and the organisation, so that suggestion implementation activities can be focused on those Improvement Ideas, which will create the greatest benefit for the

organisation in the most cost-effective way, is and will be of utmost essence for long-term success in the marketplace.

The tool, which will be used to evaluate and prioritise the collected Improvement Suggestions, is Quality Function Deployment (QFD).

The choice of QFD as an evaluation and prioritisation tool in the context of a Suggestion Scheme should cause no surprise to the reader. Most tools have purposes beyond those for which they were originally designed. Furthermore, TQM tools generally differ from mechanical tools in that they are decision – making tools (mind enhancers) (Cohen, 1995, p. 45). What is needed in this case, is exactly that; a decision-making tool.
As with any versatile tool, the applications of QFD are limited only by one's imagination. The need to evaluate potential responses against needs is universal, however, and a wide range of applications sprang up quite rapidly (Cohen, 1995, p. 21). The general idea of matching "WHATs" against "HOWs" to understand their linkage and importance has even wider applications than product development (Cohen, 1995, p.320)

In this chapter, QFD is described and discussed as a framework for managing Suggestions for Improvement. Experience was gained when the system was tested with the Suggestion Scheme, which is fostered by the Division of Quality Technology and Management, Linköping University

4.2 General principles of the system

The evaluation and prioritisation model is based on several general principles, most of which correspond to the criteria set in Chapter 3, paragraph 3.1.

First of all, the model has to be *user friendly*. This is divided further in two components; Time and Ease of handling. It shouldn't be demanding in terms of time or requiring expert knowledge in order for it to function.
Second, the *customer's* (internal and external) and the *organisation's needs* should be reflected.

Third, it should be *independent* of the user's opinion concerning the criteria used.
Fourth, it should *be dynamic.* In specific, major organisational changes should be reflected in the system; both present and future/upcoming ones. Furthermore, the evaluation and prioritisation of suggestions should not only be done among a predefined set of suggestions, which were submitted in a specific time period.
Fifth, it should be *flexible.* This has a double application. On one hand, it is required that the model is able to adjust to the organisation's specific needs. On the other hand, it should be applicable to different kind of organisations (public or private, large or small and medium, industry or service etc), or with different volumes of submitted Improvement Suggestions.
Sixth, it should be possible for the *Innovative* Ideas to stand out and for *KAIZEN* Ideas to be implemented in a reasonable time frame.
Seventh, the *human aspect* should be taken into consideration as well, apart from the profitability aspect of each Improvement Suggestion.
Eighth, the values should be *aligned.*

The model was developed according to the above mentioned principles.

4.3 Structure of the system

The whole system is based on the House of Quality, as it was mentioned before. Its typical structure will be followed, altered though and complimented with a number of additional features.

The language, which appears on the left side of the QFD matrix, represents "What" is desired by the customer (internal, external, organisation etc). The language at the top of the matrix describes "How" the organisation will respond to the "WHATs" (Cohen, 1995, p.125).

4.3.1 WHATs

As it was discussed in the previous chapter, the WHATs' column of the House of Quality (HOQ) represents the customer's requirements. However, in the

case of a Suggestion System, it might be slightly ambiguous to identify who the customer is. Is it the organisation that fosters the Suggestion System, is it its customers, is it its employees?
The submitted Ideas, by definition, refer to practically all of the company's matters and affect any of the stakeholders in different ways and to a different extend. Therefore, the feature that will be chosen for that column has to reflect the needs and requirements of all the aforementioned.

According to the author's opinion, the customer of the Suggestion Scheme is, mainly, the organisation itself. It is through its structure, way of functioning and goals that the rest of the stakeholders benefit from the implementation of the submitted ideas.
Taking that as a fact, an effective way of replying to the question of what feature to put in the WHATs column would be to use the strategic goals of the company.
Alternatively, another way that an organisation could fulfil this requirement would be to consider how it is structured and how it operates and act accordingly. By saying organisational structure, it is meant the formal and systematic arrangement of people and resources around portions of the organisation work, as suggested by Jelinek, Litterer & Miles (1981). For example, if the organisational structure is mainly a vertical one, then the rows of WHATs should be its *functions*. If it is a lateral one (process oriented), then the *processes* should occupy that place. If it is project oriented, the current or the upcoming *projects* could be the WHATs.

The author's suggestion, in this case, is to use the identified Core Processes of the organisation as the WHATs of the HOQ.

Deming (1993) states that an organisation can be viewed as a system, which means a network of interdependent components that work together to try to accomplish the aim of the system. Since the main purpose of an organisation is to satisfy its customers (Deming, 1993) and that can easier be achieved by processes than functions for example, it is important to look at the system from a process perspective. According to Rentzhog (1996, p.32), the Core Processes

of an organisation constitute the set of broadly defined processes that together fulfil the overall organisation mission. In other words, they correspond to the organisation's core business, i.e. its primary sources of making a living.

One of the reasons for choosing the core processes as the WHATs of the HOQ is because –according to Rentzhog (1996)- a core process-oriented structure fosters some features, which the model needs. The following:

a) reinforces focus on overall effectiveness: it facilitates customer orientation and co-ordination throughout the organisation
b) provides overall understanding of the business: it facilitates members' ability to make rational decisions
c) facilitates organisational learning and continuous improvements
d) increases predictability and reliability in the outcome by focusing on how things get done.

In general, the choice of the Core Processes signifies a shift of focus from the result towards the causes of action producing the result.

Also by using the core processes as the identified "customer's requirements", it is possible to avoid another problem that derives from the conflict, which might occur between different requirements. Curtis et al (1988) found that trade-offs between conflicting requirements have to be performed often, and they argue that knowing the requirements' priorities is useful for solving such conflicts. The Core Processes of an organisation are clearly identified and mapped by the top and upper middle management. Therefore, the chance of an occurring overlapping or contradiction among the Core processes considerably decreases.

Furthermore, the choice of the Core processes as the WHATs of the HOQ replies to some of the criteria the model attempts to satisfy; since the Core processes are defined by the top management, they increase the model's independence from the user's opinion. Moreover, they indirectly reflect the voice of the customer. Finally, they support the model's dynamism by integrating the major changes, which occur in the company. The classification of a certain need is not static, but generally changes over the time. Therefore, companies need to

continuously monitor the impact of product attributes on the satisfaction of customer needs (Ekdahl, 1996, p. 21)

Placing the core processes on the left side of a QFD matrix should cause no surprise to the reader, if it is seen as the second matrix, which follows the HOQ that hosts the customer requirements as "WHATs" and the core processes as the "HOWs". Schematically seen:

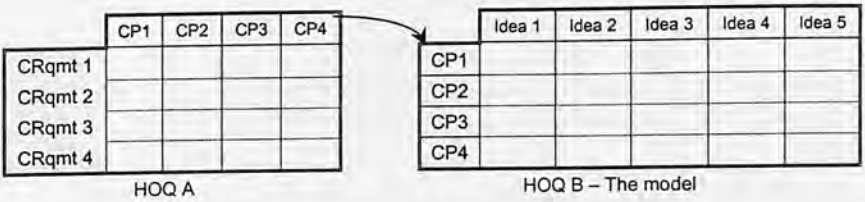


Figure 4.1: The deployment of the model

Therefore, the whole model could be seen as the second HOQ in the application of the QFD method in a company.

Nevertheless, placing the Core Processes on the WHATs rows is only a suggestion from the author. It is not a prerequisite for using the model. As one of the desired features of the model is its flexibility and adjustment to the organisation's needs, each organisation should choose for itself, which are the most convenient WHATs, e.g. projects, functions etc.

4.3.2 HOWs

In the context of the analysed model, the HOWs of the HOQ are the Improvement Suggestions themselves. The choice of placing the Core processes in the WHATs rows and the Suggestions for Improvement in the HOWs columns, derives from the question: "HOW do we serve the WHATs /organisation requirements?".

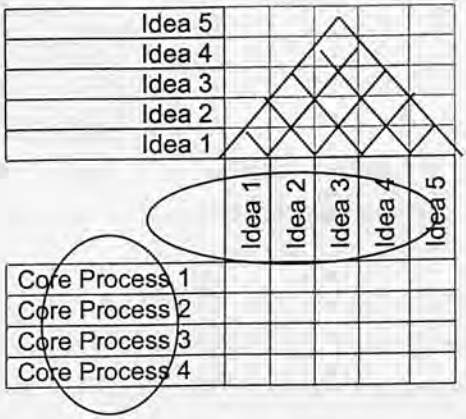


Figure 4.2: WHATs and HOWs of the model

The Ideas remain in the system and appear in the QFD matrix until they are evaluated and, if accepted, until their implementation phase begins. When rejected or implemented, they are automatically taken out of the system.

The system, theoretically, is expected to foster as many Ideas as they are submitted independently of whether that is e.g. 200 per month or 200 per year. However, a matrix that is bigger than 30 x 30 might become complicated for the user (Cohen, 1995), should one want to check the submitted Ideas in detail.
In the case of the WHATs, it would be quite unusual to observe a case of 30 Core Processes in an organisation. Therefore, the chance that the dimensions of the matrix are 30 (WHATs) x 30 (HOWs) is limited, on the WHATs part. Still, having 30 or more HOWs (Improvement Suggestions) in the matrix is quite possible.
Nevertheless, the problem can be overcome, if the users of the model adjust the frequency of the Ideas' evaluation according to the flow of submission. If a large volume of Suggestions is submitted every week, then the evaluation team should gather on a weekly basis, if not more frequently. If the flow of Ideas is more limited, then the evaluation team could gather e.g. every month or every two months. In that way, the matrix of the model won't become too large, as the

implemented or rejected Ideas would be discarded out of the volume of the evaluated ones.

4.3.3 WEIGHTS of IMPORTANCE

A very important part of the suggested system for evaluating and prioritising the Opportunities for Improvement is the weights of importance.

The core processes of an organisation, although individually important, they might differ in terms of importance among them. The suggested system allows the user to allocate different weights to the processes, which are used as the WHATs of the HOQ, depicting how important each core process is for the organisation. Customer importance ratings represent the areas of greatest interest and highest expectations as expressed by the customer (Evans & Lindsay, 1996), in this case, the organisation.

There are three types of data that are commonly used in those columns (Cohen, 1995, p. 94): Absolute Weight, Relative Weight and Ordinal Importance.

The *Absolute Importance* entries are usually used from a scaled selection of importances of between three and ten assigned numbers. A 1 to 5 point scale would reflect "Absence of importance" (1) to "Highest Importance" (5). The problem with this method is that the people, who are surveyed and assign the values, tend to rate almost everything as being important. Furthermore, no prioritisation among the WHATs takes place.

The *Relative Importance* entries reflect that if one need is twice as important as another to the customer, then the importance score of the more important need would be twice the score of the less important need (Cohen, 1995, p. 96). The values are typically placed on a 100-point scale or on a percentage scale, where 100 is the highest possible importance. The drawback of the method is that it is complex therefore it requires specific skills by the evaluation team, which are not easily found and that it carries the risk of inconsistent judgements based on circular reasoning.

Ordinal Importance, like Relative Importance, is an indication of order of importance. It only indicates that one attribute is more or less important than another, but not how much more or less important.
According to Cohen (1995), the method of relative importance is the most useful one for measuring importance. Nevertheless, he continues, every method for measuring and computing importance is nothing more than a mathematical model of how numbers of people feel (1995, p.98).

The method, which is used in the suggested model to measure and assign Importance Weights, is an alteration of the Relative Importance method. In specific, what is used is a percentage scale. The assigned weights have both to depict prioritisation among the different core processes, as well as the importance that each one individually have for the customer; in this case, the organisation.
Alternatively, the numbers could add up to 100 instead of 1. The only difference would be that 100 would multiply the final result. It is up to the evaluation team to decide what numbers they feel more comfortable with.

The distribution of weights should be a top management's consensus decision. After mapping and defining which are the core processes of the organisation, top management has to decide how important each core process is for the company individually and how important it is compared to the other specified core processes.

Change in the importance weights can occur in predefined time points (i.e. once a year), when the whole system is being reviewed and, of course, in exceptional cases, which can justify such a measure.

4.3.3.1 *Relative CURRENT Importance Weights*

The importance of each core process in relevance to the other core processes is depicted on the column of the Current Importance Weights. There, it is reflected how important the core processes are for the organisation for the present period. Of course, the range of that period can differ significantly from

one organisation to another. It could mean anything between 1 month and 2-3 years. However, since the importance of the core processes does not change by the day (with the exception of extraordinary events), and since changing the weights requires the consensus of the top management, it seems appropriate that the referring period cannot be less than 1 year.

4.3.3.2 *Relative FUTURE Importance Weights*

In the previous paragraph, there it was presented the Importance that the Core Processes have for the organisation "today". Nevertheless, it is true that the importance of each Core Process might change in time. Furthermore, some core processes might, for some reasons, become support processes, some other processes might be added in the organisation and support the previous core processes, or become core processes themselves etc. All this should be taken into consideration by the suggested system.

As it was mentioned in Chapter 3.1 when presenting the criteria and the desired features of the system, one of the most important characteristics was that of the dynamism. The system should be able to integrate any possible change concerning the Core Processes (number, nature, importance etc). A very interesting idea would be to see how important will today's Core Processes be in the future according to the estimation of the top management. And consequently, how important will Core Process X be, which is affected by the implementation of Idea Y, now and in the future? In that way, an Improvement Suggestion, which strongly affects a Core process whose importance will significantly increase in the future, should be supported into being implemented.

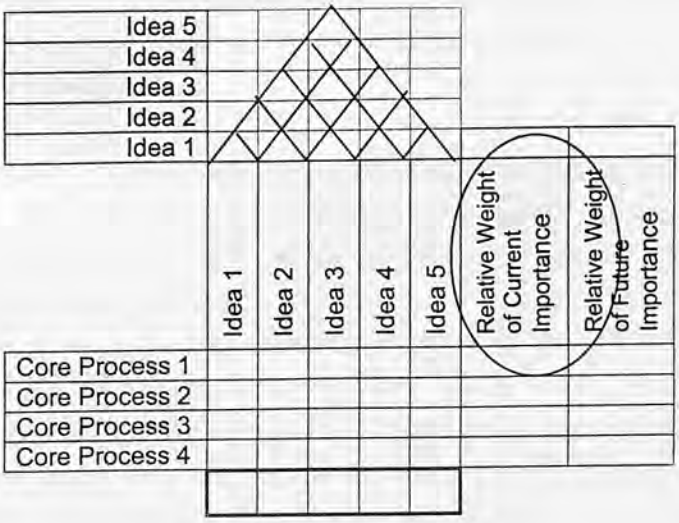


Figure 4.3: Relative Weighting Factors of the model

A reply to the previously stated question is the column next to the one of Current Importance Weights, the one, which represents Future Importance Weights. There, using the same scale that was described in the previous paragraphs, the top management can reflect the estimation for the future importance of the organisation's Core Processes.

Once again, the definition of the term "future" is depended on each organisation. A good estimation period though, would be that of 5 years.

4.3.3.3 *CURRENT & FUTURE focus*

Apart from the current or future relative importance of each Core process, another question to which the organisation should reply to, is how important does it perceives the future compared to the current situation to be. If it is a start up company, then there is a present focus. If it is a mature company, then it probably has a future focus.

The current and future importance weights are means of making conscious the two general core processes of any organisation: a) satisfying customer present needs and b) satisfying customer future needs (Rentzhog 1996). By requiring these two values every top manager will have to make a personal evaluation how important the present and the future needs should be in the prioritisation of

improvement suggestions. The timeframe of what 'future' means can be made separately in every organisation, however a strategic timeframe, i.e. 3 - 5 years, will be used in the example.

The answer can be reflected on another importance weight, which is distributed between the Current and the Future Importance Weights and adds up to 1.

4.3.4 RELATIONSHIP MATRIX

The relationship matrix hosts the relationships among the Core Processes and the Suggestions for Improvement. As Cohen (1995) says, the matrix is translating the priorities of the rows into the priorities of the columns. In specific, it depicts the extent and the direction that each submitted Opportunity for Improvement affects each Core Process of the organisation.

The strength of the relationship between a column item and a row item – called impact - appears on the cell where a row and a column intersect. Each cell is uniquely associated with one single column pair.

The prioritisation matrix allows one to judge the relative importance of columns of entries. One can put many different things into the cells of a matrix. Binary relationships, numbers, symbols representing those numbers etc. A common QFD practice is to enter numbers that express the strength or degree of the relationship between a column item and a row item (Cohen, 1995).

Although many people believe that it is easier to see graphical symbols since they carry more visual impact (Cohen, 1995, Pugh, 1981), the calculating needs of the model require the use of numbers. In this context, a scale of –9 to +9 was adopted to depict both the strength and the direction/nature of the effect (negative, positive). In the following table, the scale is being analysed:

-9	Negative	Strong Relationship	Positive	9
-3		Moderate Relationship		3
-1		Slight or Possible Relationship		1
0		No relationship		0

Figure 4.4: The model's relationship matrix scale

For example, in the following table, one can easily see patterns of relationships between column items and row items. Improvement Suggestion 4 has two very strong relationships with Core Process 1 and 3 and a moderate one with Core Process 2. On the other hand, the Core Process that is affected mostly and in a positive way by the submitted Improvement Suggestions is Core Process 3, with two strong relationships and a moderate one. The absence of relationships can also be observed easily. Improvement Suggestion 3 stands out, as it has almost no entries, apart from one that indicates a slight or possible relationship.

	Improvement Suggestion 1	Improvement Suggestion 2	Improvement Suggestion 3	Improvement Suggestion 4	Improvement Suggestion 5
Core Process 1	-1			-9	9
Core Process 2		3			3
Core Process 3	9			3	9
Core Process 4		1			1
Core Process 5			1	9	-3

Figure 4.5: Example of the relationship matrix scale

In order for the user and the automated system, to be able to immediately identify the extremely good Ideas, which result to innovative, radical changes in the organisation, the number 15 is suggested to be assigned. In other words, while a strong relationship will always be expressed by a 9 (or a –9), a 15 will be used only in specific cases and will reflect Innovative Ideas. This is done in order for such Ideas to immediately stand out of a possible large volume of moderate suggestions and then be evaluated separately and more thoroughly, due to their extreme importance. However, as Cohen (1995) says, there is no scientific basis for any of the choices made concerning the choice of scale.

Nevertheless, the impact of the Idea Y on each of the organisation's Core Processes is not enough information for the evaluation team to properly evaluate and then prioritise the Suggestion. The practice of adding the strengths of relationships could give a good estimate of the overall relationship of the columns items with the row items, assuming though, that the row items are equally important. However, as it was stated in previous paragraphs, the Core Processes are not equally important. Thus, another feature is required,

which will satisfy the need for a better reflection of each Suggestion's total impact on the organisation's Core processes.

A common practice in QFD is to associate numerical weights or priorities with items in a list. When entering such weighted items in a matrix, one can combine those weights with the relationship values in the cells of the matrix, in order to more realistically estimate the importance of the column items.
What is needed is the product of the strength of the impact and the relative importance of the row item. In other words, the relationship of the Idea and the Core Process weighted by the relative importance of the latter. By multiplying importance with strength, the "importance of the strength" is expressed. To estimate the importance of the Improvement Suggestions, their "importances of the strengths" are added.

	Improvement Suggestions										
Core Processes	**Idea 1**		**Idea 2**		**Idea 3**		**Idea 4**		**Idea 5**		**Importance Weight**
CP 1	-1	-0,2					-9	-1,8	9	1,8	0,2
CP 2			3	0,45					3	0,45	0,15
CP 3	9	2,7					3	0,9	9	2,7	0,3
CP 4			1	0,1					1	0,1	0,1
CP 5					1	0,25	9	2,25	-3	-0,75	0,25
		2,5		***0,55***		***0,25***		***1,35***		***4,3***	

Figure 4.6:Calculation of the relationships' strength between Ideas and Core processes

The numbers below the matrix are the sums of the strengths of the relationships in the columns. These numbers represent the aggregate strength of the relationships that idea Y has with all the row items. The Improvement Suggestion with the biggest total is considered to be the most important one, in terms of its relationship with all the row items. In this case, Idea 5 is the most important one.

4.3.5 ROOF OF HOQ

The roof of the HOQ is one of the least used QFD components in today's practice (Cohen, 1995). It maps the interrelationships and interdependencies between any pair of Improvement Suggestions. These relationships indicate answers to the question: "How does the implementation of one Idea affect other Ideas?". In computer software, for example, the suggestion of increasing the number of print command options might contradict the suggestion of decreasing the number of keystrokes and mouse clicks required to print. Furthermore, the roof denotes assessment of trade-offs among the Ideas. Curtis et al (1988) found that trade-offs among conflicting ideas have to be performed very often, and they argue that knowing the ideas' priorities is useful for solving such conflicts. In the same example, the software developer increases the print command options enough not to make it too complicated and time consuming to print.

This matrix process encourages one to view features collectively rather than individually (Evans & Lindsay, 1996).

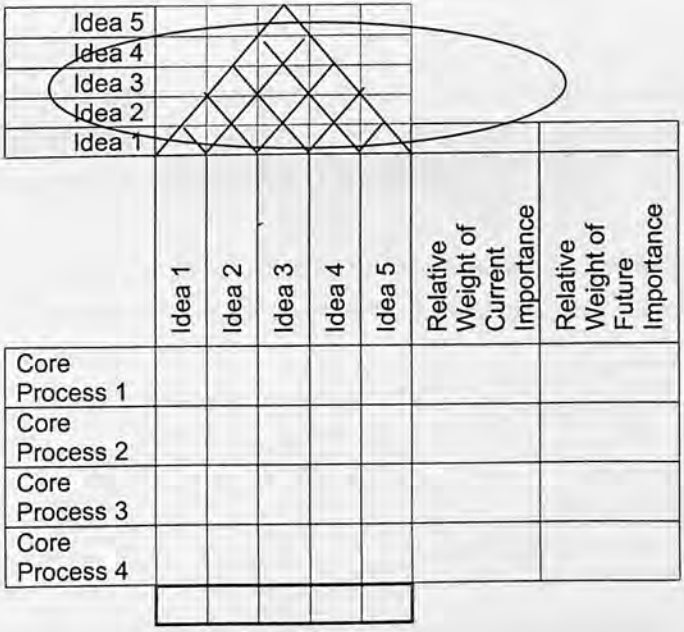


Figure 4.7: The roof of the model

Despite the significance of that component of HOQ for the evaluation and prioritisation of the Improvement Suggestions, it is fairly difficult to reflect it in numbers and then integrate it in the algorithm, which will describe the model and will provide the final result. Nevertheless, an effort of including some important information concerning the conflicting and the complimenting Ideas in the model, will be made.

The roof of the HOQ will be designed and the interrelationships among the submitted Ideas will be marked. In specific, symbols, which denote those relationships, will be assigned in each cell where a pair of Ideas intersects. Five degrees of technical impact will be identified. The following:

✓✓	Strong positive impact
✓	Moderate positive impact
(blank)	No impact
X	Moderate negative impact
XX	Strong negative impact

Figure 4.8: The scale of the roof

Of course, various different symbols could be used in order to denote these relationships. However, the translation of those relationships into numbers is complicated and won't be studied in this thesis.

Another more visible way, which could be used to illustrate the interrelationships among the Suggestions would be a correlation network diagram (Cohen, 1995, p. 158). The following:

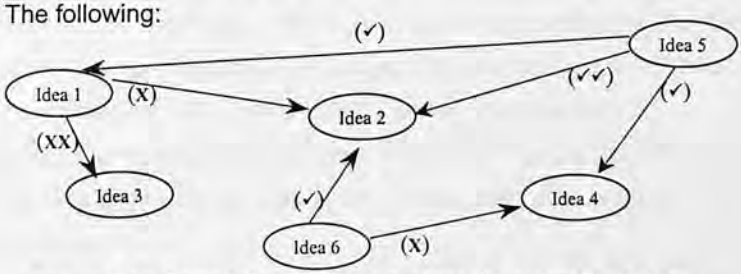


Figure 4.9: Correlation network among the submitted Ideas

The circles in this diagram represent the submitted Ideas. The arrows, which connect the circles, denote the relationships between pairs of Ideas. In specific, the Idea from which the arrow emanates has an impact on the Idea to which it points. The degree of the influence is reflected on the symbols written alongside the arrows. They are the same as the ones in Figure 4.8.

By observing figure 4.9 the following can be noticed:

- The implementation of Idea 1 affects negatively the implementation of Ideas 2 and 3
- Idea 5 has a positive impact on Ideas 1, 2 and 4
- Ideas 2, 3 and 4 only receive arrows/impacts, whereas Ideas 5 and 6 foster only arrows, which emanate from them.

Some conclusions, which could be drawn from the above, could be that engaging resources in implementing Idea 2 might not be worthwhile, since the latter is directly and positively affected by Ideas 5 and 6. Idea 5, on the other hand, seems like a good choice, as it has a positive impact on Ideas 1, 2 and 4. Idea 1 however, affects negatively both Ideas 2 and 3 and therefore, its implementation might not be beneficial to the company. Implementing Idea 6 probably requires further information than the one given in Figure 4.9. That is because the former affects two other Ideas, however, one positively and one negatively. The importance and the scores of each Suggestion should be considered before a decision is made.

4.3.6 EASE OF IMPLEMENTATION

The lower part of the HOQ, which is originally occupied by the technical difficulty of the requirements, the set targets, the competitive benchmark etc, is replaced in this system with the so called Ease of Implementation.

This term is used to describe how easy or difficult is it for the organisation to implement the submitted idea. That Ease of Implementation is divided into three different aspects:

4.3.6.1 *TECHNICAL ease*

This aspect depicts how easy is it, from a technical point of view, to implement the idea. An example could be the integration of the organisation's different databases into an enterprise wide system.

4.3.6.2 *FINANCIAL ease*

The cost of the implementation of an Improvement Suggestion is always a major issue. Especially, when taking into consideration the limited financial resources of any organisation. How affordable the implementation of an Idea is, it is reflected in this part of the system.

4.3.6.3 *ORGANISATIONAL ease*

Finally, the last feature that comprises the Ease of Implementation refers to the people of the organisation. The organisational ease of implementing an Idea reflects the reaction of the people to that. Not all submitted Ideas are popular to the people who are involved. Automating a part of a process might bring profit to the company, but at the same time, it might result in safety reduction. That could lead to resistance in the work force.

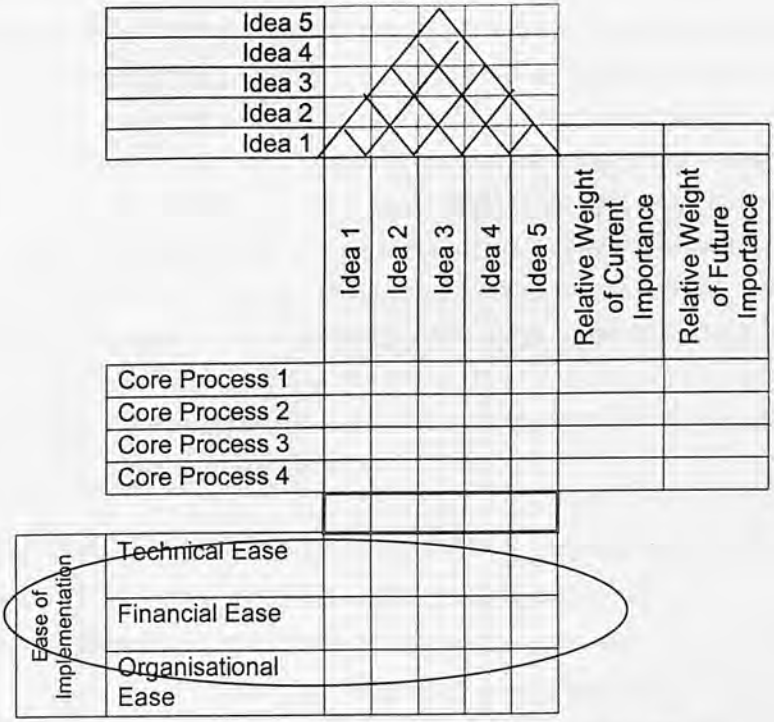


Figure 4.10: The Ease of Implementation of the model

All three aspects of Ease of Implementation will be measured in a scale of 1.1 to 1.9, where 1.1 denotes great difficulty and 1.9 denotes great ease in implementing the Improvement Suggestion. The reason for choosing such a scale is described in the paragraph 4.4, where the algorithm of the model is discussed.

4.3.7 IDEA MATURITY

As it was stated in previously, the human factor is a key feature in the concept of a Suggestion Scheme. The success of the project relies mostly on the employee's participation. Nevertheless, a possible delay in the implementation of an Idea, which is very often the case for moderate or less important Suggestions, might result in the decline of the Ideas' submission flow. The effects of that have been shown in the chapter 2.2.

Among the criteria that this model is based on, was the one of satisfying the customer –which also includes the raiser of the Ideas. Therefore, one goal of the system for evaluating and prioritising the Improvement Suggestions was to manage to realise the approved Ideas, which have been submitted a long time ago and are not yet implemented. That was due to the fact that other, better and more recently submitted Ideas, are engaging the organisation's resources. In the same time, those "mature" Improvement Suggestions should not be implemented instead of other brilliant, but recently submitted Ideas, only because they have been approved for a long time. A balance must be kept between these two requirements in order for the organisation to benefit the most.

The reply of the system to the above mentioned is reflected in a row at the lower part of the HOQ, which is called Idea Maturity row. There, each Improvement Suggestion is assigned some points according to the time that it has passed after its evaluation and approval. For example, for every fortnight passing by, the Idea is accredited with 0.1 points, with a starting base of 1.
That leads to the following table of correspondences between the time in the system and the actual time. In that table M stands for Months, W stands for Weeks and AP stands for Accredited Points.

M	0-½	½-1	1-1½	1½-2	2-2½	2½-3	3-3½	3½-4	4-4½	4½-5	5-5½	5½-6	6-6½	...
W	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	...
AP	1,0	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9	2,0	2,1	2,2	...

Figure 4.11: The Idea Maturity scale

The reason for starting with 1 as a base and not with 0 and add up from there, was because that would effect the final score negatively. That will be better understood when the algorithm is studied in paragraph 4.4.

The idea, which underlies all this, is that the approved suggestions should be implemented in a reasonable time. In order for them to reach, eventually, the top of the rank, they are gradually assigned points, which refer to the time that

they exist in the proposed system. In that way, those Ideas, which don't score really high in the part of the effect they have on the Core Processes, or in the Ease of their Implementation, but have been positively evaluated, will "chase up" the rank until they are implemented. Moderate or Very important Ideas will always be able to be implemented fast, but not against the less important Suggestions.

KAIZEN Ideas will occasionally be implemented and that will benefit the organisation, both directly and indirectly; it will benefit from the Suggestion itself and from the fact that the raiser of the Idea will be satisfied seeing it implemented and therefore, he/she will continue to participate in the Scheme.

Of course, it is always up to the organisation to define the time period, which will have to pass by, until an Idea is accredited some extra points. For example, that time interval can be one week, one month, or even one day. In that way, each organisation will be able to use this motivation tool according to its needs and decide on how much does it want to encourage the employees or not.

4.3.8 EASE OF IMPLEMENTATION & IDEA MATURITY WEIGHTING FACTORS

Another way the organisation controls the importance of the Human Factor and its contribution to the final result of the evaluation of the Improvement Suggestions is by assigning weighting factors to both the Ease of Implementation and the Idea Maturity.

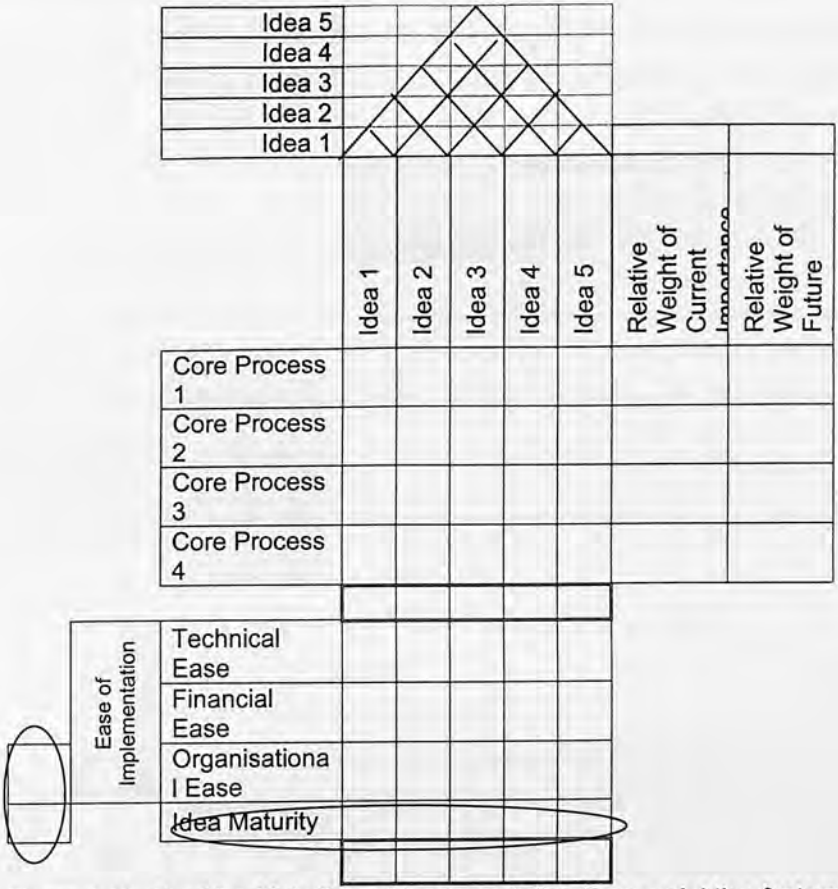


Figure 4.12: The Idea Maturity and Implementation Ease weighting factors

In specific, numerical weights, which will add up to one, could be assigned to the previously mentioned features. In that case, if the organisation is just launching the Suggestion Scheme and is very interested in its smooth and successful application, the weighting factor assigned to the Idea Maturity could be relatively big. Moreover, if the volume of suggestions submitted in the company is not too large, or if there are adequate resources and therefore, all of the approved Ideas are implemented shortly after their evaluation, then the Idea Maturity weighting factor could be smaller.

It is, again, up to the organisation –and especially, up to the top management- to decide.

4.4 THE ALGORITHM

After having described the components of the model that is based on a typical HOQ, the next step is to combine all this data and integrate it into a system, which will produce a useful result. That result will help the evaluating team to prioritise the Improvement Suggestions after having evaluated them.

The above are reflected in the following algorithm:

$$FinalScore = \{\alpha * \sum_{i=CP1}^{CPn} (WCIi * RSi) + \beta * \sum_{i=CP1}^{CPn} (WFIi * RSi)\} * \{c * (TE * FE * OE) + d * IM\}$$

with the elements:

a ,	Weight of Current Importance
WCIi,	Current Importance Weight among Core Processes
Rsi,	Relationship Strength
b,	Weight of Future Importance
WFIi,	Future Importance Weight among Core Processes
c,	Ease of Implementation Weighting Factor
TE,	Technical Ease of Implementation
FE,	Financial Ease of Implementation
OE,	Organisational Ease of Implementation
d,	Idea Maturity Weighting Factor
IM,	Idea Maturity Score

Figure 4.13: The algorithm and its elements

The idea, which underlies the algorithm, is (1) to combine the effect, which the implementation of an Idea will have on the organisation's Core processes, with (2) its Implementation Ease and (3) its time in the system (Idea Maturity). The goal is to make Innovative Ideas to stand out and be fast implemented, but also to give a reasonable implementation time frame for the KAIZEN improvement

suggestions, which can be expected to represent the majority of the submitted Suggestions.

The algorithm can be divided in two parts, each of which is between the brackets {}.

The first part calculates the impact each Suggestion's implementation will have on the Core Processes. The method that was used to calculate that score, was the one described in paragraph 4.3.4. and refers to the $\sum_{i=CP1}^{CPn}(WCIi * RSi)$ and the $\sum_{i=CP1}^{CPn}(WFIi * RSi)$ part of the algorithm. According to Cohen (1995), it is the method used to calculate the impact of the How's on the What's in the relationship matrix. The reasons for the choice of the specific scale were given in paragraph 4.3.4. Each of the features is further multiplied with a weight, which reflects the organisation's focus concerning the present and the future time. In order to do that, each part of the so far discussed algorithm is multiplied with "α", if it refers to the present, and "β", if it refers to the future. Since "α" and "β" are set by definition to add up to1, the two parts are added to present the final score of the Idea according to its affect on the Core Processes.

The second part of the algorithm consists of the Implementation Ease and Idea Maturity factors.

The Implementation Ease's three components –Technical, Financial and Organisational Ease- are considered to be of equal importance, so that the model doesn't become too complicated. In order to combine them and calculate the Implementation Ease score of the Idea, the parts are multiplied. In that way, the specific score becomes more sensitive to the variations of the Idea's performance against the three features. Furthermore, it more clearly reflects the Ease of the Suggestion's implementation.
The scale used was formed according to those particularities. As it was mentioned in paragraph 4.3.6, a scale of 1.1 to 1.9 was used, where 1.1 denoted great difficulty to implement the Ideas and 1.9 reflected great ease. The reason that 1 was chosen as a starting base was due to the multiplication

that the algorithm fosters concerning the Ease components. If they were multiplied with anything less than one, then the result would decrease instead of increase. Moreover, the choice of the 10-number scale, which was used (1.1, 1.2, 1.3,...., 1.9), derived from the fact that people are used to such scales. (Cohen, 1995) A scale of 1, 2, 3, 4, ... 10 wasn't used, as the score would increase unnecessarily much due to the multiplication. Again, it is repeated that there is no scientific base for any of the choices made concerning the scales (Cohen, 1995), but manageability and understandability.

Similar reasons lead to the choice of 1 as a starting base for the Idea Maturity factor. The difference in this case, is that the points assigned to the Idea can increase indefinitely, according to the time passed after the evaluation of the Suggestion and its implementation.

Both the Implementation Ease and the Idea Maturity factors are assigned with the weights "c" and "d", respectively. The latter represent the relative importance of the two factors for the organisation, thus they add up to 1. As a consequence of that, the two weighted features are added up in order to extract that part of the final score.

The combination of the two parts of the algorithm is done via multiplication. The choice of a mathematical operation, which would increase the final score, was made based on the concept that the ideal Improvement Suggestion would score high to all the criteria; it would affect positively all the Core Processes and it would be easy to implement. If it were too long in the system, it would score high in that criterion, as well. In order to reward the Idea with the cumulative positive effect of its overall importance, either an addition or a multiplication could be used. The multiplication was chosen due to the fact that it makes the algorithm, and thus the model, more sensitive. For example, if two Ideas score relatively the same against the Core processes' part of the model and they were evaluated on the same day, but they differ in the Organisational Ease factor significantly, that should be able to be reflected on the final score and placement in the ranking.

Another common denominator, the concept of which runs the whole model, is that the values should be aligned (Cohen, 1995). That means that always the more, the easier and the better should be assigned more points. This is the reason why, for example, the second part of the matrix was not called Difficulty of Implementation, but Implementation Ease. In that way, by definition the desired quality feature was the Ease and thus, it is assigned the higher grade.

4.5 AN EXAMPLE

In order to better understand the application of this model, this chapter presents a hypothetical example. It should be clear that in order to make the explanation the most didactical possible, this example is a simplified version of what one could find in a real implementation of the model.

Protobank is a small, national bank specialised in personal banking. It has a typical structure for its like in business; its departments include credit, investments, operations, technology, auditing, marketing and human resources.

Six months ago, the company launched a Suggestion Box Scheme. At the beginning, the employees treated the System with scepticism, therefore only few Suggestions for Improvement were submitted. Nevertheless, thanks to the Quality manager's enthusiasm and persistence and the top management's fully support, the system eventually flourished.
A large volume of Ideas is now waiting to be assessed and, if accepted, implemented. The management is aware of how important it is for the people to see their Idea implemented, in order for them to continue contributing to the system. On the same time, it is clear that the evaluation of the suggestions should be done in the most beneficial way for the company.

A cross-functional team was formed to evaluate and then prioritise the submitted Opportunities for Improvement using a model based on QFD.

At the beginning of the session, the four Core Processes, which run the company, were once again reminded and explained to the members of the

evaluation team, so that each and all of them together have a good perception of it.

Protobank's Core Processes, which have originally been identified by the top management, are the following:

(a) The **credit** process, which starts with the credit requirement and ends with money recollection
(b) The **investment** process, which starts with money deposit to money withdrawal
(c) The **service** process, which includes executing transactions and delivering information to clients
(d) The **human resources** process that starts with recruitment and ends in career development.

Apart from defining the Core processes, top management has also predefined some other features, important for the model.
In specific, the weight between Current and Future Importance of the Core processes. As it was thoroughly explained in Chapter 4.3.3, that represents how much focused the enterprise is to the present or to the future needs. By the term future, top management has agreed that they refer to a of five-year timeframe. According to those definitions and based on the fact that the bank is not going through any major changes in the future, the factors of 0,7 and 0,3 were attributed respectively to today's and future's time importance.

Furthermore, top management has decided on the relative importance of the Core processes. In particular, it has been defined how important the Core processes are for the company today and how important the management believes they will be in the future. As it was explained in previous chapters, a process might become more or less important for the organisation in the future horizon or even disappear and be replaced by new core processes.

The last feature that top management decides upon is the balance between the Ease of Implementation and the Idea Maturity factors. As the system is

relatively new in the organisation, top management has decided to support the human factor in continuing contributing with Suggestions for Improvement. Following this decision, the Idea Maturity factor was attributed with a weight of 0,4 and the Ease of Implementation factor with a 0,6.

The matrix, which the evaluation team will use, at this step looks as follows:

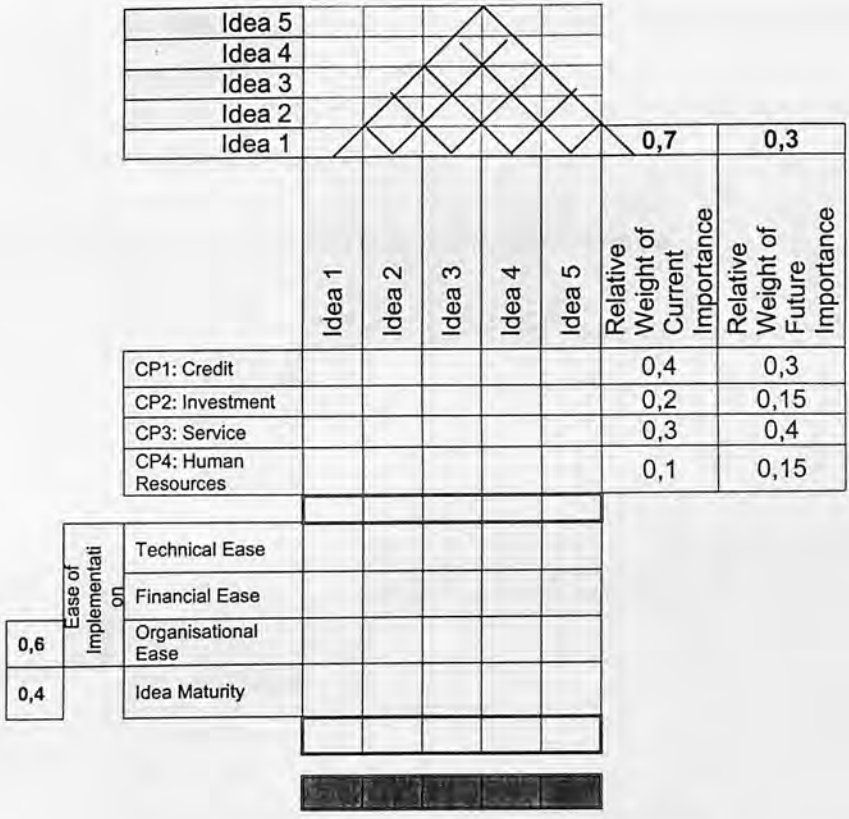


Figure 4.14: The matrix before the evaluation starts

After the quality manager has explained thoroughly all the above mentioned to the evaluation team and has engaged their understanding on the issues, the suggestion box is opened. The box includes 50 ideas from which there will be illustrated the decision process of the first 5.

a) Idea 1: Train all secretaries in the usage of Mail merge in Word, so they do not spend so much time retyping the letters to different clients

b) Idea 2: The back to back credits (credits guaranteed with the clients investments in the bank) should not be treated in the same process with other operations, as they require fast speed and are easier to evaluate. Create an alternative process for these kind of operations

c) Idea 3: Make the credit approvement system electronic, it will be faster and save money on messenger services.

d) Idea 4: Put TVs on the hallways where clients wait; this will distract them and the perception of time waiting will decrease.

e) Idea 5: Track punctuality by the time an employee logs on the network in the morning; the sign up sheet is insulting.

These ideas were now put in the matrix, in the How's columns.

		Idea 5						
		Idea 4						
		Idea 3						
		Idea 2						
		Idea 1					0,7	0,3
			Idea 1: Mail merge training	Idea 2: Back to back credits	Idea 3: Electronic credit system	Idea 4: Hallway TVs	Idea 5: Time punctuality	Relative Weight of Current Importance	Relative Weight of Future Importance
		CP1: Credit						0,4	0,3
		CP2: Investment						0,2	0,15
		CP3: Service						0,3	0,4
		CP4: Human Resources						0,1	0,15
	Ease of Implementation	Technical Ease							
		Financial Ease							
0,6		Organisational Ease							
0,4		Idea Maturity							

Figure 4.15: The matrix after the Ideas' submission

After that, each Idea was thoroughly explained to the evaluation team, until it was certain that each member understood perfectly what the Raiser of the Idea suggested. In that way, any judgmental error caused from a misunderstanding of the actual content of the Idea is reduced.

The next step is the actual evaluation of each suggestion. The members of the team discuss until they come to a consensus on how much each Suggestion influences (negatively or positively) every Core process. The result is then registered in the matrix.

Idea 1: As it is referred to the training of the secretaries in the Mail merge tool, it was assessed to affect Core Processes 3 and 4. That is because if the secretaries learn how to "produce" more letters in a shorter time, then the required time to deliver information to the customer will be reduced (Service process). Moreover, the secretaries' qualifications will be enhanced (Human Resource process).

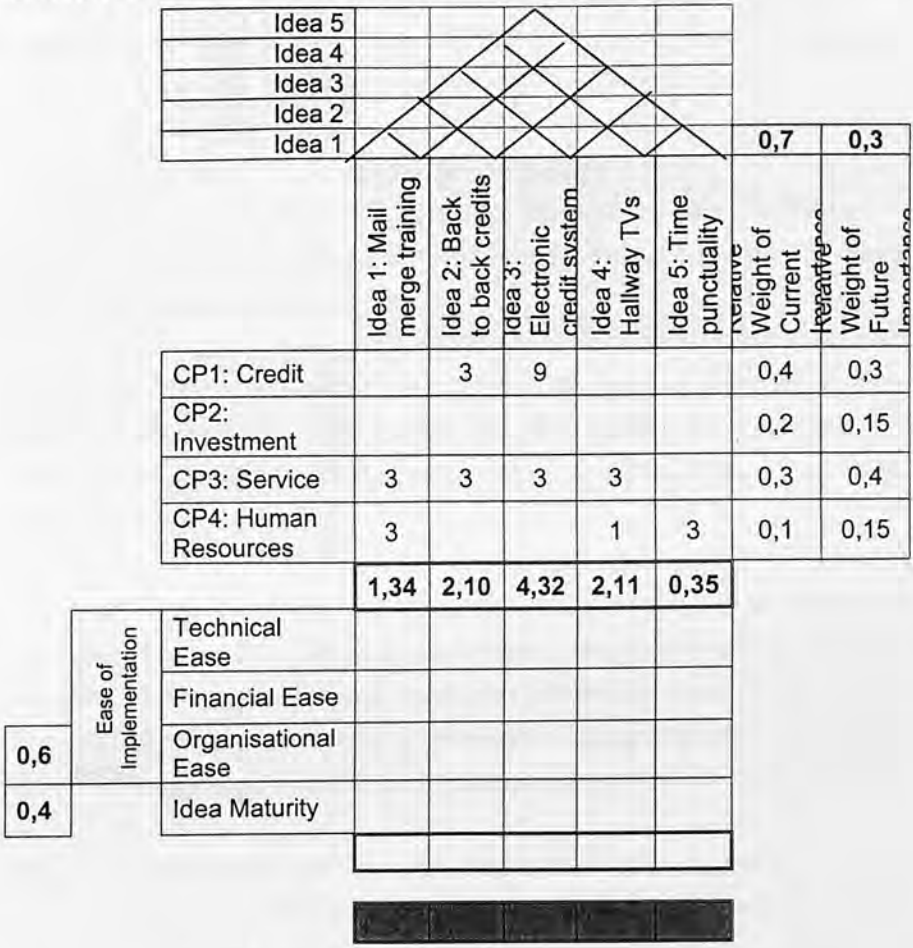
Idea 2: The separation of the back to back credits from other operations will decrease the required execution time. Therefore, it will positively affect both the Credit (3) and the Service processes (3).

Idea 3: The automation of the credit approvement system will naturally affect positively the Credit process (9). Furthermore, it will also affect the Service process (3), since it reduces the response time to the client.

Idea 4: Reducing the perceived amount of clients' time spent on waiting by putting TV's on the hallways affects positively the Service process (3) and the Human Resources (1) as employees are dealing with calmer customers.

Idea 5: This idea suggests to replace the traditional signing up on the arrival time of each employee with the automatic tracking of the time the employee logs on the network in the morning. That suggestion improves the Human Resource process (3) as it removes an insulting, towards the employee, activity.

The final matrix after the evaluation of the five Suggestions according to their effect on the defined Core processes looks as follows:



		Idea 1: Mail merge training	Idea 2: Back to back credits	Idea 3: Electronic credit system	Idea 4: Hallway TVs	Idea 5: Time punctuality	Relative Weight of Current Importance 0,7	Relative Weight of Future Importance 0,3
	CP1: Credit		3	9			0,4	0,3
	CP2: Investment						0,2	0,15
	CP3: Service	3	3	3	3		0,3	0,4
	CP4: Human Resources	3			1	3	0,1	0,15
		1,34	**2,10**	**4,32**	**2,11**	**0,35**		
Ease of Implementation	Technical Ease							
	Financial Ease							
0,6	Organisational Ease							
0,4	Idea Maturity							

Figure 4.16: The Core processes' score of the Ideas

Normally, the system will automatically extract the score of each Improvement Suggestion. However, in order for the procedure to be better illustrated, there will be presented the calculations of the Idea 1.

$$\int Core \ \Pr ocessScore \quad Idea\ 1 = \{\alpha * \sum_{i=CP1}^{CP4} (WCIi * RSi) + \beta * \sum_{i=CP1}^{CP4} (WFIi * RSi)\}$$

$$= 0.7*(0.4*0+0.2*0+0.3*3+0.1*3)+0.3*(0.3*0+0.15*0+0.4*3+0.15*3) = 1.34$$

Before continuing the rest of the evaluation procedure, the team checks (manually or automatically) whether there are any Improvement Suggestions that score negatively. In such a case, the Idea is excluded from the System and receives no further evaluation. That occurs as it is agreed that no Suggestion that affects negatively the Core processes should be implemented.
In this example, no suggestion scores negatively, therefore the evaluation team goes on assessing all of them against the next criteria.
Furthermore, the Idea, which scores highest seems to be Idea 3 (4,32), which refers to the automation of the credit approvement system. On the other hand, Idea 5 scores least (0,35).

The next step is to evaluate the Improvement Suggestions according to their Ease of Implementation. That consists of three aspects; the Technical, the Financial and the Organisational Ease, whose definition has already been given in Chapter 4.3.6.

Idea 1: The Idea of training the secretaries in Mail Merge will be technically easy (therefore a 1,8 is assigned), as it doesn't require the purchase of new software. Moreover, the involved employees will welcome it, as it will reduce their amount of routine work (1,8). However, financially it will be somehow expensive (1,4), since it requires the training of all the secretaries in the bank.

Idea 2: Separating the back to back credits from other operations, will be technically moderately difficult (1,5), but financially easily affordable (1,7). The organisational implementation ease will also be moderate, as some employees will foster the new Idea but some might resist the change (1,6).

Idea 3: The automation of the credit approvement system will be technically difficult (1,4) and therefore, moderately expensive (1,6). However, no resistance from the organisation is expected (1,7).

Idea 4: Placing TVs on the hallway is technically rather easy (1,6), but financially expensive (1,2). Nevertheless, the employees that contact clients will happily accept it (1,7).

Idea 5: The Idea of tracing the time the employees arrive at work by the time they log in the system won't experience any resistance from the organisation (1,8). Additionally, it will be moderately expensive (1,5) and technical easy (1,7) according to the required adjustments that have to be made on the software.

After evaluating the Implementation Ease of each Suggestion, the Ideas are accredited a number according to the time that they have been in the system. It is the Idea Maturity factor. Since the five Suggestions, which the example consists of, were evaluated at the same time, they are all attributed with the number 1. In order though, to make the example more illustrative of the model, there will be made the assumption that those Ideas were evaluated in different times. In specific, Idea 1 is supposed to have been evaluated since almost 9 months, Ideas 2 and 3 were recently evaluated, and Ideas 4 and 5 have been in the system since 3 and 6 months, respectively. The factor, which is accredited to them, derives from the correspondence at Table 4.11.

The calculation of the final score of each Improvement Suggestion is based on the algorithm, which was presented in Chapter 4.4 and can be automatically extracted from the system. Again, for the best illustration of the model, there will be presented the calculations of the Idea 1.

$$FinalScoreIdea1 = \{\alpha * \sum_{i=CP1}^{CPn} (WCIi * RSi) + \beta * \sum_{i=CP1}^{CPn} (WFIi * RSi)\} * \{c * (TE * FE * OE) + d * IM)\}$$

$$= 1.34 * (0.6 * 1.8 * 1.4 * 1.8) + 0.4 * 2.7 = 5.08$$

The final step of the procedure refers to the roof of the altered House of Quality. During this step it is inquired whether the implementation of each Idea conflicts or compliments the implementation of another Idea. In the case of many Suggestions, each one is assessed towards the previously evaluated ones. In

the context of this example, no Suggestion seems to impede or compliment the Implementation of another Idea.

The final matrix after the evaluation of all suggestions and the calculations of their scores looks like figure 4.17:

		Idea 5							
		Idea 4							
		Idea 3							
		Idea 2							
		Idea 1						0,7	0,3
			Idea 1: Mail merge training	Idea 2: Back to back credits	Idea 3: Electronic credit system	Idea 4: Hallway TVs	Idea 5: Time punctuality	Relative Weight of Current Importance	Relative Weight of Future Importance
		CP1: Credit		3	9			0,4	0,3
		CP2: Investment						0,2	0,15
		CP3: Service	3	3	3	3		0,3	0,4
		CP4: Human Resources	3			1	3	0,1	0,15
			1,34	**2,10**	**4,32**	**2,11**	**0,35**		
	Ease of Implementation	Technical Ease	1,8	1,5	1,4	1,6	1,7		
		Financial Ease	1,4	1,7	1,6	1,3	1,5		
0,6		Organisational Ease	1,8	1,6	1,7	1,7	1,8		
0,4		Idea Maturity	2,7	1	1	1,6	2,2		
			3,8	2,85	2,68	2,76	3,63		
			5,08	**5,98**	**11,06**	**3,05**	**1,25**		

Figure 4.17: The final score of the Ideas

Therefore, the result of the evaluation of those five Suggestions is the following rank, which includes the titles and the scores of each Suggestion:

Rank place	Idea number	Idea title	Idea score
1	3	Make the credit approvement system electronic	11,06
2	2	Create an alternative process for he back to back credits	5,98
3	1	Train all secretaries in the usage of Mail merge in Word	5,08
4	4	Place TV's on the hallways where clients wait	3,05
5	5	Track punctuality by the time an employee logs on the network in the morning	1,25

Figure 4.18: The ranking of the evaluated Ideas

What should be clear is that this order is not the result of the comparison of those five Improvement Suggestions among them. Each Suggestion has been assessed individually, independently from the existence of others. Therefore, when more Ideas will be evaluated in the future, they will assume their position in the general rank according to their score. That means, that the Improvement Suggestion X that will be submitted and evaluated after the Improvement Suggestion Y might engage a higher place in the ranking, if it scores better.

Summing it all up, the followed steps for the evaluation and prioritisation of the submitted Improvement Suggestions are presented in Table 4.19. Moreover, each step is accompanied by its recommended (by the author) actor. The cases, where the ✓ is placed among brackets, denote that the action can be performed either by the evaluating team or automatically by the software, which compliments the model.

	STEPS	ACTOR		
		Top Management	Evaluating Team	System
1	Define the Core Processes	✓		
2	Define the Current versus Future Importance Weights	✓		
3	Define Relative Importance Current and Future Weights among the Core Processes	✓		
4	Define the Ease of Implementation and Idea Maturity relative Importance Weights	✓		
5	Discuss each Idea		✓	
6	Assign values to each Idea according to its relationship to the Core processes		✓	
7	Calculate the "Core process" score		(✓)	✓
8	Exclude the Ideas which scored negatively		(✓)	✓
9	Assign values to each Idea according to its Ease of Implementation		✓	
10	Assign value to each Idea according to the time that it has been evaluated		(✓)	✓
11	Calculate the "Ease of Implementation and Idea Maturity" score.		(✓)	✓
12	Calculate the final score		(✓)	✓
13	Inquire for conflicting or complimenting Ideas		✓	
14	Prioritise: place each Idea in the ranking according to it's score		(✓)	✓

Figure 4.19: The steps for using the model

However, the question of whether the built model responded to the set criteria might arise. The following Figure depicts on the left column the general principles of the model and on the right one, the features of the model which correspond to each principle.

#	PRINCIPLES		MODEL FEATURES
1	*Reflect voice of the customer & the organisation*		Core Processes
2	*Independence of user's opinion*		Top Mgt predefines Whats and Weighting factors
3	*Dynamism*	*Integrate changes*	Core Processes' Importance Weights
		Present & Future focus	Current and Future Importance Weights
		Not comparison among predefined set of Ideas	Each Idea is evaluated individually
4	*Flexibility*	*Adjust to org needs*	The organisation decides on the scales, weights, WHATs etc.
		Suitable for different kind of organisations	No apparent limitations for the opposite
		Suitable for different volumes of suggestions	No apparent limitations for the opposite
5	*Important Ideas stand out, KAIZEN improvements implemented in reasonable time frame*		Assignment of "15", Idea Maturity
6	*Integrate Human aspect*		Organisational Ease, Idea Maturity
7	*User friendly*	*Time*	Fast
		Ease of handling	Doesn't require specific skills
8	*Aligned values*		Ease of Implementation (instead of Difficulty of Implementation) etc

Figure 4.20: Correspondence between the principles and the features of the model

4.6 IMPLEMENTATION OF THE SUGGESTED SYSTEM FOR EVALUATING AND PRIORITIZING OPPORTUNITIES FOR IMPROVEMENT

4.6.1 *Introduction: A case study*

In order to test how the system works with real data, a case study was conducted at the Division of Quality Technology and Management at Linköping University. The reasons for choosing the Division for that purpose were the following three:

- The majority of organisations in Sweden are of a small or medium size (NUTEK, 2000). Therefore, it would be of high interest to test the model in such an environment. The Division of Quality Technology and Management is considered to be such an organisation.
- The Division is an organisation, which is financed by the public sector, therefore it belongs there. Furthermore, since it doesn't produce goods but services to the students, researchers, business world and society, it could be considered that it belongs in the service sector, as well. Both the public and the service sector are in the interest of the author.
- Furthermore, the Division already has defined Core processes and operates according to them.

Since five years, the Division of Quality Technology and Management fosters a Suggestion Box Scheme. It is based on the PDSA cycle or Schewart cycle (Deming, 1994) and therefore consists of four phases; Plan, Do, Study, Act.

Each submitted suggestion has to go through all four phases, in order for it to be considered as implemented and integrated in the Division. In order to visualise the system, a form, which has a PDSA cycle as a central element, is filled in and reviewed regularly, during monthly Division meetings. There, all the suggestions are placed according to the stage that they are in.

The process is called Improvement Process and is one of the Division's defined Support Processes. In more detail, it consists of the following:

Whoever has an Idea or a Suggestion about an Improvement fills in an Idea form. On the idea form it should be noticed why the Suggestion was made, the Suggestion itself or the expected outcomes etc. This is important to be able to follow up finished improvements and learn from them. If the person who made the suggestion is not able or willing to manage the Suggestion on his own, the form is put on the blackboard and dealt with at a PDSA meeting, alternatively, a normal coffee break. Whoever is pointed out as responsible to manage the improvement gets the Idea form and keeps it until the Improvement is done and followed up. On the form, it may be noted what has been done and to which results the improvement has led. Completed improvements are presented on a PDSA meeting. When this has be done the person on charge of the improvement keeps the form and waits sometime, approximately 6 months until the final follow up of an improvement is done. This is presented on a PDSA meeting too. Depending on the result of the follow up, the decision is taken whether the improvement project can be seen as finished or if some additional work has to be done. After the end of an improvement project the form is archived at a PDSA manager.

4.6.2 *Implementation of the system*

The study was carried out in two phases.

Phase A

As the model needs data from the top management in the fields of i.e. the Core Processes or the Importance Weights, the supervisor and the author of the thesis decided that the members of the Division could be seen as equivalent to the top management. That would be the professors, the PhD students and the administrative staff of the Division. This approach was chosen due to the special character of a university division. In a research environment of a Swedish university and considering the low power distance of Swedish people (ref. Kurslid/ Hojsdedk p. 174), it seemed appropriate to involve the whole division. Everyone's opinion would be collected and then an average would be calculated and registered in the proper fields of the model. For that purpose, a simple questionnaire was designed and a limited scale survey was conducted.

What was asked in the questionnaire was for the participants to estimate the following:

- The Current versus the Future Importance Weights
- The Current and Future Relative Importance Weights of the Core Processes
- The Ease of Implementation versus Idea Maturity Weights

A total of 10 people replied to the questionnaires, which were distributed and collected by hand. Then, the answers were inserted in an Excel Workbook and the averages for each field were extracted. Since each person's opinion on the questions was valued equally, a simple average was chosen instead of a weighted one. The results of the survey are presented in Figure 4.21.

The information concerning the Division's Core Processes was obtained by the official folders, where all the processes are documented.

In specific, the Division's Core Processes are the following:

- **Research**: the goal of the research process is to develop areas, which are in need of research to a PhD dissertation or articles. The research process should be characterised by originality and relevance. The process can be separated into 3 phases: a) identification of needs, b) research and c) quantification. The professor is the process owner for the research process and the PhD student is seen as the project manager for his own project. The customers of this process are business and society, as well as the academic society.

- **Basic Education**: the goal of basic education is to educate the students in different courses in quality technology and management. The goal of the basic courses is to introduce them in the quality area and to establish a view of the quality area, which is characterised by continuous improvement and customer focus. In the advanced course, it goes into more detail and gives a more complete overview of the quality area and increases the students' ability to apply the taught material in practice. The products of the basic education process are the courses given. The courses can be seen as

consisting of two parts: the core, which equals the topics taught and the surrounding service, which is the way the topic is taught. This equals a classical What and How distinction for services (Grönroos). The overall process owner is the professor, and the teachers responsible for each single course are subowners. There are two main customers to the basic education process; business life and an engineer, who has worked 5 years in industry. The engineer is an ideal type, not a real person. Those two customers formulate and determine the needs for the content of the courses. A third customer is the course participant, who mainly has requests on how the courses are given. Improvements are done systematically at the yearly strategy meeting, as well as the monthly PDSA meetings.

- **Researcher Education**: the goal of the process is to change the mental processes of the individual towards a researcher in the quality area. It consists of a number of phases, which are seen as subprocesses to the core process Research Education: Introduction phase, Searching phase, Maturing phase and Contribution phase. All processes partly overlap in time. The professor acts as a process owner whereas the PhD student is seen as a project manager of his own research project. The primary customer of the process is a PhD student, the secondary customers are future employers in both academia and business as well as society. The Research Education process team identifies the areas of improvement in connection with PhD students' meetings, the process team meetings and the yearly strategy meetings.

- **Networking**: the goal of the networking process is to spread the message and knowledge of quality technology and management to business and society. The networking process has an internal and an external component. The internal networking aims at spreading information inside Linköping University and the Technical University. The external component of networking aims at spreading information to business and the Swedish society as well as abroad. The process owner is the professor. The identification of improvements takes place at process team meetings every second week. At every meeting a short check up is done of all

subprocesses according to measurements, improvement projects in process, new improvement projects and priority of projects.

Phase B

The second phase consisted of the actual test of the model. It took place in the Division of Quality Technology and Management and a total of 5 people (all PhD students) participated in it as the evaluation team. The following Improvement Suggestions were discussed:

1. *Introduction of Electronic Newsletter*: the Division of Quality Technology and Management has a quarterly newsletter where articles are presented, conferences are announced and, in general, the latest news of the Division itself. So far, the newsletter was printed and distributed in a paper copy. The Improvement Suggestion aims at simplifying this work by changing the form to an electronic one. This would save a lot of time for the secretary. Additionally, it would result in saving money that was previously spent on printing and postal service.
2. *New forms of examination (written reports)*: change in focus from being oriented towards final, written exams to include new forms of exams such as projects, written reports and so forth.
3. *Shared bibliography for articles*: in 1997 a student was employed for a summer job. The goal of the job was to copy all articles of all PhD students, archive them and put the bibliographical information of each article into a common computerised data base. However, the system needs regular updating. The suggestion involved the employment of another student who would repeat that job.
4. *Regular meetings on research issues*: in order to increase the transparency of the of each researcher's topics, the suggestion aims at establishing regular meetings where PhD students take turns and present one aspect of their research, e.g. reviewing an interesting article. This would make it easier to identify overlaps in the research questions. (reviewing articles)
5. *Shared software process* (use the same software): the suggestion refers to the use of the same software among the PhD students. That will improve the accessibility and use of each PhD student's files.

The supervisor of the thesis, who is also a member of the Division of Quality Technology and Management, gave the author access to the submitted Suggestions. The choice of the specific ones was based on their Importance and Urgency. For example, the introduction of an Electronic Newsletter is considered to be of major importance, due to its contribution to the networking process. On the other hand, the suggestion, which refers to the hire of a student, who would archive the produced by the Division's PhD students' articles, is urgent. That is because this work was planned to be conducted during summer holidays and no action was yet taken until early spring.

The approach, which was obtained in order to reach a decision on evaluating each feature of a submitted Idea, was that of consensus via dialogue (Senge, 1995). In order for each score to be registered in the relevant cell in the matrix, all of the members had to agree after discussing it.

The final matrix after the evaluation of the Division's Improvement Suggestions is presented in the following figure:

		Idea 5			✓		0,65	0,35
		Idea 4	✓					
		Idea 3						
		Idea 2						
		Idea 1						
			Idea 1: Electronic Newsletter	Idea 2: New forms of examination written reports	Idea 3: Shared bibliography for articles	Idea 4: regular meetings on research issues	Idea 5: Shared software process (Endnote)	Relative Weight of Current Importance	Relative Weight of Future Importance
		CP1: Researcher Education	1	1	3	9	3	0,23	0,23
		CP2: Basic Education	1	9	1	1	1	0,37	0,26
		CP3: Research	1		3	9	3	0,29	0,29
		CP4: Networking	15			1		0,12	0,22
			3,2	**3,2**	**1,9**	**5,1**	**1,9**		
	Ease of Implementation	Technical Ease	1,9	1,9	1,9	1,6	1,7		
		Financial Ease	1,9	1,7	1,8	1,9	1,7		
0,9		Organisational Ease	1,5	1,6	1,2	1,4	1,8		
0,1		Idea Maturity	2	1,2	2,7	1	1		
			5,1	4,8	4,0	3,9	4,8		
			16,1	**15,1**	**7,5**	**20,2**	**9,0**		

Figure 4.21: The case study's final score

Moreover, the final ranking as it derives from the evaluation of the Ideas is the following:

Rank place	Idea number	Idea title	Idea score
1	4	Introduction of Electronic Newsletter	20,2
2	1	New forms of examination (written reports)	16,1
3	2	Shared bibliography for articles	15,1
4	5	Regular meetings on research issues	9,0
5	3	Shared software process	7,5

Figure 4.22: The case study's ranking of Ideas

Some interesting findings, which are related to the function of the model, can be observed:

Idea 1 has scored moderately well, thanks to the outstanding performance (15) that it fosters, as far as it concerns Core Process 4. That led Idea 1 to the second place among the Ideas, which were presented in the model. However, in spite of that outstanding performance, it never "threatened" Idea 4. The latter scored first thanks to the fact that it strongly affected (9) two of the Division's relatively more important Core processes; Researcher Education (0,23) and Research (0,29). On the other hand, the Networking process, which Idea 1 affects, has a relative importance of only 0,12 at the present time. The relative future importance weights are not mentioned in the argument, as they have the tendency to be more or less equally distributed among the Core processes. Therefore, it is estimated that in the case of the Division of Quality Technology and Management, they don't affect the algorithm, and thus the final score, much.

Furthermore, although Ideas 1 and 2 scored almost equal on the Core processes and the Ease of Implementation part of the model, they received moderately different final scores. That derives from their different score on the Idea Maturity factor. Idea 2 is very new one into the system (a little more than a fortnight), whereas Idea 1 has been in the system for almost 6 months, according to the table 4.11. This difference might result to a different future for the two Improvement Suggestions. Despite of the fact that the Ideas 1 and 2 now occupy respectively the second and third place in the ranking, that doesn't necessarily mean that they will be implemented in that order. The considerable difference between them gives space for newly evaluated Ideas to come between them.

On the other hand, Idea 4 which was evaluated just recently scores first in the current ranking, thanks to the fact that it strongly affects (9) two of the relatively more important Core processes of the model. Its performance on the Implementation Ease part of the model is considered to be moderate, however it supports and compliments the very good score of the first part. The

conclusion, which can be drawn out of that observation, is that good Ideas will always surface and be implemented earlier than moderate ones.

4.6.3 Results

Before the actual test of the model, it was expected that the latter would be characterised by all the advantages and disadvantages of QFD, the tool on which the model is based. In specific, elements such as the need for a cross-functional team adequately trained in QFD or the need for plenty of time allocated on the first application on the model, were expected to be observed.

In general, this was true, however the time needed for the evaluation and then prioritisation of the Suggestions was much less than expected. The author presented and explained the model to the members of the evaluation team for 15 minutes. Then, only another 45 minutes were needed for the team to evaluate all 5 Improvement Suggestions. That results in an average of 9 minutes spent per Idea. Considering that it was the team's first contact with the model and that the members were not yet accustomed to, for example, the scales used for each different feature of the model, an even smaller time average is expected to occur in the future, as the team gains experience with the model.

However, the specific evaluating team was characterised by a certain particularity. All of the members were well familiar with the QFD tool, its use and significance. Therefore, no guidance or instructions were needed for them to understand the use of the tool itself and perform. Furthermore, they were already accustomed with co-operating among each other. Those two features might have affected the conclusions drawn from the use of the model. Nevertheless, according to the author's opinion, the latter are more related to the QFD tool than with the model itself.

Still, and in spite of the fact that the evaluation team was familiar and comfortable with the use of QFD, few issues usually related to the tool, came up.

For example, the actual content of each Improvement Suggestion had to be thoroughly explained, so that a common understanding was assured. There were some times (few, though), when one of the members of the evaluation team would change his opinion after the content of an Idea had been clarified further. In some cases, that was related to each Opportunity's for Improvement level of abstraction.
Furthermore, twice the team decided to return and review the evaluation of some Improvement Suggestions.

As far as it concerns the score related results of the model, the desired and aimed at features were observed. In specific, the very good Ideas immediately scored high and were placed in the top of the ranking. On the other hand, the Idea Maturity factor helped less important Ideas to engage a better place in the ranking.

Thus, in general, the model during the test performed as expected and only minor comments for its enhancement were made.

Among them, the suggestion of assigning weighting factors among the components of the Implementation Ease. In that way each organisation could choose to place different importance on those factors according to the status and the phase in which it is in. In other words, if an organisation were just entering the market, it would be mostly interested in the technical and financial ease of each Idea, which is been submitted. The organisation's survival and its valuable, limited resources would justify a greater focus in those two features. On the other hand, an enterprise, which is in business for a long time, might value more the effect of the implementation of an Idea on the organisation's members, than its actual cost and technical difficulty.

Another issue that came up was the clarification on where to attribute the time factor; in the Technical or the Financial Ease of Implementation. It was finally agreed that in each case, there should be considered the reason for the time delay. If it were because of technical complications, then it would be included in

the Technical Ease factor. If it derived from organisational resistance of any kind, then it would be included in the Organisational Ease factor.

CHAPTER V

CHAPTER 5
CONCLUSIONS & SUGGESTIONS FOR FURTHER WORK

5.1 CONCLUSIONS

Although the described model is fairly based on the QFD tool, it is only characterised by few of its features.

The diversity of the topics, which the Improvement Suggestions cover, together with the different nature of the organisation's Core processes, make apparent the *need for a cross-functional and well tuned evaluating team.*

However, since the WHATs of the HOQ are predefined from the top management and the HOWs are the submitted Ideas themselves, the team's work is narrowed to the sole evaluation of the Ideas. Therefore, only a *general*, but not thorough, *knowledge of the QFD tool is required by the evaluating team.* In any case, it would be useful if at least one member of the cross functional team is well trained and accustomed with the use of QFD. In cases of small organisations, where few suggestions are submitted, fewer people –even one, the quality manager for example, could carry out the evaluation process.

The required time for the evaluation of the Ideas is considered to be relatively small due to the fact that top management predefines the data of a big part of the model. As it was mentioned before, the evaluation team is assigned with the actual evaluation of each Idea against predefined criteria.
When an organisation decides to adopt the model, it might require an amount of time in the introductory phase in order to evaluate all the already submitted and not yet implemented Suggestions. Nevertheless, after that is completed, the process of evaluating and then prioritising each recently submitted Idea is not time consuming at all.

The fact that a QFD matrix bigger than 30x30 would in general worsen the use of the tool (Cohen, 1995), seems that doesn't affect the use of the model. Although this is not based on empirical data, there is a significant potential that the model won't be affected by that characteristic of the QFD tool. That is because the Suggestions are evaluated separately and independently from the rest of the Ideas. Therefore, there is no need for the evaluation team to keep in mind the (possibly) large volume of the other Ideas in order to evaluate the one. The only time, when the evaluation team needs to consider the other Ideas, is when looking for interrelationships among them, at the roof of the HOQ. Still, that doesn't complicate things further, since it requires only a simple decision on whether the two Ideas contradict or compliment each other. That is based solely on the comparison and understanding of each Idea's title, which appears on the HOWs of the matrix.

The model is a combination of numeric and qualitative tool. Important features like the significance of the Suggestion, its cost, its technical difficulty are included and estimated. However, the model doesn't only focus on those. It is not strictly technical. It embraces the human factor, as well. That is reflected on two aspects of the model; the Organisational Ease and the Idea Maturity factor, which the algorithm includes. In that way, qualitative aspects of a Suggestion Scheme, which were not taken into consideration before, participate in the model. The deriving result is that the organisation benefits the most, as both the managers and the raisers of the Ideas are happy. The first, because of the cost

and benefit aspect of the model, the latter because they see their approved Ideas to be implemented in a reasonable time frame.

A dynamic character of the model is reflected on several of its features (ie current and future weighting factors, the continuous evaluation of the submitted Ideas, the Core Processes).

Lastly, no apparent limitations or prerequisites for using the model have occurred while testing it, which would make it not applicable to different kind of organisations or with different volumes of suggestions. This is a good indication for the flexibility of the model.

5.2 SUGGESTIONS FOR FURTHER WORK

The general suggestion would be, of course, to further improve the model!

Nevertheless, the most important and challenging issue, according to the author, would be *to involve the valuable information, which the roof of the HOQ provides, into the algorithm of the model.*
Being able to integrate in the model the nature and the extent, in which the implementation of one suggestion affects the implementation of another one, would automatically add a new insight to the system. The already existing net of interrelationships among the Improvement Suggestions, which was presented in paragraph 4.3.5, Figure 4.9, would then be reflected in the algorithm, as well. That would lead to an improved allocation of the limited available resources. The difference now is that the decision-maker would more clearly see the most beneficial for the organisation net of Ideas to implement. In other words, instead of implementing Opportunities for Improvement individually, complimentary groups of Ideas could be implemented instead, excelling the power of synergy.

Another suggestion for improving the model would be to build software to support and automate it. The users of the model would welcome functions like the following:

- reject the Ideas, which score negatively in the first part of their evaluation against the organisation's Core Processes
- extract the Idea Maturity score
- mark the Ideas, which score outstanding (15)
- place outstanding Ideas in a separate matrix for further thorough evaluation
- rank the Ideas
- insert new columns in the model/HOQ to fit the submission of each new Idea
- update the ranking after the evaluation of each new Idea

A suggestion, which was made by the evaluation team who tested the model with real data, was to assign weighting factors among the components of the Implementation Ease factor.

Also, the Core Processes could be divided into subprocesses. This would provide the model with greater detail, as it would be more apparent which exact part of the Core process is affected by each Idea.

Furthermore, the model is expected to apply and perform equally well in different kind of organisations, regardless their size, the sector they belong to (e.g. public, private, service, industry), or the number of Ideas that are been submitted. The latter involves good potential, since no limitations are apparent at the moment. However, it is not based on empirical data. It is a question, which needs to be further elaborated. Therefore, a final suggestion for further work and a challenge for the model would be to test it with a large number of Ideas and in different kind of organisations.

References

REFERENCES

Aho, A.V., Hopcroft, J.E. and Ullman, J.D. (1983). **Data Structures and Algorithms**. Addison – Wesley Publishing Company

Akao, Yoji & Mizuno, Shigeru (1994) **QFD – The Customer – Driven Approach to Quality Planning and Deployment**, Asian Productivity Organization

Akao, Yoji (1990) **QFD, Integrating Customer Requirements into Product Design,**, Productivity Press

Akao, Yoji (1991) **HOSHIN KANRI, Policy Deployment for Successful TQM**, Productivity Press

Berger, A. (1995). **The Effects of KAIZEN. A journey in Japanese KAIZEN**, The Swedish Work Environment Fund. Tierps Tryckeri – Partner Print, Sweden

Bergman, B. & Klefsjö, B.(1994) **Quality from Customers Needs to Customer Satisfaction**. Studentlitteratur, Lund, Sweden

Bossert, J.L., (1991) **Quality Function Deployment - A practitioner's approach**, ASQC Quality Press

Cohen, Lou (1995) **Quality Function Deployment- How to make QFD work for you**. Engineering Process Improvement Series

Curtis, B., Kranser, H. and Iscoe, N. (1988). **A field study of the Software Design Process for Large Systems. Communications of the ACM**, 31(11):1268-1287.

Dahlgaard, J.J., Kristensen, K. & Kanji, G. (1994) **Advances in Total Quality Management, The Quality Journey**. Carfax Publishing Co, London.

Day, R.G. (1993) **Quality Function Deployment- Linking a Company with Its Customers**, ASQC Quality Press

Deming, W. E. (1986). **Out of the crisis**. Cambridge University Press, Cambridge Massachusetts

Dertouzos, M. L., Lester, R.K., Solow R.M. and the MIT Commission on Industrial Productivity, (1989) **Made in America**, Cambridge, MA: MIT Press

Ekvall, Goran (1976). Creativity at the place of work: Studies of Suggestors and Suggestion Systems in Industry, **Journal of Creative Behaviour** vol. 10, no. 1, 52-54, 70

Eureka, W.E., Ryan, N. E., (1988) **The Customer Driven Company, Managerial Perspectives on QFD**, American Supplier Institute Press

Evans, James & Lindsay, William M. (1996) **The Management and Control of Quality.** West Publishing Company

Gordon, (1993) **Communication of the ACM**, PROJECT ORGANISATION AND MANAGEMENT Vol. 36, No. 10

Gordon, J.R., (1993) **A DIAGNOSTIC APPROACH TO ORGANISATIONAL BEHAVIOUR.** Prentice Hall International Editions

Hauser, J.R., and Clausing, D. (1988) **The House of Quality**. Harvard Business Review, May – June issue, pp 63–73

Heath, J. A. (1994) **A Few Good Ideas for a Good Idea Program**. Quality Progress, January 1994, p.35 – 38

Hunter, M.R., Van Landingham, R.D. (1994), **Listening to the Customer using QFD**. Quality Progress, 27(4):55-59

Imai, M. (1986) KAIZEN. **The key to Japan's Competitive Success**. McGraw – Hill, New York

Karlsson, J. (1995) **Towards a Strategy for Software Requirements** Selection. Licentiate Thesis 513, Department of Computer and Information Science, Linköping University, Sweden

Karlsson, J. and Ryan K. (1997) A **Cost – Value Approach for Prioritizing Requirements**, IEEE Software, 14(5):67-74

Karlsson, J., (1997) **Managing Software Requirements Using Quality Function Deployment**, Software Quality Journal, 6(4):311-325

Karlsson, J., Wohlin, C., Regnell, B. (1998) An Evaluation of Methods for Prioritizing Software Requirements, **Information and Software Technology**, 39(14-15):939-947

Karlsson, Joachim (1998) **A systematic approach for prioritizing software requirements/ Managing Software Requirements Using QFD**. Linkopings Universitet

King, B., (1989) **Better Designs in Half the Time - Implementing QFD in America**, GOAL QPC

Millet, I. And Harker, P. (1990) Globally Effective Questioning in the Analytic Hierarchy Process. **European Journal of Operational Research**, 48 (1): 88-97

Muse and Finster, (1989). **A comparison of Employee Suggestion Systems in Japan and the USA**, University of Wisconsin Working Paper

Pugh, S. (1981) **Concept Selection – A Method that Works**, International Conference on Engineering Design, Iced 81, Rome, Italy

Rydbrink, Carl (1995) Suggestion System as a part of a TQM strategy. Linkopings Universitet

Saaty, T.L., (1980) **The Analytical Hierarchy Process.** McGraw-Hill, Inc.

Sharma, Jitenda (1977). **Why Suggestion Systems often fail**, International Management

Shores, R. (1990) **A TQM Approach to Achieving Manufacturing Excellence**, Milwaukee, WI: ASQC, Quality Press

Sullivan, L. (1986) **Quality Function Deployment**. Quality Progress, June issue, pp. 39-50

Index

Suggestion Raiser:

Executer:

Project number:

Process:

Activity:

Team-marking

Project:

Goal and motivation:

Expected result:

Starting date:

Actions/ measures taken:

Deadline: **Ready:**

Studied effect:

Deadline: **Ready:**

Conclusion:

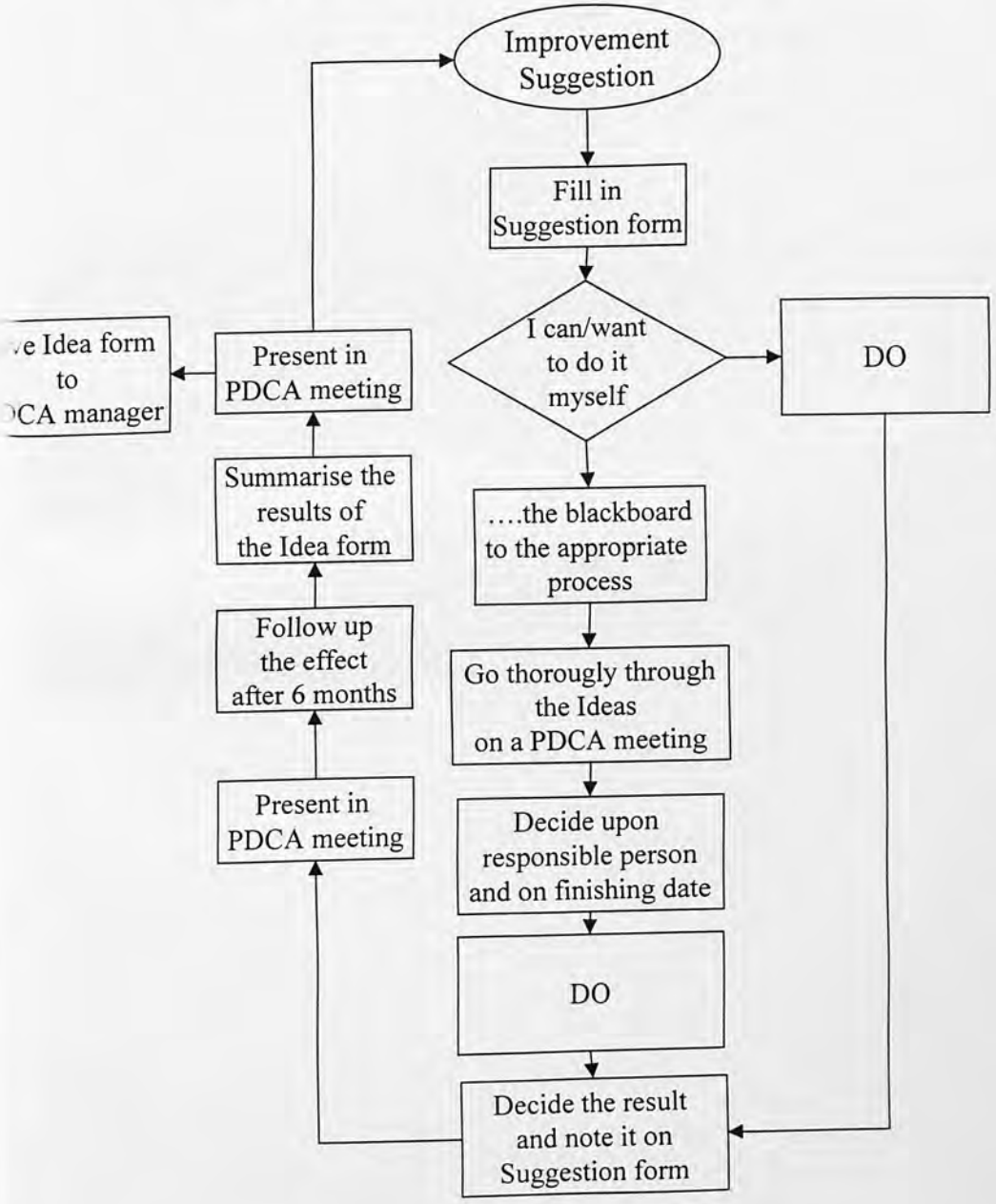
Decisions about permanent actions/measures:

What have we learnt?

Deadline: **Ready:**

Use pen: *Italics* from Idea raiser, rest from project leader.

Improvement process



Department of Mechanical Engineering
Division of Quality Technology and Management

Linköping, 23/3/2000

IMPLEMENTING QFD
IN AN EVALUATION AND PRIORITISATION SYSTEM OF IMPROVEMENT SUGGESTIONS

You are kindly requested to assign numerical weights to the defined Core Processes of the Division. The assigned numbers should add up to 1 and reflect the relative importance of the row items.

CORE PROCESSES	**Relative Weights of Current Importance**	**Relative Weights of Future Importance**
Researcher Education		
Basic Education		
Research		
Networking (Industry)		
	1	**1**

Current Importance Weight	
Future Importance Weight	
	1

Ease of Implementation Weighthing factor	
Idea Maturity Weighting factor	
	1

Thank you for your cooperation!