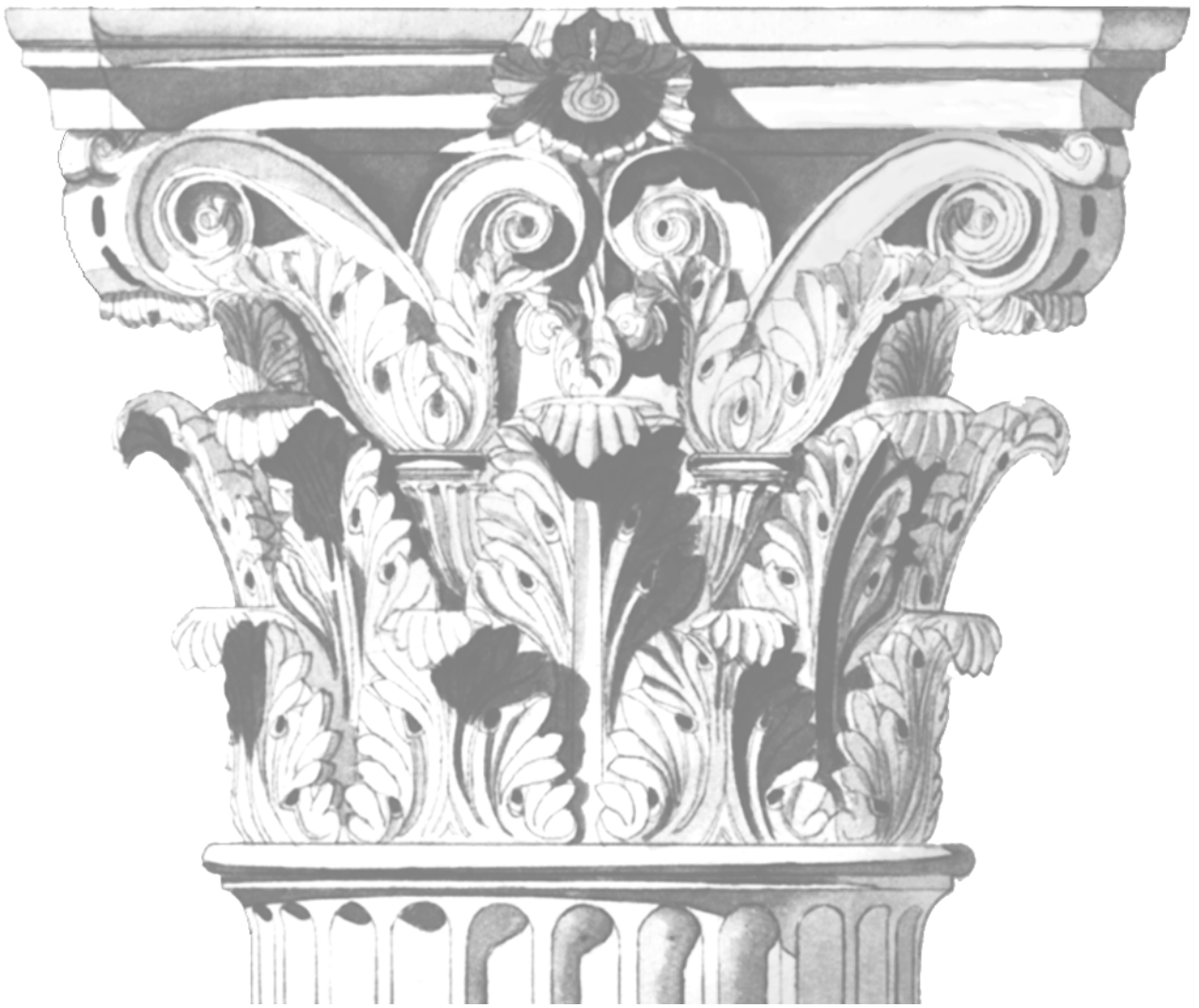
MANAGING QUALITY INSIDE A HIGH-TECHNOLOGY PROJECT ORGANIZATION

TAUNO JOKINEN

Department of Industrial Engineering and Management, University of Oulu

OULU 2004



TAUNO JOKINEN

MANAGING QUALITY INSIDE A HIGH-TECHNOLOGY PROJECT ORGANIZATION

Academic Dissertation to be presented with the assent of the Faculty of Technology, University of Oulu, for public discussion in the Auditorium L2, Linnanmaa, on March 19th, 2004, at 12 noon.

OULUN YLIOPISTO, OULU 2004

Supervised by
Professor Pekka Kess

Reviewed by
Professor Markku Pirjetä
Professor Josu Takala

ISBN 951-42-7300-1 (nid.)
ISBN 951-42-7301-X (PDF) http://herkules.oulu.fi/isbn951427301X/

ISSN 0355-3213 http://herkules.oulu.fi/issn03553213/

OULU UNIVERSITY PRESS
OULU 2004

Jokinen, Tauno, Managing quality inside a high-technology project organization
Department of Industrial Engineering and Management, University of Oulu, P.O.Box 4300, FIN-90014 University of Oulu, Finland
2004
Oulu, Finland

Abstract

This action research addresses the deployment of Total Quality Management (TQM) principles in a high-technology new product development organisation. During the period of study, the organisation grew fast. High-technology product development and hypergrowth provided a unique combination of extreme conditions for the study.

The existing concepts of TQM are presented as an organised map enabling strategic analysis for an implementation plan. The history of TQM dates back to the manufacturing industry. The key differences between product development as an operating environment and the industrial manufacturing environment are described. The deployment of TQM is described from the perspective of learning theories, leadership theories, studies of organisational culture and studies of teamwork. Based on the learning, a psychodynamic model of organisation is presented for better understanding the challenges of implementation.

The results show that, in these specific conditions, organisational culture and leadership are of essential importance for the implementation of TQM. The study also shows that, in the given conditions, TQM is specifically a learning challenge. The results of this study are presented as a framework supporting the selection of TQM implementation objectives and the planning of a strategy for organisational learning.

Keywords: leadership, learning theories, new product development, organisational culture, quality culture, teamwork, Total Quality Management

Acknowledgements

The process of doing empirical research and writing this dissertation has been a learning journey towards TQM, leadership, learning, organizational cultures and teamwork. I have not made journey alone. Many people have coached and inspired me to find the right direction. Some of them have been senior executives and some my subordinates. Those who knew Frank McGovern would agree that he was way above the others as a coach. During the 1990's, Frank was responsible for all manufacturing operations at Nokia Mobile Phones - being one of the most important persons behind the success story. Still, he preferred to call himself "production supervisor". I have had the honour to attend "Frank's university" and to learn his most important lesson: "As managers, we are in the loving and caring business".

Many people have made their knowledge available to me. I have adopted much of the learning described in this study from them. Sometimes I cannot even recognize what is my own learning and what has been taught to me in a subtle way. For such learning, I wish to thank Juha Heikinheimo, Osmo Karhu, Sakari Nikkilä, Mikko Aalto and Erkki Peltola.

Nor have I done the work described in the empirical part alone. For example, the 124 individuals who participated in the Kiehinen leadership program are not only a source of observations concerning leadership and teamwork. The participants have "Walked the Talk"- implementing the acts discussed together. Deep in my heart, I feel that these people will carry out new success stories.

Some people have become my friends during the journey. I want to thank Ari-Pekka Kainu, Markku Metsävuori and Jari Partanen for being such friends. Respect that grew through telephone calls - "consider it done" - means today more than just a trusted colleague.

During the writing process, too, the study was reviewed and commented on. I am grateful to Harri Haapasalo, Lasse Pesonen, Vesa Moilanen and Mirja Peltoniemi for this.

I want to thank professor Pekka Kess for supervising this learning journey through a period of ten years.

I want to thank the pre-examiners of this study, professor Josu Takala from the University of Vaasa and professor Markku Pirjetä from the Tampere University of Technology for their valuable comments and recommendations.

Finally, warm thanks to my wife Mirja Pirinen, my children Päivi, Pia and Suvi, and all my family.

Oulu, March 2004 Tauno Jokinen

Abbreviations

BPI	Business Process Improvement
BPR	Business Process Re-engineering
DOE	Design Of Experiments
FMEA	Failure Mode and Effect Analysis
HR	Human Resources
JIT	Just In Time
MBO	Management By Objectives
MRP	Material Resource Planning
NMT450	Standard for a specific type of analog mobile telephones
PCB	Printed Circuit Board
PDCA	Plan, Do, Check, Act
PMBOK	Project Management Body Of Knowledge
QC	Quality Control
QFD	Quality Function Deployment
R&D	Research and Development
SMD	Surface Mounted Device
TQC	Total Quality Control
TQM	Total Quality Management

Contents

1 Introduction

"Tauno – Do you know what's quality? Select the biggest problem and then remove it. Continue the process for fifty years. Sooner or later you will reach the ISO 9000 certificate; that is not important. One day you will reach the level of quality awards – don't care about that, just continue. I have done it." - Frank McGovern (1993).

1.1 Background of the study

1.1.1 Historical brief of the evolution of Total Quality Management

The modern approach to TQM was established in Japan after World War II. Due to the limited availability of raw materials and other resources, the Japanese economy was forced to improve its efficiency. By adopting a new philosophy (Deming 1986) and such concepts as continuous improvement (Imai 1986), experimental design (Taguchi 1986) and Just in Time production (including the Kanban production control system developed by Toyota during the 1970's) (Hannus 1993), Japanese companies were able to significantly improve their productivity and customer-perceived quality. The Deming Prize was established as early as 1951 (Ishikawa 1985).

Car industry is an example of the consequences. During the 1980's, it was noticed in the western countries that Japanese cars were taking an increasing market share. (Garrity 1993, Hannukainen 1993). This phenomenon was firstly recognized in the USA. The question of what the Japanese were doing in a different way quickly became a concern of interest. Concepts and propheciesy such as those by Crosby (1980), Deming (1986) and Juran (1989), were published.

The Baldrige Award criteria were taken into use in 1988 (Brown 1997) to encourage US companies to improve their performance.

In Europe, Great Britain was an early adopter of quality management. The British standard BS 5750 for quality management was published in 1979, followed by the ISO 9000 in 1989 (Rothery 1993).

ISO 9000 was widely taken into use in Europe during the early 1990's. The underlying paradigm was quality assurance. It was believed that, if all the companies within a supply chain were ISO 9000-certified, that would guarantee the delivery of uniform quality and fault-free products. One important factor behind the quality assurance paradigm was the need of nuclear and other similar industries to somehow protect themselves against their liability for the quality of their total supply chain:

> *"Another important legal aspect is the implications of ISO 9000 in cases of product liability disputes. It helps considerably to avoid claims for damages when both one's individual product and management system are supported by a product standard and by certification that one operates a quality management system to ISO 9000.* (Rothery 1993)."

Since the Finnish Quality Award was established at 1991 and the European Quality Award in 1992, awareness of TQM has also increased in Europe.

During this study from 1992 to 2003, the themes of process improvement (Harrington 1991) and process re-engineering (Davenport 1993), (Hammer & Champy 1995) have emerged. In the late 1990's, the theme of quality cultures emerged (Silén 1995).

In 2003, at the final stage of this study, the explicit concepts of TQM converged into a solid theoretical framework presented by such writers as Feugenbaum (1991), Oakland (1993) and (Dale 1999). However, deployment is still under way, and most companies are still at low levels of implementation (i.e. Silén 1997, 2001).

Besides the evolution of TQM deployment, the scope of the concept has also become more holistic. The origin of TQM has been product and manufacturing-oriented:

> *"In the past three decades Japan has emphasized quality of products, manufacturing them inexpensively and exporting them successfully. However, I want to emphasize that the term quality means quality, and the term extends to the quality of work in offices, in the service-related industries and in the financial sector* (Ishikawa 1985)."

Ishikawa (1985) uses the term Total Quality Control to cover all layers of the concept (Fig. 1). The essence of TQC lies in the central circle, which contains quality assurance narrowly defined, which means doing Quality Control (QC) well for the company's new products. Once the meanings of QC and good quality are clear, the second circle becomes involved. It represents quality defined more broadly, including the questions of how to bring about good sales activities, how to make salesmen better, and how to deal effectively with subcontractors. If the meaning is broadened even further, a third circle emerges. This circle stresses that all phases of work are to be done effectively. It utilizes the PDCA (plan, do, check, act) circle at all levels. This work involves the entire company, each division and each function. Each individual must also be actively involved. (Ishikawa 1985).

How far can a company's QC go in relation to the above three circles? The decision must be made by the chief executive officer. He must then communicate his decision to the entire company. Otherwise, people within the company may start debating unnecessarily about the QC definition. (Ishikawa 1985).

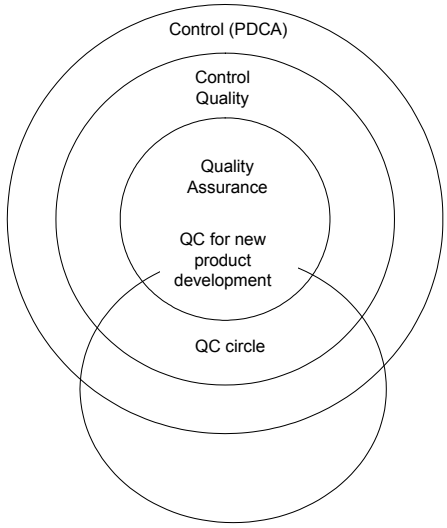


Fig. 1. Company-wide quality control (Ishikawa 1985).

1.1.2 Need for this study

The origin of TQM is manufacturing-oriented. Though the important role of product development is clearly recognized (Ishikawa 1985), product development is typically considered a black box that supplies new products and is to be controlled through the interfaces.

For example, Saraph et al. (1989) conducted a wide literature review to identify the critical factors of quality management. Based on this review, they synthesized a measuring instrument to be used for analysing the maturity of quality management. The instrument was validated through a statistical analysis based on a questionnaire filled in by 162 quality and general managers. They identified product/service design as one of the eight critical success factors of quality management. The items to be studied within product/service development were:

- Thoroughness of new product/service design reviews before the product/service is produced and marketed.
- Coordination between the departments involved in the product/service development process.
- Quality of new products/services emphasized in relation to cost or schedule objectives.
- Clarity of product/service specifications and procedures.
- Extent to which implementation/producibility is considered in the product/service design process.
- Quality emphasis by sales, customer service, marketing and PR personnel.

There is an obvious need for a study of the implementation of TQM within the black box of product development.

1.1.3 Research environment and motivation for the study

The empirical research for this study was done at Nokia Mobile Phones. The research environment was dynamic and characterized by rapid growth, rapid evolution of technology and competition with global companies, such as Motorola, Ericsson, Sony, Philips and Siemens. The author started to work at the product development of Nokia Mobile Phones in 1985. At that time, annual turnover was about 50 M€ and the number of R&D personnel was about 100. The main products were car-mounted mobile telephones and transportable mobile telephones equipped with a heavy battery. The major market areas were Scandinavia, France, England and some Asian countries. At that time, the parent company Nokia was a conglomerate best known for its cable industry, tissues, tyres and rubber boots.

At the beginning of this study, in 1992, the main products of Nokia Mobile Phones were analog hand-portable mobile telephones. Digital mobile telephones were just entering the market. The market position of Nokia Mobile Phones was that of a "global challenger", which had about half of the market share of the leading competitor. By the year 1997, Nokia Mobile Phones reached the market position of the "global master player" equal in strength to its most powerful competitor. At the end of this study, in 2002, Nokia Mobile Phones dominated the market, having twice the market share of its major competitors. Table 1 shows some of the key figures available from the annual reports (Nokia 2004). A comprehensive description of the Nokia revolution was presented by Steinbock (2001).

Table 1. Growth figures of Nokia Mobile Phones.

	1993	1997	2002
Market share	not available	21 %	38 %
Turnover (M€)	1 052 M€	4 607 M€	23 211 M€
% of Nokia turnover	27 %	53 %	77 %
Number of employees	3 759	13 400	26 090

Nokia Mobile Phones received the Finnish Quality Award in 1992. The European Quality Award was given to Nokia Mobile Phones' Europe & Africa division in 2000. The award covered both manufacturing and sales units.

The focus of this study was on product development at Product Development Site Oulu. The site was established in 1985 as the second R&D unit of Nokia Mobile Phones. By the end of the 1980's, the capability to develop complete mobile telephones was achieved, and by the end of this study, Product Development Site Oulu was one of the seven major product development sites, each employing R&D personnel up to 1000 employees. The development of systematic product development practices was started in the late 1980's by defining project milestones and checklists for milestone approval.

Product Development Site Oulu was one of the first units of Nokia Mobile Phones to be ISO 9000-certified.

The motivation for this study arose during the certification process. An effort to improve systematic product development had just been completed when further improvements were requested through the internal audit during the certification process. It was felt that some of the requirements were without practical value. The consequent frustration created a motivation to find out and prove that decisive and business-focused improvement is “the right way” to implement TQM. Through a search for evidence to support this claim, it was learned that, within each line of thinking, there are purists who offer a silver bullet to solve all problems. Equally, within each line of thinking, there are pragmatic proponents with holistic understanding. Such pragmatists combine the multiple approaches to find out practical solutions to the situations at hand. For them, there is no “right way” and no “wrong way”, some efforts to implement TQM are simply more successful than the others. The aim of this study is to identify elements that will increase the probability of success within the product development environment.

The average growth of the turnover of Nokia Mobile Phones has exceeded forty percent annually over a period of more than fifteen years. The increase of production volumes has been even greater due to the decreasing sales prices. During 2002, more than three mobile telephones were produced each second (Nokia 2003). Within the given conditions, the importance of the different dimensions of quality is self-evident; any failure of TQM will have a significant financial impact. For example, during the years when the production volumes were doubled, the number of repair personnel on the production lines and in the after-sales services also had to be doubled (assuming constant failure rates and constant productivity). Doubling the number of personnel annually stretched the capability to hire and train newcomers; in addition to the repair costs, the trend of production yield and the field failure rate also influenced to the unit’s overall capability to meet the market requirement of growth.

Also, the number of R&D personnel at Product Development Site Oulu has grown at the same rate as the turnover. Since the number of experienced telecommunications engineers in the Oulu region has been limited, most of the recruits have been new graduates. During the 1990’s, the average age of the personnel was less than thirty years. The combined effect of technological evolution and rapid growth challenged the learning capability of the organization. The role of the limited number of more experienced members in the organization has been to coach and mentor the newcomers. These conditions have created an organizational culture that emphasizes teamwork and continuous learning. The culture is characterized by minimal power distance and a lack of symbols indicating senior organizational status.

Due to the low average age of the organization, leadership skills have been a special challenge; young individuals with merits in engineering have been appointed to managerial positions. To reinforce leadership capability thorough the organization, different leadership development programs have been carried out.

1.2 Research problem

An observer walking into a mobile telephone factory can immediately identify the value-adding chain. At the beginning of the production line, an automated manipulator is placing empty Printed Circuit Boards (PCB) one by one on the conveyer. The PCB travels through the component placement machines and manual assembly points, until - at the end of the production line - a complete mobile telephone is tested and packaged to be sent to the customers. Looking around, the observer would see plenty of evidence of systematic production control: Planned and realized production volumes on whiteboards, Pareto analyses of different issues on bulletin boards and statistical process control integrated both in the assembly machines and in the automated product testers. At the end of the production line, the observer would notice that the critical performance parameters of each mobile telephone are measured by an automated tester. The units that pass the test are delivered to customers and those that fail are returned to be reworked. The pass/fail rate is called production yield – a critical quality parameter that is carefully monitored.

One day, the completed mobile telephone will be in a retail shop somewhere in the world along with multiple types and brands of other mobile telephones. In the retail shop, the customer will make his first judgement of the quality of the product. He will compare the features of the mobile telephones, the prices and the reputation of the brands – and select one. The observer might notice that the sales person of the retail shop will guide the customer's decision making in a subtle way; he will want to avoid selling products that cause him trouble afterwards.

During the period of use, the customer will continue to judge the quality of the product. He will share his feelings with other customers. Finally, one day, he will make his final judgement; when selecting his next mobile telephone, he will either buy a product of the same brand or a product of a competing brand.

The quality of the product was mostly created in R&D. The decisions concerning product features were made - perhaps years ago - by the product marketing manager of the R&D team. The technology for the unit was selected by research teams and the performance, cost, production yield and product reliability were built in by R&D engineers.

An observer walking into an R&D building cannot see the value-adding process. It would also be difficult to identify how the performance of the R&D process is monitored and controlled. He could proceed as external quality system auditors do: they first ask for the documentation of the R&D process and then interview selected members of the organization. Finally, they make their conclusions and present them to a team of executive members of the organization. The head of the organization receives the report and considers the consequences. What do these findings tell him/her about the performance of his/her organization, and what are the actions that he/she should take to ensure that the quality of products under development would meet the requirements of the customers in the future? The body of knowledge of the actions that could be taken is described in Fig. 2.

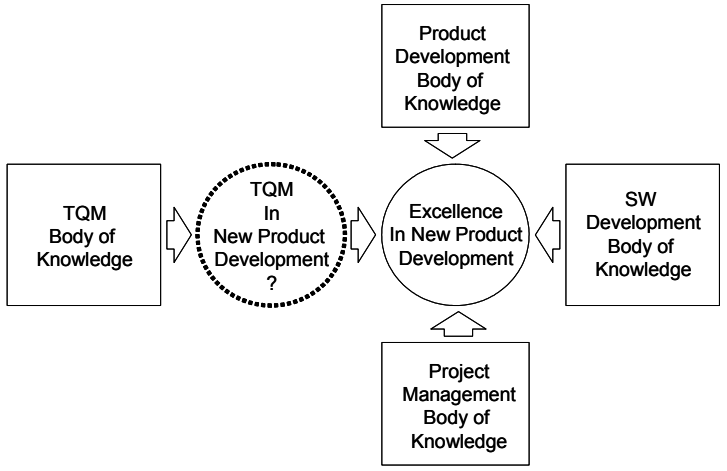


Fig. 2. Framework of existing knowledge related to excellence in new product development.

Kauppinen (1999) was one of the researchers to present a conceptual framework of the product development body of knowledge. The points of discussion related to the product development strategy are: competitive strategy, technology strategy, technology management, competence management, product portfolio management, product life cycles and risk management. The issues related to product development processes are: models and methods, customer orientation, structural organization, knowledge absorption and accelerated development.

The project management body of knowledge was presented by the Project Management Institute (2000). The framework includes generic project management information with no differentiation between new product development and other types of projects. (Fig. 3).

Project Integration	Project Scope	Project Time
Project plan development Project plan execution Overall change control	Initiation Scope planning Scope verification Scope change control	Activity definition Activity sequencing Schedule development
Project Cost	**Project Quality**	**Project H&R**
Resource Planning Cost Estimating Cost Budgeting Cost Control	Quality Planning Quality Assurance Quality Control	Organizational Planning Staff Acquisition Team development
Project Communications	**Project Risk**	**Project Procurement**
Communications Planning Information Distribution Performance Reporting Administrative Closure	Risk Identification Risk Quantification Risk Response Development Risk Response Control	Procurement Planning Solicitation Planning¨ Solicitation Source Selection Contract Administration Contract Closeout

Fig. 3. Overview of project management knowledge (Project Management Institute 2000).

Software development has created its own body of knowledge (Abran et al. 2001). The historical reason for this is that software as a product does not require manufacturing in the ordinary sense.

Quality management is included in all of the above-mentioned topics of discussion. Still, there is no clear idea about the implementation of quality management in new product development.

Based on the above discussion, the research problem of this study can be defined.

Research problem:

How to implement TQM in the product development of a fast growing business in an effective and efficient way?

The aim of this study was not to create a universal concept of TQM in new product development; the study rather approached the research problem through the perspective of organizational learning. The empirical learning in the course of the study is here reflected on through theories of learning, leadership, organizational culture and teamwork with the aim to describe the learning challenges of effective TQM implementation.

The general problem can thus be reformulated as three more focused and specific **research questions:**

Q1: What are the essential concepts of TQM and how to prioritize their implementation?

Q2: How are the concepts of learning, leadership, organizational culture and teamwork linked together within the context of implementing TQM?

Q3: What things are essentially different, while implementing TQM, in a product development environment compared to a manufacturing environment?

1.3 Research approach

Different disciplines have created their own research paradigms. Typically, natural sciences are based on the positivistic research paradigm, while the hermeneutic research paradigm is used within human sciences. Industrial engineering and management use a wide range of paradigms. Research methods consist of a number of techniques used to collect and analyse research data. The most important element while selecting the research method is that the method is compatible with the research paradigm. (Olkkonen 1993).

Burrell & Morgan (1979) described the basic assumptions about the nature of social sciences through five debates:

- Nominalism - realism: the ontological debate,
- anti-positivism - positivism: the epistemological debate,
- voluntarism - determinism: the “human nature” debate,
- ideographic - nomothetic theory: the methodological debate, and
- social order - problems of change, conflict and coercion: the order - conflict debate.

Arbnor & Bjerke (1997) described the creation of methodological approach as a process of combining the theory of science with methodology (Fig. 4). The research paradigm is partially related to the core values of the researcher; understanding one’s basic ultimate presumptions and being able to understand the presumptions of other researchers is a prerequisite to manage the methodology of research. On the other hand, the research paradigm has an influence on the whole research process, including the choice of the research problem and the research methods, the implementation of the research and, finally, the kind of contribution that can be achieved through the research.

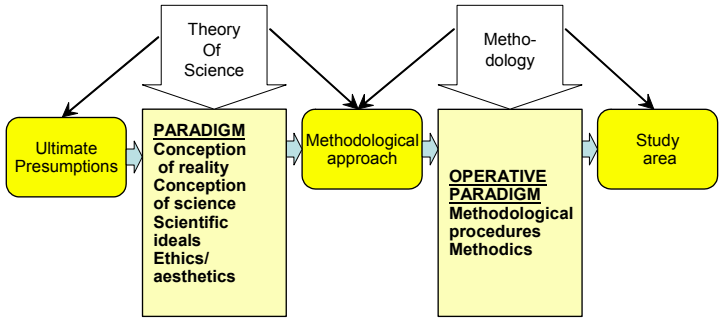


Fig. 4. Constructing a methodological approach (Arbnor & Bjerke 1997).

Arbnor & Bjerke (1997) identified three methodological approaches (analytical, systems and actors approaches) through the debates concerning research paradigms (Fig. 5). The methodological approach of this study is the systems approach. A system consists of a set of components and their mutual relations. Due to the relations, "the whole" is not merely the sum of the components. The analytical approach assumes that "the whole" is the sum of the components. The research problem of this study is of such type that there exist relations between the components of the system; for example, all the four bodies of knowledge presented in Fig. 2 are interrelated in the search for excellence in new product development. Thus, the analytical approach is not a good choice for the research approach of this study. The aim of the study is to create explanatory knowledge concerning the research problem. The aim of the actors approach is to create understanding type of knowledge. Thus, the actors approach is not a good choice for this study, either.

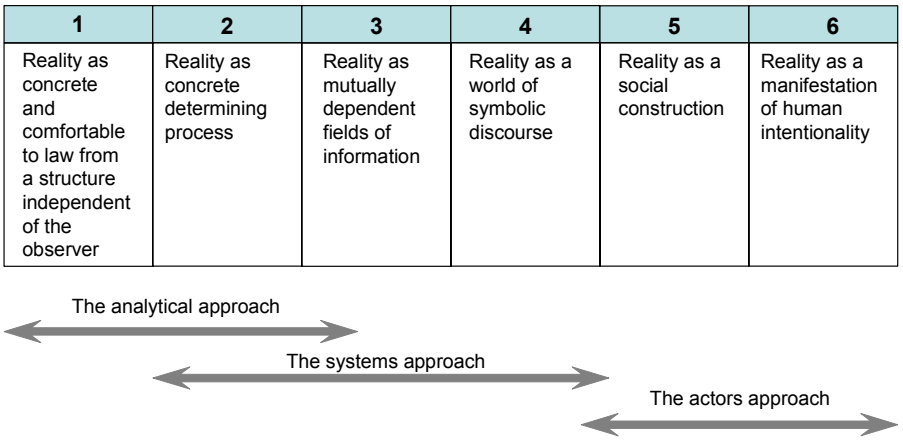


Fig. 5. The three methodological approaches (Arbnor & Bjerke 1997).

Arbnor & Bjerke (1997) described two research orientations within the systems approach: the goal-means orientation and the trial-and-error orientation. The orientation of this study is one of trial-and-error. One way to describe the methodology in a trial-and-

error orientation in the systems approach is to say that it is a step-by-step process with *recurrent analysis and intervention phases*.

From the methodological perspective, the trial-and-error orientation of the systems approach used in this study is commonly described as **action research** or **action science**. Susman and Evered (1978) described the trial-and-error process as a cyclic process (Fig. 6).

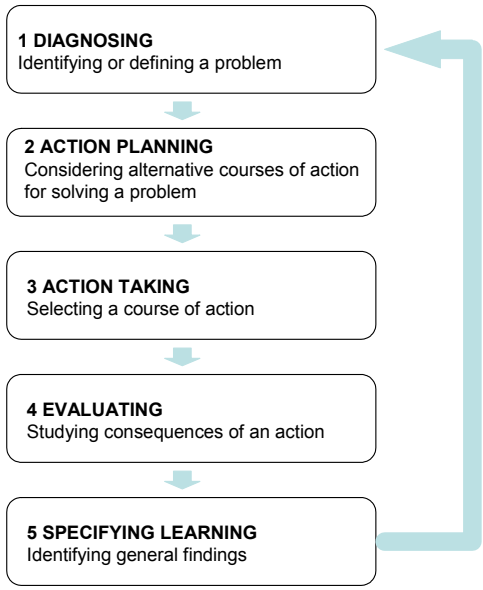


Fig. 6. The cyclic process of action research (Susman and Evered 1978).

Gummesson (2000) described the concept of management action science through ten elements:

1. Action scientists take action. The concept of action science is reserved for situations in which researchers assume the role of change agents in the processes and events they are studying.
2. Action science has dual goals: both to contribute to the client and to contribute to science.
3. Action research is interactive; it requires cooperation between the researchers and the client personnel and continuous adjustment to the new information and the new events. Mainstream researchers may feel uncomfortable with these adjustments because they interfere with their original research design.
4. The understanding gained during an action science project aims to be holistic and to recognize complexities.
5. Action science is applicable to the understanding, planning and implementation of change in business and other organizations.
6. It is essential to understand the ethical framework and the values and norms within which action science is used in a particular project.
7. Action science can include all types of data-generating methods, but requires total involvement of the researcher.

8. Constructively applied preunderstanding of the corporate environment and the conditions of business is essential.
9. Management action science should preferably be conducted in real time, but retrospective action science is also an option.
10. The management action science paradigm requires its own quality criteria.

Though the present research approach was action research, constructive research methods (Järvinen 1999) were used within the action research cycles, and constructions to solve the practical problems were created using the existing theory. The functionality of the constructions was then evaluated through market tests (Kasanen & al. 1991):

- Weak market test: Are actual, economically responsible managers ready to accept the model for use in their decision making in real situations?
- Strong market test: Has the performance of their (economically independent) units improved since the utilization of the new model or construct? Are the results (measured in economic terms) better in the companies using the model?

Based on the results, the constructions have been rejected, improved or reused during subsequent similar situations. The created constructions have been used as training materials and further tested for their practical value for trainees. Still, the aim of the constructive research method was not to create and validate novel scientific knowledge. The value of the constructions lies more in the documentation of the learning process of the action research approach.

1.4 Research process

The empirical part of this work was conducted during the period from 1992 to 2002. Action research involves two goals: to solve a problem for the client and to make a scientific contribution. The research process of the empirical studies is presented schematically in Fig. 7. The basic steps within each research cycle were as follows:

- During the first phase, the given research environment is diagnosed and an understanding of the practical problem is created. Within this phase, a preliminary action plan is created as a working hypothesis.
- The stage of recursive planning was typically followed by an action-taking phase: taking actions, evaluating and taking further actions and thus incrementally solving the problem.
- Through incremental problem solving, the hypothesis was verified and improved, leading to lessons learned and increasing the cumulative learning.

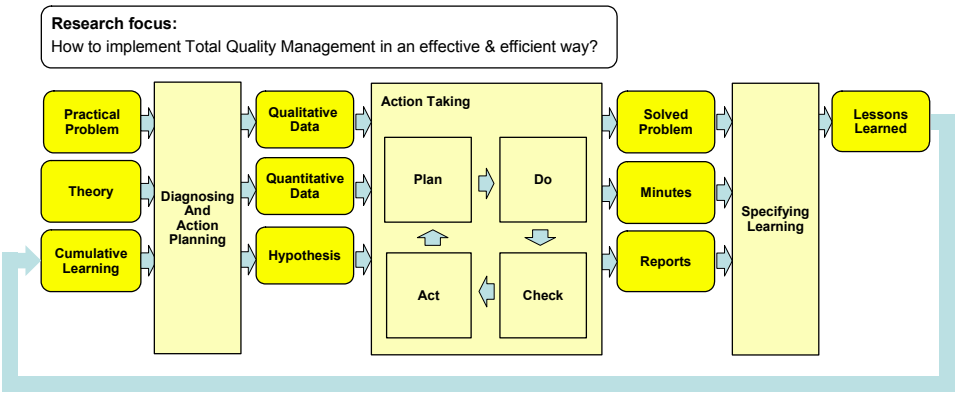


Fig. 7. The empirical research process.

There are multiple methods available to verify learning:

- Subjective judgement – have the created models and constructions helped to solve the problems?
- Team evaluation – organized specific lessons learned in workshops.
- Social evaluation – how enthusiastic have other people been about the model and constructions?
- Market test evaluation (Kasanen et al. 1991) – has the concept been copied and adopted into use by other people and organizations?

One of the characteristics of action research is that it aims at holistic understanding (Gummesson 2000). The given practical problems have not been categorized into specific scientific domains of theoretical discourses, and the theories used to create hypotheses have therefore been interdisciplinary.

This research report is based on cumulative learning (Fig. 8). Through a review of the literature, a review of related theories was compiled. The empirical studies are reported as descriptive narratives. The aim of the description of empirical studies is to enable critical analysis of this research report - to help the reader to evaluate the chain of logic from the research problem to the contribution. The process of constructing the research report has been an interactive dialogue between the theory and the empirical material. Cumulative learning has been reflected on through the theory, thus achieving further understanding of the empirically gathered knowledge. Coghlan & Brannick (2002) describe this process:

> *"Action researchers are often surprised at what happens during the writing of a dissertation. Experience shows that the writing up period is a whole new learning experience. It is where the synthesis and integration take place. From what have hitherto been isolated masses of details of meetings, events, organizational data, notes on scraps of paper and disks, notes from books and articles, a new reality emerges. Things begin to make sense and meanings form. Writing the story is key to synthesis. You are likely to have far more detail than you need or can use. Therefore, as you begin to select what to include and exclude, you are beginning to form a view of what is important in the story. You are at the next stage of reflective practice and indeed of*

action research itself. The writing project becomes an action research project as you engage in cycles of writing, reflecting, understanding how what you have written fits into the whole, and the writing further. It is far from being mechanistic task of writing up your notes."

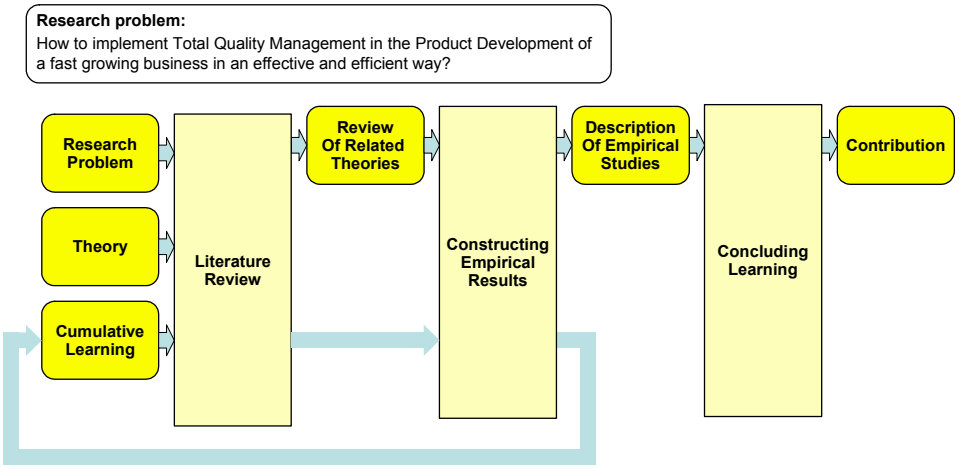


Fig. 8. Constructing a research report.

1.5 Research material

Since cumulative learning has been taking place during a period of ten years, documentation of the research results is important:

- Handwritten notes made during the study period give valuable information about the specific practical problems encountered and the formulation of hypotheses to solve these problems.
- The planning documentation with specific objectives, analyses of quantitative data and action plans further enable the researcher to recall the formulation of hypotheses.
- The strategy documentation by the company enables the researcher to recall the qualitative objectives and policies during the research. Memorandums of interviews and workshops enable recall of the qualitative data used during the pre-study phases.
- Access to specific quantitative data, such as business results, employee opinion surveys, warranty costs, production yields, etc. enables the researcher to evaluate the impact of actions taken.
- The minutes of follow-up meetings and reports enable recall of the implementation of actions.
- The training material produced based on the lessons learned enables recall of the learning process.

A valuable source of information is the material that is directly related to the research and has been published (Table 2). Apart from the seven graduate theses, there are also two books related to the study: Kivimäki-Kuitunen & Kiehinen II (2000) describe the implementation of and the key learning in the Kiehinen leadership development program. The TQM activities of Nokia Mobile Phones Product Development Site are used as a case example by Silén (2001). Besides providing another access to the details of the research cycles, these references also give the reader a second opinion.

Table 2. Published material related to the research.

Research cycle	Brief description of the research cycle	Published material
Research cycle 1	Establishing a new R&D organization. Creating operative strategy. Establishing basic quality management practices. ISO 9000 registration and identification of the preliminary research problem.	
Research cycle 2	Verifying the learning of research cycle 1 within a manufacturing environment. Learning the differences between the manufacturing paradigm and the product development paradigm.	Mattila (1994)* Piiponniemi (1994)*
Research cycle 3	Verifying learning from the facilitator's perspective. Studying management as a set of systematic practices. Meeting the challenge that TQM is more than just concepts.	Tuomaala (1997)* Hietaniemi (1997)*
Research cycle 4	Implementing the learning through management quality towards product quality. Identifying the situational and cultural elements of quality management.	Kilpinen (1999) * Kivelä (1999)* Kivimäki-Kuitunen & Kiehinen II (2000)** Silén (2001)** Salo (2001)*

* graduate thesis ** publication

1.6 Scope and limitations of the research

1.6.1 Concept of TQM

This dissertation approaches TQM as a system (Fig. 9). Some elements of that system are under the control of companies – the following are some examples:

- Salaried employees
- Machines and automation owned by the company
- Processes created by the company

Some elements of that system are out of the control of the companies, including:

- Infrastructure created by governments
- Laws and regulations

The line between these two subsystems is not straightforward: The company may or may not be subject to some government control, and vice versa, salaried employees are not totally under corporate control.

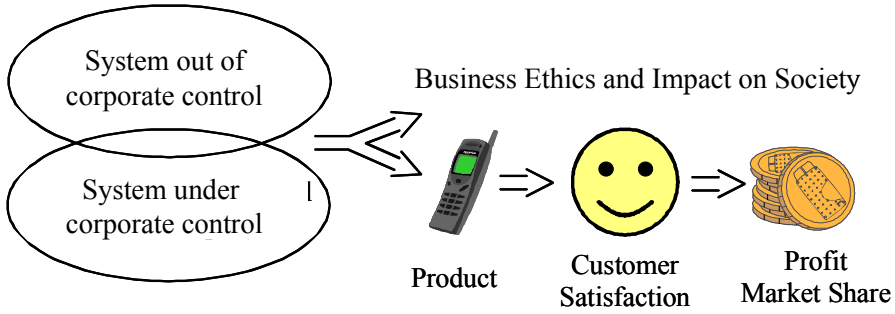


Fig. 9. TQM as a system.

The aim of TQM is long-term competitiveness measured by profitability and market share:

> *"Improvement of quality transfers waste of man-hours and of machine time into the manufacture of good product and better service. The result is chain reaction – lower costs, better competitive position, happier people on the job, jobs, and more jobs* (Deming 1986)."

> *"We start with the premise that all managers want their company to produce products of high quality and do so at low cost. They want at least their company to be competitive, and preferably to be the industry quality leader* (Juran 1989)".

Customer satisfaction is commonly seen as the critical intermediate result for achieving long-term competitiveness:

> *"Total quality control is an effective system for integrating the quality-development, quality-maintenance, and quality-improvement efforts of the various groups in an organization so as to enable marketing, engineering, production, and service at the most economical levels which allows for full customer satisfaction* (Feugenbaum 1991)."

Customers' perception of quality is based on the products created by the system.
In this context, 'product' should be understood in a wide sense, including services and the image value created by the companies. This element of quality could be called product quality:

"Reaching agreement about what is meant by quality is not simple. (The dictionary lists about a dozen definitions.) For managers no short definition is really precise, but one such definition has received wide acceptance: quality is fitness for use (Juran,1989)."

"In the phrase "quality control," then, the word "quality" does not have the popular meaning of "best" in any abstract sense. To industry, it means "best for satisfying certain customer conditions," whether the product is tangible (an automobile, a refrigerator, a microwave oven) or intangible (bus route schedule, restaurant service, hospital care) (Feugenbaum 1991)."

"Important among these customer conditions are (1) the actual end use and (2) the selling price of the product or service (Feugenbaum 1991)."

Feugenbaum (1991) describes ten dimensions of product quality:

1. Specification of dimensions and operating characteristics,
2. life and reliability objectives,
3. safety requirements,
4. relevant standards,
5. engineering, manufacturing and quality costs,
6. production conditions under which the article is manufactured,
7. field installation and maintenance and service objectives,
8. energy utilization and material conservation factors,
9. environmental and other "side" effects and
10. costs of customer operation and use and product service.

Ethical issues and impact on society are essentially linked with TQM:

"Quality is an ethic (Feugenbaum 1991)."

"Quality is the loss a product causes to society after being shipped, other than any losses caused by its intrinsic functions (Taguchi 1986)."

Business ethics and impact on society may have a positive effect on long-term profitability in some cases. Still, there are situations when these two are contradictory. Companies need to consider the role of ethics as one deliverable of their TQM system and to find an appropriate balance between profit and business ethics.

1.6.2 Interfacing theories

The focus of this study is on TQM. Through a literature review, the essential concepts of TQM were identified and constructed as a framework. The related theories: leadership, learning, organizational cultures and teamwork were studied through their relevance to TQM. (Fig. 10).

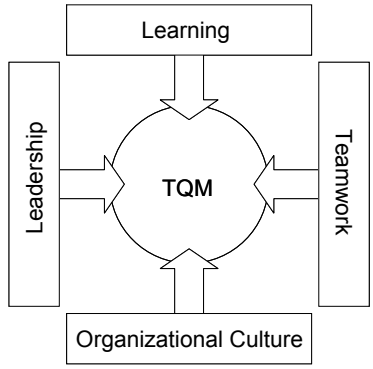


Fig. 10. Schematic presentation of the theories of the study.

The rationale for choosing leadership and teamwork as two of the interfacing theories was based on the author's empirical experience of leadership development. Teamwork had an important role in the training. For practical needs, the author was also familiar with the theoretical frameworks of leadership and teamwork before the writing phase of this study. Organizational culture was chosen as one of the interfacing theories because it is essentially related to the concept of quality culture; studies of quality culture were a crucial element of the empirical studies. The choice of learning perspective was obvious; training and competence development played a central role in the empirical studies.

Though the author's personal motivation had an impact on the choice of interfacing theories, the choices also reflect the practical challenges of the organization under study. Other choices of interfacing theories would certainly also have been possible. Inclusion of the theories of strategic management, knowledge management, change management and HR management as interfacing theories would have resulted in different conclusions – these perspectives are briefly discussed in chapter 4.5 (Further discussion).

1.6.3 Limitations

Reviewing the studies concerning fast growth of companies would give valuable information about the existing scientific knowledge about the characteristics of such business environment that is described in the empirical part of this study. Identifying the essential differences of fast growing companies and companies characterized by more mature growth would benefit the discussion of external validity of this study. Anyhow, the theories of fast growth are left out of the scope; accepting that the validation of the results of this study in conditions other than product development of fast growing business will be left for further research.

Such essential concepts as reliability and advanced statistical methods are relevant for quality management especially within product development context; however they are not within the scope of this work.

Quality management of software development is also out of the scope of this work, justified by the fact that software quality management has been developed through a path of much of its own.

One conviction of business process re-engineering considers information technology as a central lever of process management. The contribution of that approach is not discussed in this study,

Such relevant areas of theories as strategic management, change management, learning organizations, human resource management and knowledge management are left out of the scope of the study - for the practical reasons to keep at least some focus within this work.

1.6.4 Research assumptions

It is assumed that the marketplace is an environment where customers are making choices between the different products available.

It is assumed that the TQM concept is used by companies that aim to be winners in the competitive marketplace.

It is assumed that the TQM concept is used to improve the company's performance in the marketplace.

It is assumed that the company's performance is measured by the short and long-term business results compared to the competitors' business performance.

It is assumed that the outcome of a company is a product of some kind. The product always includes some intangible elements, such as service and brand. In some cases the product also includes physical goods.

It is assumed that the customer is an individual or another company that pays money for the product.

It is assumed that the quality of the product is judged by the customers. The customers are willing to pay more if the product is of good quality. The quality of the product is proportional to competitors' supply on the same marketplace measured by given preferences of the customers.

1.7 Related works

Based on Kujala (2002), academic research on quality management can be classified into the following categories:

- Historical analysis of the development and diffusion of the TQM discipline,
- empirical studies on the impact of TQM on operational or financial performance,
- defining quality, TQM constructs and analysis of TQM critical factors.
- theoretical analysis of TQM that draw on organizational theory and
- TQM and organizational culture.

Of these categories, empirical research on the impact of TQM on operational or financial performance is closely related to the research problem of this study.

Both Dale (1999) and Kujala (2002) have reviewed studies focusing on the business performance of quality award winners. Dale implicitly concludes that the research shows a clear correlation between TQM implementation and performance. Kujala concludes that there is only limited evidence of such correlation.

A sample of similar research was reviewed in this study:

- The study of Chang & Lu (1995) and Badri & Davis (1995) on the level of TQM implementation using the measurement instrument created by Saraph et al. (1989).
- The study of Ollila (1995) on the impact of ISO 9001 on customers' perception of product and service quality.
- The study of Youssef et al. (1996) on the impact of TQM on firms' responsiveness.
- The study of Huff et al. (1996) on the relationship between quality and productivity using a sample of 74 firms in 16 industries.
- The study of Hendricks et al. (1997) comparing the business performance of Quality Award winners with that of companies of similar characteristics, using a sample of 463 firms.
- The study of Tervonen (2001) on the motives of TQM implementation, the effects of comprehensive use of TQM, the influence of the duration of quality development and the implementation and success of the essential methods of quality development.

Critical consideration of these studies supports the conservative conclusions of Kujala (2002):

> *"Based on the research done in this category, one can conclude that there is only limited support regarding the effect of TQM practices for organizational performance in general applications. Some research results of empirical studies on TQM's impact on operational and financial performance suggest that implementation of successful TQM program has positive correlation to operational and financial performance. However, they do not provide evidence that TQM implementation program is source of competitive advantage leading to better competitive advantage."*

Analysis of the correlation between TQM implementation and business performance is methodologically challenging: First of all, efforts to apply quantitative measures to the level of TQM implementation constitute one source of uncertainty. Equally, creating a method to identify the impact of TQM implementation on business performance is another source of uncertainty.

It is important to notice that, though the positivistic debate about the financial impact of TQM remains at the level of verifying the existence of any such impact, it also means a lack of evidence to disprove the existence of such impact.

From the point of view of this study, before this branch of research can be used to identify effective and efficient methods to implement TQM in new product development, further research is needed.

Several dissertations have been published using Nokia Mobile Phones product development as a central source of empirical material:

- Kinnula (1999) studied software process management.
- Pesonen (2001) studied proactive profitability calculations within new product development.
- Luiro (2003) studied acquisition and analysis of performance data for mobile devices.
- Maunu (2003) studied supplier satisfaction.

Further extending the scope of search, there is a wide range of relevant research focusing on different aspects of product development and project management, including the following:

- Kulvik (1977) studied the underlying success factors of new product development.
- Leppälä (1995) studied project management practices within a contract research laboratory.

1.8 Outline of the dissertation

Chapter 1 begins by setting the stage of this study; the evolution of TQM is briefly discussed, and the research environment is described. The research problem is defined, and the philosophical pre-assumptions are discussed, followed by the choice of the research approach. The concept of TQM, as used within this study, is defined. Also, the scope and limitations of the study are discussed. Finally, related studies are reviewed.

In chapter 2, the essential concepts of TQM are first introduced and summarized as a preliminary answer to the research sub-question Q1. Next, the selected interfacing theories are introduced and summarized as a preliminary answer to the research sub-question Q2.

Chapter 3 describes the learning journey of the empirical studies. The learning journey is divided into four research cycles, each starting with the definition of a practical problem to be solved and ending up with an evaluation of the learning accomplished during the research cycle. The reader is guided through the learning journey via episodes – snapshots of what happened during the study. At the end of the chapter, the practical learning is summarized.

In chapter 4, the essential learning is summarized, and each of the research questions is answered. The validity, reliability and generalizability of the results are discussed.

2 Theoretical framework

2.1 Concepts of TQM

Kanji & Asher (1996) described 100 methods for TQM. Still, their book does not include all the concepts to be described in this study; the available concepts of TQM make up a toolbox. The challenge in implementing TQM is the need to select and implement proper tools in each specific situation. In any given situation, the maturity of the organization's quality culture defines the concepts that the organization is capable of using efficiently. The editorial work of Dale (1999) gives a solid structure and basis for the concepts of TQM.

The research environment is a high-technology product development organization, where value-added work is organized as projects. The project level is one of the perspectives of the study. The project portfolio is managed at the organizational level. Such tasks as managing strategy, human resources, quality and processes belong to the organizational level. (Fig. 11).

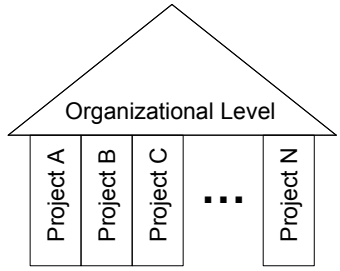


Fig. 11. Organizational perspective and project perspective for the study.

2.1.1 ISO 9000

ISO 9000 is a set of universal standards for a quality management system. It is widely accepted as a starting point for the creation of a TQM system.

> *"In 'uncommitted organizations', the ISO 9000 series of quality management systems will be seen by the employees as a quality system rather than a management tool. The Quality Department will be driving the quality management system, and the keeping of the ISO 9000 series registration is totally dependent upon their efforts*" (Dale et al. 1994).

> *"In 'drifter organizations' management has unrealistic expectations of ISO 9000 and fails to distinguish between meeting a particular standard and TQM*" (Dale et al. 1994).

The well recognized problem seems to be the lack of integration between quality management and business management (Fig. 12). Within the ISO 9000:2000 revision, the paradigm of externally set criteria has clearly changed towards an internally created TQM system: Explicit evidence of this is the change in the terms and definitions of ISO 9001:2000:

> *"The term 'organization' replaces the term 'supplier' used in ISO 9001:1994, and refers to the unit to which the international standard applies* (SFS-EN ISO 9001 2001)."

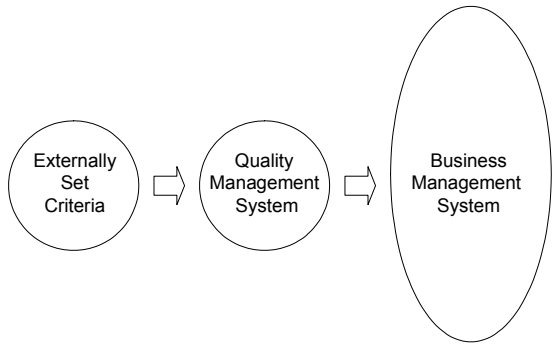


Fig. 12. Unintegrated quality management system.

The implementation of an ISO 9000-based quality management system is discussed through three topics:

1. Managing the quality system, with a specific focus on quality management practices,
2. generic basic practices, which are not specific to any organizational function, and
3. product development-specific practices.

Managing the quality management system

The standard includes one specific element that needs to be considered as an additional requirement compared to generic good management; the management needs to be prepared to **show evidence** of implementing (reasonable) good management practices. This requirement can be implemented by writing minutes of a limited set of management forums and managing a limited set of documentation called "quality records".

The basic requirements for managing the quality management system are (SFS-EN ISO 9001 2001):

- practice of management review,
- management representative,
- quality policy and quality objectives
- quality manual and
- internal auditing.

Quoting Juran (1989) and his statement on the essential role of quality council, a practical way to implement the requirement for management review is a regular practice of quality board meetings. The members of the quality board should be executive and senior managers. The quality board practice is a sustainable method to integrate business strategy and quality management at any level of TQM ambition.

The quality board should appoint a management representative, typically a quality manager.

Through establishing a quality policy, the quality board defines how the term 'quality' is understood within the company. Once 'quality' has been defined, specific quality objectives should be set.

When these three basic steps have been implemented, it is typically the task of the quality manager to organize the quality board meetings. Based on SFS-EN ISO 9001 (2001), the agenda of the meeting should include such issues as:

- results of internal and external audits,
- customer feedback,
- process performance and product conformity,
- status of preventive and corrective actions,
- follow-up actions motivated by previous management reviews,
- changes that could affect the quality management system and
- recommendations for improvement.

From the perspective of showing evidence, the minutes of quality board meetings and attachments of the discussed topics are enough to meet most requirements at the organizational level (Fig. 11).

The next explicit requirement is a quality manual. Within the simplest format, the quality manual can be a web-site including the scope definition of the quality management system, references to other applicable standards, quality policy and links to the company's standard operating procedures. If efficiently implemented, this process can provide access to policies, processes, practices, tools, templates and relevant information of the organization.

The final explicit requirement of ISO 9000 is the practice of internal auditing. If effectively managed by the management board, auditing has the clear focus of implementing business strategy. Audit results are consolidated into relevant information for the quality board in such a way that they can be used within the organization's actual decision-making process with equal value compared to any other data of the management information system.

By implementing the closed-loop management system for quality management described above, the requirements of SFS-EN ISO 9001 (2001) for continual improvement, corrective actions and preventive actions can be met.

Generic basic practices

The requirements for generic practices applicable to all functions within SFS-EN ISO 9001 (2001) include implementation of:

- managing competence,
- managing processes,
- practices for traceability,
- managing the accuracy of test equipment,
- document control (implicitly),
- managing customer-specific requirements (slightly specific to the marketing function),
- managing purchasing (slightly specific to the sourcing and purchasing function), and
- managing product realization (slightly specific to manufacturing).

With the above-mentioned practice of a closed-loop quality management system, these basic practices can be first implemented in the form of "continual improvement" projects (prioritized, based on business needs) and then monitored and further improved.

Product development-specific practices

Within chapter *7.3.1 Design and development planning* (SFS-EN ISO 9001 2001), the requirement for staged product development is explicitly stated. Based on the explicitly stated requirement for specific reviews and approvals, at least the following milestones are needed:

Project plan approval, including:

- determination of project stages
- determination of reviewing, verification and validation
- project organization and roles and responsibilities

Requirement approval, including:

- functional and performance requirements
- statutory and regulatory requirements
- lessons learned from previous products
- other essential requirements

Approval of development outputs; the outputs must:

- meet the requirements,
- provide the necessary information for purchasing, production and service provision,

– contain or reference product acceptance criteria, and
– specify the criteria for safe and proper use.

Design and development validation, including:

– product approval based on a verification plan
– records of the results of validation
– possible corrective action plans

Additionally, two specific practices are required: design verification and control of design and development changes.

2.1.2 Advanced quality standards

QS 9000 is a quality system standard developed in the USA in 1994 by a team consisting of representatives of three big automotive manufacturers - Ford, General Motors and Daimler Chrysler. (Fong & Antony 2001). The standard is fundamentally a suite of documents including a quality system assessment guide, an advanced product quality planning manual, a potential failure mode and effect analysis reference manual, a measurement or gauge capability study manual and a fundamental statistical control reference manual (Fong & Antony 2001). QS 9000 takes many of the ISO 9000 elements and turns them into requirements (Zuckerman 1996).

TL 9000 was created 1998 by the Quality Excellence for Suppliers of Telecommunications (Quest) Forum, following the example of automotive industry. TL 9000 is clearly planned to serve as an extension to ISO 9000. The specific element of this standard is standardized measurements to be used by all registered companies, providing a large repository of performance data. (Hutchison 2000, 2001).

Within the project management domain, PMBOK (Project Management Institute 2000) is kind of *de facto* standard in defining the knowledge areas and processes of project management.

2.1.3 Continuous Improvement

Continuous improvement simply means the establishment of a loop to identify the biggest problem, to remove it and to resume the process. The Deming cycle – Plan, Do, Check, Act - is mentioned in most quality-related references. Deming (1986) attributes it to Shewhard. Juran (1989) defines quality improvement as projects with breakthrough characteristics. Imai (1986) uses two terms – Kaizen and Innovation. Through innovation, breakthrough improvements are achieved, but unless the results are maintained through Kaizen, i.e. continuous small-scale improvement, the achievements will decline.
Imai (1986) and Hannukainen (1993) describe continuous improvement at three organizational levels:

1. At the management level, continuous improvement means implementation of focused improvement projects. Besides actual improvement, such projects are important for convincing the other parts of the organization that the management really takes continuous improvement seriously. Management-driven improvement projects are also important due to the cross-functional character of many of the problems to be solved (Imai 1996, Juran 1989).
2. Within organizationally empowered improvement, teams have an important role. The knowledge of the members of such teams is practical, leading to a great potential for good solutions. Participation in improvement also has a positive impact on commitment. Sometimes such improvement teams are called quality circles (Imai 1996).
3. Initiative programs constitute the third level of continuous improvement. Especially Japanese companies have successfully used such programs (Imai 1996).

2.1.4 Quality Tools

The most frequently mentioned quality tools are as follows:

Quality Function Deployment (QFD) is a technique or discipline commonly used to identify customer needs and to transfer them to technical specifications. As such, it can be seen as a tool supporting cross-functional teamwork between marketing and product development people. The tool includes the use of a specific QFD matrix called “house of quality”. When fully implemented, the technical specifications (the output of the first QFD matrix) are transferred to the input of the second stage for defining “critical art characteristics”. Within the third stage, the “critical part characteristics” are transferred to the process requirements. (Kanji & Asher 1996).

Design of Experiments (DOE) is used for the optimization of products and processes, which may involve several factors (Kanji & Asher 1996). The method is often also called the Taguchi method. Specific orthogonal matrixes are used to minimize the number of required experiments. (Taguchi 1986, Karjalainen 1990).

Failure Mode and Effect Analysis (FMEA) enables structured assessment of possible failures and indicates the areas to be investigated first. Risk Priority Number (RPN), composed of Occurrence, Severity and Detection, is used for prioritization. Like QFD, FMEA can also be considered a tool supporting cross-functional teamwork. FMEA includes several stages: System FMEA, Design FMEA, Process FMEA and Service FMEA. (Kanji & Asher 1996).

Seven-Step Problem Solving is a tool for systematic problem solving. According to Kume (1989), the process includes following steps: problem definition, observations, analysis, action, checking the effectiveness of the actions, standardization and conclusions. Quality Improvement Story is a documentation of the process.

Six-Sigma is a process using a wide range of advanced statistical techniques in a systematic way for problem solving and product/process improvement. The six-Sigma process includes five steps: Define, measure, analyze, improve and control. (Forrest & Breyfogle III 1999, Karjalainen & Karjalainen 2002).

Hoshin planning is a strategic planning method outlined at Bridgestone Tire Company in Japan in the 1960's. It is currently used by almost every Japanese company that has won the Deming Prize. Also, several American companies that adopted Management by Objectives (MBO) have given up that process and switched to Hoshin Kanri type planning. In essence, Hoshin Kanri means management of objectives in contrast to management by objectives as practised in the Western corporate environment (Soin 1993).

2.1.5 Statistical process control

The initial step towards not shipping defective products is the need to emphasize inspection as a method of quality assurance. However, if defective products are produced at different stages of the manufacturing process, even strict inspection fails to eliminate them. The focus of statistical process control is to control the factors in a particular process and not to produce defective products at the very beginning. (Ishikawa 1985).

Statistical process control is commonly implemented using a limited set of simple statistical tools. Kume (1985) describes the cause-and-effect diagram, Pareto analysis, histograms, scatter diagrams and control charts. The tools are simple because they are intended to be used by the employees on the production lines.

The cause-and-effect diagram is also called "Ishikawa diagram" and "fishbone diagram". The effect is considered to be the head, and the potential causes and sub-causes of the problem or quality characteristic/condition to be the bone structure of the fish (Fig. 13). Cause-and-effect diagrams are typically used by quality circles, quality improvement teams, problem-solving teams, etc., as part of brainstorming to elicit ideas and opinions about the possible major cause(s) of the problem and, subsequently, to offer recommendations to resolve or counteract the problem. (Dale & Shaw 1999).

Pareto analysis (Fig. 13) is used to prioritize problems of any type, e.g. problems due to quality, production, stock control, sickness, absenteeism, accident occurrence and resource allocation. The analysis highlights the fact that most problems are due to a few causes and indicates what problems should be solved and in what order. (Dale & Shaw 1999).

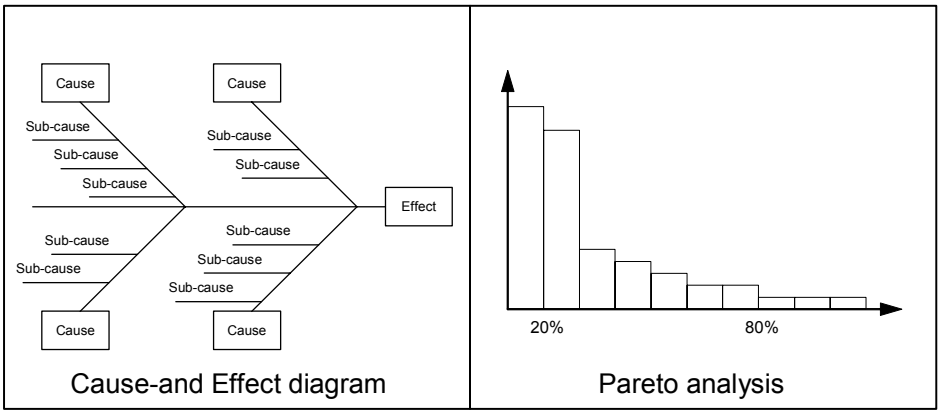


Fig. 13. Cause-and-effect diagram and Pareto analysis.

Histograms (Fig. 14) show, in a pectoral way, the frequency at which a certain value or group occurs. They can be used to display both attribute and variable data and are an effective means of letting the people who operate the processes know the results of their efforts. (Oakland & Porter 1995).

Scatter diagrams (Fig. 14) establish the association, if any, between two parameters or factors. A technique to begin such an analysis is a simple X-Y plot of the two sets of data. The resulting grouping of points on scatter diagrams will reveal whether or not a strong or weak, positive or negative, correlation exists between the parameters. The diagrams are simple to construct and easy to interpret, and the absence of correlation can be equally revealing as the finding that a relationship exists. (Oakland & Porter 1995).

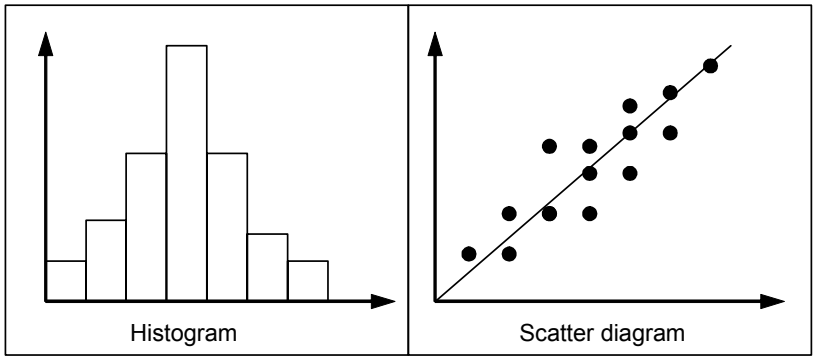


Fig. 14. Histogram and scatter diagram.

Control chart (Fig. 15) is used when monitoring a process to detect changes, or when a change has been made in process inputs to find out whether the mean or the range changes. Control chart can be used to monitor variables when the values can vary over a continuous range, and when the sample size at each sampling point is greater than 1.

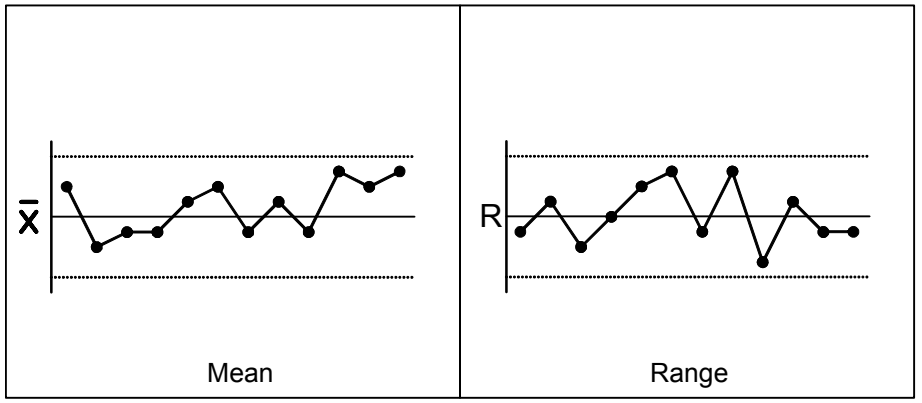


Fig. 15. Control chart.

2.1.6 Process Management

The basic definition of a process is simple. It is a series of steps that convert inputs into outputs (Burkett 1995). One essential element of process approaches compared to traditional management practices is the emphasized horizontal information flow. The fundamental part of any process approach is a customer-focused, value-added chain of activities. The performance of processes will be measured by the customer's standards rather than by traditional functional objectives. Davenport (1993), for example, describes new product development as a value-adding chain, which involves research & development, marketing and manufacturing functions (Fig 16).

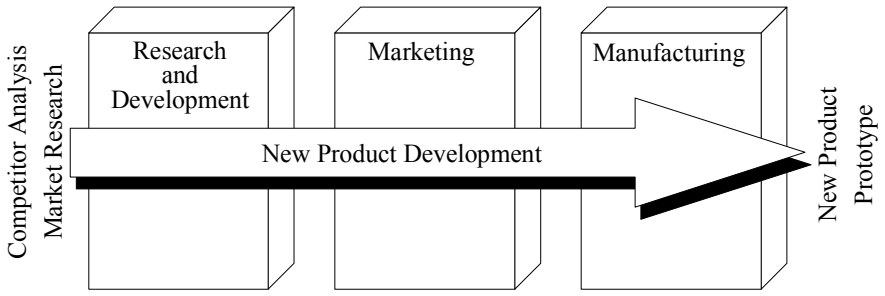


Fig. 16. New product development as a process (Davenport 1993).

Davenport (1994) identifies three basic strategies for process management: TQM, Business Process Improvement (BPI) and Business Process Re-engineering (BPR). (Fig. 17).

TQM	BPI	BPR
bottom-up approach	→	top-down driven
human enablers	method enablers	technology enablers
aim of the stabilize	aim of the streamline	aim of the change
random	systematic	creative

Fig. 17. Three process management strategies (Davenport 1994).

Within this context, TQM actually means Kaizen, which was already discussed.

Business Process Improvement (Harrington 1991) is an approach where specialized process development experts formally describe the existing processes. Then, based on measurement and set performance targets, the processes are continually improved.

Business Process Re-engineering (Hammer & Champy 1995) is management-driven activity, where the performance objectives are first defined and processes are then developed to meet the objectives.

Within the project management domain, CMMI is an emerging *de facto* kind of standard-defining framework for good project management processes and their development (Ahern et al. 2001), (Chrissis et al. 2003).

2.1.7 Principles of speed and flexibility

Just In Time (JIT), Lean, Mass Customization and visual management are modern production philosophies, which are closely interrelated:

- Just In Time focuses on continuous decrease of work in the process by eliminating stocks and minimizing set-up and waiting times (i.e. Dale 1999).
- Lean thinking avoids highly automated production systems, creating a working environment which is manageable by the employees. By maintaining and improving simple production solutions, speed, flexibility and low capital intensity can be achieved. (Womack & Jones 1990, 1996).
- Mass Customization is a combined effort of product development, marketing and production, to offer multiple choices to the customer using platforms and product variants and to be still able to produce the variants within single production lines.
- Visual Management (Shimbun 1995) aims to deliver the essential information to the employees in an easily achievable way in the working environment.

These concepts originated in a manufacturing environment. There are some emerging efforts to apply similar ideas within product development processes (e.g Goldratt 1997).

2.1.8 Benchmarking

From the late 1980's onwards, there has been increased interest towards benchmarking. This interest was first triggered by the success of the improvement methods used by Xerox Corporation (Love & Dale 1999).

Informal benchmarking is common within most companies (Love & Dale 1999):

1. Visiting other companies to obtain ideas on how to facilitate improvement in their own organization.
2. The collection, in a variety of ways, of data about competition.

There is plenty of literature available on the good practices of quality award winners and other successful companies, for example, Hannukainen (1993), Soin (1993) and Zink (1997).

Formal benchmarking is a structured and focused method, which is an integral part of continuous improvement. There are three main types of formal benchmarking (Love & Dale 1999):

1. Internal benchmarking,
2. competitive benchmarking and
3. functional/generic benchmarking

Detailed implementation of formal benchmarking has been described by, for example, Camp (1995).

2.1.9 Quality culture

Silén (1997) describes a matrix to explain quality cultures (Fig. 18). He defines the ideal quality culture as customer-oriented and innovative.

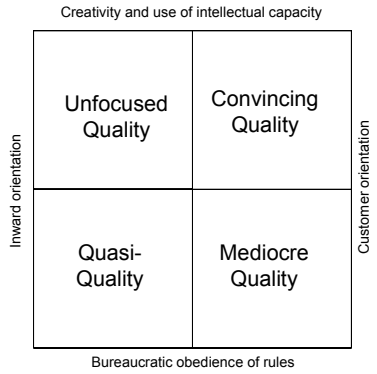


Fig. 18. Matrix of quality cultures by (Silén 1997)

Maturity models for TQM have been published by Crosby (1980), Dale et al. (1994) and Silén (1997) (Table 3). Silén's essential contribution to the studies of quality culture is the

use of structured theme interviews to identify the maturity level of each organization's quality culture.

Table 3. TQM maturity models.

Crosby (1980)	Dale et al. (1994)	Silén (1997)	
		Maturity Level	Quality Award points
Uncertainty	Uncommitted	Uncommitted	100 - 250
Awakening	Drifters	Drifters	150 - 300
Enlightenment	Tool Pushers	Tool Pushers	250 - 450
Wisdom	Improvers	Improvers	450 - 650
Certainty	Award Winners	Matured	650 - 800
	World-Class	World-Class	800 -

Kekäle (1998) studied "hard" and "soft" quality cultures: "Real TQM must contain both the hard and the soft elements". Within his empirical studies, Kekäle used the survey tool of Broadfoot & Ashkanasy (1994). The survey tool includes ten dimensions: Leadership, Structure, Innovation, Job performance, Planning, Communication, Relation to environment, Humanistic values, Individual growth and Socialization on entry. Through factor analysis, Broadfoot & Ashkanasy (1994) obtained a three-factor solution:

1. Innovative leadership
2. Rules orientation
3. Relationship orientation

Kekäle (1998) concluded his work by identifying three possible strategic choices for TQM implementation:

1. "Soft" approach, characterized by customer awareness and employee empowerment to take responsibility for quality
2. "Mixed" approach, characterized by a combination of preferred aspects of the "soft" and the "hard" approaches.
3. "Hard" approach, characterized by management by facts and traditional techniques of quality control.

The selection of the approaches should be based on their adaptability to the organizational culture unless there is a possibility to change the culture (Kekäle 1998).

Kujala (2002) constructed a model of the "ideal" quality culture. He argues that, since TQM has its roots within manufacturing, such ideal quality culture that could reach 1000 points based on the quality award criteria should work in an extremely fact-based and rule-oriented manner. He doubts as to whether such a culture would be ideal within project-oriented business with a high level of uncertainty.

2.1.10 Quality awards

The major quality awards are: the Deming Prize, established in 1951, the Malcolm Baldrige Quality Award, established in 1987, and the European Quality Award,

established 1991 (Bohoris 1995). There are the following major differences between the awards (Bohoris 1995):

- The Deming Prize focuses on the dissemination of company-wide quality control, continuous improvement and relations with suppliers. The most important aspect is the thorough application of quality control techniques.
- The Malcolm Baldrige Quality Award views quality as customer-driven and therefore focuses on customer satisfaction, benchmarking, competitive comparisons with the industry average, the industry leader and the principal competitors in the company's key markets.
- The European Quality Award further emphasizes the relations with the community and customer and employee satisfaction.

From the point of view of this study, the most relevant award is the European Quality Award (Fig. 19).

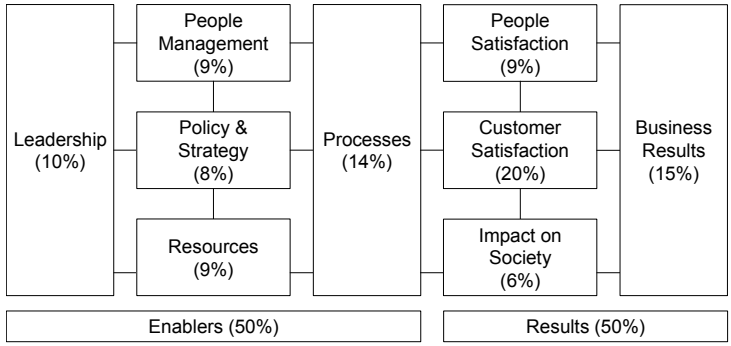


Fig. 19. The European model for TQM (Zink 1997).

There are multiple ways for companies to use quality award criteria for self-assessment and continuous improvement (Dale 1999):

- *Award simulation* involves the writing of a full submission document
- *Peer involvement* includes a less rigid way of collecting relevant data and documentation.
- In the *pro forma* approach, the criterion is described, and the person carrying out the assessment outlines his/her observations in the space provided on the form.
- In the *workshop* approach, managers gather the data and present the evidence to their colleagues at a workshop.
- *Matrix chart* involves rating a prepared series of statements.
- *Questionnaire* is usually used to carry out a quick assessment.

2.1.11 Summary of TQM Theories

At the beginning of this study in 1992, the quality concept was not yet well established. Saraph et al. (1989) made one of the first attempts to conceptualize quality management.

Analysing the presented concepts of the best-known contributors to TQM, they identified eight categories of effective quality management practices (mostly from the manufacturing perspective):

1. Role of divisional top management and quality policy
2. Role of quality department
3. Training
4. Product/service design
5. Supplier quality management
6. Process management/operating procedures
7. Quality data and reporting
8. Employee relations

Referring to the review of established concepts within TQM of this study, it can be pointed out that a wide range of consistency has been achieved during the past ten years. The concepts described in this study are widely discussed in most quality-related textbooks. The concept of quality culture is an exception. It is widely agreed that quality culture is important, but the approaches do not converge yet.

Fig. 20 consolidates the presented concepts of TQM. The work of Silén (1997) has been used to describe a path from low quality performance to world-class performance in a matrix. There is no reason to underestimate Silén's dimensions of the matrix – they are useful from the quality culture perspective. Still, the "soft" and "hard" dimensions of Kekäle (1998) serve better the purpose of consolidating TQM concepts. In this work, the dimensions are called "creative" and "normative". The dimension of creative quality can be compared to the brain metaphor of Morgan (1997) as a perspective of learning and self-organization. The dimension of normative quality can be compared to the machine metaphor of Morgan (1997) as a perspective of rationally purist thinking towards organizational behaviour.

The author tends to agree with Kujala (2002) in that purist rationality is a cultural paradigm maintained by a wide range of quality practitioners. However, since the aim of TQM is to improve business performance, one can also argue that it is the sole right and responsibility of each organization to define the concept of "ideal quality".

The concepts of TQM are placed into the matrix. The author's aim is not to claim that the positions are exactly right and fixed. Nor does he aim to claim that these are the only relevant concepts. The aim of the matrix is to enable the choice of the appropriate TQM approach in each situation at hand.

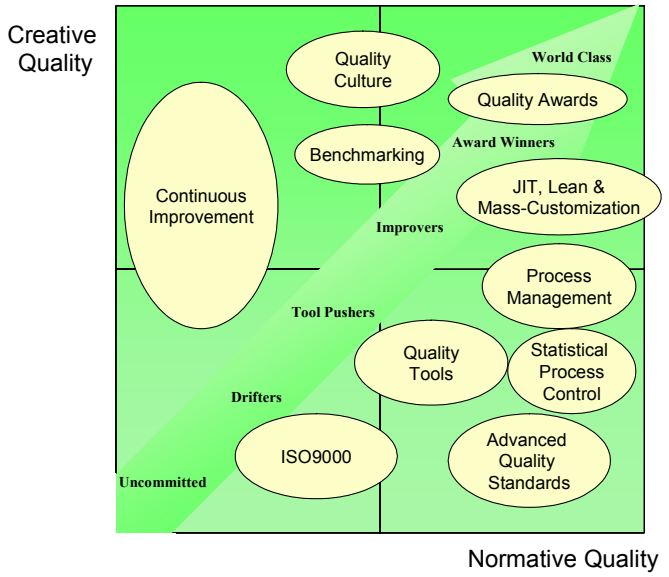


Fig. 20. Construction of TQM concepts.

2.2 Organizational leadership

Foyan said to Gaoan:
"One who can see the tip of a down hair cannot see his own eyebrow, one who can lift thirty thousand pounds cannot lift his own body. This is like the student who is bright when it comes to criticizing others but ignorant when it comes to self-knowledge."
(Cleary 1989).

Some discussion of leadership assumes leadership to be a trait that some people have and others do not have. Other discussion assumes that leadership is a process. The process viewpoint suggests it is a phenomenon that resides in the context and makes leadership available to everyone. As a process, leadership can be observed in leader behaviours, and it is something that can be learned. (Northouse 2001, Sydänmaanlakka 2003).

Some people are leaders because of their formal position within an organization, whereas others are leaders because of the way other group members respond to them. Yet, the person assigned to a leadership position does not always become the real leader in a particular setting. When an individual is perceived by others as the most influential member of a group or organization, regardless of the individual's title, the person is exhibiting emergent leadership. When an individual is engaged in leadership, that individual is a leader regardless of whether or not s/he was assigned to be the leader or emerged as the leader. (Northouse 2001).

The concept of power is related to leadership because it is part of the influence process. People have power when they have the ability to affect others' beliefs, attitudes and, naturally, actions. In the discussion of leadership, it is not unusual that leaders are described as wielders of power, as individuals who dominate others. In these instances, power is conceptualized as a tool that leaders use to achieve their own ends. Contrary to this view of power, power can be viewed from a relationship standpoint; power is not an entity that leaders use over others to achieve their own ends, but instead occurs in relations and should be used by both leaders and followers to attain their collective goals. (Northouse 2001).

The interest in leadership within this study is based on two motives:

1. Based on the European Quality Award model, leadership is the driver of TQM. Thus, it is natural that the development of organizational leadership is one element of TQM. Adair (1984) identified "courage" and "initiative" to be leadership traits that are advocated in various armed services in the western world. One of the essential motives for developing organizational leadership is to encourage individuals to take responsibility and to encourage initiative for continuous improvement.
2. The other motivation for TQM is the need to essentially manage change. As described in Table 4, the critical success factors of change are: will to change, ability to change and opportunity to change. The creation of these success factors is an act of leadership.

Table 4. Definitions of the critical success factors: will, ability and opportunity (Lanning 2001).

Desired states	Definition
Will to change	People who are expected to participate in the change project must have personal motivation and a sincere will to engage themselves in the development. This will is expressed as willingness and readiness to take concrete action for the development and even to make personal sacrifices. Will does not occur unless real effort at developing the organization can be perceived.
Ability to change	The level of knowledge and skills of those who are involved in a change project needs to be high enough for them to be able to contribute to the project. There must be adequate basic skills for dealing with the project and change management in general as well as job-specific skills enabling people to use new tools and machines and to act according to new procedures. Ability also means comprehension of project vision and understanding of one's own role in implementing the change.
Opportunity to change	There must be support for project planning and implementation from surrounding people and structures. Sufficient resources, top management support and commitment are essential to give everybody the feeling that change and development can be achieved. Supporting measurement and reward systems, reporting relationships and organizational structure, clearly delineated responsibilities as well as the rules of the game of development are essential for providing people an opportunity to change.

Each leadership situation is a combination of the situation itself, the leader's personality, the leader's actions and the personalities of the followers (Fig. 21). The leadership theories can be approached through two perspectives:

1. *The psychodynamic approach* aims to help leaders to understand the motives of their own behaviour and the motives of the behaviour of their followers. The basic assumption of this approach is that increased knowledge of self and others improves the leadership performance. One could say that increased self-knowledge changes the leader's behaviour by changing the leader.
2. *Acts of leadership* are studied as means for leaders to adopt practices that are used by successful leaders. New practices change the leader's behaviour.

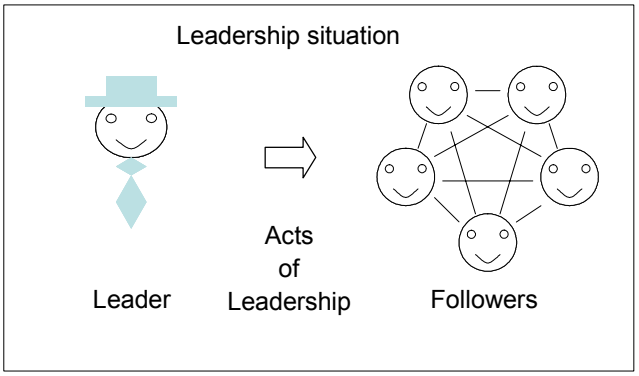


Fig. 21. Elements of a leadership situation.

2.2.1 Psychodynamic approach

The following fundamental propositions underlie the psychodynamic approaches to leadership (Stech 2001):

- Leaders are more effective when they have insight into their own psychological makeup.
- Leaders are more effective when they understand the psychological makeup of their subordinates.
- The situation improves even more if the team members are aware of their own personality characteristics, so that they can understand how they respond to the leader and to each other.
- An important underlying assumption is that the personality characteristics of individuals are deeply ingrained and virtually impossible to change in any significant way. The key is acceptance of one's own personality features and understanding and acceptance of the features and quirks of others.

The two major theorists behind the psychodynamic approach are Sigmund Freud and Carl Jung. (Freud 1964, Jung 1989). The approach of this study is widely based on Transactional Analysis, which is based on Freud's theory and was originally created for the needs of group therapy. It therefore uses terms and concepts that do not require wide knowledge of psychology (Berne 1967), (Harris 1973). (Fig. 22).

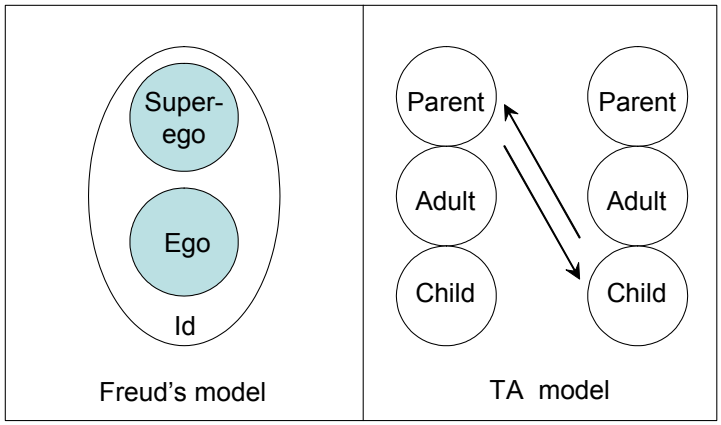


Fig. 22. Freud's model of personality compared to the Transactional Analysis model.

The transactional analysis model includes three ego states: *Parent*, *Adult* and *Child*:

- The parent ego state can be either *controlling* or *nurturing*. The controlling parent is needed when firm instructions are given. Overdoing the controlling parent ego state makes the leader judgemental, fault-finding and strict. The nurturing parent is useful when sympathy and support are needed. Overdoing the nurturing parent ego state results in an intention to be helpful and to do the job of others, not giving them an opportunity to develop their own skills (Hay 1993).
- The child ego state of contented people is *natural*: playful, creative and open. Upon frustration, the child ego state turns either *rebellious* or *over-adaptive*. The attitude of a rebellious child ego state is "I am OK you - are not OK", while the attitude of an adaptive child ego state is "I am not OK – you are OK" (Harris 1973). In this work, the term "contented" is used to refer to behaviours initiated by the "I am OK – You are OK" ego state, and "frustrated" is used to refer to behaviours initiated by different types of "Not OK" ego states.
- Adult ego state implies an ability to do reality testing. It means being able to perceive fairly accurately the state of affairs, to assign probabilities to various actions, and then to select the action that is most likely to produce the desired outcome. The adult ego state also integrates the parent and child ego states. This means that the guiding, counselling, teaching and directing parent ego states are used when needed, and the spontaneous, sensuous, and joyful aspects of the child are called into play when needed (Northouse 2001).

The parent ego state can also be understood as a value system defining the more or less rational set of rules and concepts for how to behave within specific situations. Such a value system is relevant within the context of all interfacing theories of this study: leadership, teamwork, cultures and learning. For example, the theory of double-loop learning (Argyris 1993) specifically deals with learning within/questioning the systems of cultural values. (Fig. 23).

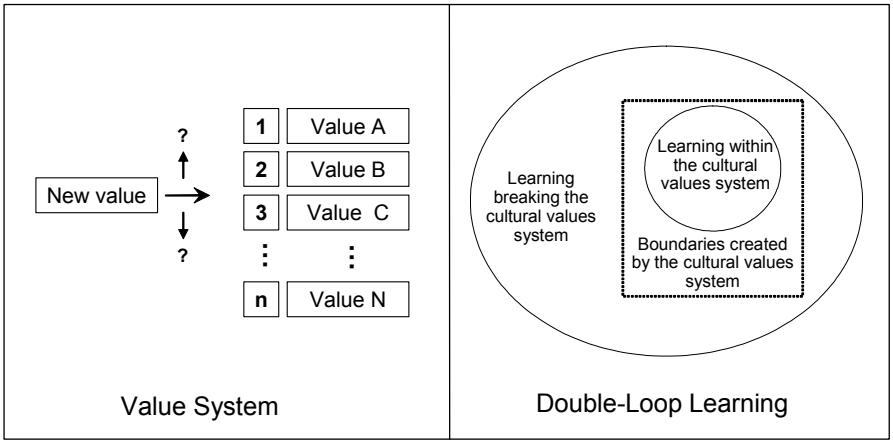


Fig. 23. Value system and double-loop learning.

Kahler (1974,1979) describes three levels of contented child ego states based on the increased level of openness. Each specific personality type described by Kahler has preferences for the different communication channels available (Thinking, Acting or Feeling).

Kahler also describes three frustrated child ego states using the term “Degrees of Miscommunications”. Within the first degree of frustration, behaviour is either “Overdoing” or “Overadapting”. When stress is further increased, the behaviour changes to either “Drooping”, “Attacking” or “Blaming” behaviour, finally ending up in ”Despaired” behaviour. (Kahler 1979).

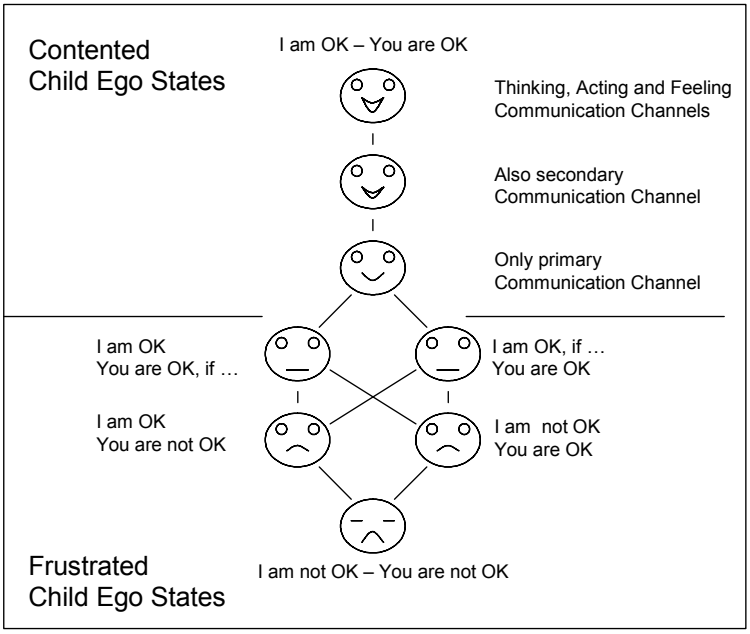


Fig. 24. Contented and frustrated child ego states (Kahler 1979).

Kahler (1974) describes the concept of miniscript, including not-OK counterscripts and OK counterscripts, with specific *drivers* and *allowers*. The drivers are not-OK counterscript slogans, which come from the not-OK Nurturant Parent. These counterscripts invite the occurrence of not-OK script injunction. The allowers come from the OK Nurturant Parent and strengthen the OK script injunction.

Miniscript is a pattern of frustrated behaviour initiated by one's personal driver leading to the punishment of despair in the "I am not OK –You are not OK" ego state. Kahler (1974) has identified five specific drivers indicating the "OK, if …" behaviour:

1. Having *hurry up* characteristics, we respond particularly well to short deadlines, and our energy peaks under pressure. Given time to spare, however, we delay starting the job until it becomes urgent and then make mistakes in haste. (Hay 1993).
2. *Be perfect* characteristics involve a quest of perfection – no errors, everything must be exactly right the first time. However, we apply high expectations constantly and fail to recognize when a lower standard would be appropriate. (Hay 1993).
3. *Please people* is characterized by being good team members, encouraging harmony within the group and trying to draw the team closer together. When criticised by others, however, we may take it personally and get upset even when the comments are worded constructively. (Hay 1993).
4. *Try hard* is all about the effort put into the task, so we tackle things enthusiastically. However, we may be more committed to trying than succeeding. Our initial interest wears off before we finish the task. (Hay 1993).

5. *Be strong* people stay calm under pressure. They keep on thinking logically even when others may panic. However, they are highly self-critical about their own shortcomings and consider it a weakness in themselves and other people to ask for help. (Hay 1993).

2.2.2 Acts of leadership

The acts of leadership can be studied through the perspectives of "hard" and "soft" deliverables of leadership:

- The "hard deliverables" - planning, organizing, leading and controlling, are essential elements of leadership, though leadership is more about influencing other people than just implementing the basic management functions (Robbins & Coulter 1996). *Functional leadership theory* (Adair 1984) focuses on the hard deliverables of leadership.
- The "soft deliverables" of leadership – commitment, motivation and job satisfaction, are described by the theory of *transformational leadership* (Bass & Avolio 1994) and studies of *charismatic leadership* (Conger 1989).

Functional leadership

The functional leadership theory rests on three basic tenets: (1) Functional leadership is behaviour or a set of behaviours that occur in a group, (2) there are shared functions that can be performed by an appointed leader or by any or all of the group members, depending on the requirements of the situation, and (3) the key leadership functions facilitate the accomplishment of tasks and the maintenance of group relationships. (Carnevale et al. 1990).

For a group to fulfil its task and to be held together as a working team, certain functions will have to be performed (Adair 1984):

- Planning; seeking all available information, defining the group's task, purpose or goal and making a workable plan.
- Initiating; briefing the group about the aim and the plan, explaining why the aim or plan is necessary, allocating tasks to group members and setting group standards.
- Controlling; maintaining group standards, influencing tempo, ensuring that all actions are taken towards objectives.
- Supporting; expressing acceptance of persons and their contributions, encouraging group/individuals, disciplining group/individuals, fostering team spirit, relieving tension with humour and reconciling disagreements or getting others to explore them.
- Informing; clarifying task and plan, giving new information to the group, i.e. keeping them "in the picture", receiving information from the group and summarizing suggestions and ideas.
- Evaluating; checking the feasibility of an idea, testing the consequences of a proposed solution, evaluating group performance and helping the group to evaluate its own performance against standards.

Adair (1984) assumes that leadership skills can be developed by exercising the practices used by effective leaders:

- Thinking; developing the skills of analysing, synthesising and valuing and becoming more aware of the conscious and unconscious mind.
- Decision making and problem solving; developing the skills of systematic decision making and problem solving.
- Communication; developing the skills of effective speaking, listening, clear writing and chairing meetings.

Transformational leadership

Transformational leadership is an expansion of transactional leadership. Transactional leadership emphasizes the transaction or exchange that takes place between leaders, colleagues and followers. This exchange is based on the leader discussing with others what is required and specifying the conditions and rewards these others will receive if they fulfil those requirements. (Bass & Avolio 1994).

Transformational leaders do more with colleagues and followers than set up simple exchanges or agreements. They behave in ways to achieve superior results by employing one ore more of the "Four I's" (Bass & Avolio 1994):

1. *Idealized influence.* Transformational leaders behave in ways that result in their being role models for their followers. These leaders are admired, respected and trusted. Followers identify with their leaders and want to emulate them. Among the things the leader does to earn this credit is his/her ability to prioritize the needs of others over his or her own personal needs. The leader shares risks with the followers and is consistent rather than arbitrary. He or she can be counted on to do the right thing, demonstrating high standards of ethical and moral conduct. He or she avoids using power for personal gain and only uses it when needed.
2. *Inspirational motivation.* Transformational leaders behave in ways that motivate and inspire those around them by providing meaning and challenge to their followers' work. Team spirit is aroused. Enthusiasm and optimism are displayed. The leader gets his/her followers involved in envisioning attractive future states. The leader creates clearly communicated expectations that followers want to meet and also demonstrates commitment to the goals and the shared vision.
3. *Intellectual stimulation.* Transformational leaders behave in ways that stimulate their followers' effort to be innovative and creative by questioning assumptions, reframing problems and approaching old situations in new ways. Creativity is encouraged. There is no public criticism of individual members' mistakes. New ideas and creative problem solutions are solicited from followers, who are included in the process of addressing problems and finding solutions. Followers are encouraged to try new approaches, and their ideas are not criticized because they differ from the leaders' ideas.
4. *Individualized consideration.* Transformational leaders pay special attention to each individual's needs for achievement and growth by acting as coaches or mentors. Followers and colleagues are developed to successively higher level of potential. Individual consideration is practised as follows: New learning opportunities are

created along with a supportive climate. Individual differences in terms of needs and desires are recognized. The leader's behaviour demonstrates acceptance of individual differences (e.g., some employees receive more encouragement, some more autonomy, others firm standards, and yet others more task structure). Two-way exchange in communication is encouraged, and "management by walking around" work spaces is practised. Interactions with followers are personalized (e.g., the leader remembers previous conversations, is aware of individual concerns and sees the individual as a whole person rather than just an employee). The individually considerate leader listens effectively. The leader delegates tasks as a means of developing followers. Delegated tasks are monitored to see if the follower needs additional direction or support and to assess progress; ideally, however, followers do not feel they are checked on.

Charismatic leadership

Conger (1989) studied charismatic leadership. He was able to identify an action pattern of charismatic leaders and assumed that charismatic leadership is a skill that can be learned – at least to some extent. Conger presents the pattern as a process of four steps:

1. *Sensing opportunity and formulating a vision.* Charismatic leaders posses two skills characterizing this stage, which, when combined, often set them apart from other leaders. (1) The first is their sensitivity to their constituents' needs. Constituents, in this case, may comprise both members of the leader's organization and customers. (2) The second quality is an unusual ability to see the deficiencies of the existing situation as well as the untapped opportunities. Given their sensitivity to deficiencies, charismatic leaders in mature organizations are therefore most likely to be agents of radical change.
2. *Articulating the vision.* Charismatic leaders tend to be different from others because of their goals and the way in which they communicate them. Usually, they are characterized by a profound sense of strategic vision. Their goals tend to be idealized and challenge the status quo. As a result, subordinates are likely to perceive the leader's goals as extraordinary vision rather than ordinary goals. By presenting utopian goals to his/her followers, the leader provides a sense of tremendous challenge and motivation for change. Since the vision is a perspective shared by the followers and promises to meet their aspirations, it tends to be very acceptable despite its radical departure from the present situation. In articulating their goals, charismatic leaders are also likely to differ from others along two important dimensions. (1) The first is the way in which they describe their vision. Charismatics begin by describing the current situation as unacceptable. In this sense, they strive to create dissatisfaction. This is a critical step in every successful change process. At the same time, charismatic leaders describe their future vision as the most reasonable and attractive alternative. And while the visions and goals are often ideal, charismatic leaders describe them as both realistic and attainable. In communicating their vision, they aim to create in their subordinates a compelling desire to be led in the direction of the vision despite its often significant hurdles. (2) The second dimension involves the way in which charismatics communicate their own motivation to lead. In their rhetoric, they may choose words reflecting self-confidence, conviction, expertise, dedication to the cause

and a concern for their followers' needs. These qualities may also be expressed through the leader's behaviour, actions, personal appearance, body language and dress.

3. *Building trust in their vision.* To be effective as a leader, it is often important that the subordinates desire the goals the leader proposes. Commitment by coercion or edict is not likely to provide sufficient motivational energy for long-term success. Thus, the leader must build exceptional trust among his subordinates in himself and in the goals he articulates. The charismatic leader does this through personal risk-taking, unconventional expertise and self-sacrifice. These qualities set charismatic leaders apart from others. Essentially, these leaders attempt to create extraordinary levels of trustworthiness. They accomplish this by showing concern for their followers' needs rather than their own self-interest. This is a critical part of the leadership equation, since the leaders' goals may involve great uncertainty and risk. To compensate for this, they must build extraordinary trust by demonstrating total dedication to the cause they share with their followers. They may, for instance, engage in acts that demonstrate exemplary levels of commitment and self-sacrifice to achieve the mission's goals. The greater the risk taken, the greater the trustworthiness that is likely to be developed.
4. *Achieving the vision.* At the final stage, charismatic leaders generally differ from others because of their extensive use of personal example and role modelling, their reliance on unconventional tactics and their use of empowerment practices to demonstrate how their vision can be achieved. By role modelling certain managerial practices, by describing their perspectives on the marketplace and in their organization and by immersing others in their style of decision-making, charismatics convey what they perceive to be the critical approaches to success. Also, their vision may contain elements of an ideology that provides a set of decision rules for day-to-day problem solving and approaches to the market. Moreover, the charismatic leader demonstrates the unconventional tactics that the organization must employ if it is to achieve the leader's vision, and through praise, charismatics build their followers' belief in their ability to achieve the vision.

2.3 Learning

The Theory Into Practice (TIP) database contains descriptions of over 50 theories relevant to human learning and instruction (Kearsley 2003). The interest of this study in learning is based on practical needs to implement quality-related competence development. Sydänmaanlakka (2000) describes the elements of competence development as follows:

- Development of corporate vision, strategy and objectives.
- Definition of required corporate-level core competencies.
- Mapping competencies within each organizational unit based on skill evaluation at the individual level.
- Identification of critical competencies for each organizational unit.
- Identification of competence gaps.

– Creating and implementing competence development plans at the organizational and individual levels.

The hierarchy of competence consists of four levels. (Sydänmaanlakka 2000):

1. At the corporate level, competence is an abstract set of core competencies and other competencies. The definition of core competencies includes a need to reflect on the relationship of core competencies with competitive advantage through added value to customers (Hamel & Prahalad 1994).
2. At the organizational unit level, competencies are more specific sets of areas of expertise. This is the hierarchic level for development plans, as the level of concreteness enables linking the competencies to individual capabilities.
3. At the team level, competence is the combination of skills and skill sets of the individual members. The team's capability to utilize the team members' competence is also significant.
4. At the individual level, competence includes knowledge, skills, attitude, expertise and contact networks. At this level, competencies can be described and discussed as lists of skills.

The many utilizable approaches to learning include the following (Carnevale et al. 1990, Rae 1985):

– Reading,
– attending lectures,
– direct on-the-job training,
– action/hands-on learning,
– coaching by a supervisor or another expert,
– self-development and
– training courses outside work.

Acknowledging that there is no need for a "teacher" to be present while learning takes place, this study discusses the possible ways to manage and facilitate learning.

2.3.1 Taxonomy

The theory of Taxonomy guides us towards consistent evaluation of individual competence levels, which has importance in evaluating the existing competencies, setting competence development objectives and evaluating learning results. Taxonomy includes three domains (Krathwohl et al. 1964):

– *Cognitive*: Objectives that emphasize remembering or reproducing something that has presumably been learned.
– *Affective*: Objectives that emphasize a feeling, an emotion or a degree of acceptance or rejection.
– *Psychomotor*: Objectives that emphasize some muscular or motor skill, some manipulation of material and objects or some act that requires neuromuscular co-ordination.

This study focuses especially on the cognitive and affective domains. Table 5 lists the competence levels at the highest level of the hierarchy. A practical definition used in the empirical part of this study is presented as a reference. A similar practical definition of skill levels is used by the studied case company. The relevance of the practical definitions is based on the need to quantify the individual skills to be used for planning and implementing competence development.

Table 5. Levels of competence.

Level	Practical	Domain of Taxonomy	
		Cognitive	Affective
1	Knowing	Knowledge	Receiving
2	Understanding	Comprehension	Responding
3	Acting	Application	Valuing
4	Coaching	Analysis	Organization
5	Innovating	Synthesis	Characterization by a value complex
6		Evaluation	

Within the context of developing TQM, the competence "Level 3-Acting" means that the learner has experience of using the skill independently in actual working situations. Reaching such competence level may take up to three years, depending on the type of competence. Successful passage through the learning process requires both cognitive comprehension of the competence and affection to value the competence.
From the perspective of organizational competence development, the practical competence level "3-Acting" is of specific interest for three reasons:

1. It is reasonably easy to evaluate how much experience an employee has about using a competence.
2. The benefits of any training program are artificial if the new competence acquired through training is not actually taken to use.
3. Application of knowledge is a prerequisite for the higher levels of learning.

Krathwohl et al. (1964) defines the criteria for level 3 as follows:

- *Definition of the cognitive domain*: Application - The use of abstraction in particular and concrete situations. The abstraction may be in the form of general ideas, rules or procedures or generalized methods. The abstraction may also consist of technical principles, ideas and theories, which must be remembered and applied.
- *The definition of the affective domain* includes three levels of subdivision: (1) The lowest sub-level is “acceptance of value”; the learner shows positive curiosity towards the phenomenon, behaviour, object, etc. However, there is still readiness to re-evaluate one’s position. (2) The second sub-level is “preference for value”; behaviour at this level implies not merely the acceptance of a value, but the individual is sufficiently committed to the value to pursue it, to seek it out, to want it. (3) The third sub-level is “commitment”; belief at this level involves a high degree of certainty. The ideas of “conviction” and “certainty beyond a shadow of a doubt” help to convey further the level of behaviour intended.

The prerequisites for level 3 competence in the cognitive taxonomy are (Krathwohl et al. 1964):

- Knowledge defined as a capability to recall specifics and universals of the topic, such as terminology, principles, conventions, etc.
- Comprehension defined as capability to explain and summarize learning at any level of generality.

Fig. 25 describes the cognitive and affective domains of learning as a matrix demonstrating the relationship between the cognitive and affective domains of learning. Multiple factors have an effect on which of the domains is more important; if the topic of learning is such that the desired new behaviour requires changes in values and attitudes (i.e. leadership and interpersonal skills), the importance of the affective domain increases. Equally, if an employee has long experience of using an old method, the importance of the affective domain increases.

At higher levels of learning, understanding of the limitations and applicability of the newly learnt matters increases. The practical definition of "Level 4-Coaching" in Table 5 emphasizes the learner's capability to apply the knowledge in special situations that do not involve straightforward application of basic knowledge. That also enables the capability to coach based on extensive competence. "Coaches" are able to support those with lower-level competence to succeed with the task at hand.

Matching the practical definition of competence level, the cognitive definition and the affective definition are not straightforward; application of knowledge has a different meaning in different situations. For example, one can learn to apply basic mathematics at school and even reach the levels analysis, synthesis and evaluation. On the other hand, application of such abstract competencies as TQM and project management requires on-the-job learning.

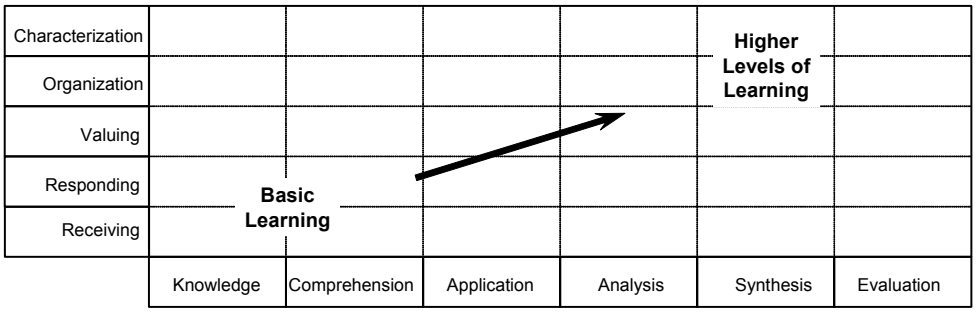


Fig. 25. Matrix of cognitive and affective domains of learning.

2.3.2 Pedagogy vs. Andragogy

The tradition of learning is based on teaching children. This tradition assumes that the learner is a dependent person with limited experience. Students are motivated primarily by external pressure from their parents and teachers. This tradition has led to "teacher-

directed" learning to such an extent that Knowles (1975, 1984) differentiates the terms *pedagogy* and *andragogy* as different disciplines. Pedagogy focuses on teaching children and andragogy focuses on facilitating adult learning.

In Fig. 26, the concepts of pedagogy/andragogy (Knowles 1975), learning types (Gagné 1970) and learning theories (Carnevale et al.1990) are presented as a continuum of learning. Interpersonal skills have been added to the list of learning types, though they were not originally presented by Gagné.

Typical Learner	Learning Type	Learning Theory
Adults	(Interpersonal skills)	Humanist
	Problem solving	Constructivist
	Rule learning	Structuralist
	Concept learning	
	Discrimination learning	Behaviourist
	Verbal associations	
	Chaining	
Children	Stimulus-response learning	
Animals	Signal learning	

Fig. 26. Simplified concept of learning theories, learning types and their use.

2.3.3 Learning types

Signal learning is the simplest type of learning. Pavlov's example of dogs demonstrates signal learning; a bell is rung at the same time as food is given to the dogs. Salivating is the dog's biological reaction to the food. At the end of the training, the dog salivates after hearing the ring of the bell. The essential point of this learning type is that the original food-salivation response is a type of reflex. (Gagné 1970).

Stimulus-response learning is slightly more complex. Through positive and negative enforcement, the learner is encouraged towards the desired behaviour. For instance, children are encouraged to learn their first words. This type of learning includes much trial and error. As successes are reinforced, the learner finally ends up with successful performance. (Gagné 1970).

Chaining as a learning type involves combination of the results of stimulus-response learning with sequences of more complicated behaviour. (Gagné 1970).

Verbal associations is a new level of complexity in learning. People are unique due to their capability to share knowledge through words. This fact also changes the paradigm towards learning. Within the context of children, we can start using the higher level of learning types. Concerning adult learners, this learning type is typical while studying foreign languages.

Discrimination is the next learning type. We learn to respond differentially to the characteristics of objects that serve to distinguish them from one another: shapes, sizes, colours, textures, and so on. (Gagné 1970).

Concept learning refers to concrete concepts. Concept learning enables us to describe and generalize such concepts as 'up', 'down', 'right' and 'left'. This refers to concepts that are concrete in the sense that they depend upon direct observation. Though very much of our learning is based on verbal instructions, the importance of demonstrations and learning by doing should not be underestimated (Gagné 1970).

Rule learning refers to abstract concepts. These concepts cannot be learned through observations, as they include a rule that we need to know by definition. The word "uncle" is a good example. Before we can properly use the word we need to be aware of the rules related to "uncle". (Gagné 1970). We can also use "TQM" as an example of abstract concept. Through this example, we can demonstrate the importance of learning prerequisites; understanding of the abstract concept of "TQM" requires understanding of a set of other concepts. If the essential prerequisites are missing, the learning is superficial learning of buzz words.

Problem solving is a process that yields new learning. The learner is placed finds himself in a problem situation. He recalls previously acquired rules in an attempt to find a "solution". In carrying out such a thinking process, he may try a number of hypotheses and test their applicability. When he finds a particular combination of rules that fit the situation, he has not only "solved the problem" but has also learned something new. The newly learned entity is not formally different from a rule. (Gagné 1970).

2.3.4 Learning theories

Behaviourist learning theory assumes that new behaviour can be caused and shaped by a well designed structure around the learner (Carnevale et al. 1990). In the behavioural/reinforcement orientation, the unit of analysis is a stimulus-response (S-R) association. Depending on the purpose of the analysis, such S-R units may involve either microscopic or macroscopic amounts of behaviour. When, upon a repeated presentation of a stimulus, an appropriate response to it is made, the response is said to be "under the *control* of the stimulus". Whatever the nature of the stimulus, response or reinforcement, establishing stable stimulus control depends on the same two learning conditions: *practice* of an appropriate response in the presence of a stimulus that is to control it and *reinforcement* following this practice. (Gropper 1983).

Structuralist learning theory assumes that learning should be a clearly planned and structured sequence with the teacher holding the central role as the manager of learning. Learning should be planned using systematic instructional design. The first step of instructional design is the need to define measurable learning objectives, such as solving specific problems. The rules needed for problem-solving are defined as a hierarchic set of higher-level and lower-level rules, until each rule is broken down into *atomic components* (i.e., steps that are so simple that each individual in the target population may be assumed to be able to perform each step either perfectly or not at all) (Scandura 1983).

Constructivist learning theory emphasizes the rules and mental models that learners have previously created to make sense of their experiences. New learning is a process of revising the learner's mental models based on the new experiences. As each learner has a different history of experience, the learning process is also strongly individual. (Thompson 2000).

Humanist learning theory further emphasizes the freedom of the learner to choose his/her focus of interest. Rogers & Freiberg (1994) argue that, apart from having specific learning objectives, it is even more important to learn generic skills that are usable in everyday life (Table 6).

Table 6. Interpersonal skills

Carnevale et al. (1990) Skills appreciated by employers	Adair (1984) Skills of leadership
Learning to learn	Clear writing
Reading, writing and computation	Better listening
Speaking and listening effectively	Effective speaking
Problem solving and creative thinking	Problem solving
Managing personal and professional growth	Creative thinking
Negotiating, teamwork and interpersonal skills	
Influencing and leadership	

Though the underlying paradigms of learning theories do have implications for the implementation of practical learning situations, such as education and training, the focus in the discussion of learning theories is on the learning process of the learner.

The learner's learning objectives and current learning level have an impact on the choice of the primary learning approach. However, each of the learning theories is present in practical learning situations; the behaviourist learning approach is needed to create motivation for learning and maintaining the instructor's authority during the learning situation, the structural learning approach is needed for presenting the concepts to be learned in an effective way, the constructivist learning approach is needed for the internalization of the learning, and the humanist learning approach is needed to support the learner's human growth.

For instance, Engeström (1994) describes the principles of good education as an integrated learning process through six steps, each demanding specific learning actions:

(1) Motivation: The awakening of conscious, substantial interest towards the subject.

(2) Orientation: The formation of a preliminary hypothesis, which explains the principle and structure of the knowledge necessary for solving the problem.

(3) Internalization: The enrichment of the preliminary model with the help of new knowledge.

(4) Externalization: The application of the model as a tool in solving concrete problems.

(5) Critique: The student tries to determine the limits of applicability of the model.

(6) Control: The student examines his/her own learning.

2.3.5 Experiential learning

Experiential learning is accordant with the paradigms of the constructivist learning theory. As the focus of this study is on the implementation of TQM competence in an expert organization, the theory of experiential learning warrants further discussion.

Kolb (1984) describes experiential learning as a continuous process grounded in experience. The process of learning requires the resolution of conflicts between dialectically opposed modes of adaptation to the world. Rather than a molecular educational concept, experiential learning is a holistic process and involves transactions between the person and the environment. Learning creates knowledge.

The widely quoted cyclic learning model (Kolb 1984) includes four specific learning steps: Reflective observation, Abstract conceptualization, Active experimentation and Concrete experience.

Experiential learning is a process of reconstruction, whereby new learning is first tested within the protective belt of personal experiential knowing and through a timely process perhaps accepted as part of the learner's "hard core" of personal experiential knowing (Malinen 2000) (Fig. 27). Referring to the individual value system (Fig. 23), which was discussed when describing the affective domain of the taxonomy and will be discuss later within the context of the psychodynamic leadership theory, one should note that such protection of the hard core of personal experiential knowing is necessary for psychological stability.

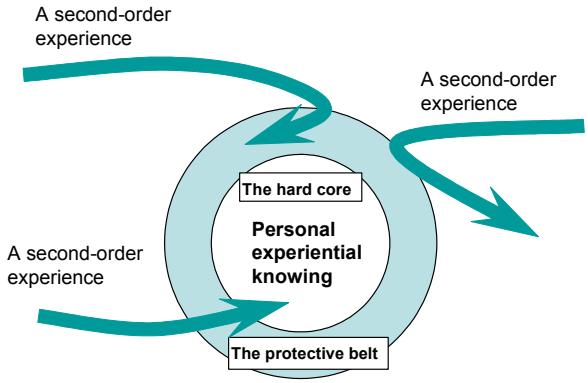


Fig. 27. Personal experiential knowing "meets" second-order experiences (Malinen 2000).

Engeström (1994) describes the psychological conditions for creating a sustainable study motivation: "A substantial motivation arises when a student experiences and recognizes a conflict between his/her knowledge or skill, and the requirements of the new task he/she is facing."

Schön (1987) has described, through cases, how to teach practitioners who need to develop their own insight.

2.3.6 Learning styles

Perceptual preferences for remembering new and difficult information by (1) hearing it (auditorily), (2) seeing it visually, (3) handling manipulative instructional resources (tactually) and/or actively participating while standing or moving (kinesthetically) may be the most important aspect of learning style. These preferences frequently either *enable* or *prevent* individuals from achieving things easily. (Dunn & Dunn 1999).

Another differentiating element between individuals is the analytic vs. holistic learning style. Analytics learn sequentially, one fact after another, each new fact gradually building up full understanding. Holistic learners, in turn, learn in a contrary pattern. (Dunn & Dunn 1999).

Kolb (1984) describes four specific learning styles: *Convergent* learning style, *divergent* learning style, *assimilation* and *accommodative* learning style. (Kolb 1984) also demonstrates the importance of individual preferences for learning types through an assessment tool called Learning Style Inventory (LSI).

2.4 Organizational culture

The interest in organizational culture has increased rapidly since such practical writers as Peters & Waterman (1982) and Deal & Kennedy (1982) first drew public attention to the theme. The number of published articles increased from a few tens to thousands during the 1980's (Alvesson & Berg 1992). One reason for the active interest has been the need for "soft" approaches within the field of management theories.

The perspectives of cultural studies are numerous, depending on the origin of the theorists; organizational culture researchers disagree vehemently about fundamental issues, such as the following (Martin 1992):

- Is culture a source of harmony, an effect of irreducible conflicts of interests, or a reflection of the inescapable ambiguities that pervade contemporary organizational life? Can it be inconsistent and expressive of difference? Can it incorporate organizational life?
- Must culture be something internally consistent, integrative and shared?
- What are the boundaries around culture(s) in organizations? Are boundaries essential?
- How do cultures change?

2.4.1 Perspectives of cultural studies

Burrell and Morgan (1979) described four sociological paradigms for categorizing theories of cultural studies (Alvesson and Willmott 1996):

- "The *functionalist paradigm* combines an objectivist philosophy of science with a regulation theory of society. Burrell and Morgan identify this as the dominant paradigm in social science and comment that it tends to be 'highly pragmatic in

orientation … problem oriented in approach … [and] … firmly committed to a philosophy of social engineering as a basis of social change'" (Burrell and Morgan 1979), (Alvesson and Willmott 1996).

- "The *interpretive paradigm* is concerned to understand how people use symbols (e.g. words, gestures) to render their world 'objectively real'." (Alvesson and Willmott 1996)
- "The *radical structuralist paradigm* is distinguished by its combination of an objectivist philosophy of social science with a radical change theory of society. Organizational behaviour is understood to be conditioned, if not determined, by structures of domination – such as institutionalized exploitation of labour within the capitalistic mode of production." (Alvesson and Willmott 1996).
- "Finally, in the *radical humanist paradigm*, a subjectivist philosophy of science is combined with a radical change theory of society. In common with radical structuralism, the radical humanist paradigm understands social order to be a product of coercion, rather than consent. But its focus is upon contradictions within consciousness rather than contradictions with the structures of (capitalistic) society." (Alvesson and Willmott 1996).

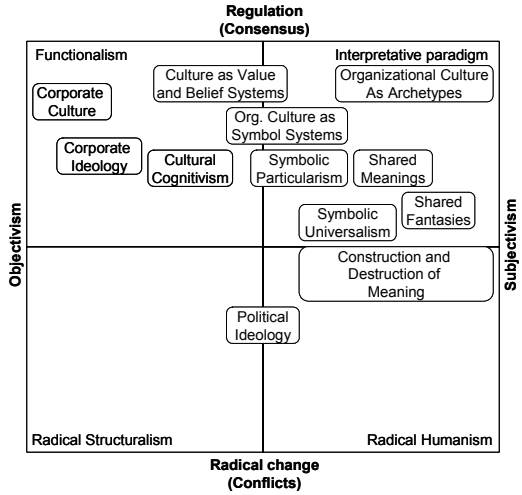


Fig. 28. Twelve perspectives of cultural studies in relation to Burrell and Morgan's classification scheme (Alvesson and Berg 1992).

2.4.2 Concept of organizational culture

The shared meanings that make up the core of a culture are man-made and incorporated into the people within the culture, but yet transcend them. In other words, the shared meanings of a group are within them and cause them to interpret things in particular

ways, but are also open to change if more effective "solutions" to the problems of survival are desired by the group (Trompenaars 1993).

The structural model of Schein (1991) describing the levels of culture (Fig. 29) is widely used as the basic concept of culture studies.

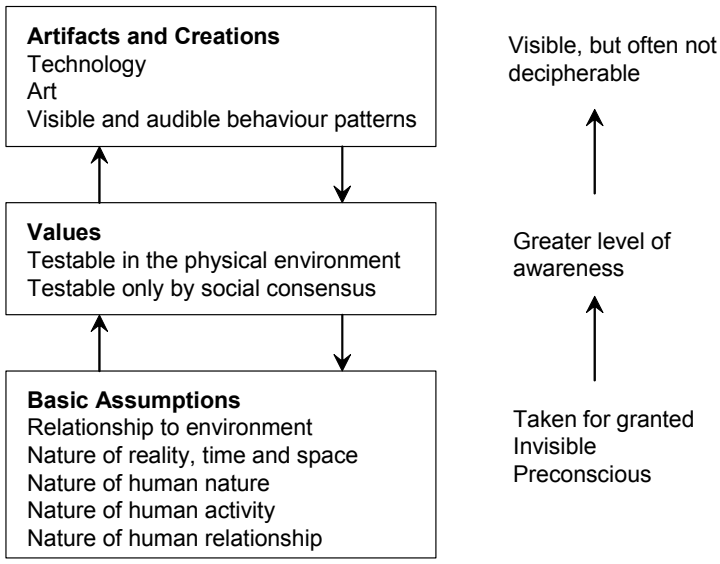


Fig. 29. Levels of culture and their interaction (Schein 1991).

The most visible level of the culture is its *artifacts and creations* – its constructed physical and social environment. At this level, one can look at physical space, the technology output of the group, its written and spoken language, its artistic productions and the overt behaviour of its members. (Schein 1991).

In a sense, all cultural learning ultimately reflects someone's original *values*, their sense of what "ought" to be, as distinct from what is. When a group faces a new task, issue or problem, the first solution proposed to deal with it can only have the status of a value because there is not yet a shared basis for determining what is factual and real. Someone in the group, usually the founder, has convictions about the nature of reality and the optimal ways to deal with it and will propose a solution based on those convictions. (Schein 1991).

When a solution to a problem works repeatedly, it begins to be taken for granted. What was once a hypothesis, supported only by a hunch or a value, gradually comes to be treated as reality. We come to believe that nature really works in this way. If a basic assumption is strongly held in a group, members would find behaviour based on any other premise inconceivable. (Schein 1991).

Hofstede (1991) and Trompenaars (1993) studied the diversity of basic assumptions between nations. The solutions to three universal problems faced by mankind distinguish one culture from another. The problems – people's relationship to time, nature and other human beings – are shared by mankind, but their solutions are not. The latter depend on

the cultural background of the group concerned. Hofstede (1991) identified five basic problem areas as the dimensions differentiating between nations:

1. Power distance,
2. collectivism versus individualism,
3. femininity versus masculinity,
4. uncertainty avoidance and
5. long-term orientation versus short-term orientation.

2.4.3 Managing organizational culture

Alvesson and Willmott (1996), presenting the critical theory, state:

> *"The cultural doping metaphor represents management as a socialization agency. Socialization is the process through which humans acquire, and identify with, the values, customs and aspirations of the social groups in which they live and grow up. Socialization can also be defined as cultural learning. Cultural doping is firmly in the agendas of human resource management and (Total) Quality Management initiatives, for example, and is increasingly identified as the key to success of such initiatives"..."In induction and development programs, employees are told – more or less explicitly – how they must perceive and relate to established organizational reality, and how they should participate in organizational rites where the 'correct' values, virtues and ideals are communicated. Often the influence is exercised on a subconscious level, making it difficult for employees to recognize it and subject it to critical scrutiny."*

Being aware of the complexity of managing organizational culture and also the ethical aspects mentioned above, this study focuses on the management of organizational culture. The model of four levers of control (Simons 1995a, 1995b), (Table 7) has been used through the empirical part of this study as a framework for analysing the applied means of control.

Table 7. The model of four levers of control (Simons 1995a).

Potential	Organizational blocks	Managerial solution	Control lever
To contribute	Uncertainty about purpose	Communicate core values and mission	Belief systems
To do right	Pressure of temptation	Specify and enforce the rules of the game	Boundary systems
To achieve	Lack of focus or resources	Build and support clear targets	Diagnostic control systems
To create	Lack of opportunity or risk	Open organizational dialogue to encourage learning	Interactive control systems

The role of **diagnostic control systems** is to follow up the critical performance parameters. Managers use these systems to monitor goals and profitability and to measure the progress toward targets, such as revenue growth and market share. The diagnostic control systems create objectives and help the organization to focus their activity towards the critical performance targets. (Simons 1995a). Diagnostic control systems are widely used as the primary method within the field of TQM and as an ideal of using quantitative measures and fact-based management. The other three levers of control are supplementary, but specifically within a high-technology project organization, where the implementation of valid quantitative measures is challenging, the importance of the other three levers of control further increases.

Companies have used **belief systems** for years in an effort to articulate the values and directions that senior managers want their employees to embrace. They draw employees' attention to the key tenets of their business (Simons 1995a):

- How the organization creates value,
- the level of performance the organization aims to attain and
- how individuals are expected to manage both internal and external relationships.

Formal belief systems help employees to have a clear and consistent understanding of the core values of the business and their places within the business. Belief systems can also inspire employees to create new opportunities: they can motivate individuals to search for new ways of creating value. We all have a deep-seated need to contribute, i.e. to devote time and energy to worthwhile endeavours. Belief systems help employees to understand the larger purpose of their efforts or to see how they can add value in a way that can make a difference. (Simons 1995a).

Boundary systems are the third lever of control: "Boundary systems are the organization's brakes. And, like racing cars, the fastest companies need the best brakes". Boundary systems are stated in negative terms or as minimum standards. The boundaries in modern organizations, embedded in standards of ethical behaviour and codes of conduct, are invariably written in terms of activities that are off-limits. Effective managers anticipate the inevitable temptations and pressures implicit in their organizations. They spell out the rules of the game based on the risks inherent in their strategy and enforce them clearly and unambiguously. (Simons 1995a).

While the diagnostic control systems follow up the selected critical performance parameters, the **interactive control systems** collect such additional information of the trends and atmosphere in the company that is not yet visible in the measurable parameters. In small companies, the management and the employees can sit at the same table and informally explore the impact of emerging threats and opportunities. In larger companies, the solution recommended by Simons is periodic meetings. Interactive control systems have four characteristics that set them apart from diagnostic control systems (Simons 1995a):

1. They focus on constantly changing information that top-level managers have identified as potentially strategic.
2. The information is significant enough to demand frequent and regular attention from operating managers at all levels of organization.

3. The data generated by the interactive system are best interpreted and discussed in face-to-face meetings of superiors, subordinates and peers.
4. The interactive control system is a catalyst for an ongoing debate about underlying data, assumptions and action plans.

2.4.4 Change mechanisms of organizational culture

Organizations are created by people, and the creators of organizations also create culture through their own assumptions. Once the organization develops a substantial history of its own, its culture becomes more of a cause than an effect. Culture controls the manager more than the manager controls culture, and it does this through the automatic filters that bias the manager's perceptions, thoughts and feelings. As culture arises and gains strength, it becomes pervasive and influences everything the manager does, even his own ways of thinking and feeling. (Schein 1991)

Culture is created in the first instance by leaders; culture also is embedded and strengthened by leaders. When culture becomes dysfunctional, leadership is needed to help the group to unlearn some of its cultural assumptions and to learn new assumptions. Such transformations require what amounts to conscious and deliberate destruction of cultural elements, and it is this aspect of cultural dynamics that makes leadership important and difficult to define. In fact, the endless discussion of what leadership is and is not could perhaps be simplified if we recognized that the unique and essential function of leadership is the manipulation of culture.

Creating a new culture and changing the culture during the early stages of growth is easier than changing a mature culture. Schein (1991) describes 11 culture change mechanisms:

1. *Natural evolution* means that if the organization is not under too much external stress, and if the founder or founding family is around for a long time, the culture simply evolves by assimilating what works best over the years.
2. *Self-guided evolution through organizational therapy* means assessing the strengths and weaknesses of the culture and modifying it if that is necessary for survival and effective functioning.
3. *Managed evolution through hybrids* means putting such managers in key positions that are familiar with the organization but whose personal assumptions are somewhat different from the mainstream in the direction in which the company needs to move.
4. *Managed revolution through outsiders* means appointing outsiders to key positions on the grounds that the organization needs to be more "professionally" managed.
5. *Planned change and organization development* aims to integrate diverse and warring subcultures.
6. *Technological seduction* includes managed introduction of specific technologies for the sake of seducing the organization's members into new behaviour.
7. *Change through scandal, explosion of myths* applies most clearly when incongruities exist between espoused and in-use theories. If such incongruities are visibly exposed

through internal or external events, it may be possible to force some cultural assumptions to be re-examined.

8. *Incrementalism* means that, in every decision-making domain under the manager's discretion, the decisions are patiently but consistently biased toward a new set of assumptions.
9. *Coercive persuasion* is done by using right incentives, consistently challenging the old assumptions and supporting and rewarding any evidence of movement in the direction of new assumption.
10. *Turnaround* is a combination of many mechanisms fashioned into a single program by a talented change manager or a team of change agents.
11. *Reorganization and rebirth* destroy physically the group that is a carrier of a given culture. By definition, that culture is destroyed and whatever new group begins to function begins to build its own new culture. This process is traumatic and therefore not typically used as a deliberate strategy, but it may be relevant if economic survival is at stake.

2.5 Teamwork

Teamwork has a central role within this study:

- Within the domain of TQM, teams are used for continuous improvement projects, quality circles, empowered working teams and problem solving. Teams also have an important role in managing functional boundaries.
- Within the domain of project management, projects are typically organized as teams.
- Within the domain of learning, team learning is essentially used in the context of experiential learning theory. Learning team is also a central solution in seeking for knowledge that is not easily available.
- Within the domain of leadership, creating visions, missions, strategies, etc. is essentially an act of teamwork.

A team is a group of people distinguished by three specific characteristics:

1. Existence of such shared purpose that unifies the three group needs defined by Adair (1984): To achieve a common task, how to work as a team and how to meet the individual needs of team members.
2. Existence of such communication and decision-making practices that the team resources can be effectively utilized.
3. Existence of such shared feeling of security that the members are free from fear to give their full contribution to the team's purpose. (Aalto 2000).

For reasons of team dynamics, a group of people smaller than four members has difficulties to achieve the specific characteristics. Equally, a team size of 20 to 30 members is a maximum to avoid disintegration into sub-teams.

Larson & LaFasto (1989) described three types of teams based on different objectives (Fig. 30).

Broad Objective	*Dominant Feature*	*Process Emphasis*	*Dominant Selection Criteria*	*Examples*
1. Problem Resolution	Trust	Focus on issues	• Intelligent • "Street smart" • People sensitive • High integrity	• American Leadership Forum •Centers for Disease Control •Presidential Cabinet •Executive Management team
2. Creative	Autonomy	Explore possibilities and alternatives	• Cerebral • Independent thinkers • Self-starters • Tenacious	• IBM PC team • McDonald's Chichken McNugget team • US Space Command • Boeing 747 team
3. Tactical	Clarity	Directive Highly focused tasks Role clarity Well-defined operational standards Accuracy	• Loyal • Committed • Action-oriented • Sense of urgency • Responsive	• Cardiac surgery teams • USS Kitty Hawk crew • Sport teams • Mountain-clinbing teams

Fig. 30. Three types of teams (Larson & LaFasto 1989).

2.5.1 Team composition

Besides professional skills, the personalities of the team members also significantly contribute to the functioning of the team. Launonen (1999) described seven theories for team member analysis (Table 8).

Table 8. Theories for team member analysis (Launonen 1999)

Study	Research Problem	Object	Method
Jung (1989)	Individual style	Individual	Questionnaire
Briggs & Myers (1957)	Individual style	Individual	Questionnaire
Parker (1990)	Team player style	Individual/team	Questionnaire Team discussion
Benne & Sheats (1948)	Individual role	Individual	Observation Group discussion
Belbin (1981)	Team role	Individual/team	Questionnaire Team discussion
Platt et al. (1988)	Team role	Individual/team	Team discussion Team skill development game

Belbin defines team role as: "A tendency to behave, contribute and interrelate with others in a particular way". The nine team roles, their contributions and acceptable weaknesses are (Belbin associates 2003):

1. *Plant;* creative, imaginative, unorthodox. Solves difficult problems, *but* ignores incidentals. Too pre-occupied to communicate effectively.
2. *Co-ordinator;* mature, confident, a good chairperson. Clarifies goals, promotes decision making, delegates well, *but* can often be seen as manipulative. Off-loads personal work.
3. *Monitor Evaluator;* sober, strategic and discerning. Sees all options. Judges accurately, *but* lacks drive and ability to inspire others.
4. *Implementer;* disciplined, reliable, conservative and efficient. Turns ideas into practical actions, *but* somewhat inflexible. Slow to respond to new possibilities.
5. *Completer Finisher;* painstaking, conscientious, anxious. Searches out errors and omissions. Delivers on time, *but* inclined to worry unduly. Reluctant to delegate.
6. *Resource Investigator;* extrovert, enthusiastic, communicative. Explores opportunities. Develops contacts, *but* over-optimistic. Loses interest once initial enthusiasm has passed.
7. *Shaper;* challenging, dynamic, thrives on pressure. The drive and courage to overcome obstacles, *but* prone to provocation. Offends people's feelings.
8. *Teamworker;* co-operative, mild, perceptive and diplomatic. Listens, builds, averts friction, *but* indecisive in crunch situations.
9. *Specialist;* single-minded, self-starting, dedicated. Provides knowledge and skills in rare supply, *but* contributes only on a narrow front. Dwells on technicalities.

2.5.2 Team evolution

To become a team, a group needs to go through the stages of team evolution and to solve the problems described in (Fig. 31).

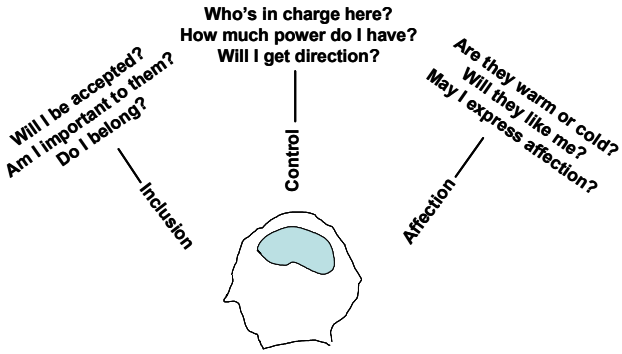


Fig. 31. Questions related to entry into a group (Ross & Ross 1982).

Forming-Storming-Norming-Performing (Tuckman 1965) is the most well-known model of team evolution:

– In the *forming* stage, team members test what type of behaviour will be acceptable, what the team's task is, and how the group will do the work (Launonen 1999).

- The *storming* stage is sometimes described as hostility between the team members and resistance to the team's task. Anyhow, storming refers to conflicting interests inside the team. Hostility and resistance are not necessarily the visible manifestation of such conflicts. During the storming phase, the team creates the norms for how to deal with conflicts. Successfully dealt with conflicts strengthen the team, while failures increase insecurity.
- Within the *norming* phase, the team has created norms and structures that enable them to complete the work tasks. The team's identity is still fragile, and critical dialogue is avoided.
- In the *performing* stage, the team has structure and purpose, and the interpersonal relationships are stabilized. The team has a good capability to manage conflicting interests, enabling open dialogue and dynamic team roles.

Katzenbach and Smith (1993) describe team evolution as passing through five stages: (1) working group, (2) pseudo-team, (3) potential team, (4) real team and (5) high-performance team.

2.5.3 Levels of security in a team

The feeling of mental security in a group is a driver for effective dialogue and decision making. Aalto (2000) studied the levels of security in teams and described eight levels:

1. *A Fearing Group;* a group whose members fear each other, the group leader or a strong individual in the group is called a fearing group. In such a group, the members are inhibited and unable to be their own selves. They begin to hide aspects of their personalities in order not to be ridiculed, rejected or abandoned. Creativity is low and fear makes people do things they would not do outside the group. Discussions concern only facts, and the group members have both suppressed emotions of aggression and other emotions that are expressed in a harmful way.
2. *An Insecure Group;* the members in an insecure group feels uncertainty concerning how others will react to (honest / open) expressions of one's self. There may also be fear. If someone expresses him/herself (openly / genuinely) and does not receive positive feedback, he or she will withdraw into a shell and be wary of expressing him/herself openly in the future. If others ignore the expressions or give lame approval, the person may either express him/herself more openly or be even more protective the next time. Conversations still move on a superficial level, even though some people may try to express their emotions.
3. *An Unfamiliar Secure Group;* in an unfamiliar but secure group, the members are not afraid of each other, nor do they feel insecure. However, the group members do not know each other very well, and self-expression is therefore cautious and tentative. The reason behind the group meeting creates a basic level of security, so that no one feels vulnerable when expressing themselves. An example of this type of group could be a group of people who gather for a course and do not know each other beforehand. Conversations move more or less around facts, and people are cautious about expressing opinions, emotions and values.

4. *A Familiar Secure Group;* in a group of this kind, the members know each other fairly well and are fairly confident that they will not become vulnerable if they express their opinions and emotions. The feeling of security, however, is not yet based on mutual knowledge or trust. Subconscious feelings of security may have been (attained / achieved) through, for instance, activity or trust-building exercises.
5. *An Open Group;* an open group is a group where the members' opinions and emotions are accepted, i.e. no one underrates the opinions or experiences of others. The members have courage to express their opinions, emotions and even values.
6. *A Group Accepting Weaknesses;* a group of this kind allows expressions of fear, failure, insecurity, helplessness and other emotions of weakness. Even expressions of needs are acceptable. People dare to laugh at themselves and others safely. This level of security may have been (attained / achieved) by trust-building exercises, games and fooling around.
7. *A Group Allowing Vulnerability;* in this phase of the group's security development, the feeling of security has reached the level at which people may become spontaneously aware of their painful memories. The members also dare to speak of these painful memories to the group and are able to feel both anger and sorrow without fear. Feelings of shame begin to decrease. In activity exercises, this level of security may become obvious when the group is doing regression, taking care and doing inner healing exercises.
8. *A Merciful Group;* if the above level of security enabled the members to share their experiences of having been hurt, the most secure level enables them to share experiences of how they have hurt others and be accepted with an attitude of forgiveness. This means access to the deeper emotions of guilt, shame and worthlessness. The person reveals his or her own dark side, his or her own tendency to be evil. The merciful group does not (attain/achieve) this level automatically by increasing the feeling of security. This level is attained only if the members themselves have already faced their own dark side and been able to process/deal with it. If one is not merciful to oneself, it is difficult to be merciful to others.

2.6 Summary of interfacing theories

The discussion of interfacing theories was started by presenting the psychodynamic approach to leadership. It was noticed that concepts similar to the "parent ego state" of the psychodynamic model of the transactional analysis approach (Fig. 22) can also be identified in learning theories: a value system within the affective domain of taxonomy (Krathwohl et al. 1964) and learning inside/outside the cultural value system within the theory of double-loop learning (Argyris 1993). The cultural value system is an extension of the concept of individual psychodynamic behaviour towards organizational psychodynamic behaviour. Values and basic assumptions, as described by Schein (1991) (Fig. 29), make up the essence of the concept of organizational culture. Malinen (2000) (Fig. 27) describes experiential learning as a process of reconstruction, where the new learning meets the hard core of personal experiential knowing; a protective belt is needed

to provide psychological stability. It can be concluded that learning, at least in some situations, involves reorganization of the value system of the "parent ego state".

One can simplify the basic assumptions of the structural learning theory (Scandura 1983) by defining learning as a rational process of storing the cognitive domain (Krathwohl et al. 1964) of knowledge into the learner's brain by carefully planned structural instructions. This approach assumes that the object of learning is the "adult ego state" of the psychodynamic model.

The author's synthesis of the two contradictory approaches is that the "parent ego state" as an object of learning is more valid when the type of new learning essentially includes intentions to change the learner's behaviour. Such conditions include situations where the learner has existing experiential knowledge of the topic of learning. The "adult ego state" as an object of learning is more valid when (1) The topic of learning is new to the learner, and (2) the aim of learning is to reach the lower levels of competence (Table 5).

The role of the "child ego state" (Fig. 22) in a process of learning where the object is the "parent ego state" is essentially to be the source of learning motivation. The "Four I's" of the transformational leadership theory (Bass & Avolio 1994) essentially focus on influencing, inspiring and stimulating the "child ego state" of the followers. Of the learning theorists, Engeström (1994), for example, describes "cognitive conflict" as a source of learning motivation – conflict is essentially related to "frustration" of the "child ego state".

By extending the psychodynamic approach to the organizational level of the organizational culture, rational organizational assets and leadership can be constructed as a psychodynamic model of organization (Fig. 32). The model is analogous to the Parent-Adult-Child of transactional analysis. Rational organizational assets within the model mean, for instance, organizational structure, processes and information technology. Tiihonen (1990) presented another psychodynamic model of organization based on Freud's topography. The similarity of organizational culture to a value system is obvious. Equally, the contents of rational organizational assets and management system are essentially identical. Drawing an analogy between the child ego state and organizational leadership requires further discussion. Tiihonen (1990) describes "Primary System" as a source of initiative and energy. This is also the role of organizational leadership. Tiihonen (1990) further describes the primary system as a source of irrational behaviour from the point of view of the organization's task orientation. He points out that unsatisfied human needs are the source of irrational behaviour. In that sense, using the term "organizational leadership" is a simplification, but that can be justified by the simplified nature of the Parent-Adult-Child model compared to the Freudian topology. To justify the logic of the model, there should also exist contented and frustrated states of organizational leadership. Furthermore, the frustrated states should include rebellious and over-adapting behaviours. Referring to the metaphors of "organizations as political systems" and "organizations as instruments of domination" presented by Morgan (1997), the existence of such states of organizational leadership can be justified.

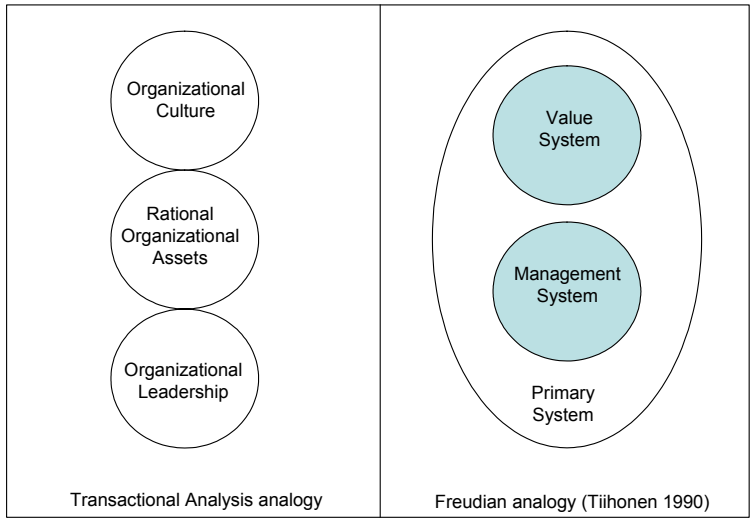


Fig. 32. Two psychodynamic models of organization.

The implementation of a new concept called Total Quality is an organization-wide learning process.

The intention is to change the learners' behaviour. Using an analogy with the model presented by Malinen (2000) within the context of experiential learning (Fig. 27), organizational learning means a change of the cultural value system. The change is completed, when the new learning is fully integrated to the cultural value system as described within the affective domain of the learning taxonomy (Krathwohl et al. 1964). The requirement for such change is a critical mass of committed organizational leadership to go through the learning process (Fig. 33). While planning such a learning process, all the elements of the presented psychodynamic model of the organization need to be considered: (1) What is the level of change of the organizational culture, (2) what are the rational cognitive elements to be learned, and (3) how to create the critical mass of organizational leadership to implement the learning process.

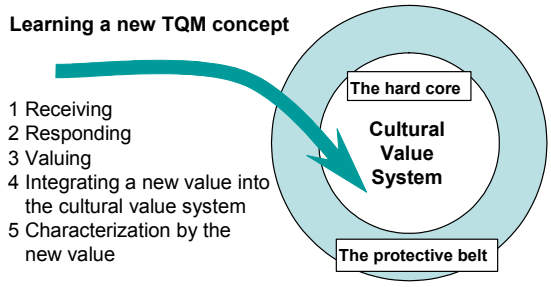


Fig. 33. Learning a new TQM concept.

Teamwork has a specific role within this context; a new team is an organization that creates its norms, i.e. cultural value system, through a process of evolution. Referring to

chapter 2.4.4 (Change mechanisms of organizational culture), learning that requires radical changes of the organizational culture is easier within the team context than within the context of a more stable organizational structure. The above-mentioned critical mass of committed organizational leadership can be created through teams that are facilitated to manage change.

3 Empirical research

The empirical research for this dissertation was conducted through four research cycles (Fig. 34). The first three research cycles provided the pre-insight for this study, and the fourth addressed the implementation of learning in an R&D organization with appr. 1000 employees over a period of 6 years. In the research cycles 1 and 2, the author's role was that of a senior manager with budget responsibility for the actions taken. The author was reporting to the executive manager of the organization, who was responsible for strategic choices and business profitability. In research cycle 3, the author first created a construction to manage operational excellence in R&D and then took actions to facilitate its implementation, studying the unique nature of quality management from a senior manager's and a facilitator's perspective. The ultimate intention was to minimize the impact of the author's own influence on the results achieved through the implementation of the model. During research cycle 4, the author's role was that of a quality manager in a small team of quality managers. Each member of the team had their own roles and responsibilities. The author's responsibilities included participation in strategic management, development of leadership and quality competencies and managing strategic re-engineering projects. Much of the learning described in the empirical part of this study includes the contribution of multiple actors. Still, the author had an essential role within each of the episodes described in the study.

Each research cycle started with a practical problem to be solved. The problem was diagnosed and an action plan to solve the problem was outlined. Through the episodes, actions were taken to implement, evaluate and improve the plan. Finally, the learning of each episode was specified. Within research cycle 1, research cycle 2 and research cycle 4, the model of four levers of control (Simons 1995a) was used as one tool to structure the learning of the methods of control used within the episode.

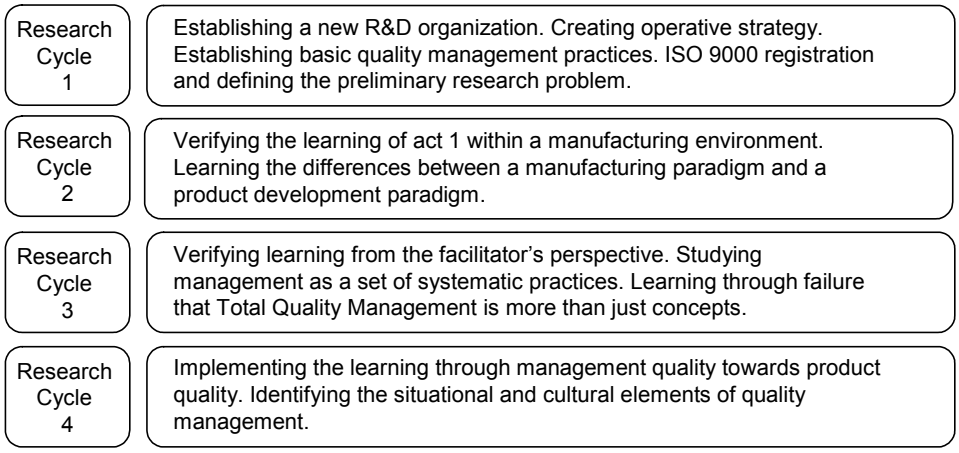


Fig. 34. Structure of empirical studies.

The structure of the research environment is presented in Fig. 35. The first two research cycles took place in a recently established business unit called Special Products; first in the R&D Unit and later in the Manufacturing Unit. The third research cycle was carried out both in the Special Products business unit and at Product Development Site Oulu. The fourth research cycle was conducted at Product Development Site Oulu.

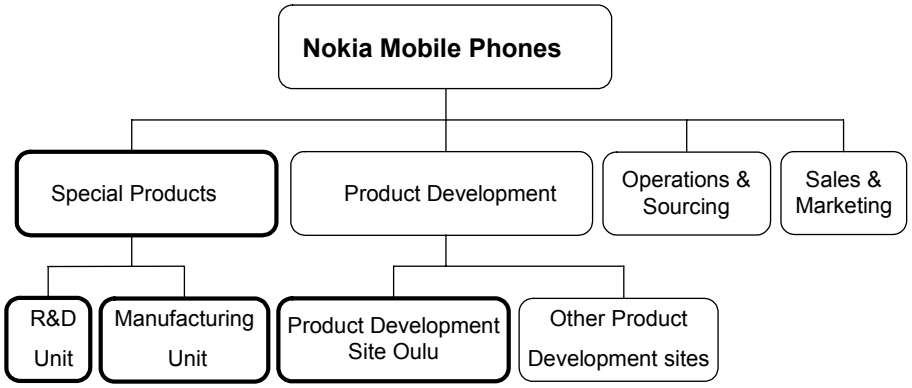


Fig. 35. Simplified structure of the research environment.

3.1 Research cycle 1 - Establishing Special Products R&D Unit

The Special Products Business Unit was established in 1991 to achieve improved focus in customer-driven, small and medium-volume mobile telephone business cases. The first such business opportunity was the NMT450 mobile telephones, which were out of the mainstream. Due to the emerging markets in the former Eastern European countries, the

demand was increasing as the technology provided an easy and cost-efficient way to establish basic telecommunication services.

The Special Products Business Unit initially included an R&D team of four engineers, a manufacturing unit of 60 employees, one product marketing manager and a small management office team.

During the first research cycle, the R&D unit of Special Products was established. During 1992-1996, the author held multiple senior management roles related to Special Products - starting as product development manager.

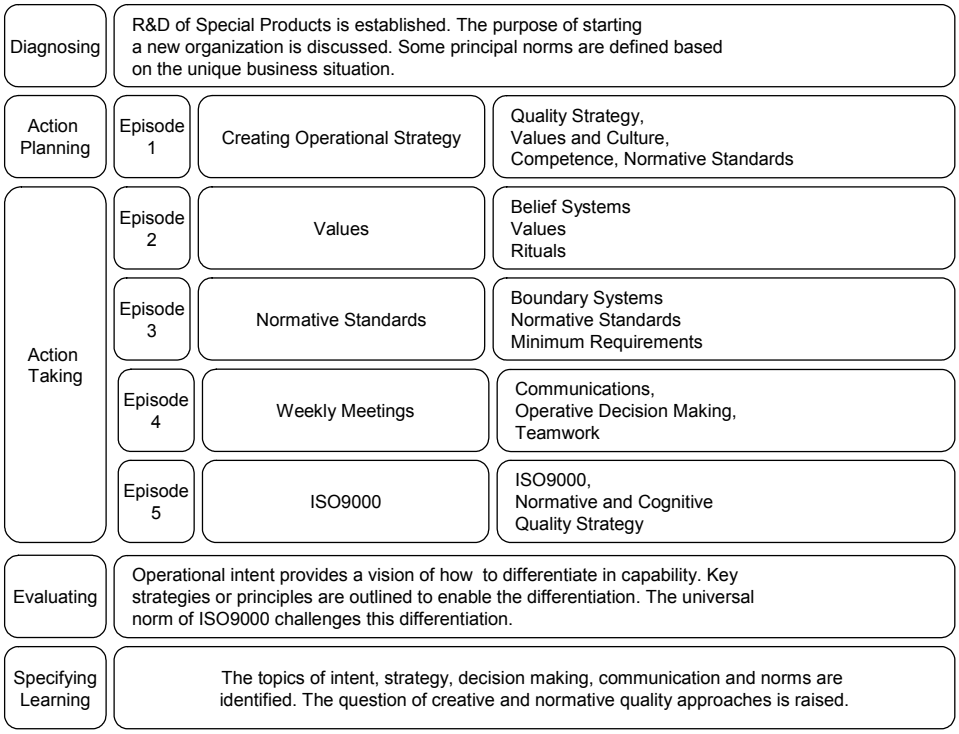


Fig. 36. Structure of research cycle 1.

Diagnosis

The Special Products Business Unit was committed to deliver products to customers with tight schedules. Their product mix included two product families: transportable and hand-portable mobile telephones. In each product family, several frequency and software variations were needed for specific customer requirements. The basic technology was more than five years old; and the availability of components was therefore a challenge. The number of R&D engineers was limited. A specific problem was the software of the hand-portable products; the existing software was three technology generations old, and there were no competent resources available to modify the old software code.

The following conclusions concerning critical success factors were made based on an analysis:

- Fast growth is the strategy baseline.
- People and competence are the critical resources to be used as economically as possible.
- A short product development cycle time is needed to create competitive edge in the marketplace.
- Product quality must be better than the level of competition.
- Some compromises can be made concerning product cost structure, as the products are segmented to business users, and there is no competing technology available.

3.1.1 Episode 1 - Creating operational strategy

The analysis showed that the strength/opportunity of the business unit was the level of experience of the limited resources. Also, small size and clear focus were seen as an opportunity. Based on this baseline, the following statement of operational intent was created:

> *"Special Products wants to be a role model in Nokia Mobile Phones, how good and flexible co-operation between marketing, production and R&D can create agility to react to the customers' changing needs."*

Based on the operational intent of the business unit, the operational intent of the R&D unit was outlined as follows:

> *"Success in R&D based on people who will learn and succeed in an environment that stimulates entrepreneurship and exploits diversity of individuals. Continuous quality improvements by everyone's involvement to minimize R&D times doing first time right."*

Three enablers were identified to meet the operational intent:

- Learning and succeeding,
- entrepreneurship and
- continuous quality improvement.

The operational strategy was created based on these elements:

- A plan to update the product technology step by step to state of the art was outlined. Each step included the launch of a new product family with major improvements in one technology area, focusing the resources and maximizing the reuse of existing technology.
- A plan to develop the desired core competencies was outlined. A personal long-term learning plan was drawn up for each individual. The objectives were based on strategic need, individual talent and individual preferences. Most of the learning program was based on learning by doing under the supervision of the core team.

- Entrepreneurship was identified as a desired behaviour. The communication material highlighted two characteristics of entrepreneurship: courage to enjoy the challenges and willpower to reach for something with full effort.
- The continuous quality improvement policy stated:
  - "We will focus our quality improvement to prioritized activities. While improving our practices we aim to remove the problems instead of fine-tuning them to acceptable level."

An operational manual ("White Book") was produced. The manual consisted of quality bulletins; each of which was published to document a solution to a specific problem. A hand copy of the operational manual was delivered to all members of the R&D team.

Later on, the operational manual was updated annually. Outdated bulletins were removed and new bulletins were compiled based on actual need. The quality bulletins of the first version are listed in (Table 9).

Table 9. List of quality bulletins approved 21.9.1992

	Bulletin	drafted
1	Operational strategy	19.8.1992
2	Practice of weekly meetings	1.6.1992
3	Definition of engineering skills and competence ownership	2.6.1992
4	Project planning	4.6.1992
5	Milestone reviews and acceptance criteria	10.6.1992
6	Rules for product, unit, module and component coding	19.8.1992
7	Rules for document approvals	19.8.1992

3.1.2 Episode 2 –Values

The three enablers of success (Learning and Succeeding, Entrepreneurship and Continuous Quality Improvement) were soon replaced by the established Nokia Values: Customer Satisfaction, Respect for the Individual, Achievements and Continuous Improvement.

In addition to practical implementation of the values based on leadership, rituals enforcing these values were created. An example of such rituals was the graduation ceremony. Each time a member of the personnel graduated, a highly formal graduation ceremony was arranged. The time was always Friday from 15.00 to 16.00. Instead of the normal dress code - jeans and T-shirt, all personnel used a black tie on those Fridays, showing respect to the new graduate. The ceremony was opened by the supervisor of the graduate, who presented the merits of the master's thesis. Next, the senior management also made their remarks of the merits. Finally, each member of the personnel had an opportunity to describe the merits of the graduate as a work mate. After the working hours, the graduation ceremony continued in a less formal manner.

3.1.3 Episode 3 – Normative standards

Besides the operational strategy, the bulletins of the operational manual (Table 9) included formal procedures for performing specific tasks. For example, the contents of project plans were specified and the project milestone approval criteria were clearly described. The number of bulletins was kept limited, as each requirement was punctually followed up. All projects, with no exception, needed to have a project number, a project brief and an appointed project manager before they existed. The manufacturing unit did not produce any product units without the signed production release issued by the project manager, and no units were delivered to the customers without a sales release signed by the marketing manager and the business unit manager.

The normative standards were simple and limited in number. Each time such a normative standard was adopted by the team, the respective bulletin was removed from the next update and replaced by a new normative standard.

3.1.4 Episode 4 – Weekly meeting

The operative management of the R&D unit was implemented through a regular practice of weekly meetings. The meeting time was each Monday at 9:30 - late enough in the morning so that everyone had had time to read their post and do the routines after the weekend, but early enough in the week, so that the agreed decisions could be scheduled into personal plans.

After a few meetings, based on feedback from the participants, it was also agreed to limit the length of the meeting to exactly one hour. The decision that the meeting would start punctually at 9:30, regardless of whether all participants were present or not, and end punctually at 10:30, even in the middle of someone's sentence, helped to create one element of the culture of the R&D unit.

The meeting had a standard agenda described in the operational handbook. Through the minutes, it was possible to communicate, decide and document all the essential information concerning product development.

Reporting in the weekly meetings was based on open actions and the target dates of the next milestones. In the case of major deviations, the priorities of the project portfolio were discussed, new resources were allocated to the high-priority projects, and low-priority projects were delayed.

Two years later, it became evident that the meeting practice did not meet its purpose in its existing format. The number of personnel had grown to 30, and the project meeting practice had been established in some projects. The structure of operative decision making and information sharing was re-evaluated and changed to match the current organizational situation. A management team was established, and the meeting system was divided into three elements:

1. project meetings for decision making related to the project,
2. weekly meetings to share general information, and
3. management meetings to make operative decisions.

With the new format, the Special Products weekly meetings were held every Monday from 9:30 to 10:30, until the Special Products business unit was restructured in May 2002.

3.1.5 Episode 5 – ISO 9000

Product Development Site Oulu was ISO 9000-certified in 1992. The schedule of related audits is presented in (Table 10).

Table 10. Schedule of ISO 9000 certification audits.

Certification audit	Schedule
Internal audit 1	June 1992
Internal audit 2	August 1992
Pre-assessment	September 1992
Internal audit 3	November 1992
Assessment	December 1992

In August 1992, it was recognized that it would also be beneficial for the Special Products R&D unit to be included in the scope of the certificate. The current status of the certification process was discussed on 12.8.1992. Through the internal audits within the Product Development Site Oulu, altogether 13 nonconformities were identified, including two classified as major, and the certification team began to urgently work for solutions.

An internal audit was organized in the Special Products unit on 1.9.1992. The most serious nonconformity concerned the missing practice of manual signatures of document reviews and approvals, which had been replaced by status indication (draft, proposal, approved) within the electronic databases. A critical discussion was held to find out why an outdated practice should be established merely to meet the requirements of ISO 9000. More specifically, there was no requirement in ISO 9000 for manual signatures, but the requirement was the auditor's interpretation of the standard.

Another critical discussion was held concerning the "White Book". The internal auditor expressed as his requirement that such documents competing with the Quality Manual should not exist.

Anyhow, the "White Book" was updated in such a way that it described the local implementation the Quality Management System. Also, a new bulletin titled "Rules for document approvals" was added to the "White Book", including the practice of manually signed reviews and approvals using a specific template.

The "White Book" was formally approved for use on 21.9.1992, only one day before the ISO 9000 certification pre-assessment by external auditors. The approval was done in the weekly meeting, and personal copies were given to all employees.

Evaluation

The business results of this research cycle were good; during the first year, the number of employees increased to twelve (12). A total of fifteen projects were completed, and the market position strengthened remarkably. Within a few years, Special Products became

able to maintain profitable growth, to gain a dominant position in the NMT450 marketplace, to establish three new business lines and to increase the number of R&D engineers to much over 100.

3.1.6 Specifying Learning

During the first research cycle, the basic concepts of quality management were established in the new R&D unit. As the organization was new, the cultural basic assumptions of the organization were also created. Practically speaking, the role of development manager also included the tasks of quality manager. The process of establishing an operational intent, communication and focused step-by-step implementation was clearly compatible with the theory of charismatic leadership (Conger 1989). Within this research cycle, the four levers of control (Simons 1995a) were effectively used (Table 11).

Table 11. Levers of control in research cycle 1.

Belief systems	Interactive control systems	Diagnostic control systems	Boundary systems
Operative intent Values Rituals	Weekly meetings	Business results Project schedules	Normative standards Approvals to use money

Questions about future steps arose during the period of ISO 9000 certification. The ISO 9000-based quality management system conflicted with the current approach of focused problem solving based continuous improvement. The conflict is visualized in (Fig. 37): Should multiple problems be solved to an acceptable level or a limited number of problems to a good level? Considering that each problem solved also required the establishment of control in such a way that the improved performance level could be maintained, it was assumed that a limited number of problems should be addressed. Focusing to a limited number of problems meant that it took more time to meet the ISO 9000 requirements, but this also enabled continuation of the process towards higher levels of ambition.

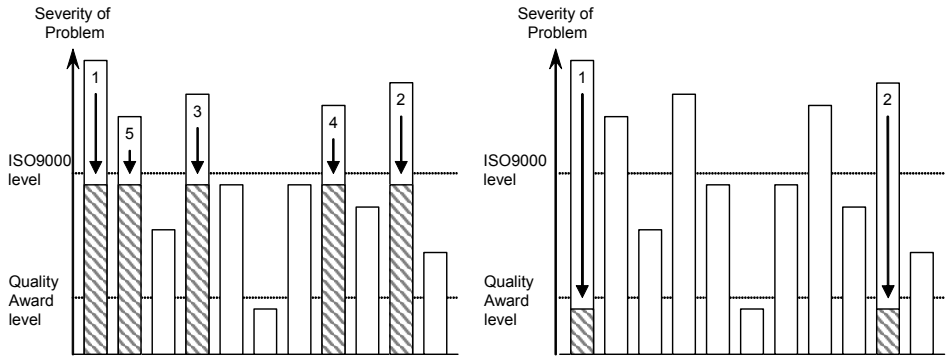


Fig. 37. Two levels of ambition in problem solving.

Another question about the future concerned continuous improvement. The activity was clearly driven by the author, but such activity as self-initiated improvement and "everyone's involvement" was not a visible element of the organizational culture, though it was encouraged. The organizational focus was more towards operative business results than continuous quality improvement. There may be two root causes for this:

- Either the people were too busy to achieve the short-term business results during the establishment of the organization, or
- the total amount of change satiated the capacity of change acceptance.

3.2 Research cycle 2 – Reengineering Manufacturing Unit

At the beginning of 1993, the author's responsibilities were increased, first through his appointment as the manager of production technology and procurement of the Manufacturing Unit of Special Products, followed by a later appointment as operations manager.

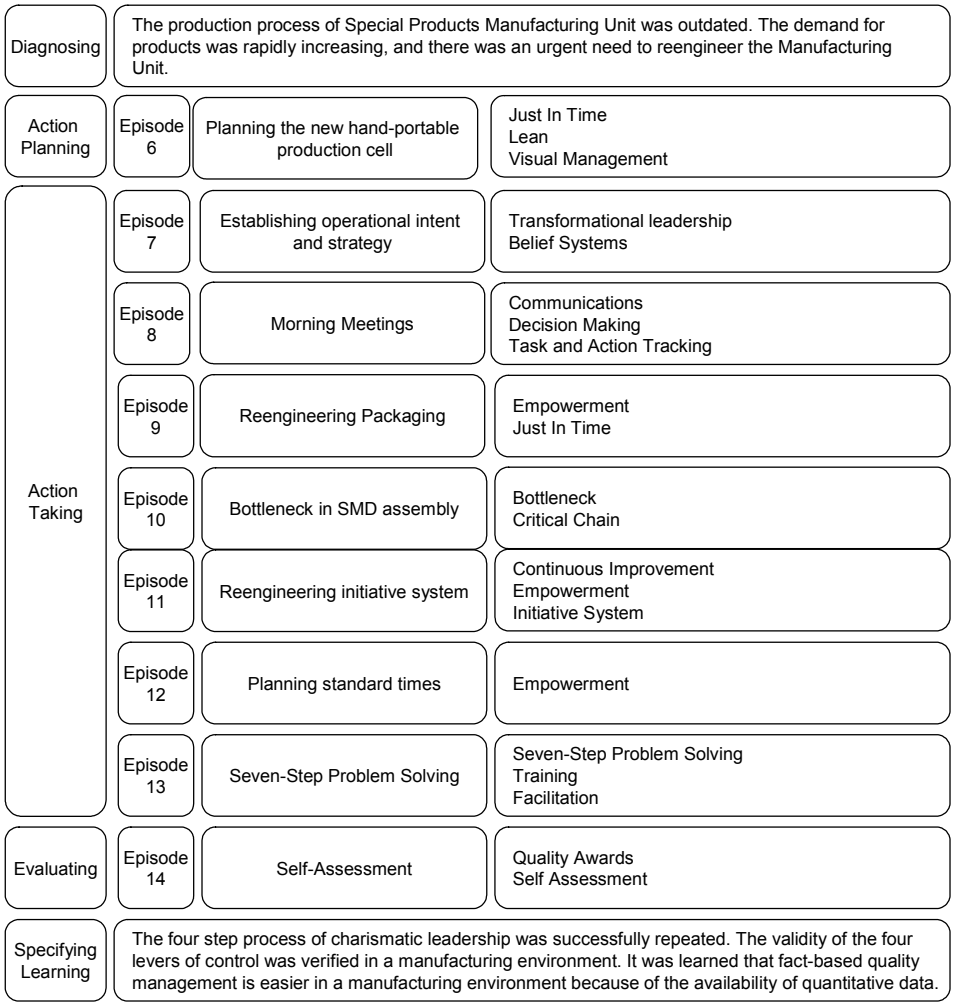


Fig. 38. Structure of research cycle 2.

Diagnosis

The production volumes were increasing, and the manufacturing unit had difficulties meeting the required production volumes. Through the ramp-up of a new hand-portable product family, further increase of demand was expected.

The root cause for the delivery problems consisted of the old products and the old manufacturing process. The process was intermittent and compatible with the functional production model (Tersine1995). Production lots of a few tens of units were manually transferred from one working point to another. As each product consisted of six or even more modules, and most modules required multiple production phases, the production flow was complex and difficult to manage. After each production step, production

supervisors entered the status into the Material Resource Planning (MRP) system (Tersine 1985).

3.2.1 Episode 6: Planning the new hand-portable production line

The planned production volume of the new hand-portable product was fivefold compared to current production. The technology of the new product enabled the use of more continuous production flow.

The process used by the Nokia Mobile Phones mainstream production lines was based on highly automated conveyor lines, where products passed from one end of the line to the other (Fig. 39).

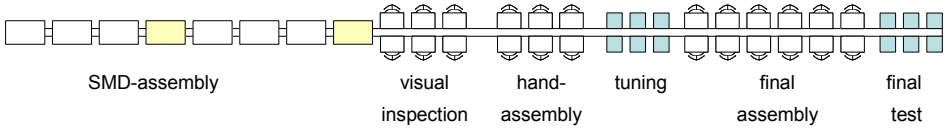


Fig. 39. Simplified drawing of a highly automated production line.

The same process could not be used, because the volume was still too small to allow correct balancing of the line. Especially, the volumes were too small to integrate SMD assembly directly to the production lines. The SMD assembly unit had to serve multiple production lines.

Anyhow, continuous material flow was taken as a planning requirement. The principle of keeping the inventories visible and preferably moving was one of the key enablers of the change to be implemented. The question of how to implement this principle on the production lines of single products was problematic. Based on plenty of planning and discussion, a solution of manual conveyors using palettes moving materials from one working phase to another was planned jointly with a team of key operators.

The key operators proposed a solution of a manual conveyor with two rails. The products would move on the upper rail and the empty palettes would be transported back on the lower rail. On the upper rail, the palettes would be pushed manually, and on the lower rail a motor-driven belt would convey the trails back to the beginning of the line (Fig. 40).

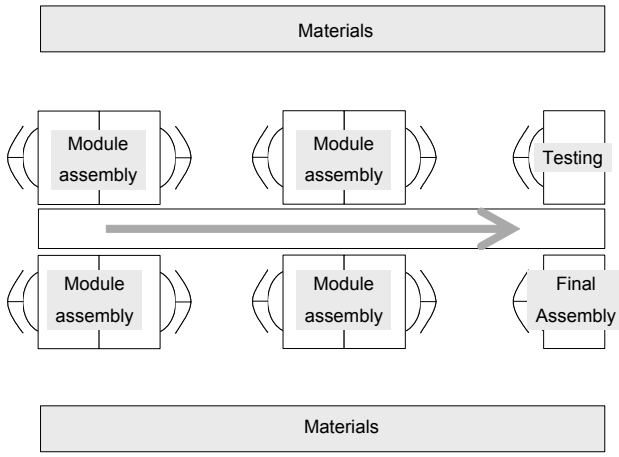


Fig. 40. Solution for a manual conveyer line.

Based on standard times calculations, each such manual assembly cell could produce 150 units daily in two production shifts with seven operators working in both shifts. The same solution could be used for all products, and a total of six such production cells could meet the full demand.

Compared to highly automated production lines, the solution was ten times cheaper, and re-erection for new product types was easy. As there was no complex automation involved, the solution was also robust; the production operators were able to solve all malfunctions by themselves. Summa summarum – the solution was lean.

3.2.2 Episode 7 - Establishing operational intent and strategy

Based on the learning of Research Cycle 1, operational intent and operational strategy were established. Operational intent was stated as follows:

"Special Products Wants to be the Best Mobile Telephone Factory in Town."

This definition of operational intent was received curiously but sceptically. The short history of the manufacturing unit included a fair number of disappointments and instances of poor performance. Also, having a look at the performance of the mainstream production lines evoked the question of whether this level of challenge was in any way realistic.

Three management principles were established to meet the operational intent:

Principle one: Visual management

Besides the fact that the new production model enabled visibility of the production flow, whiteboards on the floor were used to set the production target for each production team. At the beginning, the targets were set on a daily basis, but it soon became apparent that the results should be monitored every two hours. This enabled a reaction during the same

working day. Thus, the teams reported the results every two hours, and in the case of deviations, the reasons were discussed immediately.
Discussions with the operators showed that the reason for low productivity was not laziness of the operators, but hassles within the production system. It was exclusively the management's responsibility to remove the obstacles of good productivity.

Based on the team targets, the production supervisors gave individual targets for each individual operator on a paper template. The operators reported their results on an hourly basis, and the root causes for deviations were solved together.

In addition to visual production flow and punctual target setting, active attention was given to overall tidiness. All unfinished products were to be on trays, and no boxes were allowed to be stored on the floor.

Principle two: Fast feedback

The principle of visual management made it possible to react to problems immediately. The principle of fast feedback challenged the management. It was stated that all the analysis and follow-up systems to be created should enable reaction to problems within 15 minutes. In practice, this meant that the practices of collecting data and printing reports at weekly intervals were mostly dropped. In case of relevant production control, the use of white boards or similar methods was the preferable way. Operators' reporting the status on whiteboards and whether control limits were exceeded allowed the management to take actions immediately.

Principle three: Continuous improvement

The third principle was exactly the same as in research cycle 1. Prioritizing problems and removing them one by one.

The operational intent was written on a whiteboard in the factory and formally signed with date and place.

The operators were summoned together, and the principles were clearly described to everyone. As the factory worked in two shifts, this information sharing was arranged separately for both shifts. Later on, similar information sharing was organized every two or three weeks. As a curiosity, it could be mentioned that, though this kind of information sharing took 20 minutes off production, its impact on the daily production volumes was still positive each time. The author also wrote an article (dated 7.7.1993) in the internal news bulletin of Nokia Mobile Phones Salo area operations. In this article, the operational intent and the three principles were described. T-shirts with the texts "Something Special …" and "Best in Town" were ordered and given to all operators of the factory.

The author's commitment to the operational intent in a clear and visible manner caused plenty of discussion on the operational intent in both the Special Products Factory and the Mainstream Factory. As the level of challenge of the operational intent was "Mission Impossible", the overall reaction was curious. It was important to show people that the "promise" was followed by decisive actions. Within a few weeks, as real evidence accumulated of decisively improving results, curiosity changed to commitment. At the end of June, people really made their best to make the operational intent happen, and in September, there were no more references to "Mission Impossible", but people felt they had a realistic objective that could be met. Table 12 shows the increase of production

volumes during this period. C factor was the measure used to follow up productivity. In short, C factor value of 1 is possible to achieve when employees use 80% of their working hours with 120% efficiency. This 80%-120% principle is the basis of trade union agreements concerning performance-based salary bonuses. Considering training, sick leaves, product fixing, learning curve of new operators, etc., actual values of 1.2 to 1.5 indicate good productivity.

Formula 1: C factor = A/B, where

A = Working hours actually used for production
B = Working hours needed for production based on standard times

Table 12. Increase of production during the production ramp-up phase.

Month	Production volume	Productivity index	Number of operators
April 1993	1 700	C=2.7	60
June 1993	6 600	C=1.3	90
September 1993	13 200	C=1.5	120

From the business point of view, the April volumes were clearly below the acceptable level, while the June volume was the minimum to keep vital customer commitments. In September, however, the production volume was able to meet the demand.

The enablers of increased production were:

- Increase of personnel,
- increase of productivity and
- change of average standard times due to a new product mix.

The improvement in productivity as described in the figures while at the same time adding new operators is remarkable. The new production model enabled visibility of the production flow and made it possible to remove the obstacles of productivity one by one.

3.2.3 Episode 8 - Morning meetings

Based on the positive impacts of the weekly meeting practice in the R&D unit, a practice of regular meetings was also established in the Special Products manufacturing unit. As the rhythm of production is faster than the rhythm of R&D, meetings were held every day at 8:30 and took 10-20 minutes. All the staff and key operators gathered around a whiteboard. First, the production figures and problems of the previous day were discussed. Then, all actions listed on the whiteboard were tracked. Completed actions were filed as paper copies and removed from the whiteboard. Each participant had an opportunity to raise production problems to be discussed. Based on the discussion, action number, action, action owner and target date were written on the whiteboard.

This practice of daily action tracking enabled an effective system for continuous improvement. At the beginning, some participants had a tendency not to complete the actions as agreed. As this caused their name to be written on the whiteboard connected with a list of non-closed actions, to be seen by everyone in the factory, this behaviour was

quickly changed. The meeting practice also enabled everyone to be aware of the workload and available resources of the team members.

Another topic brought up in these meetings was the phenomenon of a practice getting embedded as part of the organization's culture. At the beginning, the participants needed to be called to the meeting each time. The behaviour was sort of reluctant. As the author was sharing his working week, being in Oulu on Mondays and Fridays and in Salo from Tuesdays till Thursdays, it was quite typical that the meetings were not organized when the author was not present. At the next step, the responsibility to manage the meetings was given to the deputy, which solved that problem. But still, if none of us were present, the meeting was typically not held.

Finally, at the end of June, the situation was such that participation in the morning meeting was part of the cultural behaviour. If none of the formal leaders were present, the participants appointed a chairman. This phenomenon of "a practice being embedded into organizational culture" was typical during this study; the time frame varied from a few weeks to a few years, depending on the character of the practice to be embedded. From the managers' point of view, this means that the new practice needs to be managed and takes management energy until it is embedded into the culture. This creates a limit to the managers' capability to implement new practices.

3.2.4 Episode 9 - Re-engineering packaging

The team of three operators packaging phones complained about the limited space for packaging. The available space was about 25 square meters. The piles of boxes and cartoons of packaging material took up a lot of space, as did also the accessories.

One of the root causes for the problem was that all the materials were ordered to the factory from the central warehouse based on "production lots". As a result, the packaging area was full of boxes, including a set of antennas, batteries, user guides, etc. for a production lot of a few tens of mobile telephones. To make the situation even worse, the number of actual mobile phones produced in the factory was not exactly the same as the number of accessories ordered for a production lot. As a result, either there were boxes including material for one or two extra packages or new boxes were opened to get the parts for the last few sales packages.

At the same time it was noticed that, though the standard time of packaging was two or three minutes/package, the actual time used by the operators was more than 15 minutes leading to a C-factor of 7 or higher. Although productivity was low, the packaging operators were working in a committed and highly effective way all the time – so what was the extra work they were doing besides the planned work included in standard times?

One element was the hassle with the boxes half used and half opened. That was clearly a management problem. Another element was that they did not follow the planned methodology; instead of waiting until the whole production lot of telephones was ready for packaging, they started to make preparatory work by setting up cartoons. As the standard time was calculated based on the assumption that the setting up of cartoons is part of the set of movements during the packaging; they actually added extra time to the method.

An even more important observation was that when they needed to wait for products to be finished, they walked to the production lines and picked and packaged products one by one. The root cause for this behaviour was their built-in need to work continuously – from the manager's point of view a very admirable characteristic. Unfortunately, this behaviour concealed the fact that packaging was not properly balanced with production.

The phenomenon of operators causing themselves extra work was exceptionally problematic during this research cycle, because any survey for bottlenecks in production would typically show everyone to be busy completing their tasks. Still, from the point of view of total output, there was only a single bottleneck affecting the total output of the factory.

It took some time to convince the operators that there was no actual benefit from doing the extra work they were doing. The discussion led to an agreement that if they have any extra time available, they should use it to improve their working methods. The principles of JIT and Lean were also discussed. The practice of ordering material based on "production lots" was to be replaced by the "delivery for need" practice.

The packaging operators were suspicious at the beginning, but as soon as they realized that "delivery for need based" material flows were already used in the mainstream production unit, and that the operators in the central warehouse were more than happy to quit "production lot based" material collection, which caused them a lot of work, the planning of the new system was on the way.

A new way to organize packaging was drafted. Based on the draft, the details were discussed, and the operators noticed that there were options to organize the space available for packaging in such a way that no additional space was needed.

The end result was that the operating principle was totally changed. The packaging team made a weekly plan for packaging. Space-taking packaging material was delivered from the central warehouse with a service level of two days (within two hours if necessary) to the factory's warehouse area. Materials that were only used in the Special Products factory and did not need plenty of space, such as type labels, antennas and user guides, were delivered by the subcontractor directly to the warehouse area for packaging instead of storing them in the central warehouse. Some specific items, e.g. battery units, were directly delivered by the supplier to the warehouse area for the packaging team based on a daily plan.

Nine months later, production volume was tenfold. The same team was still capable of managing the packaging process and the packaging material flows, and the space needed for packaging was no bigger than the original 25 square meters.

3.2.5 Episode 10 - The bottleneck in SMD

In October 1993, the demand for products further increased. Planning showed that the capacity of the SMD assembly unit was approaching the critical level, and one more placement machine was ordered and would be available in November. SMD assembly was now being done in four shifts, enabling production for 24 hours a day, including Saturdays. It was still possible to have some flexibility by using overtime hours for production on Sundays.

At the beginning of October, SMD assembly seemed to be suffering from persistent bad luck. Though overtime hours were used, the production level was lower than in September. While discussing the reasons, machine failures and other mishaps were considered to be the root cause. Luckily, there was some capacity available in mainstream production, and a special lot of 1000 assembled PCB's was received to keep the hand-assembly running and to meet the customer commitments.

As the bad luck seemed to continue, efforts were made to find out what was really happening. It was noticed that the inventory of assembled PCB's was very low and the next production phase did not have enough material for production. The production was controlled by packaging, which had a prioritized list of customer orders to be completed. While there was a lack of assembled PCB's, they started to order small lots of assembled PCB's in order to complete the next delivery as soon as possible. This was against the agreed planning cycle. A one-week fixed production plan was used for SMD assembly to optimize productivity.

Production systems have a balance between inventory, flexibility and productivity. In JIT, Lean and Mass Customization based production systems, some productivity is intentionally wasted to decrease the inventory and to add flexibility. Through continuous improvement, a capability to further decrease the inventory and to increase flexibility can be achieved. As a result, productivity also improves.

In this episode, the inventory was too low and flexibility too high. This caused low productivity. As SMD assembly was the bottleneck of the whole factory, the end result was a remarkable loss of production capacity.

After realizing this, it was agreed that, until the SMD assembly capacity could be increased, the whole production had to be planned to maximize the productivity of SMD assembly. This meant producing longer series of one product type at a time - even when an urgent customer delivery needed a few more SMD assemblies. The decision was to wait until the scheduled production of that specific type of SMD assembly. In the worst case, that meant one week delay of the delivery.

This decision caused delays in deliveries during the next few working days, until the level of the SMD assembly buffer inventory was stabilized at the planned level. After that, the SMD assembly capacity was back to the required level and the production targets of October and November were met.

This episode is a good example of hidden bottlenecks. The example may seem trivial, but the identification of the root cause took quite a long time. Such hidden bottlenecks also have implications for expert organizations; if identification was difficult in an environment where everything is visible and measurable, identification is probably even more difficult in expert organizations.

3.2.6 Episode 11 - Re-engineering the initiative system

Increased production (and operating income) enabled hiring of new staff. A diploma thesis worker focusing on TQM implementation was hired. The specific task given to him was to walk around the factory, to discuss with operators and thereby to identify improvement opportunities. The recruited diploma thesis worker had lots of fresh energy

and good leadership skills. The practice of having a full-time employee facilitate continuous improvement had an important role in further improving the operational effectiveness of the factory.

When the diploma thesis worker started, there were two employee initiative systems in use in the factory. One of them was called “Yellow Cards”. Each employee had an opportunity to bring a problem to the management’s attention by describing the problem on a “Yellow Card”. The “Yellow Cards” were discussed in the morning meeting, and actions to remove the problem were agreed. The other system was the “Initiative System”. Employees wrote improvement initiatives, which were formally filed by the “Initiative Committee”. A statement was requested from a relevant specialists, and an “Initiative Payment” based on the estimated business value of the specialist was paid.

The problem with the “Yellow Cards” was that the operators were shy to raise problems, so the number of written “Yellow Cards” was not very big. The problems of the “Initiative System” were even worse. First of all, the time needed to process the initiatives was many weeks. When the operator got the answer, he/she had already forgotten the issue. Also, writing the statements was just an extra workload for the specialists. It was not very typical that the initiatives were really implemented. The operator got a small reward, but nothing really happened. This frustrated both the initiator and the specialists.

As the first step in implementing a new practice, the “Yellow Card” template was re-designed in such a way that it included an implementation diary. It showed when the initiative was filed, when it was received, when it was further discussed with the originator, what the implementation plan was, and when the initiative was finally implemented.

As the second step, a transparent box for “Yellow Cards” was mounted next to the “Initiative Box”. The “Yellow Card” was very clearly visible in the transparent box and a target time was given to the diploma thesis worker to start further discussions of implementation within 15 minutes from the moment when the “Yellow Card” was filed. In addition to reacting to the “Yellow Cards” placed in the box, the diploma thesis worker walked around among the operators and helped them to write “Yellow Cards”.

The further discussion of the initiative was a remarkable improvement, as it enabled the problem to be clarified better. In many cases, the discussion also enabled identification of the root cause of the problem, and in such cases, the focus of the initiative covered a wider area. In most cases, implementation was a very simple issue that could be done by the originator and the diploma thesis worker. In some cases, the diploma thesis worker was able to solve the problem with other members of the staff. Only a few of the most important issues required further discussion with the management team.

If the business value of the initiative was remarkable, the diploma thesis worker helped the originator to write an official initiative to be forwarded to the initiative committee. As the initiatives were typically already implemented, and also as they were discussed in more detail, the quality of the formal initiatives improved significantly. As a consequence of this, a few quite remarkable initiative payments were given. The biggest “Initiative Payment” in the history of Nokia Mobile Phones was given to one of the Special Product’s operators during that time.

The conclusion that could be drawn from this episode was that the most important motivating factor for production operators to be active in this "Initiative Program" was the implementation of their initiatives. The "Initiative Payment" was a secondary issue for their motivation, though it is naturally important from the justice and fairness point of view. Managing the implementation and payment practices separately led to good results.

The other important consequence of this episode concerns the role of the facilitator. In "Episode 7 - Morning meetings", the problem of limited management energy to manage change was considered. Facilitators with good leadership skills can increase total management power by a remarkable factor.

Fig. 41 shows the change in initiative activity. The initiative program was launched in December 1993. There was an immediate increase in "Yellow Cards" and an increase of initiatives after some delay. For reference, in the period from January 1994 to April 1994, the number (including both "Yellow cards" and "Initiatives") was 230 pcs/100 employees/year. The Finnish industrial average in 1992 was 18 pcs/100 employees/year (Mattila, 1994).

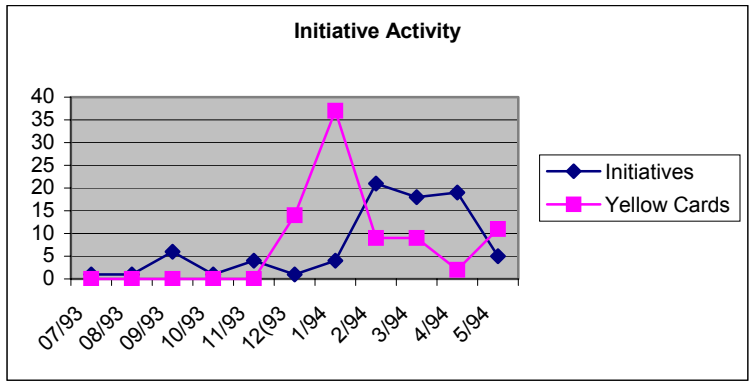


Fig. 41. Change in initiative activity (Mattila 1994).

3.2.7 Episode 12 - Planning standard times

During the research cycle, production operators were called repeatedly to participate in different planning activities. For instance, it was a standard practice that selected operators participated in the product development of new products from the very beginning. When production finally started, they were appointed key operators for that new product. During the product development phase, they planned and erected the work places, wrote the working instructions and assembled the pre-production series. The experiences were good.

One important task in production planning during the product development phase is the estimation of standard times. A job analyst trained selected operators to use the standard time calculation software. The estimations were used for planning and balancing the work between different work places. The rewarding system of the factory was based on total delivery accuracy, yields and the results of quality control. As standard times

were not used for work quotas or as a basis for individual rewarding, it was a mutual interest of the employees and the management to find ways to decrease standard times.

3.2.8 Episode 13 - Seven-Step Problem Solving

In the spring 1994, all employees of the factory were trained in the Seven-Step Problem Solving technique. The training feedback was positive - even enthusiastic. Still, the author did not notice any signs of people starting to use the technique. After a while, the author ordered another whiteboard and placed it in the middle of the SMD assembly line. The author agreed with the supervisor of SMD assembly to start using systematic problem-solving techniques in the area. A fishbone diagram of root causes for failures was drawn on the whiteboard and potential improvement ideas were identified. The whiteboard was an effective tool for sharing information between the four shifts.

One example of the improvement actions was that a map of the production line was drawn and placed on a bulletin board. Each malfunction of the production line was marked on the map by a pin. The map with pins was photographed once a week and the pins were removed. The photograph was used for maintenance. Surprisingly, it turned out that PCBs were frequently jammed at certain junctions of the conveyer belt. When the jamming took place, the operators slightly pushed the PCBs forward and solved the malfunction. The problem was permanently fixed by an easy adjustment, but the existence of the problem was not recognized before the use of the map. This specific problem naturally caused loss of production capacity. It also caused variation in the time from paste printing to reflow soldering and increased the number of soldering problems.

The use of whiteboards for systematic problem solving was further extended based on the experiences obtained at the SMD assembly line. Each of the whiteboards was appointed an owner from among the staff. It was obvious that the success or failure of each problem-solving cell depended on how committed the owner was to using the technique.

The essential learning in this case was that, although the problem-solving method was good and the training was of high quality, management action and commitment were needed for implementation. The selected staff members acted as facilitators. They called the people together and ensured the initiative.

3.2.9 Episode 14 - Self-assessment

In 1994, a self-assessment based on the European Quality Award criteria was conducted in the Special Products factory (Mattila 1994). The results are shown in Table 13.

Table 13. Results of European Quality Award self-assessment (Mattila 1994).

Category	Result	Weight	Total
Leadership	57 %	10 %	57
Quality Policy and Strategy	54 %	8 %	43
People Management	50 %	9 %	45
Resources	53 %	9 %	48
Processes	60 %	14 %	84
Customer Satisfaction	40 %	20 %	80
People Satisfaction	65 %	9 %	59
Impact on Society	53 %	6 %	32
Financial Results	80 %	15 %	120
Total EQA score			**567**

3.2.10 Specifying Learning

The process of charismatic leadership (Conger 1989) was repeated by establishing operational intent, communicating it and decisively implementing it step by step. This time, the organizational culture was also influenced by the radical change.

The model of four levers of control (Simons 1995b) was studied in the manufacturing environment (Table 14). This time, there were plenty of quantitative measures available. Some measures showed the impact of improvements within a few hours. This is a major difference compared to the R&D environment, where it is much more difficult to control process performance with valid quantitative measures. It was clearly noticed that, besides the diagnostic control systems, the three other levers of control were also effective.

Table 14. Levers of control in research cycle 2.

Belief systems	Interactive control systems	Diagnostic control systems	Boundary systems
Operative intent	Morning meetings	Business results	Normative standards
Nokia values	Weekly production planning	Production figures	Working instructions
	Improvement teams	Productivity index	Quality control
		Delivery accuracy	Approvals to use money
		Production yields	
		etc.	

It was evident that productivity is a function of the applied processes. The use of such principles as JIT and visual management remarkably improved performance. Within the

production environment, this kind of impact is visible and measurable. The interesting challenge is to utilize this learning in an R&D environment.

Within this research cycle, the importance of facilitators was clearly demonstrated in initiating empowerment and self-initiated improvement.

3.3 Research cycle 3 – Operational excellence model

The success of the Special Products Business Unit was excellent in terms of such business measures as:

- Market share,
- profitability and
- return on equity.

This gave rise to two crucial questions:

- What were the root causes of success?
- Does something that was learnt here enable increasing the probability of success in future business cases?

Both of the described cases included a pattern of repeated actions:

- Establishment of operational intent,
- setting of normative practices, such as regular meetings and
- continuous improvement

The author tends to believe that this pattern has helped to achieve success within these cases, but a look at other possibilities does not prove the link.

The potential root causes are visualized in (Fig. 42), leading to further questions:

- Was the business environment somehow exceptionally favourable?
- Was the business strategy exceptionally good?
- Does the establishment of operational intent and principles have some specific impact on increasing the probability of success?
- Did the management team have some unique leadership characteristics?
- Was there something specific in the management practices used?
- Was there something special in people's competence and behaviour?
- Was there some competitive advantage in the business processes used?
- Was the success purely co-incidental?

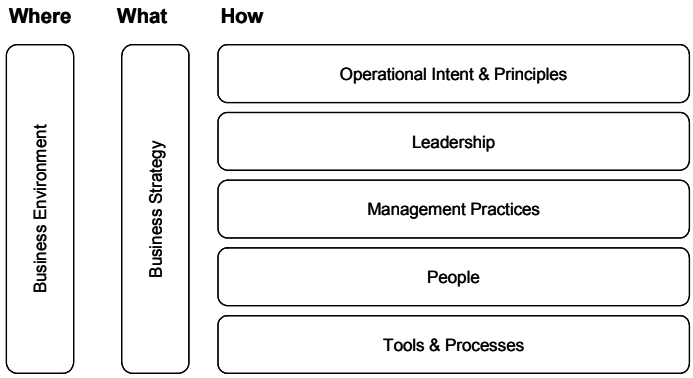


Fig. 42. Visualization of potential root causes of success.

It is obvious that the impact of intermediate variables is so significant that the identification of any simple root causes is not feasible. The case appears even more complicated as soon as we may acknowledge that fact that many of the variables are interrelated.

Seen from another perspective, business strategy, operational intent and principles, leadership and management practices belong to a larger entity of quality of management.

It is the management's responsibility to keep people competent and committed. It is the management's responsibility to ensure that tools and processes are continuously improved to meet the business requirements. This leads to the structure described in (Fig. 43). So, the real question here is: How to manage the quality of management?

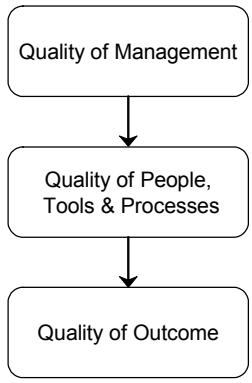


Fig. 43. Structure of quality management.

Within research cycle 3, a construction to manage the quality of management was studied and piloted (Fig. 45).

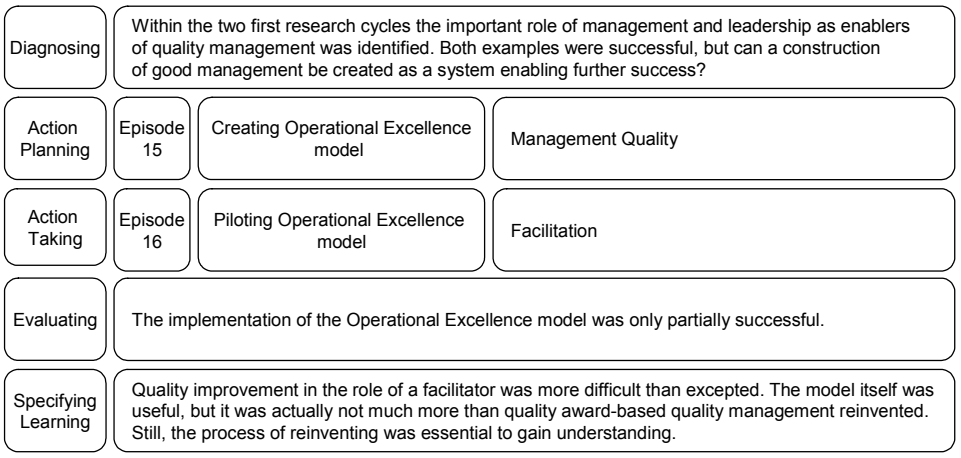


Fig. 44. Structure of research cycle 3.

3.3.1 Episode 15 - Creating an operational excellence model

The aim of this episode was to define a set of critical management practices and to describe them as a system that could be managed. Through a set of interviews and workshops, it was possible to identify a set of existing management practices. A selected set of the practices was further studied to identify how systematically the practices were implemented. Through the interviews, the following elements were studied:

- *Isolation of the practice*; what were the name, owner, description and defined purpose of the practice?
- *Triggering of the practice*; how was it ensured that the practice would be implemented?
- *Alignment to strategy*; was there evidence that the goals and objectives of the practices were aligned to the overall business strategy?
- *Alignment to customer needs*; were the external/internal customers identified, was there evidence that the goals and objectives were aligned to the customer needs?
- *Control and continuous improvement*; was there evidence that the four levers of control (Simons 1995a) were used to follow up the performance of the selected practice.

The maturity of each element was assessed using the scale shown in Table 15, following the quality award criteria.

Table 15. Scale for maturity assessment.

Scale	
Anecdotal or non-value-adding	0 %
Some evidence of a soundly based system	25 %
Clear evidence of a soundly based system	50 %
Clear evidence of a measured and controlled system	75 %
Could be used as a role model for other organizations	100 %

An example of the condensed conclusions of one such interview is presented in appendix 1.

Based on the results, a model of seven essential management processes, called OPEX-7, was created. “OPEX” stands for Operational Excellence. The model was specifically intended for use in Product Development (Fig. 45).

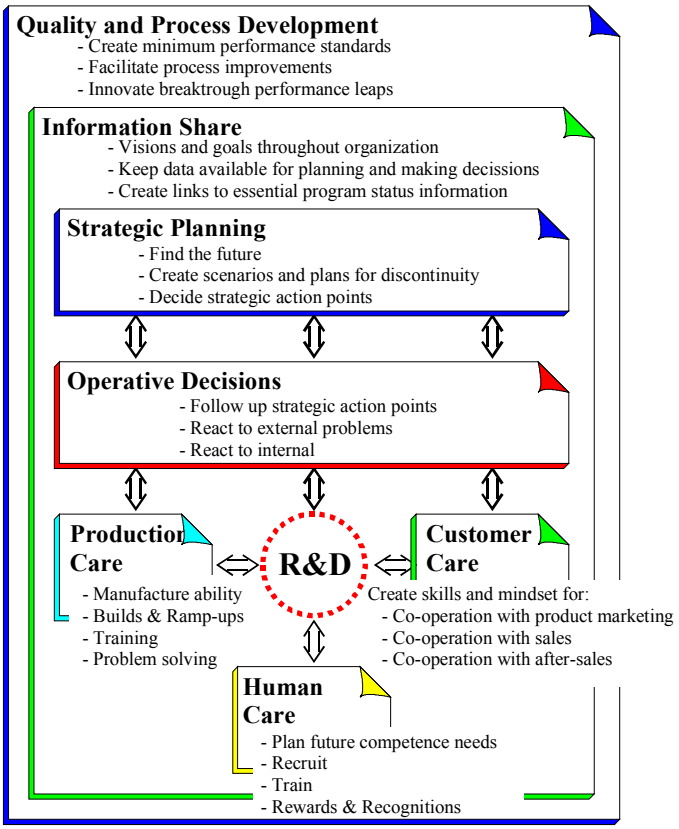


Fig. 45. OPEX-7 model

If the model were changed today, two more processes would be added:

- **Financial Control**, which was clearly identified within the interviews, but was intentionally left out. The justification for this was (without underestimating the importance of financial management) that people management was such a predominant performance driver in Product Development.
- **Subcontracting and Supplier Management,** which are equally related to the interfaces of product development and the relations with customers and manufacturing.

3.3.2 Episode 16 - Piloting OPEX-7 model

The model was piloted in two organizations:

1. Tuomaala (1997) studied the applicability of the model for managing a business unit, focusing on five processes: Quality development and maintenance, human resource development, customer support, production support and information sharing. The work was started by interviewing the key people of the organization. The first findings concerning quality management indicated that the quality maintenance practices, such as quality manual, auditing and milestone reviews, were well established. However, she identified an improvement opportunity concerning systematic Quality Improvement. Similarly, she was able to identify improvement opportunities concerning all of the five defined processes. Based on her findings, she created a proposal for improvements for the executive manager of the unit. The executive manager was committed to three of the processes: Quality Improvement, Customer Support and Production Support. The management, however, decided to postpone the implementation of the plan concerning Human Resource Development and Information Sharing. Though the decision made by the executive manager essentially changed the original plan, the end result was still in line with the expectations. The reasoning of the executive manager was valid and helped to focus on what was achievable. The most important thing was that, by aligning the plan, the commitment and support of the executive manager was achieved
2. Within Product Development Site Oulu, the model was piloted through a set of workshops with the management team. In these workshops, the management team:

   - Agreed on a **Name** for each of the processes.
   - Allocated a member of the team as the **Owner** of each process.
   - Created a **Mission statement** for each of the processes
   - Identified the **Customers** and **Customer Needs** for the processes
   - Identified the essential **Steps/Elements** of the processes.
   - Identified the methods to **Control** the process performance
   - Identified the **Improvement Objectives** for each of the processes

In September 1997, however, the management team decided to discontinue the effort as too time-consuming. The learning was integrated into the existing practices.

3.3.3 Specifying learning

In both cases, the development of management practices was facilitated by the contribution of the quality manager. In both cases, a reasonable level of management commitment was achieved. In both cases, some positive results were achieved within the area of achievable mutual commitment (Fig. 46). But in neither case was the aim of a managed system attained. The biggest benefit was the increased understanding of the management processes, which was utilized in the further research cycles.

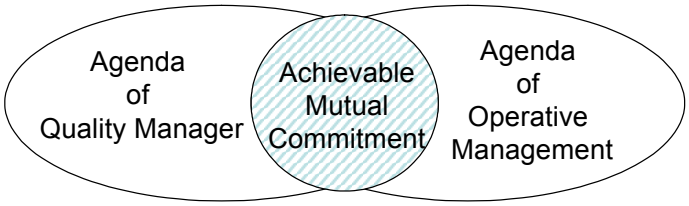


Fig. 46. Area of achievable mutual commitment.

The main reasons for the merely partial success in this research cycle were as follows:

- The model was pushed by external facilitators, as described earlier as a source of disintegrated quality management (Fig. 12).
- The management's own understanding of good management was not properly considered.
- There was no clear sponsorship for the change.
- The existing and well-known models, such as the Quality Award Criteria, were not used.
- The management seemed to be reluctant to define their own work as a controlled process.

3.4 Research cycle 4 - Managing quality at a product development site

Within the two first research cycles, quality management was studied from the perspective of operative management. The four-step process of charismatic leadership (Conger 1989) was described during the discussion of leadership theories: Establishing a vision, effective communication of the vision, gaining trust for the vision and decisive implementation of the vision were found effective while creating a new organization and implementing change. The validity of the four levers of control (Simons 1995b) was also verified. Especially within product development, the additional means are valuable, as the kind of quantitative data required for diagnostic control systems are not extensively available.

Within the third research cycle, quality management was studied from the facilitator's perspective. It turned out that implementation was more difficult for the facilitator than

for the operative manager. The importance of management commitment was identified, and the essential role of a sponsor that really supports quality management was recognized.

Within this research cycle, quality management at Product Development Site Oulu was studied over the period of 1997 to 2002 through the perspective of the quality manager. The structure of research cycle 4 is described in Fig. 47.

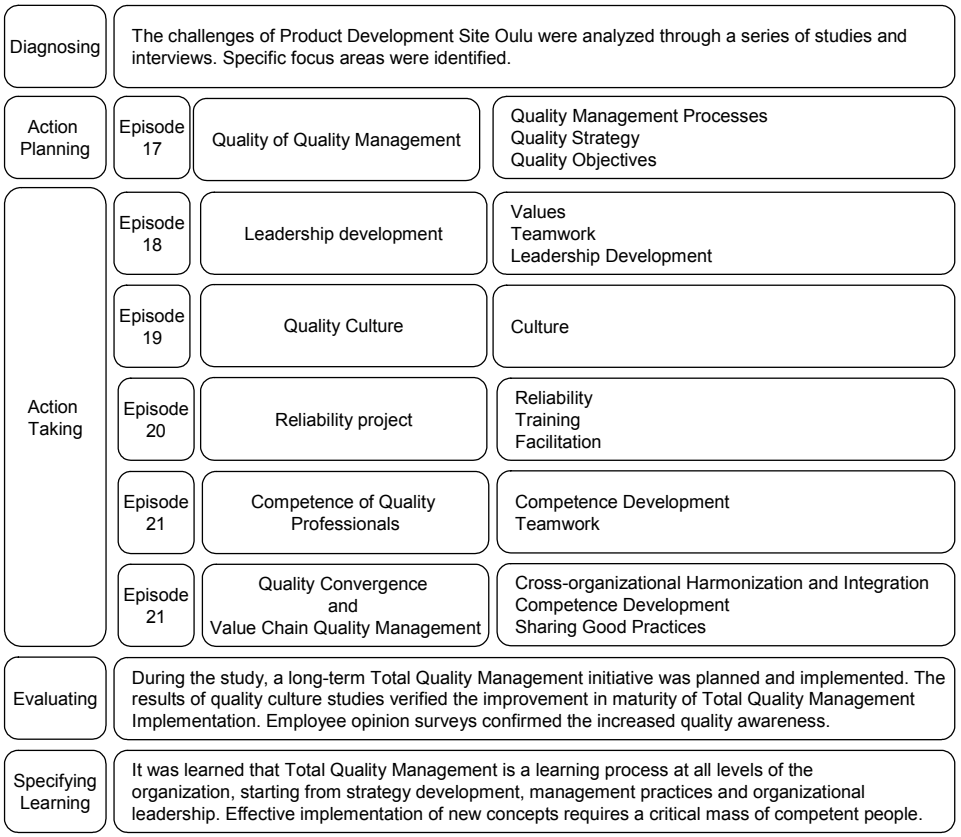


Fig. 47. Structure of research cycle 4.

3.4.1 Diagnosis

Three specific sources of data were used to create a plan for quality improvement: a workshop with senior and executive management, the results of quality award-based self-assessment and the results of an employee opinion survey.

Through the workshop with the management team, ten critical success factors were identified:

- Strategic planning,
- leadership,
- flexibility/agility,
- innovativeness,
- integration and miniaturization,
- communication,
- quality,
- customer orientation,
- development time and
- values.

It was agreed that performance in these ten success factors should be world-class by the end of year 2003. Agility, communication and quality were identified as the first focus areas to be improved.

The results of quality award-based self-assessment showed improvement needs in the areas of:

- Vision and goals throughout the local unit,
- prioritization of strategic goals,
- internal and functional boundaries,
- technical and management skills in jobs and
- employee satisfaction.

The results of the annual employee opinion survey revealed improvement needs in the following areas:

- It is unclear what "quality" means and how it is measured at the personal level and in everyday work.
- Feedback from managers is inadequate.
- It is difficult to find and get information.
- People do not know who is responsible for what.
- Feedback from end customers is lacking.

Based on these three analyses, a correlation matrix (Fig. 48) was created to reflect the relation between the management processes and the identified improvement needs. The matrix showed that it would be possible, by improving the performance of the seven processes, to improve all of the selected focus areas. As described in episode 16, the ownership of each of the processes was shared between the members of the team, and each member created an improvement plan for his/her area of responsibility.

			Strategic Planning	Operative Decisions	Information Share	Human care	Production Care	Customer Care	Processes & Quality	
1	Vision ang Goals throghout local unit	**5**	**9**		**9**					**90**
3	Managing quality, processes and profitability	**3**	3	3	3	3	3	3	**9**	**81**
12	Customer needs in future projects	**4**	3	3		3		**9**	3	**84**
22	Fact based decissions	**4**	3	**9**	3				3	**72**
24	Prisoritising strategic golas	**5**	**9**	**9**	3					**105**
32	Internal and functional boundaries	**5**	3	3	3	3	**9**	**9**	3	**165**
36	Continuous Process Improvements	**3**	3	3	3	3			**9**	**63**
40	Innovativeness in process development	**4**	3	3	3	3			**9**	**84**
42	Managing technical and managerial skills	**5**	3			**9**			3	**75**
47	Actions to maintain employee satisfaction	**5**		3	**9**	**9**		3	3	**135**
	Agility	**5**	3	**9**	**9**	3	3	3	3	**165**
	Communication	**5**	3	3	**9**	3	3	3	3	**135**
	Quality	**5**	3	3	3	3	3	3	**9**	**135**
			219	**228**	**267**	**192**	**99**	**150**	**234**	

Fig. 48. Correlation matrix of improvement needs and OPEX-7 processes.

The results were also cross-checked against the key strategies of the company that were relevant for product development:

- Improve product quality.
- Reduce inventory levels.
- Come closer to customers.
- Options for productivity gains.
- Update the skills of people.
- Forecast technology better.
- Speed up time-to-market.

3.4.2 Episode 17 - Quality of quality management

The maturity of the quality management processes was also studied by interviewing the head of the quality management team using the methods described in episode 15. The maturity of two quality sub-processes was assessed: quality system management and quality improvement:

1. Quality system management was mainly guided by the quality policy and the ISO 9000 standard. Activity was focused on the maintenance of the quality manual and on managing internal and external audits. There were challenges to keep the executive site management involved. For instance, a management review was cancelled several times due to more urgent tasks of the executive site management. The conclusion concerning the maturity of quality control as a process based on self-assessment was: "The quality system management is clearly a mature and active process. The biggest problem seems to be that there is no shared vision of the purpose of the process. This causes some scepticism and weakens the commitment of the organization."
2. While assessing quality improvement as a process, it turned out that there was only anecdotal evidence of the quality management team being involved in quality improvement. Quality improvement was carried out through the strategy deployment and annual planning processes managed by the site management and the technology line management. The lack of integration was identified to be the basic root cause for the lack of enthusiasm towards the ISO 9000-based quality system.

Based on the assessment, a number of improvement needs were identified:

- The annual planning and follow-up of the quality management team needs to be improved.
- The link between quality management and operative management needs to be improved.
- A quality strategy needs to be drawn up to clarify the purpose of the quality management team.
- Clear and measurable objectives for quality management need to be outlined.
- A more active and visible role in quality improvement needs to be taken.

Quality objectives and measures were defined for leadership quality, process quality and product quality (Table 16).

Table 16. Quality objectives and measures.

Management quality	Process quality	Product quality
Results of employee opinion survey	New product revenue	Production yield
Results of management self-assessment	R&D time to market	After-sales costs
	Slip rate of product launch	

A five-year strategy path for quality improvement was created by focusing first on management quality and then on quality awareness and product quality. In the year 2000, the strategy path was updated to the form shown in Fig. 49.

Fig. 49. Strategy path of quality.

Link quality and strategic management included such activities as: Participating in and facilitating strategic planning, establishing a practice of regular quality board meetings, organizing leadership development programs and enforcement of values.

Increase awareness in quality included such activities as: Organizing basic quality training, creation and implementation of a quality competence plan and organizing studies of quality culture.

Breakthrough in product quality meant implementation of a re-engineering project of reliability engineering in product programs.

Quality convergence and value chain quality management included collaboration with a wide range of actors to benchmark and harmonize quality management practices.

Product creation factory included an intention to implement the principles of JIT, mass customization and visual management in the processes of an expert organization.

The implementation of the strategy was planned and followed up using the Hoshin method. The highest level of the plan was directly taken from the strategy path of quality and the quality objectives. A specific action plan was created for each of the focus areas. The implementation plan was evaluated and followed up through regular workshops by the quality management team.

The implementation of follow-up was based on traffic lights:

- ***Green*** indicated that the planned objectives were clearly met, or no remarkable risks were identified on the way to meet the objectives.
- ***Yellow*** indicated such difficulties in implementation that delays or partial completion could be expected.
- ***Red*** indicated major difficulties in implementation. Classification as red meant that the owner was no longer capable of meeting the objective. In such cases, the management needed either to re-formulate the objective or to allocate further resources.

The planning dialogue was based on the use of the traffic lights. Each objective was first evaluated by using the lower-level plans, and the results were then consolidated into the higher-level plans. Based on the consolidated status, the existing plans were further clarified and improved.

3.4.3 Episode 18 - Leadership development

Leadership represents 10 % of the total score in the European Quality Award criteria. In the case described here, leadership was a specific challenge; due to fast growth, many of the employees working in challenging management positions had minimum experience of managerial work. The average age of the personnel was less than 30 years. Many of the managers had only had a few years of engineering experience before being appointed to a managerial task. At the company level, there were available leadership development programs for a handful of the most experienced managers. Locally, training programs for people starting in their first management job had been organized during the past few years. However, there was an evident need for advanced leadership training for the managers who already had some experience of leading people.

The summary of the submission for the 2000 European Quality Award states (Nokia 2001):

> *"Leadership at Nokia is firmly grounded in the four Nokia Values; the organization's culture and leadership development activities flow from them. The Nokia management style requires "leadership at all levels" – not just at the top of the organization. Our approach to leadership development focuses on action learning – not only knowing the theory, but putting it to practice and reviewing the results to reinforce learning across teams. This reinforces our principal value, continuous learning, which helps us renew our capabilities and ensure our competitiveness in changing market conditions."*

To meet the challenge of leadership, three training programs were started:

- *Values training*; encouragement to take initiative and introduce the concept of value-based leadership to a wide range of personnel. It was assumed that introduction of the leadership theme as early as possible would promote learning and be beneficial later when some of the trained people would be appointed to management jobs.
- *Teamwork training*; being part of the above-mentioned basic management training program, it aimed to increase the understanding of team leadership.

– *Advanced leadership development program*; focused on meeting the needs of managers who already had a few years of managerial experience.

Value enforcement

The Nokia Values were established 1992. Since that, their deployment has been followed up by means of employee opinion surveys. After the first wave of enthusiasm, a sense of scepticism was apparent, and the executive management decided to take actions to re-enforce the deployment of values. In 1996, the members of the Compass leadership development training program were given the task to establish a value enforcement program. The training team studied the status of value deployment through interviews and questionnaires. The essential results were:

– Nokia was a value-driven company.
– For Nokia employees, values were the third most important reason to work for Nokia.
– Values are very personal. No-one can tell what values mean to another person.
– Customer Satisfaction was the best known value (70 %) and Achievement the least well known (40 %).
– Contradiction between values and everyday actions will create cynicism and discredit the values.
– Even when people knew the Values at a verbal level, they did not know what they meant in practice.

Another finding from the interviews was that people have preferences towards values that are close to their own personality. As values are a personal and sensitive topic, the team understood that it would be useless to set up a training program that would state: “These are the values and this is the specific correct value-based behaviour”. The challenge of value enforcement was divided into two objectives:

1. Knowing the values and
2. Understanding the benefits of the values.

By teamwork, a Value Toolbox was created to be used in value enforcement. The toolbox included:

– A story-book of value deployment
– An animated values video of values
– Games
– A value workshop

The principal idea behind the story-book and the video was to demonstrate the desired behaviour through real-life examples. The games typically demonstrated decision-making situations without “correct“ answers – the participating teams needed values for their decision making. The value workshop was based on the recognition of personal preferences. The workshop was based on the principle that an efficient team needs to utilize the diversity of individual preferences.

The Compass training team created a detailed implementation plan for using different methods of value development within their own working environment. Each participant

was committed to implementing a scheduled enforcement project for a selected target group.

Within Product Development Site Oulu, a series of four-hour values workshops was organized. The topic was discussed based on the themes of diversity of people and teamwork. The training components are described in Table 17. Each training session was concluded by a workshop in small teams: what are the practical means to improve teams' effectiveness by deploying the Nokia values.

Table 17. Training content of the value workshop.

Training topic	Training component	Learning objective
Nokia values	Leadership at all levels	understanding
Psychodynamic leadership theory	Parent-Adult-Child model	knowing
	Individual values system; (Parent)	understanding
	Child ego states	knowing
	Diversity of people	understanding
Teamwork	Importance of different team roles	understanding
	Diversity of team roles based on Nokia values	understanding
Values in practice	Workshop	understanding

As a result of the combined effort of the Compass training team and other actions initiated by the executive management, Nokia today gains advantage in competition through value deployment. The development of the appreciation of values is shown in Fig. 50.

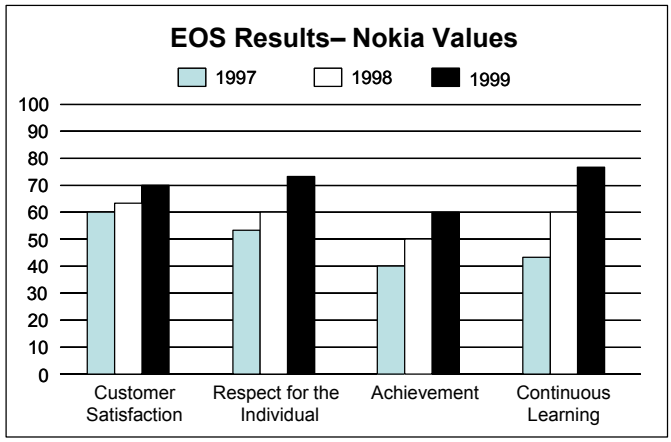


Fig. 50. Development of value appreciation (Nokia 2001).

Teamwork training

A two-day training product was created for the participants of the basic management training program to further increase their competencies in leadership and teamwork. During the first day, a set of teamwork exercises was organized. The exercises highlighted three themes: "shared vision", "teamwork and emotions" and "shared

leadership". Before each set of exercises, the underlying theory was introduced. After each exercise, the team members:

- First analysed their learning individually using a learning journal.
- Then discussed within the team about learning.
- Finally were guided by the team observer to further improve their performance.

After each set of exercises, the learners summarized and presented to each other the key aspects of the theme they had learnt.

During the second day, the key learning was further studied through facilitated discussion on the implications for managerial work. The content of the training program is shown in Table 18:

Table 18. Content of teamwork training.

Training topic	Training component	Learning objective
Nokia values	Leadership at all levels	acting
Psychodynamic leadership theory	Parent-Adult-Child model	understanding
	Individual value system; (Parent)	acting
	Child ego states	acting
	Diversity of people	acting
Teamwork	Phases of team evolution	acting
	Belbin team roles	understanding
	Creating shared vision	acting
	Teamwork and emotions	understanding
	Shared leadership	understanding
Psychodynamic leadership theory	Self-knowledge	acting
	Giving and taking feedback	understanding
	Leadership and emotions	acting

Advanced leadership training

The Kiehinen leadership training program has been organized annually since 1997. Typically, 21 trainees were carefully selected to each of the six training programs based on their working experience and number of subordinates.

The objective of the training was clearly defined: "Increased capability to use one's own personality as a management tool." As all of the trainees were speaking the same language, working in the same company on similar tasks and even working in the same facilities, it was possible to plan very intensive training. The training was action-oriented, and teamwork was extensively used in all training modules. The content of training is shown in Table 19.

Table 19. Content of Kiehinen leadership training

Module	Duration	Name	Leadership theme	Learning objective
1	3 days	Teamwork	Values and Personality	Coaching
2	2 days	Corporate Economics	Rationality	Acting
3	3 days	Strategy	Analytical Creativity	Acting
4	2 days	Sales & Marketing	Emotional Creativity	Understanding
5	2 days	Quality and Processes, Project Work Initiation	Taking and Giving Leadership Space	Coaching
6	3 days	Leadership	Action-Oriented Creativity	Coaching

The content of the training program was described in more detail by Kivimäki-Kuitunen & Kiehinen II (2000). Since the manuscript of the book was produced as a teamwork exercise by the trainees, the book describes the most essential learning of the training program.

In September 2002, a questionnaire was sent to the participants of the completed training programs to evaluate the effectiveness of the training. The results of that study are shown in appendix II.

3.4.4 Episode 19 - Quality competence management

While following up the implementation of the quality management plan, it was noticed that quality competence development is an essential element of the implementation. A list of quality-related skills was drawn up by the quality management team during a plan evaluation workshop. The members of the organization were categorized into four groups:

1. *Quality Community*, including the people closely working on the different themes of quality management,
2. *Management*, including the members of the organization in different managerial positions,
3. *Key Performers*, meaning such potential change agents that were trusted and influential members of the organization, but did not belong to the management, and
4. Everyone.

The targets for competence levels were defined using a matrix of skills and organizational categories. The current competence levels were also estimated. The competence development plan was created based on this analysis. The plan was updated several times through workshops and task forces. As an anecdote, it appeared that participation in such activity helped people to identify the gaps in their own competence and thus supported competence development. The latest version identified about 100 quality-specific skills within seven categories:

1. *TQM principles*; knowing and understanding the underlying principles of a number of quality approaches, such us quality standards, quality awards, process approaches, JIT, Lean and Mass Customization, and quality culture.

2. *Company-specific quality tools and methods*; such as Seven-Step Problem Solving, process management tool, benchmarking, Hoshin planning and auditing.
3. *Business and strategy knowledge;* the scope and level of knowledge needed depends on the actor's role and experience. The knowledge includes such topics as process knowledge, project management, customer knowledge and strategy deployment.
4. *Software quality management skills;* including the skills specific to software development.
5. *Facilitation and change management skills,* such as: facilitation, change management, negotiation skills, presentation skills, training skills and coaching.
6. *Product quality plan implementation skills* include a set of 37 specific skills needed in the quality management of product programs.
7. *Statistical competence* includes the capability to utilize a wide range of statistical tools and techniques, such as Gage-RR, ANOVA and Taguchi method.

An estimation of the time required to learn the quality-related skills was made (Table 20). Though it is not necessary for all employees to be aware of everything, the table shows the scale of the learning challenge. The practical requirement for competence in product programs is that a wide range of people have level 2 competence and at least one employee with competence level 4 is easily accessible. Based on the estimated learning times, the organization of a level 2 training course for a product program including ten skills takes one week. The learning challenge for the quality professional is even higher; they should be the persons able to coach the organization. Reaching level 3 competence in 50 skills requires almost three years of focused and intensive learning.

Table 20. Estimated learning times for different competence levels.

	Level	Definition	Learning time
1	Knowing	Capability to recall the terms and definitions and having access to further learning	15 minutes/skill
2	Understanding	Capability to summarize the essential knowledge and to use the skill under guidance	4 hours/skill
3	Acting	Capability to use the skill independently	40 hours/skill
4	Coaching	Capability to describe the knowledge structurally, understanding the applicability, limitations and alternative solutions of the knowledge area	100 hours/skill
5	Creating new	Capability to synthesize new learning to one's cumulative knowledge. Capability to write journal articles of the topic.	400 hours/skill

Through the analysis, it was identified that quality competence management requires a clear focus. The competencies were classified into three categories:

1. *Strategic skills*, characterized by direct business importance and an existing competence gap. These competencies should be managed top-down led by the senior management.
2. *Widespread skills*, characterized by a lesser sense of urgency, but still with an essential role in creating the quality culture and language. People should be encouraged to

acquire these skills, and the availability of training should be organized by the quality management.

3. *Specialist skills*, characterized by the vision that a few specialists could meet the competence needs of the organization.

Two specific skills were defined as strategic:

Seven-step problem solving was seen as an essential tool due to its generic usability. Systematic problem solving was seen to support teamwork in such working groups that were not working together intensively enough to enable true teamwork. A set of one-day training sessions was organized for selected technology lines.

Product quality plan implementation skills were defined to be another strategic focus. Their implementation is described in episode 21.

A specific learning focus was set for the quality managers working in product programs. An individual assessment was done for all team members. Based on the assessment, an owner was allocated to each of the specific skills. The responsibilities of skill owners included organizing training and coaching for the whole organization. Short and long-term learning objectives were also agreed on.

3.4.5 Episode 20 - Quality culture

From February 1998 till February 2000, Product Development Site Oulu participated in a national research project studying the quality cultures of R&D organizations. Guided by the research team, a set of workshops was organized by the participating companies to create a model for the maturity assessment of quality culture. The main topics of the model were:

- Leadership,
- Strategy,
- Customer and market orientation,
- Knowledge management,
- People and competence and
- Process management

Each topic included subtopics and R&D-specific definitions for maturity levels based on Silén's (1997) model presented in Table 3. During the study, the maturity of the quality culture of Product Development Site Oulu was assessed three times. Two assessments were organized by external experts belonging to the research team. Both involved a set of interviews of senior management, middle management and R&D engineers. The first set of interviews was organized in the summer 1998. The research team assigned the culture to the category of "Tool Pushers", giving it about 450 points on the scale of 0 to 1000 used for quality awards. The second assessment one and a half years later indicated an increase of 150 points up to the level of 600 points and a quality performance level of "Improvers". A self-assessment was also organized by the senior management team using the model created by the research project. These results also indicated quality performance at the level of 600 points. The results indicated steady progress of the

quality culture. It also enabled benchmarking the performance with other R&D organizations in Finland.

Since the model used by the research team involved a quantitative approach and studied culture based on artefacts and creations, i.e. at the most visible cultural level of Schein's (1991) model (Fig. 29), it was considered useful to further study the in-depth levels of the quality culture. A pro gradu study of the topic was organized. During the study, altogether 55 members of the organization were interviewed:

- 12 interviewees belonged to senior management,
- 16 interviewees belonged to middle management and
- 27 interviewees were R&D engineers.

The use of a fully structured questionnaire was avoided. Instead, a method of semi-structured theme interviews was used, where the first question was:

"What questions should be asked to study the essential questions of quality culture?"

The following themes emerged (Kilpinen 1999):

- Definition of "quality",
- quality performance of the company,
- quality guidelines,
- job descriptions,
- competencies and learning,
- communications,
- culture of leadership and decision making,
- atmosphere and
- growth and organizational structure.

In the report of Kilpinen (1999), authentic citations of the interviews were given, which makes the report a valuable source of information. Besides, it was assumed that the implementation of the interviews also increased the quality awareness of the interviewees, which was an objective of the quality strategy.

Based on the results, a set of workshops with senior management were organized. The workshops were also used to train the participants to use the Seven-Step Problem-Solving method. Through the analysis, one specific cultural paradigm was clearly identified: It was a taboo to criticise the realism of project schedules. During the project meetings, such expressions as: "We have project risks concerning the schedule" were used instead of saying that the project will be delayed. Each member of the organization at all levels had their own "realistic estimations", and the actual plans were created based on those. Anyhow, this ruined the resource planning system, as the resource planning data were based on the "official" schedules. Thus, the new projects were initially planned based on false data of resource availability. This naturally led to delays of new projects. From time to time, the number of running projects exceeded the capacity, and some projects had to be cancelled.

Based on the finding, a strategic breakthrough project for the year 2000 was launched to improve program predictability. The project was managed by a team of senior managers. Through extensive data analysis, an implementation plan was created to

improve project planning, project resource planning, project tracking and pipeline management.

3.4.6 Episode 21 - Re-engineering reliability process

Breakthrough in product quality was the third focus on the strategy path of quality (Fig. 49). The implementation of the strategy was organized as an annual strategic breakthrough project of Product Development Site Oulu. The business rationale behind the decision was based on an analysis showing that sustainable advantage in competitiveness could be achieved by increasing product reliability. The objective of the project was radical improvement in the capability to develop reliable products. The executive managers of the site formed a steering group for the project. The project was implemented following the steps of Business Process Re-engineering (Davenport 1993) (Fig. 51). The implementation of the first four steps of re-engineering is described in detail by Kivelä (1999).

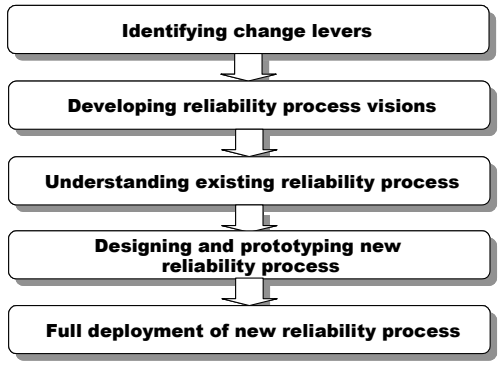


Fig. 51. Steps of a reliability process re-engineering project (Kivelä 1999).

The project team was composed of internal and external experts. Through a set of workshops, the change levers (Fig. 52) were identified. The driver of the method (Fig. 53) was reliability estimation. The product structure was used to estimate the field return rate of subsystems and specific components. Whenever actual field data were available, the estimation was based on after-sales data. The reliability risks of new technology were analysed using Failure Mode and Effect Analysis.

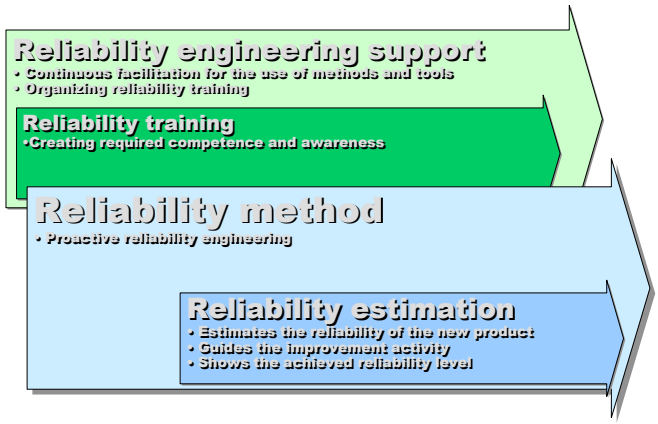


Fig. 52. Identified change levers (Kivelä 1999).

The estimation was compared to the target value. Improvement actions for specific solutions were planned to decrease the gap between the target value and the estimation. The impact of each improvement action was estimated based on an improvement factor of the original estimation. The Seven-Step Problem-Solving method and the action tracking database were used for problem selection, planning, implementation, verification and follow-up.

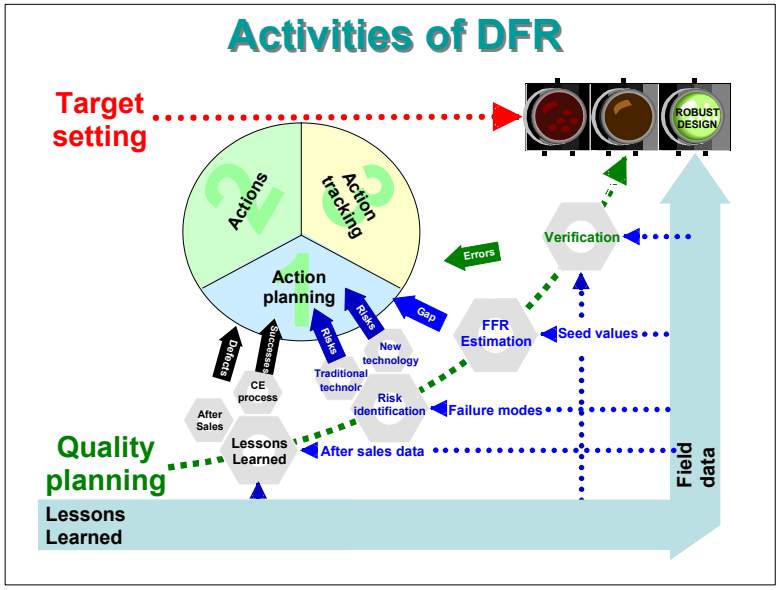


Fig. 53. Activities of Design for Reliability process.

The other essential change lever was training and facilitated implementation of the learning. The training was organized using an external training provider. Besides ensuring training capacity, this also enabled the creation of a quality training competence centre,

whereby the needs for a collaborative network could be met. The training included three training modules (Fig. 54).

Fig. 54. Reliability training program (Kivelä 1999).

During the first training module the reliability engineering process was introduced. The sources of field data were also discussed, and the participants were finally instructed in the method of Failure Mode and Effect Analysis.

During the second training module, the reliability improvement practice was studied and Seven-Step Problem Solving was practised. An important element of the training program was the facilitated project assignments. The training participants were selected from starting product programs, and a mentor was appointed for each training course. The mentor facilitated the implementation of the project works, by first ensuring that the essential reliability risks of the programs were addressed and then following up throughout the process that the improvement actions were planned, implemented and verified.

During the final training day, the results of the project assignments were presented to the other participants and selected members of senior management. The business value of the project assignments was estimated by using the template presented in Table 21. Within the template, the starting point was estimated to be the warranty costs without any improvement actions. Next, the improving effect of the project assignments was estimated. Finally, it was estimated how much the training influenced the total savings, understanding that some improvement would have taken place even without such training. Though the estimations included a high level of uncertainty, the estimated business value was typically so high that all members of the training team became convinced about the value of the method.

Table 21. Fictive example of the estimated impact of training

Project work	Estimated impact on warranty cost	Estimated improvement	Value of Improvement	Impact of training
Connector	2 M€	50 %	1 M€	0.1 M€
Display	1 M€	90 %	0.9 M€	0.4 M€
Antenna	10 M€	80 %	8 M€	8 M€
Cover	8 M€	50 %	4 M€	-
Total	21 M€		13.9 M€	8.5M€

Altogether more than 200 employees were trained during 1999–2002. Based on the employee opinion surveys, the approach was received positively. The training program did have an impact on both business performance and quality awareness. The role of the facilitators was essential; the training was also piloted at three other R&D sites, but in the absence of facilitators and organizational commitment, equally good results were not achieved. It was also noticed that the reliability estimation based on history data was not accurate enough to predict the actual performance of the products. To improve reliability prediction, Salo (2001) studied triangulation as a method to further improve accuracy. Within the model, process maturity, people, competencies and working hours used for reliability improvement were considered as additional sources of information.

3.4.7 Episode 22 - Quality convergence and value chain quality management

It was clearly noticed that managing quality locally within product programs was not enough. Total quality is implemented within a value chain. Most aspects of the technology used by product programs are actually created by someone else: The technology of other projects is re-used, such new technology that is created by advanced development projects from multiple product development sites is used, and parts of the projects are subcontracted from partners, suppliers and subcontractors. Another major element is the product software created by specific software development units. During the product development phase, the sourcing of materials, manufacturing processes and after-sales practices are also decided about. To achieve total quality, it is also necessary to plan the quality control and management applied during the manufacturing phase of the product. A set of activities was organized to harmonize and integrate practices between different product development units through benchmarking, sharing good practices and organizing collaborative development projects.

Quality network days

During the study, the quality professionals available at Product Development Site Oulu were organized into three specific groups:

1. The team of program quality managers was established to facilitate the implementation of the reliability engineering process. Later on, the responsibility of the team was extended to facilitate all quality-related management within product programs. A full-time program quality manager was allocated to each product program.
2. The team of software quality engineers focused on developing software processes, facilitating process implementation and managing software-related statistics (Kinnula 1999).
3. In addition to these two teams, some technology lines had allocated quality specialists for specific tasks.

The quality planning and management practices between these three organizational groups were not integrated and harmonized. During the year 2000, a practice of regular networking days was established. The latest quality strategies of the company were presented, members of the quality community presented their good practices, and the competencies of quality professional were discussed. Task forces were established to solve specific problems in the harmonization of common practices. As an example, through an assessment of competencies, a significant gap within the facilitation and change management skills was identified. Based on that finding, specific training for the members of the quality community was organized.

In 2002, the same training concept was used for the program quality managers of all major Finnish product development sites. During the preparation of the network days, the quality skill definitions of all the sites were collected together and harmonized by a task force.

Quality College

Quality College was established in 1999 to create shared training products for the program quality management. A small team of senior quality managers from five European product development sites identified the elements of program quality management. The good practices and challenges of each site were discussed in a series of workshops. The concepts and guidelines for generating training components and products were created. General training material was produced, including a multimedia CD with the training components for “level 1 – knowing”, which promoted the learning of program quality management skills.

Common ISO 9000-based quality management system

Historically, each product development site had created their own ISO 9000-based certified quality management system. Due to organizational changes, the practice met with some challenges; certain units were managed globally, and it was difficult to define the scope of each certificate and the roles and responsibilities of quality management. During the year 2001, three Finnish product development sites established a taskforce to harmonize the quality system management. Common quality management processes were

outlined, and a shared web-based quality manual was compiled. Based on the learning, a project including members from seven European product development sites established a project for a common quality certificate. The project included three specific tasks: the establishment of a common quality board, the compilation of a common quality manual and the establishment of a common audit system. The project was completed within six months. Later on, other product development sites also adopted the common certificate.

3.4.8 Specifying learning

Within this research cycle, the quality management of an R&D organization of more than a thousand employees was studied. Based on an analysis of critical success factors, quality objectives and a five-year strategy path for quality were issued. The quality strategy was carefully integrated into the business strategy, and implementation followed the principle "first management quality and then people, tools and processes". It was soon noticed that quality management was a learning challenge. An analysis of the levers of control used (Table 22) shows that the diagnostic control systems are slow. For instance, reliable data of warranty costs are only available more than six months after the product launch. The results of self-assessments and employee opinion surveys are available once a year. Within the manufacturing environment, quantitative data were often available during the same working day. This fact clearly emphasises the central role of interactive control systems within product development. Data for fact-based quality management needs to be collected through discussions and workshops.

Table 22. Levers of control within research cycle 4 (Simons 1995a).

Belief systems	Interactive control systems	Diagnostic control systems	Boundary systems
Quality strategy path	Strategy work	Business results	Milestone reviews
Nokia values	Quality board	Results of self-assessments	Approvals to use money
	Plan evaluation workshops	Employee opinion surveys	
	Task forces	Warranty costs	
	Interviews	Production yields	
	etc.	Project slip-rates	

The other essential learning of the research cycle emerged from Kilpinen's (1999) studies of quality culture. Quality is created by the people of the organization. Each individual had their own understanding of quality, and they all believed themselves to be producing good quality. Their practical question was how to do the job better? The quality of work within mechanical engineering is different from the quality of work within software engineering, so there can be no universally applicable generic quality training. Thus, in developing organizational leadership, behaviour to take initiative, acquire learning and solve problems is crucially important. Organizational leadership is also important within

the manufacturing environment, but achieving a high level of control and managing quality is more difficult in expert organizations.

3.5 Managerial implications

Within the empirical part of the study, TQM was studied through four action research cycles:

The two first cycles provided the pre-insight for the study. During these cycles, quality management within an R&D organization and a manufacturing organization was studied by the author in the role of a senior manager. Within both cases, a mission for the organization was established and communicated to all members. In both cases, the mission was successfully implemented by taking focused and decisive actions. This pattern is in line with the theory of charismatic leadership (Conger 1989). In both cases, the organizational culture was strongly influenced. The R&D unit was a new organization, and the aspect of cultural influence is well support by the theory of organizational cultures. In the manufacturing unit, too, there was a radical change, which explains the influence on organizational culture.

In the third research cycle, the aim was to establish a set of systematic management practices to enable consistent implementation of the learning from the first two research cycles. Through a series of interviews and workshops, such model similar to the theory of functional leadership was created. The implementation of the model was studied by the author in the role of a facilitator within two organizations. In the first organization, the executive manager recommended implementation in accordance with practices that were already reasonably firmly established, which is why the original goal was not reached. In the second organization, the management team decided to discontinue implementation, as the benefits were not considered worth the efforts. Through this research cycle, it was learned that implementation and the attainment of management commitment to such practices was more difficult than excepted. It was also learned that, instead of reinventing the wheel, such existing models as the quality award criteria should have been used.

Within the fourth research cycle, the implementation of the TQM principles was studied in a highly dynamic expert organization. Through an analysis, a strategy for TQM implementation was created. While implementing the strategy, it was noticed that TQM is actually a learning challenge. The concepts and principles of TQM are well established. Implementation requires strategic choices and a wide range of competence development. Organizational learning to such a level that new concepts are successfully implemented requires carefully planned and structurally analytic training, to ensure shared understanding of terminology and concepts. It is also equally important to facilitate the use of the concepts. The critical success factor of a training program is that the learners are facilitated to use the new concepts in such a way that the first experiences of use are positively valued.

TQM, especially within the given research environment, specifically involved change towards the unknown; continuous improvement consists of solving problems that are called quality problems. When the problems are permanently solved, they are no longer called quality solutions but everyday practices, such as project planning and milestone

reviews, and totally new issues are called quality problems. Solving a problem permanently requires a learning process that passes through the steps of knowing, understanding, acting and coaching. At maturity levels of over 500 points on the scale of quality award criteria, the solutions need to be standardized and taken into use organization-wide. Preferably, the practice of periodic evaluation and continuous improvement are also taken into use. Practically, this requires such a competence creation process that a wide range of people are trained to the competence "level 2 – Understanding", and a core team with competence at the "level 4 – Coaching" is set up.

The planning of change towards the unknown is described in episode 17. Based on a framework of strategies and objectives, a set of activities was planned using the Hoshin method. The plan was regularly reviewed and improved. The essential point of the Hoshin planning method is its strategic nature. It is not possible in the beginning to know whether or not the planned actions will be successful, and how much time and resources they will take. It is assumed that some of the actions will be successful. Through the review and learning process, the successful actions will be identified, until a proper project plan can finally be drawn up. Table 20 shows that the resources needed to create knowing and understanding are small compared to those required for implementation. While planning towards the unknown, it is essential to spend enough time on testing and piloting rather than allocating the limited resources to an insecure implementation.

During the research cycle 4, the implementation was started by integrating quality management and strategic management and then increasing quality awareness. The first step was necessary to ensure the "Opportunity to change" as described by Lanning (2001). Through value training, leadership development and increasing quality awareness, a "willingness to change" was provoked with the hope that someone within the organization would take initiative and start a personal learning and problem-solving process. As Lanning (2000) states: "Will does not occur unless real effort at developing the organization can be perceived." For this reason, such breakthrough projects as described in episode 21 are essential.

In the empirical studies, the model of four levers of control (Simons 1995a) was used. The validity of the model was confirmed as an extension to measurement that is typically referred to as the driver of TQM implementation. The model was also valid in the manufacturing environment, but especially useful within the context of managing quality in R&D. The limited amount of real time and valid and reliable data forced us to use interactive control systems. Such methods as converting the weak signals of opinions into a set of traffic lights and expressing the opinions of the management team as "points of quality award criteria" enabled the delivery of data to other participants of the organization and the creation of a system that allowed follow-up and management.

Finally - the motivation for this study was evoked during the ISO 9000 certification process through frustration with the need to implement practices that were without practical value. Ten years later, while implementing the ISO 9000 version 2000 in a much wider and much more complex environment, it was noticed that the original question was wrong. All of the sites had reached a maturity level of quality management that clearly exceeded the ISO 9000 requirements (Fig. 55). When such a level is reached, there are no standards available that could indicate what should be done next. The organization has to find the path to the world-class category by itself.

The journey has been like climbing a mountain with a team of newcomers. We did have a mission assigned to us in 1992 by the executive management of Nokia Mobile Phones to be “Dynamic Champions in 2002”. We interpreted that mission to mean 880 points on the Quality Award Criteria scale – analogously to the 8800 World Record level of decathlon. In 1997, we condensed that objective into the sentence “Locomotion to World-Class” and a picture of a locomotive climbing a mountain. While climbing the mountain, we did not reach that level, but we were close enough to have a vision of it. When we were still below the level of ISO 9000 certification, we did not know what would mean to exceed 500 points. Today, I do not have any idea of what 1000 points, the summit of the mountain, looks like.

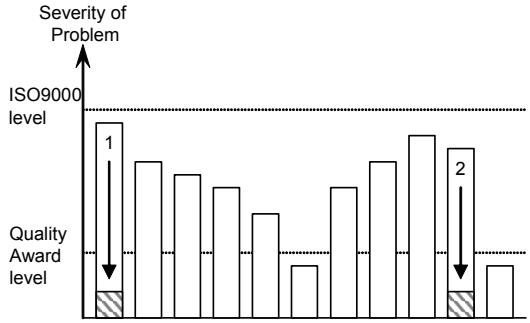


Fig. 55. Continuous improvement.

4 Discussion

4.1 Consolidating the dialogue between theory and empirical learning

Independently of the research approach, some criteria are common to all scientific research: The aim of scientific research is to produce new scientific knowledge, which should be well-founded on such argumentation that the results are sufficiently credible, and only published knowledge can be used for this argumentation. (Airala & Pekkanen 2002). The specific epistemological challenges concerning action research are reliability and generalizability of the results; the built-in subjectivity of the research approach contradicts the requirement for objectivity. Equally, the generalizability of results obtained in a single case study is questionable. (Lukka 1991).

Yin (1994) proposes that the challenge of reliability should be managed by writing the research report in such a way that the academic society can judge its objectivity by following up the chain of logic from the research problem to the conclusions. Also, such published evidence as presented in Table 2 gives the reader an opportunity to have a second opinion of the research.

Lukka (1991) proposes that the challenge of generalization could be managed by reflecting on the empirical learning against the tenets of the existing theory. In this chapter, the screening process of the contribution (Fig. 56) is described through the author's subjective learning process. The aim is to give the reader one more perspective and opportunity to follow up the chain of logic of this study.

During the empirical part of the research, different constructions were created to describe the practical process of problem solving; some of the constructions were plans outlined during the analysis phase, while others were lessons learned during the phase of evaluating learning. Much of the material was used for training purposes. Different theories were studied to support the process of practical problem solving.

Throughout the writing phase of this study, the focus has been on creating scientific knowledge based on empirical material. The existing theories have been studied to align the learning with the current scientific knowledge. The essential issue in this screening process has been to focus on the body of TQM knowledge; the practical innovations

within such fields of interest as leadership, teamwork and organizational culture are not within the scope of this study.

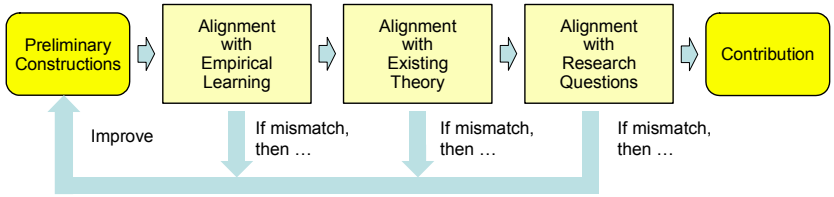


Fig. 56. Screening process to validate the contribution.

The essential learning of this study is described through five specific constructions:

1. the map of essential TQM concepts (Fig. 60),
2. the psychodynamic model of organization (Fig. 32),
3. the definition of five competence levels (Table 5),
4. the description of the difference between manufacturing and product development as environments for TQM implementation (Fig. 62 and Fig. 63), and
5. the description of TQM implementation as a learning process (Fig. 61).

These constructions serve as a framework to support the strategic choices of TQM implementation – especially in product development.

From the subjective perspective, the learning process of the psychodynamic model of organization made the biggest contribution to the content of this study. The learning began in 1987, when the author read Harris (1973) and was introduced to the "Parent-Adult-Child" model of transactional analysis (Fig. 22). The model has since been used by the author to further understand his own and others' behaviour. The static type of the model was a problem until the author was introduced to the work of Kahler (1974, 1979). Using the concept of 'miniscript' Kahler describes the child ego states as a dynamic pattern (Fig. 24).

These concepts have been used in different types of leadership development, as described in chapter 3.4.3 . Team development has been embedded in most training activity; the empirical material on team development includes observations on the development of more than thirty teams. During the training projects, the dynamics of child ego states was presented in the simplified form shown in Fig. 57. The approach was found useful in explaining the underlying individual presumptions in different storming situations during team evaluation.

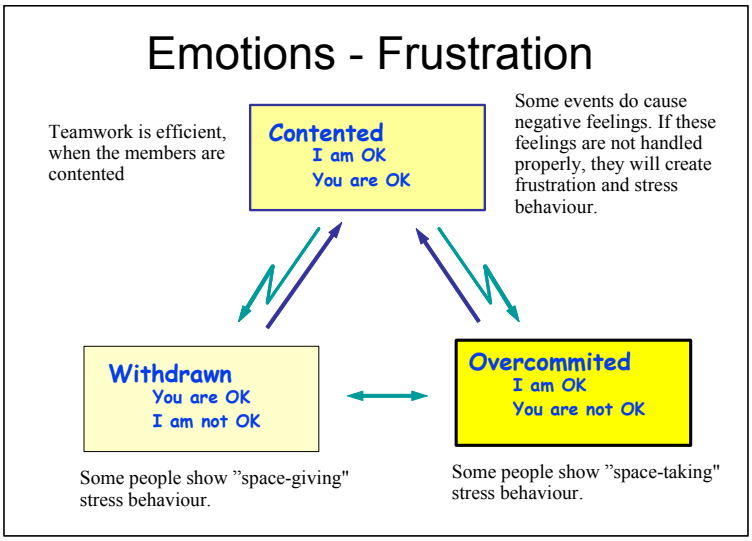


Fig. 57. Training material on child ego states.

During team development training, a model analogous to the psychodynamic model was used to visualize the essential elements of facilitating team development. The Parent-Adult-Child of teamwork facilitation was described as “Shared Vision”-“Shared Leadership”-“Shared Feeling of Psychological Security”. The concepts of “Shared Vision” and “Shared Leadership” are well supported by the existing literature related to teamwork, but the identification of the concept of “Shared Feeling of Psychological Security” was a process that required several years of practical team development. In the beginning, it was assumed that the child ego state of a team could be described as “Shared Joy of Achievement” analogously to the behaviour of sports teams. Further observations showed, however, that high-performing teams also share negative feelings, i.e. grief and different types of fear, more openly than other teams. Based on that, the term “Shared Feelings” was adopted. Through personal discussions with Mikko Aalto and being introduced to his description of the levels of security (Aalto 2000), the current understanding was achieved.

The practical team development exercises showed that “Shared Leadership” can manifest as behaviour typical of high-performing teams. “Shared Vision” and “Shared Feeling of Psychological Security” can be used as the basic tenets of methodology during team development.

At the same time, the author also had some interest to describe organizational behaviour through a psychodynamic model. Once again, the challenge concerned the child ego state. Fig. 58 presents a configuration of the model as presented on 27.10.2000 in a student seminar.

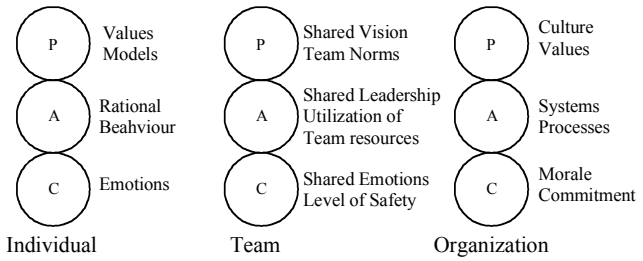


Fig. 58. Draft psychodynamic models of individual, team and organization.

The insight of describing the child ego state as "organizational leadership" occurred during the writing phase of the study. The idea was first rejected as too obscure, but as the construction passed the test that contented, withdrawing and overcommitted child ego states can be identified in "organizational leadership", the construct was further considered. A search of the literature revealed that Tiihonen (1990) had also presented a psychodynamic model of organization in his dissertation. Based on an analysis of Tiihonen's work, it was concluded that the existing theory supports the presented approach. As the presented construction also supports the answer to the research problem, the model was validated.

At the same time, the psychodynamic model of a team was rejected for three reasons: (1) Team is an organization; no logic supports the rationale to present both of these approaches. (2) The model concerning teamwork is actually not a psychodynamic model; the model suggests ways to facilitate team evolution. (3) Teamwork facilitation is not directly within the scope of the research problem.

The second essential path of learning is related to the map of essential TQM concepts and the difference between manufacturing and product development as environments for TQM implementation. When the difference between the environments is presented schematically, as in Fig. 62 and Fig. 63, it is self-evident; when valid and reliable measures are not available, new means of control are required. Anyhow, being close to the phenomenon under study made identification difficult. The section on establishing a mission and a regular practice of meetings - as presented in the chapters 3.1.1 , 3.1.4 , 3.2.2 , and 3.2.3 - describes a pattern that was identified during the first two research cycles of the empirical studies. The pattern seemed to lead to the realization of the expressed mission in a way that could not be explained: two cases and a few additional observations during other practical situations are not enough for generalization. Still, this observation led to a search for further explanation.

While trying to describe successful management as a set of systematic and managed practices during the research cycle 3, the author came upon the work of Simons (1995a). The four levers of control (Table 7) expanded the concept of measurement to the concept of control. The concepts of "Belief Systems" and "Interactive Control Systems" clearly provided the missing link. Since the author identified the new concepts, they have been used for practical purposes and training of other members of the organization – for example, they were an essential element of the interviews done by Tuomaala (1997). The challenge of the concepts of Simons pertained to "Boundary Systems". In the original format, that means "something not to be done". Through practical learning, the concept

was expanded to include things that "should all be done always". The concept was first called "minimum performance standards" and, finally in this work, "normative standards". The essential element of "Boundary Systems" is that they are tested by the organization; if they are found not to be real "Boundary Systems", they will lose their intended effect of control.

During the final phases of writing this thesis, the author became familiar with the theory of charismatic leadership (Conger 1989, Conger & Kanungo 1998). The theory of charismatic leadership is obviously the original missing link. Charismatic leaders (1) recognize a change opportunity, (2) express the change in the form of an emotionally inspiring vision, (3) lead the implementation of the vision through personal commitment and (4) achieve their visions. This approach still leaves an open question – is this the only type of charisma in leadership. The author tends to disagree, but the contribution of Conger and Kanungo closes the discussion.

The next essential learning path focuses on the map of essential TQM concepts (Fig. 60). The topic of interest originally came up in personal discussions with Silén and in reading his works (Silén 1995, 1997, 1998 and 2001). The original map was drawn around Silén's construction of an "Innovative" and "Customer-oriented" quality culture. Though the original construction was well received as training material, it was too complicated. The work of Kekäle (1998) presenting the "Soft" and "Hard" dimensions of quality gave a better format for the map. Since "Innovative Leadership" and "Rules Orientation", supported by the work of Broadfoot & Ashkanasy (1994), are cultural factors that can be developed independently, the model gave a solid basis for establishing a map of TQM implementation. The original map was used as training material on multiple occasions and constituted the basis for writing the theoretical part on TQM in this study. During the writing process, the map (Fig. 20) was slightly modified based on further understanding – perhaps the most essential modification concerned the combination of the concepts of empowerment, teamwork and continuous improvement. The actual theoretical discussion did not reasonably support the assumption that these concepts could be separated (even though there is plenty of discussion about empowerment and teamwork). Still, the original approach was returned to the final version (Fig. 60); teamwork and empowerment are more practical than theoretical issues.

Another essential discussion concerns learning. The origin of this discussion was the practical observation that a training program does not necessarily lead to the implementation of learning in practical working situations. The training in seven-step problem solving, as described in chapter 3.2.8 was only one of these examples. Chapter 3.4.6 describes the re-engineering of the reliability engineering process. The essential goal of the above-mentioned project was to create such training that will change the actual behaviour of the organization. During the planning phase, Erkki Peltola was involved in the project as a member of an organization specialized in organizing learning. Peltola (1998) described the challenges of learning as a function of the size of the learning organization (Fig. 59). Based on Peltola, the learning process of an individual is easy compared to that of a team; the team needs to learn how to utilize the skills of the individuals. At the organizational level, the learning challenges are even greater.

Based on the aforesaid discussions, a set of strategic conclusions was made: (1) Teamwork training should be further emphasized as an enabler to support organizational learning. (2) Systematic practices supporting teamwork, such as seven-step problem

solving, should be further emphasized. (3) The implementation of the re-engineering project requires a team of competent and committed facilitators.

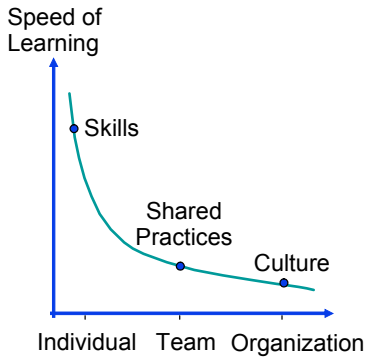


Fig. 59. Learning within different perspectives (Peltola 1998).

A model of learning levels similar to that presented in Table 5 was in use at Nokia. During the study, the model was used to manage the competence of the team facilitating the implementation of the re-engineering project. The model was found useful. Still, when people were evaluating their skill levels, there seemed to be a tendency to overestimate actual competence. There are presumably two reasons for such overestimation: (1) The overestimated figures look better in the databases available to HR people and possibly affecting the respondent's future career. (2) Without actual knowledge of the higher levels of competence, the reference to self-evaluation is vague.

Due to the tendency to over estimate one's competence, a very practical question was used in many situations: "How many years of experience do you have of the practical use of this competence?" Evidence of the actual use of the competence was used to define whether someone had level 3 (acting) or lower competence. Equally, evidence of coaching others was elicited for level 4 (coaching).

It was learned that people who had participated in training and reached level 2 (understanding) competence were still insecure about the use of the new skill and did not reach good results. As a consequence, they avoided using the skill. The facilitators were able to encourage the use of the skills, thus helping the people to cross the learning gap even in cases where the facilitator did not have a higher level of competence, either. The role of such facilitators or peers with multiple years of experience of the use of the skill (competence level 3 or 4) was even more influential; they were able to help people to reach good results and thus to increase their self-confidence. This learning is described in chapter 3.5 (Managerial implications):

> *"Practically consistent implementation of a new competence requires such competence creation process that wide range of people is trained to competence "level 2 – Understanding" and a core team with competence "level 4 – Coaching" is created."*

During the writing phase of this study, learning theories were reviewed to find justification for the learning levels. The theory of taxonomy (Krathwohl et al. 1964)

provided a solid theoretical basis for the definition of learning levels. Besides, the definition of the cognitive and affective domain of taxonomy further explains the original question (Why will the learning not be implemented after a training program?); the implementation of new learning requires positive affection towards the newly acquired content. Successful use of the new skill is a prerequisite for such positive affection. The definitions of the learning levels (Table 5) are based on the learning journey described. The construction is not novel scientific knowledge – such constructions do exist, but the concepts are needed to explain the essential learning of this study.

4.2 Answering the research problem

Q1: What are the essential concepts of TQM and how to prioritize the implementation?

A construction of TQM concepts was created based on a review of the TQM theories (Fig. 20). Reflecting the construction through the empirical studies, the first research sub-problem can be answered: Fig. 60 describes a map of the progress from "Uncommitted Quality" to "World-Class Quality". The coordinates of the map are: "Quality through initiative and innovation" and "Quality through normative standards". The coordinates are strategic choices, but to reach world-class quality, both elements are necessary. Based on the model of the four levers of control (Simons 1995b), a driver for each quadrant of the map is allocated.

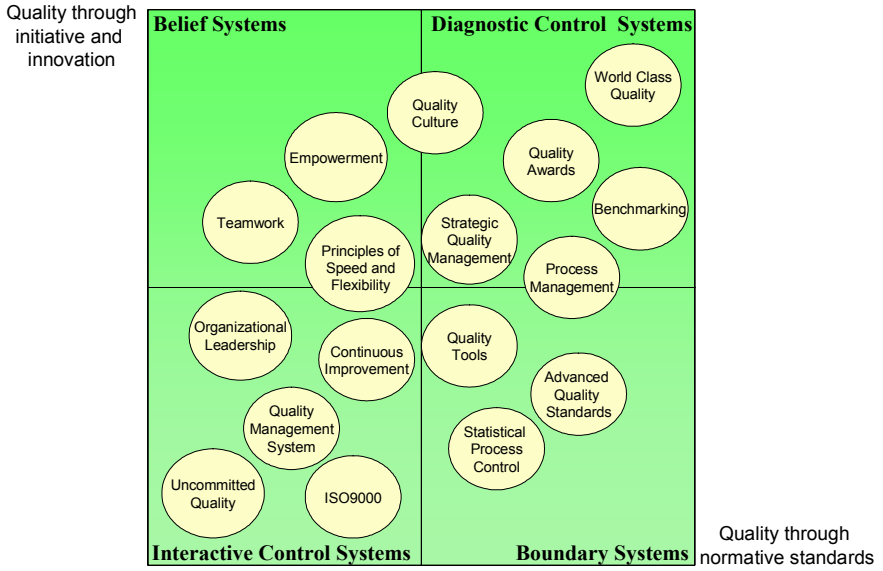


Fig. 60. Map of essential TQM Concepts.

Within the fist quadrant, the primary lever of control is interactive control systems. A system for quality management and continuous improvement needs to be established. The preferred system is a quality board who monitor the performance and establish improvement actions. The requirements for an ISO 9000 quality standard can be used as a reference for improvement, and the requirements can be met through reasonable effort.

Within the second quadrant, the driver of improvement is belief systems. Establishing a vision and purpose for the organization, directions on how to contribute can be given to the employees. By establishing organizational values, organizational leadership and initiative can be encouraged. Compared to the preliminary construction, such concepts as teamwork and empowerment are added to the model.

Within the third quadrant, the driver is boundary systems. Normative standards are decisively created and controlled by the management. Such practices are necessary to provide structure for quality management.

Within the fourth quadrant, normative and innovative quality is managed through a quality strategy that is clearly linked with business objectives. Within this quadrant, diagnostic control systems is the driver. The objectives for continuous improvement are created by comparing the organization's own performance to the best-in-class performance.

Q2: How are the concepts of learning, leadership, organizational cultures and teamwork linked together within the context of implementing TQM?

While summarizing the interfacing theories, a psychodynamic organizational model was presented. Within the research cycle 4, it was essentially learned that the implementation of TQM is a learning process. Besides developing such rational organizational assets as structure, processes and information technology, organizational culture and leadership also need to be developed. Consistent and organization-wide implementation of TQM is a holistic learning process where the critical mass of committed leadership is a prerequisite. (Fig. 61).

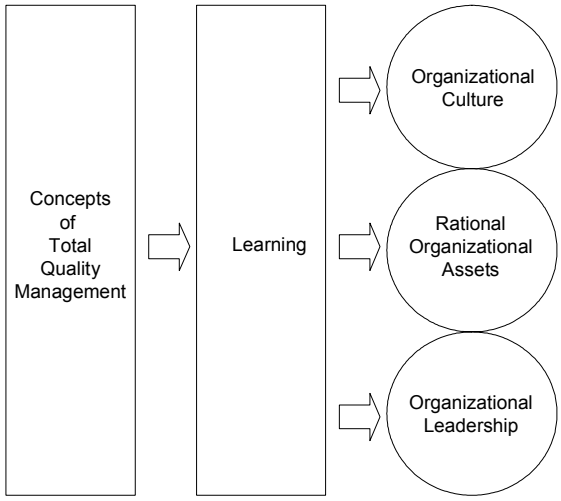


Fig. 61. Implementation of TQM as a learning process.

In creating changes in organizational culture, teams have a central role, as they are able to create their own values systems when sufficiently established. A team may also be able to create the critical mass of organizational leadership to drive a change of organizational culture.

Q3: What is essentially different while implementing TQM in a product development environment compared to implementing TQM in a manufacturing environment?

TQM within a manufacturing environment was studied during the research cycle 2. It was essentially learned that the time perspective in manufacturing was short compared to product development. Measurable results caused by improvement actions were typically available during the same day. The process of continuous improvement was essentially based on quantitative data (Fig. 62).

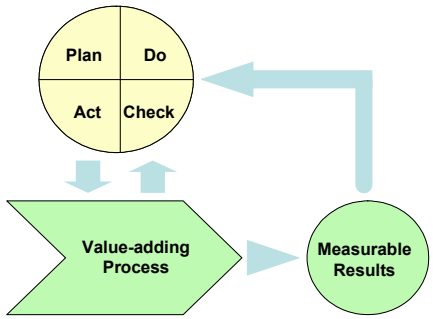


Fig. 62. TQM within a manufacturing environment.

TQM within a product development environment was studied in the research cycles 1 and 4. It turned out that valid and reliable results of improvement actions were typically only expected to be available in a distant future. Such essential data as the business performance of new products, production yields and field failure rates were typically only available several months after the product launch. Taking the product development time into consideration, the total time from action to consequences was measured by years. Such time span also includes the impact of intermediate variables to such extent that the exact correlation between actions and consequences is questionable. For that reason, estimations and evaluations were an essential tool to predict the consequences of actions. The process of continuous improvement was based on fuzzy data from workshops and discussions, i.e. interactive control systems. The implementation of strategies was characterized by continuous dialogue between planning and doing (Fig. 63).

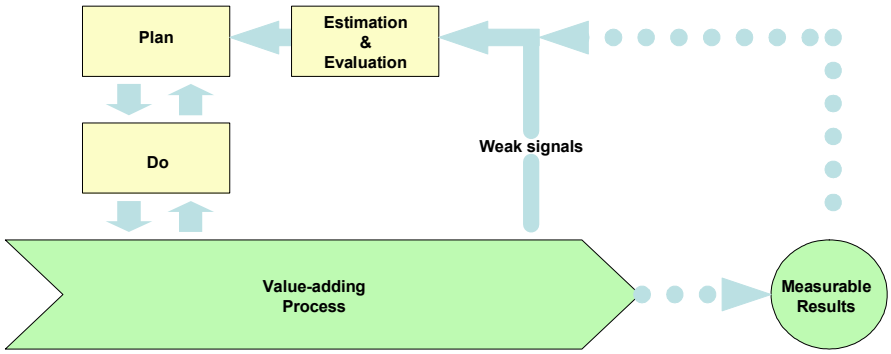


Fig. 63. TQM within a product development environment.

Based on the answers to the research sub-questions, the research problem can be answered.

Problem statement:

> How to implement TQM in the product development of a fast growing business in an effective and efficient way?

The existing TQM theories include a wide range of principles applicable within organizations to gain competitive advantage. By definition, consistent implementation of the principles requires that they are consistently used throughout the organization. The use of each principle requires both cognitive and affective learning. The prerequisite of consistent implementation is a critical mass of competent individuals able and willing to coach others. The individuals may be managers, other trusted members of the organization or specifically appointed facilitators. Apart from technical skills, specific leadership, facilitation and change management competencies are required.

The implementation of such a learning process is a major effort; it takes years to achieve the competence for coaching others in a new competence. Thus, before actually starting implementation, it is necessary to ensure management commitment and the availability of sufficient resources. The quality manager needs to link quality improvement with business management. Some means for this linking are related to strategic planning and leadership development. It is one of the quality manager's responsibilities to monitor the organizational performance, to keep the management aware of improvement opportunities and to manage the selected improvement projects.

In addition to implementing improvement projects, the quality manager is also responsible for promoting and maintaining general quality awareness with the hope that improvement actions are taken through organizational initiative and leadership.

To achieve sustainable advantage in competition, the level of 500 points on the scale quality award criteria needs to be exceeded. Within the quadrant of diagnostic control systems (Fig. 60), each step forward requires careful strategic discussion before implementation. Potential improvement actions should be selected based on quantitative analysis of current performance and anticipated impact on business performance. There are two strategic choices for the implementation of the improvement projects:

- Some selected improvement actions should be implemented through breakthrough projects by creating new normative standards, managed by a senior manager and followed up by a steering group. The implementation requires sufficient change agents, creating a learning environment to enable the change agents to reach the required competence level for coaching the implementation, implementing a training program for the target group of the improvement project and, finally, implementation to be controlled until the learning is integrated into the organizational culture.
- A wider range of improvements can be implemented by providing basic training and encouraging organizational leadership and initiative to take the learning to use.

Sustaining the quality maturity level of 500 points requires concurrent use of both methods. The breakthrough projects provide evidence of management commitment to the organization; besides, some cross-functional problems can only be removed by management actions.

The intermediate solution, i.e. setting a normative standard and almost implementing it, weakens the organizational trust in the management's commitment to TQM.

Finally, quality is created through a value chain. Though it is relevant and sufficient to start the work locally, no part of the value chain should be overlooked.

4.3 The scope of applying the results

The terms high-technology project organization and product development of a fast growing business have been used to describe the empirical research environment of this study. The source of empirical data is one single company in specific business conditions. Though the empirical data is collected through four different research cycles over a time period of ten years, the applicability of the results should still be further considered.

The impact of the unique characteristics of the business environment may be interpreted through two perspectives:

1. As the results are based on the specific type of business conditions, they are valid only in similar type of conditions.
2. As the results are based on non-typical application of TQM, they may uncover such characteristics of the phenomenon that are hidden in more typical situations of application.

Considering the first perspective, the results are most valid in the conditions of new product development of high-technology products and fast growth. The empirical material is not sufficient enough for the evidence of such assumption that the results would also be applicable in the conditions of any new product development and lesser degree of growth. The author tends to assume that the results of this study could be generalized to concern any dynamic and knowledge intensive circumstances.

Considering the second perspective, conducting the same study in different business environment would highly probable been led to different conclusions; perhaps highlighting such success factors that are more essential in those particular circumstances. Anyhow, the author still tends to assume that the result of this study have

value also in other circumstances than characterized by the empirical studies. The application of the results requires anyhow further consideration.

In this study the empirical learning has been reflected through existing theories and constructed as answers to research questions. The constructions have been presented in such level of abstraction that they also can be applied in other business circumstances than those of the empirical case.

For example the map of essential TQM concepts (Fig. 60), does not propose the strategy path to be used. Kekäle (1998) proposes three strategic choices, soft, mixed and hard) in his study that has presented similar dimensions of TQM implementation. In this study it has been more emphasized that both dimensions need to be implemented to meet the quality award levels of TQM implementation. Still, the priorities of strategic choices need to be considered based on the specific circumstances. In each of the research cycles of this study, the selected strategy path has been similar: First, interactive control systems (e.g. regular meting practices, workshops and face-to-face discussions) were established, then, belief systems (e.g. operational intent, values and principles of success) were established, and finally, normative practices (e.g. milestone reviews, practices of production control, and reliability engineering process) were established step by step. This approach could be described as a strategy path through initiative and innovation.

Morgan (1997) used McDonald's as an example of a franchising type of fast food business concept that has used the "machine metaphor" successfully. That strategic choice could be described as a strategy path through normative standards. The essential differential characteristics of fast food restaurants and the presented empirical case is the level of dynamics and knowledge intensity. An interesting detail in the McDonald's case is the excessive effort used to arrange corporate training programs to enable consistent global implementation of the business concept.

The research cycle 2 of this study presents a case that the quality path through initiative and innovation was successfully used in a manufacturing environment characterized by a high level of dynamics but a low level of knowledge intensity. Although diagnostic control systems were abundantly available in the case, the extension of measurement to the four levers of control (Simons 1995a) was found to be beneficial.

The discussion of the scope of applying the research results can be summarized as two conclusions:

1. The research results are most valid in a business environment characterized by dynamics and knowledge intensity – such as new product development of a fast growing business.
2. The research results are intended to provide new knowledge for TQM implementation even in a generalized business environment. Still, the empirical material of the study is not sufficient to validate such an assumption without further research.

4.4 Validity and reliability

Four tests have been commonly used to establish the quality of any empirical social research (Yin 1994):

- *Construct validity*; establishing correct operational measures for the concepts being studied.
- *Internal validity*; establishing a causal relationship whereby certain conditions are shown to lead to other conditions, as distinguished from a spurious relationship.
- *External validity*; establishing the domain to which the finding can be generalized.
- *Reliability*; demonstrating that the research operations, such as data collection, can be repeated with the same results.

Construct validity

To meet the test of construct validity, an investigator must be sure to cover two steps (Yin 1994):

1. Select the specific types of changes that are to be studied (in relation to the original objectives of the study).
2. Demonstrate that the selected measures of these changes actually reflect the specific types of change that have been selected.

The research environment was a rich source of data for the selected research problem. The research problem was studied through four research cycles, each with a different perspective for triangulation. Finally, the learning was reflected on through a wide range of relevant theories, and the research results were presented. One can assume that the research data are sufficient to meet the criteria of the first step.

During the study, employee opinion surveys and assessments (internal and external) were carried out to monitor the impact of the actions taken. Also, business measures were followed up to identify possible financial impacts. Unfortunately, the effect of intermediate variables (efforts of the other members of the studied organization) made it impossible to prove a clear quantitative correlation between the increased TQM implementation maturity and the financial results. One can still assume that the chain of evidence from the research problem to the contributions as described in this research report is sufficient to meet the second step of testing construction validity.

Internal validity

First, internal validity is a concern for studies where the investigator tries to determine whether event x led to event y. If the investigator incorrectly concludes that there is a causal relationship between x and y without knowing that a third factor, z, may actually have caused y, the research design has failed to deal with a threat to internal validity. (Yin 1994).

Understanding that such intermediate factors are present, one can assume that triangulation of the problem through four research cycles is sufficient to meet this criterion.

Second, the concern about internal validity may be extended to the broader problem of making inferences (Yin 1994).

Understanding the challenges of making inferences, one can assume that a study period of ten years is sufficient to identify the emerging patterns described in this research report.

External validity

The third test deals with the problem of knowing whether the research findings are generalizable beyond the immediate context of the study. An analyst should try to generalize the findings to "theory" (Yin 1994).

The research environment of this study was unique; the factors of growth and business success of Nokia Mobile Phones in a fiercely competitive environment are a topic of interest alone. One should consider whether learning in such a specific environment is generalizable; the research environment is one specific company in one specific country, and the basic research assumptions are focused on the specific business environment.

Still, the learning of this study is described at such a level of abstraction that one can assume that the contribution is also applicable to a wider context.

Reliability

The final test to establish the quality of this study is reliability. The objective is to ensure that, if a later investigator followed exactly the procedures described by an earlier investigator and conducted the same study all over again, s/he would arrive at the same findings and conclusions. (Yin 1994).

Time cannot be turned back, and this study cannot be repeated. The reliability of this study rests on this research report – the reader should be able to "repeat the study" by mentally following the chain of logic through the description of the study. Not all of the learning can be described here; some of the research data are confidential, and the tacit knowledge of the author cannot be shared. Still, all reasonable effort has been made to help the reader to follow the path of logic from the research question to the contribution and to evaluate the learning from his/her own perspective. Another source of increased reliability is the published graduate theses and other related materials listed in Table 2. One can assume that all reasonable effort has been made to confirm the reliability of this study.

4.5 Further discussion

This work has been a learning journey; each question answered has given rise to new questions. It is evident that further questions of curiosity exist. The approach to TQM in this study is holistic. The problems of roles and responsibilities in TQM are not widely discussed in this study; such discussion would have meant including at least such theories as strategic management, human resource management and information technology into the scope of this study.

It is quite obvious that the three roles of management as described in Fig. 64 are the relevant way to approach the problem. Strategic management should set the goals and

objectives for both external and internal reality. This process should be a collaborative activity of the members concerned. It is the essential role of operative management to implement the business strategy. As the focus of quality management is the internal reality of the organization, “quality strategy” should include all relevant approaches to increase the capability of the organization. Lillrank (1998) presents the concept of capability strategy instead of quality strategy. The author tends to agree with this view.

Fig. 64. Three roles of management.

The essential question is:

Who should be responsible for implementing the capability strategy?

The capability strategy consolidates and integrates the quality strategy, the human resource strategy and the information technology strategy. It is no wonder that the debate of ownership on capability strategy is ongoing both in theoretical discourse and at the practical level. One can assume that a capability strategy owned by any of the three functions will lead to sub-optimal implementation. However, as the convergence of these three functions will continue, the solution to the mentioned problem is an interesting further debate.

5 Conclusions

In this thesis, effective and efficient implementation of TQM in a product development organization has been studied. The research material has been collected through an action research of ten years within a dynamic project organization. The learning journey is presented by a descriptive narrative about the central phenomenon of the study. The learning of the research is reflected through the existing theories of TQM, leadership, learning, organizational cultures and teamwork. Finally, the learning has been crystallised in the form of answers to the research questions.

The following contributions of the thesis confirmed the existing knowledge:

1. The validity of the existing TQM concepts was further confirmed.
2. The validity of the model of four levers of control (Simons 1995a) was further confirmed.
3. The validity of the psychodynamic model of organization (Tiihonen 1990) was further confirmed.

The following contributions of new knowledge were made:

1. The presented map of essential TQM concepts (Fig. 60).
2. Extending the concept of measuring to the four levers of control within the context of TQM.
3. The presented simplified version of the psychodynamic organizational model for the context of implementing TQM.
4. The presented difference of implementing TQM in a product development environment compared to implementing TQM in a manufacturing environment (Fig. 62 and Fig. 63).
5. The essence of an interactive control system within the context of TQM of R&D.
6. The presented two strategic choices of managing learning within the context of TQM.

The contribution was validated by first acquiring the knowledge through action research and then crystallizing the essential learning through the writing process of this research report.

The reliability of the contribution was confirmed by presenting the learning journey as a descriptive narrative, enabling the critical reader to follow the logic of conclusions.

The generalization of the contribution was confirmed by using such a level of abstraction while presenting the results that that they can be used by other researchers.

How much better than the competitors does an organization need to be to win? The Finnish ice-hockey team won the World Championship of 1995. The background of that victory is described by Saarinen et al. (1995). "Litet Bättre" – just a little bit better was the philosophy of Curt Lindström, the coach of that team.

References

Aalto M (2000) Ryppäästä ryhmäksi. My Generation, Ryttylä.

Abran A, Moore JW, Borque P, Dupuis R & Tripp LL (2001) SWEBOK: Guide to the software engineering body of knowledge: Trial version 1.0 [online]. IEEE computer society, Washington [cited 12 January 2004]. Available from: http://www.swebok.org/.

Adair J (1984) The Skills of Leadership. Gower Publishing Company Limited, Aldershot.

Ahern DM, Clouse A & Turner R (2001) CMMI Distilled; a Practical Introduction to Integrated Process Improvement. Addison-Wesley, Boston.

Airala M & Pekkanen M (2002) Tekniikan alan väitöskirjaopas. Teknillinen korkeakoulu, Espoo.

Alvesson M & Berg PO (1992) Corporate Culture and Organizational Symbolism. Walter de Gruyter, Berlin.

Alvesson M & Willmott H (1996). Making Sense of Management; a Critical Introduction. SAGE Publications, Thousand Oaks

Arbnor I & Bjerke B (1997) Methodology for Creating Business Knowledge; Second Edition. SAGE Publications, Thousand Oaks.

Argyris C (1993). Knowledge for Action. Jossey-Bass, San Francisco.

Badri MA & Davis D (1995) A study of measuring the critical factors of quality management", International Journal of quality and reliability management, Vol 12 no 2. 36-53.

Bass BM. & Avolio BJ (1994), Improving Organizational Effectiveness through Transformational Leadership. Sage Publications, Thousand Oaks.

Belbin associates (2003) [modified 14 July 2003] Belbin team-roles [online]. [cited 01 August 2003]. Available from http://www.belbin.com/belbin-team-roles.htm.

Belbin MR (1981) Management Teams – Why they Success or Fail. Butterworth-Heinemann Ltd, Oxford.

Benne KD & Sheats P (1948) Functional roles of group members. Journal of social issues, Vol 4 no 2. 345-381.

Berne E (1967) Kanssakäymisen kuviot: Ihmissuhteiden psykologiaa. Gummerus, Jyväskylä.

Bohoris GA (1995) A comparative assessment of some major quality awards. International journal of quality & reliability management, Vol 12 no 9. 30-43.

Briggs KC & Myers IB (1957) Myers-Briggs Type Indicator. Educational Testing Service, Princeton.

Broadfoot L & Ashkanasy N (1994) A survey of organizational culture measurement instruments. Paper presented at the Annual Meeting of Australian Social Psychologists, Cairns, Queensland, Australia, April 1994.

Brown MG (1997) Baldrige Award Winning Quality; Seventh edition: How to interpret Baldrige Criteria for Performance Excellence. ASQC Quality Press, Milwaukee.

Burkett MA (1995) Clarifying roles and responsibilities. CMA magazine, Vol 69 no 2. Hamilton, 26-28.

Burrell G & Morgan G (1979) Sociological Paradigms and Organisational Analysis. Arena, Aldershot.

Camp RC (1995) Business Process Benchmarking; Finding and Implementing the Best Practices, ASQC Quality Press.

Carnevale A, Gainer L & Meltzer A (1990) Workplace Basics; The Essential Skills Employers Want. Jossey-Bass, San Francisco.

Chang P & Lu K (1995) Current status of total quality management implementation in Taiwan companies. TQM magazine, Vol 7 no 1. 14-19.

Chrissis MB, Konrad M & Shrum S (2003) CMMI Guidelines for Process Integration and Product Improvement. Addison-Wesley, Boston, Mass.

Cleary T (1989) Zen Lessons; The Art of Leadership. Shamhala, Boston.

Coghlan D & Brannick T (2002) Doing Action Research in Your Own Organization: Sage publications, London.

Conger JA & Kanungo RN (1998) Charismatic Leadership in Organizations, Sage publications, Thousand Oaks.

Conger JA (1989) The Charismatic Leader; Behind the Mystique of Exceptional Leadership. Jossey-Bass, San Francisco.

Crosby PB (1980) Quality is Free. Penquin Group, New York.

Dale BG & Shaw P (1999) Tools and Techniques; An Overview. In Dale BG (Ed.) Managing Quality; Third Edition. Blackwell Publishers Ltd, Oxford. 280-314.

Dale BG (1999) Managing Quality; Third Edition. Blackwell Publishers Ltd, Oxford.

Dale BG, Lascelles DM & Boaden RJ (1994) Levels of Total Quality Management Adoption. In Dale BG (Ed.) Managing Quality. Prentice Hall, New York. 117-127.

Davenport TH (1993) Process Innovation; Reengineering through Information Technology. Harvard Business School Press, Boston.

Davenport TH (1994) Managing in the new world of process. Public productivity & management review, Vol 18 no 2, Thousand Oaks 133-147.

Deal TE & Kennedy AA (1982) Corporate Cultures; The Roles and Rituals of Corporate Life. Addison-Wesley.

Deming WE (1986) Out of the Crisis. Massachusetts Institute of Technology, Center for Advanced Engineering Study, Cambridge, Mass.

DRM associates (2002) [modified 1 December 2003] New product development body of knowledge [online]. [cited 12 January 2004]. Available from: http://www.npd-solutions.com/bok.html.

Dunn R & Dunn K (1999) The Complete Guide to the Learning Strategies Inservice System. Allyn & Bacon, Boston.

Engeström Y (1994) Training for Change; New Approach to Instruction and Learning in Working Life. International Labour Office, Geneva.

Feugenbaum AV (1991) Total Quality Control: Third Edition, Revised. McGraw-Hill Book co, Singapore.

Fong JLC & Antony J (2001) QS9000: An overview and comparison with ISO9000. The TQM magazine Vol 12 no 4, Bedford. 315-318.

Forrest W & Breyfogle III (1999) Implementing Six Sigma; Smarter Solutions Using Statistical Methods. John Wiley & Sons, New York.

Freud S (1964) Johdatus psykoanalyysiin. Gummerus, Jyväskylä.

Gagné RM (1970) The Conditions of Learning; Second Edition. Holt, Rinehart & Winston, London.

Garrity SM (1993) Basic Quality Improvement. Regents/Prentice-Hall, New Jersey.

Goldratt EM (1997) Critical Chain. North River Press, Great Barrington (Mass.)

Gropper (1983) A Behavioral Approach to Instructional Prescription. In: Reigeluth CM (ed) Instructional Theories and Models; An Overview of their Current Status. Lawrence Erlbaum Associates Publishers, Hillsdale. 101-161.

Gummesson E (2000) Qualitative Methods in Management Research; second edition. Sage Publications, Thousand Oaks.

Hamel G & Prahalad CK (1994) Competing for the Future. Harvard Business School Press, Massachusetts.

Hammer M & Champy J (1995) Reengineering the Corporation; A Manifesto for Business Revolution. Brealey, London.

Hannukainen T (1993) Laatuyritykset: Laatujohtaminen maailman valioyrityksissä. 2. uudistettu painos. Metalliteollisuuden Kustannus Oy, MET, Helsinki.

Hannus J (1993) Prosessijohtaminen: Ydinprosessien uudistaminen ja yrityksen suorituskyky: Toinen, uudistettu painos. Gummerus Kirjapaino Oy, Jyväskylä.

Harrington HJ (1991) Business Process Improvement; The Breakthrough Strategy for Total Quality, Productivity and Improvement. McGraw-Hill inc, New York.

Harris TA (1973) Minulla menee hyvin. Entä sinulla?. Otava, Helsinki.

Hay J (1993) Working it out at Work; Understanding Attitudes and Building Relationships. Sherwood Publishing, Watford.

Hendricks KB & Singhal VR (1997) Does implementing effective TQM program actually improve operating performance? Empirical evidence from firms that have won quality awards. Management Science, Vol 43, no 9, September 1997.

Hietaniemi J (1997) Kilpailukyvyn parantaminen teknisiä asiakastukiprosesseja kehittämällä, Diplomityö. Oulun yliopisto, Teollisusstalouden osasto, Oulu.

Hofstede G (1991) Cultures and Organizations; Software of the Mind. McGraw-Hill, Maidenhead.

Huff L, Fornell C & Anderson E (1996) Quality and productivity; contradictory and complementary. Quality Management Journal, Vol 4 no 1. 22-39.

Hutchison EE (2000) TL9000 Quality management system; Overview. Annual Quality Congress Proceedings ASQC, Milwaukee. 234-236.

Hutchison EE (2001) The road to TL9000: From the Bell breakup to today. Quality Progress Vol 34 no 6, Milwaukee. 33-37.

Imai M (1986) Kaizen: The Key to Japan's Competitive Success. McGraw-Hill Publishing Company, New York.

Ishikawa K (1985) What is Total Quality Control? The Japanese Way. Prentice-Hall, Englewood Cliffs.

Jung CG (1989) Psychological Types; Reproduction. Routledge, London.

Juran JM (1989) Juran on Leadership for Quality; An Executive Handbook. The Free Press, New York.

Järvinen P (1999) On Research Methods. Tampereen yliopistopaino Oy, Tampere.

Kahler T (1974) The miniscript. Transactional Analysis Journal, Vol 4 No. 1. 26-42.

Kahler T (1979) Managing with the Personal Communication Model. Human Development Publications, Little Rock.

Kanji GK & Asher M (1996) 100 Methods for Total Quality Management. Sage Publications, London.

Karjalainen E (1990) Tuotteen ja prosessin optimointi koesuunnittelulla: Taguchi-menetelmä. Metalliteollisuuden kustannus, Helsinki.

Karjalainen T & Karjalainen E (2002) Six Sigma; Uuden sukupolven johtamis– ja laatumenetelmä. Quality Knowhow, Hollola.

Kasanen E, Lukka K & Siitonen A (1991) Konstruktiivinen tutkimusote liiketaloustieteessä. The finnish journal of business economics, Vol 40 no 3. 301 – 327.

Katzenbach R Smith H (1993) The Wisdom of Teams: Creating the High Performance Organizations. Harvard Business School Press, Boston.

Kauppinen S (1999) Development of Technological Competitiveness by Integrating Instruments and Automation in Process Machinery, dissertation. University of Oulu, department of economics, Oulu.

Kearsley G (1992) [modified 27 February2003] About TIP WWW Version 2.5 [online]. [cited 06 March 2003]. Available from: http://tip.psychology.org/.

Kekäle T (1998) The Effects of Organizational Culture on Successes and Failures in Implementation of Some Total Quality Management Approaches, dissertation. Universitas Wasaensis, Vaasa.

Kilpinen A (1999) Laatukäsitykset ja yrityskulttuuri, Pro gradu-tutkielma. Oulun Yliopisto, Kasvatustieteellinen tiedekunta, Oulu.

Kinnula A (1999) Software Process Engineering in a Multi-site Environment; An Architectural Design of a Software Process Engineering System, dissertation. Oulun yliopisto, Oulu.

Kivelä K (1999) Design for Reliability; Designing and Prototyping Reliability Breakthrough, masters-thesis. University of Oulu, department of industrial engineering, Oulu.

Kivimäki-Kuitunen A & Kiehinen II (2000) Work, Rest & Play; matkaevästä Nokian nuorilta esimiehiltä. Mermerus, Maarianhamina.

Knowles M & Associates (1984). Andragogy in Action. Jossey-Bass, San Francisco.

Knowles, M. (1975). Self-Directed Learning. Follet, Chicago.

Kolb DA (1984) Experiential Learning; Experience as the Source of Learning and Development. Prentice-Hall, Inc., Englewood Cliffs.

Krathwohl DR, Bloom BS & Masia BB (1964) Taxonomy of Educational Objectives: The Classification of Educational Goals; Handbook II; Affective Domain. David McKay Company Inc, New York.

Kujala J (2002) Total Quality Management as Cultural Phenomena; A Conceptual Model and Empirical Illustration, dissertation. Helsinki University of technology, department of industrial management and organizational psychology. Espoo.

Kulvik H (1977) Factors Underlying the Success or Failure of New Products, dissertation. Helsinki University of Technology, Espoo.

Kume H (1985) Statistical Methods for Quality Improvement. AOTS, Tokyo.

Lanning H (2001) Planning and Implementing Change in Organizations; A Construct for Managing Change Projects, dissertation. Helsinki University of Technology, Espoo.

Larson CE & LaFasto FM (1989) Teamwork; What Must Go Right/What Can Go Wrong. Sage Publications, Newbury Park.

Launonen M (1999) Business Process Re-engineering with Teams; Case Studies in Manufacturing in the Electronics Industry, dissertation. University of Oulu, department of economics, Oulu.

Leppälä K (1995) Inside a Contract Research Laboratory; A Study of Concepts, Methods and Performance, dissertation. University of Oulu, Oulu.

Lillrank P (1998) Laatuajattelu: Laadun filosofia, tekniikka ja johtaminen tietoyhteiskunnassa. Kustannusyhtiö Otava. Helsink.

Love R & Dale (1994) Benchmarking. In Dale BG (Ed.) Managing Quality. Prentice Hall, New York. 390-403.

Luiro V (2003) Acquisition and Analysis of Performance Data for Mobile Devices, dissertation. University of Oulu, Oulu.

Lukka K (1991) Laskentatoimen tutkimuksen epistemologiset perusteet. The Finnish journal of business economics, Vol 40 no 2. 161-183.

Malinen A (2000) Towards the Essence of Adult Experiential Learning ; A Reading of the Theories of Knowles, Kolb, Mezirow, Revans and Schön. SoPhi, University of Jyväskylä 2000, Jyväskylä.

Martin J (1992) Cultures in Organizations; Three Perspectives. Oxford University Press, New York.

Mattila M (1994) Laatujohtamisen kehittäminen matkapuhelintuotannossa, diplomityö. Tampereen Teknillinen Korkeakoulu, Konetekniikan osasto, Tampere.

Maunu S (2003) Supplier Satisfaction; The Concept and a Measurement System; A Study to Define Supplier Satisfaction Elements and Usage as a Management Tool, dissertation. University of Oulu, Department of Industrial and Engineering Management, Oulu.

McGovern F (1993) Personal discussion.

Morgan G (1997) Images of Organizations; 2'nd Edition. Sage Publications ltd, Thousand Oaks.

Nokia (2001) Summary of the submission for the 2000 European quality award. [online]. Nokia, Espoo [cited 06.March 2003]. Available from: http://www.nokia.com/downloads/eqa/44870_EQA_KANSI.pdf.

Nokia (2004) Annual reports [online]. Nokia, Espoo [cited 23.February 2004]. Available from: http://www.nokia.com/nokia/0,,36094,00.html.

Northouse PG (2001) Leadership: Theory and Practice; Second Edition. Sage Publications, Thousand Oaks.
Oakland JS & Porter LJ (1995) Total Quality Management: Text with Cases. Butterworth-Heinemann, Oxford.
Oakland JS (1993) Total Quality Management: The Route to Improving Performance; Second Edition. Butterworth-Heinemann, Oxford.
Olkkonen T (1993). Johdatus teollisuustalouden tutkimustyöhön. Helsinki University of Technology, Industrial Economics and Industrial psychology, Report no 152, Espoo.
Ollila A (1995) Quality Improvements through ISO 9000 Standards; Can ISO 9000 Quality Standards Improve Quality? A Classification of Business-to-Business Companies, dissertation. Helsinki University of technology, Espoo.
Parker GM (1990) Parker Team Players and Teamwork. Jossey-Bass Inc., San Francisco.
Peltola E (1998) Personal discussion.
Pesonen LTT (2001) Implementation of Design to Profit in a Complex and Dynamic Business Context, dissertation. University of Oulu, Oulu.
Peters T & Waterman R (1982) In Search of Excellence: Lessons Learned from America's Best-Run Companies. Warner Books, New York.
Piiponniemi I (1994) Materiaalivirrat matkapuhelinten tuotannossa, diplomityö. Tampereen teknillinen korkeakoulu, Tampere.
Platt S, Piepe R & Smyth J (1988) Teams – A Game to Develop Group Skills. Gower Publishing Company Limited, Aldershot.
Project Management Institute (2000) A Guide to the Project Management Body of Knowledge (PMBOK Guide); 2000 Edition. Project Management Institute, Pennsylvania.
Rae L (1985) The Skills of Human Relations Training. Nichols, New York.
Robbins SP & Coulter M (1996) Management; Fifth edition. Pretience Hall, New Jersey.
Rogers, C.R. & Freiberg, H.J. (1994). Freedom to Learn (3rd Ed). OH: Merrill/Macmillan, Columbus.
Ross RS & Ross RM (1982) Relating and Interfacing: An Introduction to Interpersonal Communication. Prentice Hall, Englewood Cliffs.
Rothery B (1993) ISO 9000; Second Edition. Gower Press, Aldershot.
Saarinen E, Lindström C, Raevuori A & Virta M (1995) Poppamies. WSOY, Porvoo.
Salmi T & Järvenpää M (2000) Laskentatoimen case-tutkimus ja nomoteettinen tutkimusajattelu sulassa sovussa. The Finnish journal of business economics 2/00. 263-275.
Salo T (2001) Reliability Prediction in the Early Phases of Product Development, masters-thesis. University of Oulu, Department of Industrial Engineering and Management, Oulu.
Saraph JV, Benson PG & Scroeder RG (1989) An instrument for measuring critical factors of quality management. Decision Sciences, Vol 20. 810-829.
Scandura JM (1983) Instructional strategies based on structural learning theory. In: Reigeluth CM (ed) Instructional theories and models: An overview of their current status. Lawrence Erlbaum Associates, Publishers, Hillsdale. 213-246.
Schein EH (1991) Organizational Culture and Leadership. Jossey-Bass, San Francisco.
Schön DA (1987) Educating the Reflective Practitioner; Toward a New Design for Teaching and Learning in the Professions. Jossey-Bass, San Fransisco.
SFS-EN ISO9001 (2001) Quality Management Systems Requirements. Suomen Standardoimisliitto SFS, Helsinki.
Shewhart WA (1939) Statistical Methods from the Viewpoint of Quality Control. Graduate school, Department of Agriculture, Washington.
Shimbun NK (1995) Visual Control Systems. Productivity press, Portland.
Silén T (1995) Organisaatiokulttuuri ja johtaminen; Kahden yrityksen kulttuurimuutosprosessin ja TQM-järjestelmän tarkastelu, väitöskirja, Helsingin yliopiston valtiotieteellinen tiedekunta, Helsinki.
Silén T (1997) Kansallista laatustrategiaa koskeva selvitys. Kauppa ja teollisuusministeriön tutkimuksia ja raportteja 15/1997, Helsinki.
Silén T (1998) Laatujohtaminen – menetelmiä kilpailukyvyn vahvistamiseksi. WSOY, Porvoo.
Silén T (2001) Laatu, brandi ja kilpailukyky. WSOY, Helsinki.

Simons R (1995a) Control in age of empowerment. Harvard business review, Mar-April 1995. 80-88.

Simons R (1995b) Levers of Control; How Managers Use Innovative Control Systems to Drive Strategic Renewal. Harvard Business School Press, Boston, MA.

Soin SS (1993) Total Quality Control Essentials: Key Elements, Methodologies, and Managing for Success. McGraw-Hill Inc, Singapore.

Stech EL (2001) Psychodynamic Approach In: Northouse PG (ed.) (2001) Leadership: Theory and Practice; Second Edition. Thousand Oaks, London, New Delhi. Sage Publications Inc. 189-213.

Steinboc D (2001) The Nokia Revolution; The Story of an Extraordinary Company that Transformed an Industry. American Management Association, New York.

Susman GI & Evered RD (1978) An assessment of the scientific merits of action research. Administrative Science Quarterly 23, 582-603.

Sydänmaanlakka P (2000) Alykäs organisaatio - Tiedon, osaamisen ja suorituksen johtaminen. Gummerus Kirjapaino Oy, Jyväskylä.

Sydänmaanlakka P (2003) Intelligent Leadership and Leadership Competencies; Developing a Leadership Framework for Intelligent Organizations, dissertation. Helsinki University of technology, Department of Industrial Management, Espoo.

Taguchi G (1986) Introduction to Quality Engineering: Designing Quality into Products and Processes. Asian Productivity Organization, Hong Kong.

Tersine RJ (1985) Production/Operations Management: Concepts, Structure & Analysis; Second Edition. Prentice Hall, Englewood Cliffs.

Tervonen A (2001) Laadun kehittäminen suomalaisissa yrityksissä, väitöskirja. Lappeenrannan teknillinen korkeakoulu, Lappeenranta.

Thompson PW (2000) Radical constructivism: Reflections and directions. In Steffe FP & Thompson PW (Eds.) Radical constructivism in action: Building on the pioneering work of Ernst von Glaserfeld. Falmer Press, London. 412-448.

Tiihonen E (1990) Psykodynaaminen organisaatiomalli, väitöskirja. Oulun Yliopisto, Oulu.

Trompenaars F (1993) Riding the Waves of Culture: Understanding Cultural Diversity in Business. The Economist Books, London.

Tuckman B (1965) Developmental sequence in small groups. Psychological Bulletin, Vol 63. 384-399.

Tuomaala S (1997) Prosessiajattelun soveltaminen liiketoimintayksikön kehittämiseen. diplomityö. Oulun yliopisto, Taloustieteen osasto, Oulu.

Womack JP & Jones DT (1990) Machine that Changed the World. Rawson Associates, New York.

Womack JP & Jones DT (1996) Lean Thinking: Banish Waste and Create Wealth in Your Corporation. Simon & Schuster, New York.

Yin RK (1994) Case Study Research: Design and Methods; Second Edition. Sage Publications. Thousand Oaks.

Youssef MA, Boyd J & Williams E (1996) The impact of total quality management on firms' responsiveness: an empirical analysis. Total Quality Management, Vol 7 no 1, February 1996. 127-144.

Zink KJ (1997) Successful TQM: Inside Stories from European Quality Award winners. Gower Publishing Limited, Aldershot.

Zuckerman A (1996) Meeting QS9000 requirements. Iron age new steel. Vol 12 No 9, 92.

Appendix 1 Maturity of management development process

The owner of Management Development was interviewed 23.5.1996.

It was noticed that the process is clearly defined. The definition includes a booklet of 32 pages where, for instance, the CEO of the Company defines the purpose and mission of Management Development. The trainees are defined as customers. The total maturity of Management Development was high (75%).

Two improvement opportunities were identified:

- There is no clear link showing that the number of participants, participant selection and learning objectives were defined based on an analysis of strategic needs.
- There was no practice to measure the opinion of participants' direct managers as to whether the Management Development met their expectations.

The scale used for the maturity assessment is presented in table A1.1 and the maturity by studied issues is described n table A1.2.

Table A1.1. The used scale of the assessment

Scale	
Anecdotal or non-value-adding	0 %
Some evidence of soundly based system	25 %
Clear evidence of a soundly based system	50 %
Clear evidence of measured and controlled system	75 %
Could be used as role model for other organizations	100 %

Table A1.2. Maturity profile of Management Development

Element	Maturity
Definition and description	100 %
Link to strategy	25 %
Customer focus	75 %
Control by belief systems	75 %
Control by boundary systems	25 %
Control by diagnostic control systems	50 %
Control by interactive control systems	100 %
Overall maturity	38

Appendix 2 Results of the survey of the Kiehinen leadership program participants

A total number of 38 responses were received from 103 participants (Table A2.1).

Table A2.1. Response percentage to the Kiehinen training effectiveness questionnaire.

Year of training	Number of answers	Number of participants	Response percentage
2001	14	21	67 %
2000	7	21	33 %
1999	10	21	48 %
1998	2	24	8 %
1997	5	16	31 %
Total	38	103	37 %

The participants of the training were asked: "How many subordinates did you have before and after the training?" The results are shown in Table A2.2.

Table A2.2. Number of subordinates.

Year of training	Before training	Now	Growth percentage
2001	34	34	0 %
2000	52	70	35 %
1999	24	134	453 %
1998	18	36	103 %
1997	55	232	321 %
Average	38	93	154 %

The participants of the training were asked: "Estimate how many subordinates less or more you would have if you had not participated in the training?"

Only 12 answers were received, showing an average impact of increase of 27 subordinates. (Counting this for the whole population gives an average impact of increase of 9 subordinates.)

Three of the respondents indicated that the training had had a decreasing impact on the number of subordinates, the average decrease being 90 subordinates, as they had re-evaluated their motivation to managerial work.

Still, concerning the impact on number of subordinates, most of the respondents either did not see any impact at all or said that they could not estimate the impact.

The participants of the training were asked: "How long does the learning process continues after the training?" and "Describe the learning process after the training." The typical answer was that there is a three-year learning process after the training:

- The first year is the "maturing phase"; it includes enthusiasm and experimentation with the learning.
- The second year is the "implementation phase". The learning transforms from "given knowledge" to "my knowledge".
- The third year is the "harvesting phase"; the implementation of the learning does nott need specific attention.

The participants of the training were asked: "What was the most important learning for you?" Table A2.3 shows the answers given more than once.

Table A2.3. Most important learning of the training.

Learning topic	Number of answers	Percentage of all answers
Teamwork	10	26 %
Self-confidence	9	24 %
Self-knowledge	9	24 %
Importance of commitment	7	18 %
Networking	6	16 %
Understanding people	4	11 %
Self-acceptance	3	8 %
Strategic planning	3	8 %
Target setting	2	5 %
Communication	2	5 %
Helicopter view	2	5 %

The participants of the training were asked: "How much more productive your current subordinates are due to the training you had?" The results are shown in Table A2.4 and Fig. 1.

Table A2.4. Increase in subordinates' productivity.

Year of training	Increase in the productivity
2001	19 %
2000	33 %
1999	13 %
1998	11 %
1997	5 %
Average	17 %

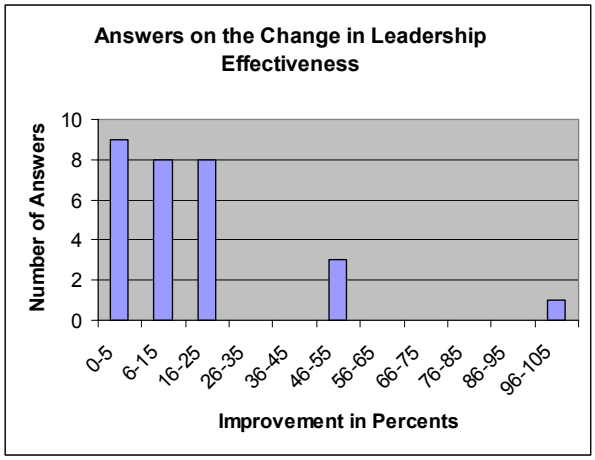


Fig. A2.1. Answers on the change in leadership effectiveness presented as categorized.

Based on the presented figures the cost/revenue of the training was calculated (Fig. 2).

Cost	k€/trainee	Percentage of training cost	Percentage revenue
Trainers	4	23 %	0.4 %
Accommodation and travelling	1	6 %	0.1 %
Lost workin hours	13	71 %	1 %
Total	**17.5**	**100 %**	**2 %**

Revenue	
Average number of subordinates	93
Median of increased productivity	10 %
Cost per employee	100 k€
Annual revenue/trainee	**930 k€**

Fig. A2.2. Cost/revenue calculation of Kiehinen leadership training.

The calculation shows 930K€ revenue/trainee for the leadership development training program. Still the uncertainty of these quantitative figures is high, and the figures should therefore not be generalized to indicate that investments to leadership development create annual savings of the order of multiples of tens compared to costs. The direct training cost was only 23 % of the total training costs (including lost working hours). Keeping in mind the potential benefits of the training, the quality of leadership training should not be underestimated.