Using critical systems thinking to compensate for lack of management commitment in the implementation of TQM-based organisational learning

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Abstract: There is an 80% failure rate for organisational development programmes like total quality management (TQM). Scholars and practitioners agree that success and failure of TQM and other organisational learning programmes depend on having strong management commitment. As this may not always be possible to obtain, one might ask whether good implementation methods based on systems thinking could compensate for lack of management commitment. An action research study spanning twenty years and three research cycles in different organisational settings has been used for investigating the question. Although the evidence is not conclusive, the findings indicate that implementation methods based on critical systems thinking (CST) may compensate for lack of management commitment by bootstrapping a solution that takes advantage of system complexity and political tension among actors. Key to the bootstrapping method is the development of a network of super users (expert users of quality management systems) whose informal power and authority may compensate for lack of involvement from formal management.

Keywords: Critical systems thinking, organisational learning, total quality management, bootstrapping, super users.

Introduction

Managers and scholars have been recognising the need for organisations to adapt, improve and learn at least since the industrial revolution achieved momentum in the early nineteenth century (Beniger, 1986), but the failure rates of organisational development methods remain high. Failure rates when trying to implement organisational learning through methods like total quality management (TQM) are estimated to be about 80% (Senge, 1999; Burns, 2004, pp. 3-4; 2011). By looking at the nature of the TQM strategy and the nature of the organisational environment, it is possible to classify the explanation for the high failure rates into four categories.

The first and perhaps most popular explanation of why TQM efforts fail is lack of management commitment (Beer, 2003). The explanation can be articulated through systems theory in economics (Lilienfeld, 1978, chapter 5), and is supported by survey research showing significant correlation between management commitment and implementation success (Hill, 1991; Wright & Taylor, 2003; Soltani et al, 2005). The explanation also tends to be in agreement with how the TQM management consultancy community view the situation (e.g. Beckford, 2002). The assumption underlying the explanation is that the technical issue of how to design quality management systems (QMS) is relatively simple in comparison with the issue of getting sustainable management commitment.

A related but slightly different explanation of why TQM systems and other systems fail comes from the soft systems methodology (SSM) community. Although scholars and practitioners within this community would agree that the technical challenge of TQM design are trivial compared with the social aspects of the problem, their concern is not primarily on management commitment per se but of failure to reach a common understanding of what the
QMS is supposed to do (Checkland, 1981). Unless there is a common understanding among managers and shareholders of what the organisation is trying to achieve by introducing TQM, management commitment means commitment to different understandings which will then predict and explain TQM failure.

A third type of explanation, complementary to the previous one, is the view that TQM failure has less to do with negotiating a common understanding of the problem and more to do with failure to understand the complex system dynamics of how organisations actually work (Senge, 1990). From this perspective of System Dynamics (SD), issues like common understanding and management commitment may be part of reason for failure if the model used to represent the common understanding of the problem is a misrepresentation of the actual system dynamics. The explanation is related to the economic systems explanation in the sense that management commitment is essential for running any kind of systems engineering project, but it differs by having an engineering perspective rather than an economic perspective. Management commitment is important, but it is more important with engineering competence for designing the controls based on an adequate understanding the real system dynamics (cf. Beer, 1972).

A fourth type of explanation, coming from the world of critical systems thinking (CST), is the idea that TQM implementation has to deal with a combination of political and technical issues and implementation failure is due to poor alignment between methods and issues (Flood & Jackson, 1991; Flood, 1993). This perspective was originally developed as an ideological critique of SSM (cf. Jackson, 2003), but can also be seen as a critique of System Dynamics (Flood, 1999). However, it is in comparison with the economic systems theory explanation that the fourth explanation differ the most. Rather than seeing management commitment as fundamental for TQM success, the CST perspective makes the TQM practitioner think of TQM implementation as emancipation of labour from management oppression through guerrilla warfare in technically unpredictable environments. If TQM implementation goes wrong, there are no external excuses. The TQM practitioner has failed due to lack of competence in selection and use of implementation methods.

The classification of systems explanations of why TQM efforts fail is summarised in table 1. Complexity of environment and adaptability in strategy are used as discriminators.

<table>
<thead>
<tr>
<th>TQM strategy</th>
<th>Simple</th>
<th>Complex</th>
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<tr>
<td>Pre-planned</td>
<td>Failure due to lack of management commitment (Beckford, 2002; Beer, 2003)</td>
<td>Failure due to not understanding the complexity of the organisational system and its environment (Senge, 1999)</td>
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<tr>
<td>Adaptive</td>
<td>Failure due to lack of common understanding the problematic situation (Checkland, 2005)</td>
<td>Failure due to poor choice and use of methods for analysis, design and implementation (Flood &amp; Jackson, 1991; Flood, 1993; 1999)</td>
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Table 1. Use of complexity and adaptability to classify between different explanations of TQM failure

In principle, all four groups of explanations may be totally adequate, but they give rise to different types of corrective and preventive actions. Following the logic of Beckford (2002), the right type of preventive action would be to avoid TQM implementation without a high degree or management commitment. In real life, however, it may not be an option for a practitioner to withdraw from a given TQM programme once having committed to it through time, effort and formal agreements. In this case, the important question for the practitioner is whether good implementation methods can compensate for lack of management commitment to implement TQM-based organisational learning.
The object of the research is defined by this tension represented by the diagonal from upper left to lower right in table 1. The economic systems theory explanation of TQM failure by lack of management commitment may be correct, but that does not exclude the possibility for reframing the problem through the use of CST and then explaining TQM failure by not having efficient methodology for dealing with lack of management commitment. This leads to the research question of whether CST-based implementation methods can compensate for lack of management commitment.

The account of the study is reported by having the paper divided into several sections. After explaining the motivational problem in this introductory section, there follows a literature review going into more detail by selectively reviewing literature on the merits of TQM, the role of management commitment in TQM, and how the development of quality management systems (QMS) can be used for implementing TQM. The review results in hypotheses of proposed causal relationships between management commitment, use of CST for QMS implementation and TQM success. This is followed by a section on how an action research design can be used for studying the hypotheses through data collection and methods of data analysis. Then comes a section used for analysing the outcome of the experiment, and is followed by a discussion of findings in the context of related research. The final part of the paper is a conclusion section summarising contributions to research and practice with a short comment on limitations and suggestions for further research.

**Research background and hypotheses**

According to Flood (1993), total quality management (TQM) is an organisational development method based on systems thinking and statistical methods. Some of the so-called gurus of the TQM movement, such as Deming (1994), also emphasised the fundamental importance of systems thinking in TQM. However, the systems perspective was something that evolved over time. The roots of TQM were in the advancements in quality control made by industrial engineering research at the time when modern statistics was being developed (Shewhart, 1931). TQM adopted a total perspective in the fifties under the name of company-wide quality control (QWQC) and total quality control (TQC) (Feigenbaum, 1961; Ishikawa, 1985), until it became a management fad under the name of TQM in the 1980s and 1990s (Cole, 1999).

The reason TQM became fashionable during this period is often told from the perspective of popular books and TV documentaries made at the time when the Japanese were starting to outdo the American automotive and electronics industries. What seemed like a paradox at the time was how the Marshall plan, aiding Japan and other countries after the second world war by financial means and industrial engineering to prevent communism to take foothold, resulted in the Japanese building a growth economy while the Americans were experiencing a period of financial stagnation.

The TQM fad in the 1980s and early 1990s was to a large extent a rediscovery of the basic principles of scientific management from the beginning of the century (Wren, 2005), although now trying to a larger extent to integrate the scientific management approach with the humanistic values and systems perspective of organisational development (Deming, 1986; 1994; French & Bell, 1995, chapter 12). For the purpose of convincing organisations to adopt the TQM paradigm, however, the American consultancy industry ignored this historic perspective, and chose to describe TQM as a new management paradigm fundamentally different from old ways of thinking. This could be contrasted with the evolutionary
perspective used by Japanese scholars and management consultants (Ishikawa, 1985). Shingo (1987), for instance, said that the Japanese miracle started in 1905 with Frederick Taylor’s “Shop Management” (1903) being translated into Japanese, and believed that the impact of a few American statisticians and industrial engineers teaching in Japan for some months after the war was minor event in the overall development of TQM.

In other words, what could be described as a difference between Japanese TQM and American TQM of the period was that the Japanese were thinking of TQM as an evolutionary process applying and adapting industrial engineering to the Japanese culture while the Americans wanted to sell TQM as a revolutionary management philosophy. The Japanese perspective on TQM was long-term with a focus on the whole organisation as an ecological system. The American perspective was short-term with a focus on the organisation as a commodity that could increase in value by use of TQM tools and methods.

There are few doubts about the merits of TQM in Japan and the Far East. The low cost and superior quality of Japanese products produced numerous studies and books about the nature of Japanese quality management and how the West should learn from the Japanese (e.g. Womack, Jones & Roos, 1990; Liker, 2004). Such studies and other experiences have continued in supporting the management consultancy industry with books and methods about TQM implementation, although the programmes have often been reformulated as individual commodities such as ISO 9000 (Seddon, 1997), Balanced Scorecard (Kaplan & Norton, 1990), Business Process Engineering (Hammer & Champy, 1993), Lean Production (Womack, Jones & Roos, 1990), Six Sigma (Harry & Schroeder, 2000) and Lean Six Sigma (George, 2002). Although the individual quality improvement programmes may be slightly different from each other in various ways, from the viewpoint of how organisations are being assessed when competing for the regional TQM awards such as the European Quality Award (EQA), they can all be seen as TQM methods or components of a TQM strategy.

In the case of the EQA, organisations are being assessed and compared by use of the European Foundation for Quality Management (EFQM) excellence model. When assessing an organisation against the EFQM model, questions concerning the merits of TQM are not addressed. The soundness of TQM is taken for granted as TQM is interpreted to represent the state of the art in methods of organisational development and industrial engineering. The matter of concern is to which extent the given organisation has managed to implement useful aspects of the current body of knowledge of TQM. The assessment method consists of looking at nine criteria that are further divided into a large number of sub-criteria. There are five enabler criteria called leadership, strategy, people, resources & partnership and processes, and there are four result criteria called society results, people results, customer results and business results. Each of the nine criteria is measured on a different scale to weight the criteria according to relative importance for reaching optimal TQM results.

Using the EFQM assessment method makes it possible to measure TQM performance $P(t)$ on a scale between 0 and 1000. In order to predict how performance develops over time, Stewart (1996) refers a simple model of learning and continual improvement based on the assumption that performance improvement is proportional to what has not yet been learned, giving rise to the differential equation

\[
\frac{dP(t)}{dt} = k(M - P(t)).
\]
In this equation the constant \( M = 1000 \) represents the maximum level of performance and the constant \( k \) reflects the method and effort being used to achieve learning.

By using \( M_i \) to represent the maximum score for each of the five enabler criteria and four result criteria in the EFQM model and \( P_i \) to represent the performance score for each criterion, the following system of differential equations can be used for describing the dynamics of continual improvement where \( u_i(t) \) is a constant associated with each EFQM module. The stepwise constant function \( u_i(t) \) represents the difficulty of the task and the resources being put into the learning effort.

\[
\frac{dP_i(t)}{dt} = u_i(t)(M_i - P_i(t))
\]

Regardless of how accurately the model captures the dynamics of learning, the model is a useful tool for formulating the TQM implementation problem in the language of control theory. From this viewpoint, the input variable \( u(t) = (u_1(t), u_2(t), \ldots, u_5(t)) \) represents the level of difficulty and use of resources (man-hours) on each of the five enabler criteria of the EFQM model and the output variable \( y(t) = (P_1(t), P_2(t), \ldots, P_9(t)) \) represents the observed performance level for all the nine criteria of the model.

When the control variable \( u_i(t) \) is zero, the equation says there will be no change in performance level \( P_i(t) \). For the time intervals when the control variable \( u_i(t) \) is constant, the solution to the equation is

\[
P_i(t) = M_i - C e^{-kt}
\]

where \( C \) is a constant depending on the initial skill level \( P_i(0) \).

If one were to look at the EFQM model at the sub-criteria level, there is a complex network of assumed causal relationships between the various sub-criteria which then implies a general theory of TQM implementation dynamics. However, for the purpose of investigating the general merits of a CST-based TQM implementation approach it should be sufficient to estimate the growth constant \( k \) in equation 1, representing the quality of the change programme, which can then be used for predicting the time it takes for the learning curve to reach a specific percentage level of excellence.

**Hypothesis 1.** There is a positive correlation between the quality of the change management programme and the success in implementing change.

According to Deming (1986) there were two major reasons why Japan succeeded with TQM after the war while the US failed. The first reason was poor change management programmes based on inadequate understanding of operations research, systems theory and statistical methods. The other reason was lack of top management commitment. Although Deming had spent much time teaching statistical quality control to engineers in America in the 1940s and 1950s, he observed that the teaching had little impact when there was limited management commitment for implementing the methods in a necessary company-wide fashion.
The language of game theory can be useful for reasoning about the management aspect of TQM implementation. In a typical organisational development situation there are at least three groups of players; workers, managers and change agents. A change agent may be a manager or a worker, but as his primary interest is in applying, developing and testing theories about organisational development, he is often a representative of a staff function, a consultancy firm or academia.

A traditional perspective on TQM implementation is the management driven change approach where change agents are trying to transform organisational culture in order to optimise objectives set by management. Working from this perspective, Tapiero (1996) suggests using game theory for understanding the conflict between a supplier wanting to minimise the costs of quality control before delivering and an organisation wanting to minimise the costs of quality auditing the supplier’s quality management systems and the received products. A similar model could be used for describing the game between workers and supervisors (Øgland, 2013). Taking this game theory view it becomes clear that it is rational for suppliers or workers not to commit to excellence unless there is a control regime that makes it necessary. The engineering challenge from a management perspective is to develop a system for controlling the social dynamics, and there is no need to understand more about the social dynamics than what is necessary for obtaining and maintaining control.

An alternative perspective on TQM implementation is to consider the TQM game from the viewpoint of those being subject to control. From this perspective the instrumental rationalism and technology associated with TQM efforts like scientific management is sometimes interpreted as a conflict between capital and labour where labour is being systematically deskillied, alienated and made expendable (Marcuse, 1964; Braverman, 1974). Elster (1982) suggests that the best way of understanding and analysing this conflict is through the means of game theory. Organisational development professionals working with labour unions sometimes use strategies aimed at team development and awareness in order to stimulate conflicts that might contribute to democracy at the workplace (e.g. Greenwood & Levin, 2007). Interventions in such a context are typically focused on creating workshops and environments that allows people to figure out how to solve the problems themselves.

In both the traditional and the alternative perspective the role of management commitment plays an important part. The assumption in the game theory formulation of the traditional perspective is that workers will avoid aligning with the rules of TQM unless there is strong management commitment. The assumption in the game theory formulation of the alternative perspective is that management is committed to deskillling, alienating and exploiting the workers through the means of TQM unless the workers influence TQM design and implementation. Although the two perspectives describe two different understandings of social reality, they both share the belief that employee perception of management commitment has an impact on employee behaviour (Øgland, 2008).

**Hypothesis 2.** There is a positive correlation between perceived management commitment to change and the success in implementing change.

How managerial power is translated and inscribed into the TQM implementation method is another important issue. Some TQM implementation success stories, such as how the Six Sigma programme was used for implementing TQM at General Electric, focus on how a high quality TQM implementation programme was chosen and implemented through use of top
management commitment (Welch, 2003). In some cases, however, this approach has resulted in failure because choosing a good TQM implementation method and getting top management commitment to TQM does not necessarily mean that there is management commitment to the implementation method.

Jacobsson and Brunsson (2000), in their study of the ISO 9001 standard as a mean for implementing TQM, have repeatedly found situations where management can be highly committed to TQM in the sense of having discussions and seminars, giving motivational speeches and writing strategy documents about ISO 9001 and TQM while there is little or no progress in terms of ISO 9001 compliance on the factory floor. An additional problem is that implementing TQM sometimes means a shift in managerial ways of thinking. In cases when management is committed to TQM without making such a change even the best methods may be implemented in a manner that not only cement inefficient ways of working but also contributes in making the situation worse (Seddon, 1997).

When thinking about the purpose of TQM being to create and sustain an organisational culture that complies with the ideas, values and practice that gives the highest possible score on the EFQM assessment scale, one is free to choose the method of transforming the current culture into a TQM culture. It is not important whether the organisation is implementing TQM through a Six Sigma programme, through an ISO 9001 compliant quality management systems, or whether the implementation approach has no relation to any such formal programmes. What matters is that the organisation is becoming a learning organisation in the sense of developing dynamics that give an approximate match with equation 1 when measuring performance through the use of the EFQM model.

The benefit of TQM implementation methods making use of ISO 9001 or other well-defined programmes, standards and implementation methods is that it becomes possible to discuss TQM implementation by participating in practitioner communities or scholarly communities dedicated to such programmes, standards and methods. Regardless of whether one sees the TQM implementation from a management position, a worker position or an independent position, by focusing on specific methods for TQM implementation the debate can be more concerned with issues like what to do if there is uncommitted management, unmotivated employees and incompetent personnel running the TQM implementation programme.

Some TQM implementation methods based on critical systems thinking (CST) are designed specifically for the purpose of mixing tactics depending on socio-technical context (Jackson & Flood, 1991; Flood, 1993). Although this would include using tactics based on management alignment if that is the most efficient approach for implementing TQM in a given setting, the critical aspect of the approach refers to the political aim of using TQM as a means for improving social conditions along with business performance. Nevertheless, while there are systems scholars who have committed to such ideals, not much has been written about workforces being emancipated as a result of CST-driven TQM.

On the other hand, within the Scandinavian tradition of information systems research it has been shown that it is possible to develop information systems while at the same time making sure that the new technology has positive social consequences for the organisation as a whole (Nygaard, 1996). The Bootstrap Algorithm (table 2) is a systems development framework that has emerged out of the past twenty years of Scandinavian research on how to implement information systems in socio-technically unpredictable environments. It is an approach with a strong political focus in the sense that it looks at the network of existing users and systems
and tries to strengthen and expand that network through technical and political means without making explicit comments about issues like management commitment.

<table>
<thead>
<tr>
<th>Start with</th>
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<tbody>
<tr>
<td>simple, cheap, flexible solution</td>
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<tr>
<td>small network of users that may benefit significantly from improved communication with each other only</td>
</tr>
<tr>
<td>simple practices</td>
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<tr>
<td>non-critical practices</td>
</tr>
<tr>
<td>motivated users</td>
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<tr>
<td>knowledgeable users</td>
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1. Repeat as long as possible: Enrol more users
2. Find and implement more innovative use; go to 1
3. Use solution in more critical cases; go to 1
4. Use solution in more complex cases; go to 1
5. Improve the solution so new tasks can be supported; go to 1

Table 2. Bootstrap algorithm for information infrastructure development (Hanseth & Aanestad, 2003)

Similar to how Senge (1990) sees personal mastery as one of the five disciplines necessary for developing organisational learning, the Bootstrap Algorithm starts with a (small) group of motivated and knowledgeable users and continues to enrol users through the process of improving and expanding the solution until the algorithm terminates. Particularly motivated and knowledgeable users who become important for other users are sometimes referred to as super users (Kaasbøll, 2013).

This way of formulating a theory of organisational learning based on bootstrapping and super users can be seen as consistent with perspectives on how to apply critical systems thinking within the context of organisational learning (Flood, 1999). The common denominator is the use of complex adaptive systems (CAS) framework as a means for dealing with complexity when trying to use the Bootstrap Algorithm as a framework for articulating a specific control algorithm for the system dynamics in the equations 2 and 3.

The control algorithm is defined by comparing each of the components of the response variable $y(t)$ with the corresponding maximum value from the EFQM model and then distribute the available resources by assigning the components in $u(t)$ either the value of zero or a positive constant. If $u_i(t)$ is zero then the learning rate for the skills $P_i(t)$ is also zero, as can be seen from the differential equation. The higher the value of the constant $u_i(t)$, the quicker the skill will be learned relative to how proficient the practitioner already is.

The control strategy can be thought of as a portfolio management method in the sense that resources are continually being reallocated among the five enabler criteria depending on what is needed for increasing the total return of investment as measured by result criteria of the EFQM model (Øgland, 2008; 2009b; 2013). As the constants $k_i$ are not known a priori, regression analysis may be used for estimating the constants and thus make predictions of how difficult the learning of the basic skills associated with the enabler criterion is.

In the same way as management commitment was seen as important for TQM implementation success when looking at the TQM implementation game from the viewpoints of different players, the political power found through fragments of management commitment is used in the bootstrapping process for cultivating super users to gradually take over the whole system in a process of collective emancipation (Øgland, 2009a).
Hypothesis 3. There is a positive correlation between management commitment to change and the quality of the change management programme.

A final concern that needs to be taken into consideration is organisational culture. For instance, the New Public Management (NPM) idea is based on the assumption that the public sector can be made more effective and efficient by applying methods of management and organisational logic used in private sector organisations. Although this can to a certain extent be confirmed by the success of applying TQM models like the EFQM model in organisations like the British Inland Revenue and the Danish Tax Administration (Cristian & Costels, 2011), there are also failed experiments in NPM implementation and theoretical arguments questioning the validity of the basic assumptions that NPM rest upon (Chang, 2008).

In the case of using the Bootstrap Algorithm for implementing health information systems by focusing on super users, the issue of culture and environment has been identified as something that needs to be looked more deeply into (Manda & Sanner, 2012).

Hypothesis 4. The correlation between the quality of the change management programme and the success in implementing change depends on the environment in which the programme is executed.

Research methodology
TQM is often implemented and maintained through Plan-Do-Check-Act (PDCA) cycles used for diagnosing the situation and planning interventions (“plan”), implementing interventions (“do”), evaluation (“check”) and making decisions based on the results (“act”) (Deming, 1986; Flood, 1993, p. 13). According to Checkland and Holwell (1998), the development or improvement of a theoretical framework and methodology for organisational change can be characterised as action research as long as the epistemology in terms of framework of ideas, methodology and area of application is declared prior to experiment. In other words, the PDCA-cycle can be interpreted as an action research method as long as the CST framework and the bootstrap methodology are declared before evaluating the results of the interventions.

Sample and procedure
The population for this study consists of the kind of organisations that the IT-function of the Norwegian Tax Administration (NTAX) can be seen to represent. In broad terms this means organisations made up of software engineers and technical personnel working within a professional public sector bureaucracy and following the general rules and regulations of that bureaucracy. Examples of such organisations could be the IT-function of an educational bureaucracy, a healthcare bureaucracy or a government bureaucracy.

Over a period of 20 years, three public sector organisational settings have been investigated. Between the years from 1992 to 1998, the CST framework and bootstrap methodology was used for investigating TQM implementation at the Climate Department of the Norwegian Meteorological Institute (DNMI). Between the years 1999 and 2005, the framework and methodology was used for investigating TQM implementation within the IT-department of NTAX from the viewpoint of the quality management function within the department. From 2006 to 2011, the framework and methodology was used for investigating TQM implementation within the IT-department of NTAX from the viewpoint of a quality audit function outside of the IT-department.
The procedure used for collecting data has consisted of using the EFQM assessment model (figure 1) both for assessing the organisation as a whole and for assessing the implementation team as a separate organisation. In order to assess the level of management commitment to TQM for the organisation as a whole, the assessment of the enabler component called “leadership” in the total organisational assessment is compared to the total assessment score. The reason for making use of the leadership component both as predictor variable $X$ and part of the response variable $Y$ is because this is useful when investigating the mediator variable $Z$ representing the quality of the TQM intervention by using the EFQM model for assessing the implementation team. Although there will be an implicit positive correlation between $X$ and $Y$ due to how the procedure is defined, this should be of minor importance as it only contributes in making the overall hypothesis slightly more difficult to prove.

![EFQM excellence model (Oakland, 1999)](image)

The purpose of the implementation team is to assist the organisation in increasing the EFQM score. There is a link between the two assessments in the sense that the results from the EFQM assessment of the improvement team relates to all the nine components in the EFQM assessment of the organisation as a whole. From the reverse perspective there may be a few components in the EFQM components from the assessment of the organisation as a whole that relate to the process of how the improvement team is working and what they are getting done in the case when the improvement team is a part of the organisation. In this study there was such a link between 1992 and 2005, but no such link when improvement team was external to the organisation between 2006 and 2011. In general, however, it is expected that the way the two assessment models interlink becomes less important as the organisation increase in size.

As explained by Oakland (1999), there are different ways of using the EFQM model for making assessments. The most advanced use and most reliable results are given when the model is being used by organisations competing for the European Quality Award (EQA). In such cases the organisation first has to prepare a report to the European Foundation for Quality Management (EFQM). This report will then be used for finding out whether the organisation is expected to have reached a sufficiently high level of TQM to be visited by EFQM assessors to carry out a lengthy investigations based on interviews, observations, and document study. On the other end of the scale there are simple EFQM questionnaires that can be used by internal organisational teams for getting simple but less reliable assessment scores.
In this study the EFQM model was used between 2001 and 2004 as an operational tool for assessing the IT function as a whole and for assessing the quality function as a part of the IT function. During the earlier and later periods of research other models were used. EFQM data for 2000 was constructed from earlier data and used as an initial baseline. For this reason there are only five years of EFQM measurements that can be used for testing the relationship between management commitment, quality of improvement programme and TQM implementation results. Data from the rest of the study, covering the TQM implementation at DNMI and the TQM implementation at NTAX from a quality audit perspective, will be used for comparing how the correlation between quality of implementation method and implementation results vary in different organisational settings. More details about the nature of the data and how the comparison was done will be given as part of the commentary in the section dealing with analysis of results.

**Measures (data collection)**

As pointed out above, the study focuses on the relationship between the three variables of management commitment to change (\(X\)), implementation success (\(Y\)) and quality of implementation approach (\(Z\)). The variable \(X\) is represented by the box in the EFQM model called “leadership” when using the model to assess the organisation as a whole. According to the model in figure 1 this means that the range of the variable \(X\) is between 0 and 100 (10.0%). The variable \(Y\) represents the sum of all the nine boxes in this same context of assessing the organisation as a whole, providing a score range between 0 and 1000 (100.0%). The variable \(Z\) represents the sum of all the nine boxes when the EFQM model is being used for assessing the quality function as an independent part of the organisation as a whole, which results in the same score range between 0 and 1000.

The annual EFQM assessments of the organisation as a whole were based on mixing document reviews and quality audits in order to investigate particular issues that could have some relevance to one or more of the factors included in the EFQM assessment programme. Individual audits would typically be ISO 9001 audits, CobiT audits or specific audits and checks having to do with the quality standards and procedures used by NTAX. Each of these audits and controls produced numerical outputs in different ways, like compliance scores between 0 and 100% and maturity scores between 1 and 5, but by mixing them together in different ways and using them as input for the calculations used as part of the EFQM assessment method, the scores for \(X\), \(Y\) and \(Z\) were updated on a monthly basis. In some cases default values or educated guesses were used as a basis for doing the calculations to produce EFQM results for particular criteria or sub-criteria when no audits, controls or document reviews had been done.

The EFQM model as a whole was never used for defining audits or defining areas to improve. It was used as an umbrella for getting a total score from the various types of investigations and improvement projects being implemented. The use of the EFQM model also changed over time due to increased understanding and experience in how it should be used. As a consequence of this, the changes in EFQM score could partly be a result of organisational improvement and partly as a consequence of the measuring system being calibrated to get more accurate results. The only attempt to filter data before performing tests and conducting statistical analysis was in the case of the variable \(Z\). Further comments on why and how this was done will follow as part of the analysis or the results.
**Model and analysis (data analysis)**

The model in figure 2 gives a visual representation of the assumed structural relationship between management commitment, quality of change programme (change agency) and implementation success in different organisational environments.

![Figure 2. Model of causal relationships in the organisational change process](image)

The arrow in the upper right corner of the model suggests that implementation success ($Y$) can be explained by management commitment ($X$). As the strength of the relationship should depend on the quality of the change programme, the arrow in the upper left corner and the arrow in the middle visualise how the quality of the change programme ($Z$) could be seen as a mediator variable. In the context of this model, the hypotheses presented earlier can now be formulated as testable hypotheses.

**H1:** There is a positive correlation between the quality of the change management programme and the success in implementing change.

**H2:** There is a positive correlation between management commitment to change and the success in implementing change.

**H3:** There is a positive correlation between management commitment to change and the quality of the change management programme.

The lower part of the model is used for testing the validity of the upper part of the model when looking at different organisational environments. If management is highly committed to TQM one might speculate that the TQM implementation program in itself is of less importance because the organisation as a whole is working towards the goal of TQM. On the other hand, if there is very little management commitment the TQM implementation programme becomes extremely important as it has to compensate for socio-technical unpredictability.

**H4:** The correlation between the quality of the change management programme and the success in implementing change depends on the environment in which the programme is executed.

The hypothesised relationships in the model will be concentrated on annual averages and measurements from the EFQM assessments analysed by linear regression analysis at the 0.05 and 0.01 levels of significance (Rowntree, 1981). Due to the small set and low quality of the quantitative data, the analysis will also be supported by commenting and reflecting on related qualitative data.
Analysis of results

The way EFQM assessments were introduced at NTAX started in July 2001 by trying to compare documents and practice according to the categories in the Common Assessment Framework (CAF) model. Preliminary results were published in monthly status reports in August and September while the total assessment was published as an individual CAF evaluation report by the end of September. From then on the assessment results were adjusted as a consequence of audits and controls using different standards such as ISO 9001, ISO 15504, CobiT and the QMS controls and NTAX checklists. The results are shown in table 3.

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Leadership</th>
<th>Policy &amp; strategy</th>
<th>People</th>
<th>Partnerships &amp; resources</th>
<th>Processes</th>
<th>Customer results</th>
<th>People results</th>
<th>Society results</th>
<th>Key performance results</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
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<td>10</td>
<td>44</td>
<td>9</td>
<td>9</td>
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<td>40</td>
<td>9</td>
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<tr>
<td>Nov</td>
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<td>24</td>
<td>20</td>
<td>20</td>
<td>35</td>
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<td>47</td>
<td>20</td>
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<tr>
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<td>15.2</td>
<td>15.6</td>
<td>58.4</td>
<td>39.0</td>
<td>15.6</td>
<td>9.6</td>
<td>49.0</td>
<td>247.8</td>
</tr>
</tbody>
</table>

Table 3. EFQM evaluation of the organisation 2001

As can be seen from the table, there is much variation in the data during the two first months until the CAF report was published. The recorded variation is a result of trying to figure out where the baseline for the study is, using guesswork to fill in parts of the CAF/EFQM model before data from audits, checks and document reviews were available. The publication of the CAF report by the end of September resulted in an adjustment of the model results for October that hardly changed as further data collection and analysis continued and resulted in monthly updates of the tables until the end of the year.

Table 4 shows how monthly updates and adjustments were continued for the whole of 2002. While most months resulted in only small adjustments, a critical review of the whole process in April and May resulted in the publication of a new individual EFQM evaluation report and a change of assessment results across most of the model domains. The effect of this review can be observed by comparing the data from the rows representing the month of April and the month of May. While the society results remains on the same level, as society results had not been systematically addressed through the use of audits and document reviews, the outcome associated with all the other criteria are reduced as the review came to the conclusion that previous assessments had been too optimistic. As is reflected in the August row, however, later investigations resulted in adjustments in the opposite direction, and for the rest of the year they keep on fluctuating primarily as a result of investigations (improved understanding) and data calibration rather than as a direct consequence of how the TQM implementation was progressing.

In November 2002 the assessment methodology was changed in terms of reporting results with one decimal precision. The reason for doing this was not because the EFQM assessments had become more precise but because monthly changes were often so small that they were only measurable by using this more refined type of scale. This is particularly noticeable in the columns of table 4 representing people results and society results. In the case of other columns, however, there could be large variations in both directions both as a consequence of particular improvements and improved knowledge of the actual performance
level. On the whole, however, experience with the EFQM model and improved understanding of how the organisation was performing suggested that the quality of the assessment data were starting to improve.

<table>
<thead>
<tr>
<th>Organisation 2002</th>
<th>Leadership</th>
<th>Policy &amp; strategy</th>
<th>People</th>
<th>Partnerships &amp; resources</th>
<th>Processes</th>
<th>Customer results</th>
<th>People results</th>
<th>Society results</th>
<th>Key performance results</th>
<th>Total</th>
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<tr>
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</tbody>
</table>

Table 4. EFQM evaluation of the organisation 2002

The results for 2003, shown in table 5, are indeed more stable in the sense fluctuating less from month to month. This would indicate that the EFQM was becoming a better instrument for measuring the consequence of the TQM implementation programme, but it was still far from perfect. This can be illustrated by looking at the July results where people results and key performance results were misrepresented as an unfortunate consequence of an ongoing investigation that resulted in the more robust adjustments presented in the August row.

<table>
<thead>
<tr>
<th>Organisation 2003</th>
<th>Leadership</th>
<th>Policy &amp; strategy</th>
<th>People</th>
<th>Partnerships &amp; resources</th>
<th>Processes</th>
<th>Customer results</th>
<th>People results</th>
<th>Society results</th>
<th>Key performance results</th>
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</tr>
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<td>29.7</td>
<td>14.8</td>
<td>50.4</td>
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</tr>
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<td>60.0</td>
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<td>31.3</td>
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<tr>
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<td>14.7</td>
<td>53.8</td>
<td>390.5</td>
</tr>
</tbody>
</table>

Table 5. EFQM evaluation of the organisation 2003

The final update of the EFQM score was published in October 2004, as can be seen from the 2004 month by month overview in table 6. By this time the assessment methodology had become more mature, but it had still not reached the level of maturity needed for producing
reliable results. The anomalies shown in the rows for April and May were caused by attempts to improve and simplify the use of the EFQM model, but the attempt was not successful. After this attempt was abandoned, the results from the final months of the study can be seen to be consistent with the trend generated from the EFQM results recorded during the first three months of the year.

Table 6. EFQM evaluation of the organisation 2004

<table>
<thead>
<tr>
<th>Organisation 2004</th>
<th>Leadership</th>
<th>Policy &amp; strategy</th>
<th>People</th>
<th>Partnerships &amp; resources</th>
<th>Processes</th>
<th>Customer results</th>
<th>People results</th>
<th>Society results</th>
<th>Key performance results</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>37.5</td>
<td>33.8</td>
<td>31.3</td>
<td>25.3</td>
<td>47.5</td>
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<td>67.5</td>
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</tr>
<tr>
<td>Mar</td>
<td>37.5</td>
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<td>31.3</td>
<td>25.3</td>
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<td>14.6</td>
<td>67.5</td>
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</tr>
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<tr>
<td>Avg.</td>
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<td>45.7</td>
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<td>36.6</td>
<td>16.5</td>
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<td>422.3</td>
</tr>
</tbody>
</table>

During the final three months of the study there is no recorded change in the evaluation of the EFQM criteria. The reason for this was because the second cycle of the action research had reached a stage where it had to be terminated. Although these final assessment results were published as part of the study, they were simply repeating the results from the previous month without making any active investigations to find out whether the status had actually changed.

Table 7 gives an overview of the annual averages from the bottom row of the tables 3 to 6.

Table 7. EFQM evaluation of the organisation

<table>
<thead>
<tr>
<th>organisation</th>
<th>Leadership</th>
<th>Policy &amp; strategy</th>
<th>People</th>
<th>Partnerships &amp; resources</th>
<th>Processes</th>
<th>Customer results</th>
<th>People results</th>
<th>Society results</th>
<th>Key performance results</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>25.9</td>
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<td>36.6</td>
<td>16.5</td>
<td>63.0</td>
<td>422.3</td>
</tr>
</tbody>
</table>

Despite the fact that the EFQM evaluation of the IT function was done in an imprecise manner, which can be seen in table 7 by the way data results for a criteria like customer results makes a large improvement leap from 2002 to 2003 and how the evaluation of processes give the impression of oscillating results, the data sequences representing leadership and the total are both seen to be increasing in a strict manner.

By use of mathematical transformations and exponential regression on the data from the first column in the table above to make it fit with the equations 2 to 4, the learning curve for developing leadership can be modelled as
This particular model would suggest a period of about 25 years for developing a 90% level of leadership excellence in this particular context. Using the same method for modelling the learning curve for the total EFQM score to match the logic of equation 1, results in the formula

\[ P(t) = 100 - 93.753e^{-0.09t}. \]

In comparison with the estimated period of 25 years for developing a 90% level of leadership excellence, this formula suggests a period of about 22 years for developing a 90% level of total organisational excellence.

In parallel with these results and how the EFQM model was used for assessing the organisation as a whole, similar data collection and analysis was applied on the change agents (quality function) in terms of annual EFQM self-assessments. An overview of the results is given in table 8.

<table>
<thead>
<tr>
<th>Change programme</th>
<th>Leadership</th>
<th>Policy &amp; strategy</th>
<th>People</th>
<th>Partnerships &amp; resources</th>
<th>Processes</th>
<th>Customer results</th>
<th>People results</th>
<th>Society results</th>
<th>Key performance results</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>20,0</td>
<td>16,0</td>
<td>18,0</td>
<td>18,0</td>
<td>28,0</td>
<td>40,0</td>
<td>18,0</td>
<td>12,0</td>
<td>30,0</td>
<td>200,0</td>
</tr>
<tr>
<td>2001</td>
<td>45,6</td>
<td>36,4</td>
<td>41,0</td>
<td>41,0</td>
<td>63,8</td>
<td>91,2</td>
<td>41,0</td>
<td>27,4</td>
<td>68,4</td>
<td>456,0</td>
</tr>
<tr>
<td>2002</td>
<td>40,0</td>
<td>36,0</td>
<td>40,5</td>
<td>38,3</td>
<td>44,8</td>
<td>53,2</td>
<td>36,0</td>
<td>18,0</td>
<td>50,1</td>
<td>356,0</td>
</tr>
<tr>
<td>2003</td>
<td>15,0</td>
<td>32,0</td>
<td>12,0</td>
<td>32,4</td>
<td>35,5</td>
<td>20,0</td>
<td>9,0</td>
<td>6,0</td>
<td>15,0</td>
<td>176,9</td>
</tr>
<tr>
<td>2004</td>
<td>19,1</td>
<td>22,4</td>
<td>21,6</td>
<td>25,2</td>
<td>44,5</td>
<td>47,0</td>
<td>19,2</td>
<td>6,0</td>
<td>29,4</td>
<td>234,4</td>
</tr>
</tbody>
</table>

Table 8. EFQM evaluation of the TQM implementation approach

When looking at the results in table 8 one might get the impression that the quality of the TQM implementation approach started out well and then got worse as the total EFQM outcome is continually dropping for the years 2001 to 2003 before making a small leap upwards in 2004. However, similar to the use of the EFQM model for the organisation as a whole, there was a problem with ongoing calibration of data in the process of finding the proper baseline for measuring continual improvement. In 2003 a proper baseline had still not been found, but the use of the EFQM method by this time had matured to the level where most of the changes in individual EFQM criteria between 2003 and 2004 were caused by change of practice rather than change of measurement methods.

By using the columns marked leadership and total in table 7 to represent management commitment \((X)\) and implementation success \((Y)\), and using the total column in table 8 to represent quality of implementation approach \((Z)\), linear regression can be used for testing the claims of the first three of the four hypotheses listed in the methodology section. However, as the proper baseline for the data in table 8 was the year 2003 rather than 2001, the value of 200 is subtracted from the total for the three first columns in the table in order to avoid lack of correlation being caused by measurement method rather than actual performance.

The theoretical prediction is that there should be a strong positive correlation between \(X\) and \(Y\), a strong positive correlation between \(Z\) and \(Y\) and a possibly less strong positive correlation...
between $X$ and $Z$ as this would support the claim that lack of management commitment could be compensated with a high quality implementation approach. Figure 3 gives an overview of the outcome from the viewpoint of the research model.

![Figure 3. Model of causal relationships in the organisational change process](image)

The standard error $SE_r$ for the correlation between $X$ and $Y$ is 0.0327. This means that the null hypothesis of no correlation can be rejected at the .05 and .01 level. In the case of the correlation between $Z$ and $Y$, the standard error $SE_r$ is 0.2234, meaning that the null hypothesis can also in this case be rejected at both the .05 level and the .01 level. In the case of the correlation between $X$ and $Z$, however, the correlation $r$ is 0.5962 and the standard error $SE_r$ is 0.2882, meaning that the null hypothesis can be rejected at the .05 level but not on the .01 level.

Despite having few data of questionable quality, the data are nevertheless consistent with the idea that the strong correlation between management commitment to change and implementation success can be explained by the quality of the change programme in terms of its ability to translate power from management into the programme and the ability of the programme to execute. The model is confirmed on a .05 level of significance, but on a .01 level there is not sufficient statistical evidence to reject the idea that there might be no relationship between the management commitment to TQM and the change programme’s ability to empower the super users.

The next concern was to investigate the role of the organisational environment ($W$) as a moderator variable for understanding how the relationship between the CST-based TQM approach ($Z$) and the level of TQM success ($Y$). During the 20 years of action research on how to implement TQM through the use of a CST-based TQM implementation method known as the bootstrap algorithm, the study covered three cycles of research spanning three different organisational settings. What has been described so far is the use of EFQM during the second cycle. As the EFQM method was not used during the first and third cycle, there is no way of making a precise comparison between the three organisational environments.

What has been done in figure 4, however, is to compare the relationship between the implementation method and implementation results through the use of indicators related to implementation method and implementation results. In the case of DNMI between 1992 and 1999 the indicator for implementation method was the development of technical documentation and the output was the volume of published climate research. In the case of the alternative approach at NTAX between 2006 and 2011 the indicator for implementation was the ISO 9004 maturity level on a scale between 0 and 5 for the audit quality management system and the indicator for implementation was the predicted year of zero defects for the unit being audited. The outcome is shown in figure 4.
Although different methods were used for measuring the quality of the change programme and implementation success in these two other environments, the change programme was the same. In both cases the squared correlation coefficient is larger than it was in the first case. In the case of DNMI this fits with the fact that DNMI was a politically less complex organisation than NTAX, causing fewer headaches in implementing change. At DNMI it was easy to identify super users when the quality management system for the climate data in question was designed, developed and operated by research scientists in collaboration with executive assistants. These kinds of QMS super users were knowledgeable and motivated as their research depended on having efficient quality control routines.

At NTAX1 the QMS super users were often formally assigned, but sometimes lacking in knowledge and motivation. As a consequence of this, the running of the bootstrap algorithm depended on identifying informal super users who took special interest in issues like the development of software standards and quality control procedures. Although this required some trial and error in order to identify the right person, it became gradually possible to cultivate a network of QMS super users that became part of the QMS information infrastructure of the organisation.

In the case of NTAX2 the measurements were designed in a different manner from the other two cases and the strong linear relationship should be interpreted as the greater effort in trying to raise the quality of the change programme the greater resistance there is in the organisation in terms of the “year of zero defects” sliding further and further away. This fits with the fact
that the method in use was designed for cases like DNMI and NTAX1 that were characterised by handling a population of socially and technically complex problem situations, but was not appropriate for cases like NTAX2 that consisted of handling a single problem situation.

In the NTAX2 situation, the focus was on a particular QMS dealing with COBOL software development. As this particular system had been a great success when working with the NTAX1 organisation as a whole, partly due to the COBOL software QMS super user, it made sense to focus specifically on this system at a time when it was necessary to focus the study on a smaller part of the network. Unfortunately, the QMS super user retired shortly after this happened and was replaced with a super user who was only formally committed to running the QMS. There were also other organisational changes and events that worked against an effective operation of the QMS, but the lack of having super users to cultivate a network of practice was the main problem.

**Discussion**

The study can be seen to consist of two parts. First the relationship between the variables $X$, $Y$ and $Z$ on the upper part of the model in figure 2 were investigated by using data from the action research covering the years 2000 to 2004. Then the impact of the moderator variable $W$ on the relationship between $Z$ and $X$, represented by the bottom part of the model in figure 2, was analysed by looking at differences between the three cycles of action research covering the whole period between 1992 and 2011.

The observed correlation between management commitment ($X$) and implementation success ($Y$) fits with Beckford’s (2002, p. 311) comment that “management commitment is the single most critical issue in the pursuit of quality. Without it, the programme will fail – as so many do. Each of the writers mentioned in this book mentions the need for commitment – normally listing it as the first step in the programme”. Deming, for instance, who is often described as the main guru of the TQM movement decided in his latter years as a consultant never to give organisational presentations without top management being present. One of his assistants told a story (Gitlow, 1993, p. 80) about how they were consulting at one of America’s largest firms with Deming on his eighty-first birthday. The top management of the company had arranged a birthday party, complete with a huge cake, in his honour. Deming opened the session by saying, “Do you know what is wrong with your company?” The room was silent – one could hear a pin drop. Deming pointed to the president and chief executive officer and said, “Him. He is what’s wrong with your company.”

Although Deming may have been right in his finger pointing, pointing fingers may not always be the most effective way of solving problems. According to Brunsson and Jacobsson (2000), there are complex reasons why organisations talk TQM without doing the walk. Although the study showed a strong correlation between management commitment $X$ and implementation success $Y$ at NTAX, the observed levels of management commitment and implementation success were both quite modest. If one had spent time trying to gain management commitment rather than implementing the quality management infrastructure, perhaps nothing would happen at all, as Brunsson and Jacobsson would predict. On the other hand, following the ideas of Flood and Jackson (1991) on how to apply CST for implementing TQM, the NTAX approach was a multi-methodological approach that made use of political and technical strategies depending on the continually changing nature of the problem situation, and thus predicting implementation success.
The main point of the research, however, was to investigate whether a good methodology could be used for compensating lack of management commitment. The bootstrap algorithm was suggested as a possibly good methodology for implementing TQM in cases where there was limited management commitment. It was then suggested that the bootstrap algorithm could be used as a mediator variable \( (Z) \) for explaining what seemed to be implementation success \( (Y) \) through management commitment \( (X) \).

In the study, the correlation between quality of method \( (Z) \) and implementation result \( (Y) \) was both stronger and more significant than the correlation between management commitment \( (X) \) and quality of method \( (Z) \). The strong positive correlation between good methods and good results confirms what has been suggested through other studies on how the CST-approach for implementing TQM is an effective approach (Flood, 1993). This should hardly come as a surprise as the multi-methodological aspect of the CST-driven TQM approach simply consists of addressing the complete body of knowledge of TQM and systems development through a structured approach. The total systems intervention (TSI) multi-methodology used for this purpose is formulated on such an abstract level that TQM failure would be attributed to the potential practitioner’s lack of competence in the various methods and techniques rather than anything having to do with the TSI approach itself.

The positive correlation between management commitment \( (X) \) and quality of method \( (Z) \) fits with the assumptions of how the bootstrap algorithm can be used for developing organisational learning by focusing on what Senge (1990) calls personal mastery or more specifically what Kaasbøll (2013) refers to as the super users of the information infrastructure. According to the logic of this algorithm, it does not matter whether super users are being formally appointed by management or whether they become information super users in the sense that they are the users that other users keep asking when they need help or assistance. What matters is the ability of the algorithm to cultivate personal mastery among the formal and informal super users and keep them motivated and knowledgeable as they develop their level of expertise. According to this theory of organisational development, the learning organisation will bootstrap itself through a process of becoming more professional. As the power structure of the professional bureaucracy is different from the power structure of a machine bureaucracy like the IT function of NTAX (Mintzberg, 1983; Statskonsult, 2002), part of the learning process becomes a process of emancipation in the sense that the super users increase their power while the traditional management decrease their power and may end up as an administrative support function in the professional bureaucracy.

In sum, what the first part of the study suggests is that a strong correlation between management commitment to TQM and TQM implementation success can sometimes be explained as a spurious relationship. In the NTAX case the statistics show a strong relationship between management commitment and implementation success, despite the fact that there was minimal management commitment to TQM. This paradox can be explained by considering how the bootstrap algorithm was used for identifying and cultivating super users who would develop standards and improve processes in their own self-interest as a part of their own journey towards personal excellence and professionalism.

The second part of the study looked at the same TQM implementation method as it was used in three different setting. In the first case it was used for developing TQM in an organisational environment made up of scientists and engineers. In this environment the method was a success, as illustrated by the high correlation between implementation method and implementation success, and could be explained by the fact that all the people involved
were self-driven professionals. In the second case the TQM method was used in a more political environment, and although it was designed in a slightly more sophisticated manner, the resulting correlation between implementation method and implementation success was smaller. The explanation for success in this environment was that the bootstrap algorithm was useful for identifying and cultivating individuals who had been formally appointed as super users or those who had become informal super users by their own initiative.

In the final case, where the TQM method was applied on a single process in the same political environment, there was a negative correlation between TQM method and TQM success. In this final cycle the action research was designed through contractual agreements but there was little management commitment and there were few informal super users that were sufficiently motivated and knowledgeable to use the quality management system by their own initiative. As these contractual agreements were based on the New Public Management (NPM) idea of partially outsourcing the IT department from NTAX through the belief that this would result in cost effectiveness and improved control, the fact that the TQM implementation became increasingly more difficult could be seen as consistent with research suggesting that NPM sometimes results in reduced cost effectiveness and less efficient control (Chang, 2008).

From the viewpoint of Jackson (2003) the complex adaptive systems (CAS) perspective used for formulating the bootstrap algorithm is not a critical perspective in itself. There is nothing inherently political about the use of methods from complexity theory as can be illustrated by how genetic algorithms are used for solving game theory problems by trial and error (selection and mutation) rather than trying to understand the nature of the conflicts between the players (Axelrod, 1984). As Jackson sees it, proper use of the various methods in a multi-methodological approach depends on applying the world perspectives represented by the sociological paradigms that give meaning to the individual methodologies being put into use. While Flood and Jackson (1991) developed a method (total systems intervention, TSI) for guiding the practitioner through sequences of system methods based on different sociological paradigms, in this study the bootstrap algorithm was used in a similar way.

The initial step of the bootstrap algorithm depends on soft systems thinking in order to understand the problem situation by giving meaning to the five bullet points of the starting conditions of the algorithm. Previous research has indicated that the outcome of this phase becomes more useful when not only developing SSM-like diagrams but formulating the system model and action strategy in the context of a formal game (Bennett et al, 2001; Øgland, 2009c). As the bootstrap algorithm moves into its main loop, the viewpoint changes into hard systems thinking, dynamic systems thinking, cybernetics and complex adaptive systems thinking. Previous research has looked into different ways of applying mathematical and semi-mathematical system theory for solving the game problem as it unfolds in the main loop (Øgland, 2008; 2009a, 2009b; 2013). When the algorithm terminates, the outcome of the process is investigated from the viewpoint of emancipatory systems thinking or postmodern systems thinking. In order to make the outcome relevant for planning new interventions in same or different organisational contexts, it is practical to use game theory for making the analysis precise when applying either of these two paradigms (Elster, 1982; Øgland, 2009d).

When comparing the use of the bootstrap algorithm as a CST approach for implementing TQM with Flood’s (1993) example of how TSI can be used for implementing TQM, intellectual reasons for why TSI should lead to TQM implementation success carry over to the bootstrap algorithm approach as they are in certain respects identical CST-driven multi-methodologies used for navigating different types of systems methodologies for handling the
The total lifecycle of systems development. Although the bootstrap algorithm has been developed within a context of Scandinavian CST while TSI was developed in the context of British CST, both meta-methodologies have been discussed, tested and used internationally, and they are both based on the same sociological traditions with a similar technical background in operations research and information systems (cybernetics). The two meta-methodologies are not identical, however. In the context of information systems theory one would say that TSI is a programme management method while the bootstrap algorithm is a portfolio management method (Øgland, 2013). What this means is that TSI is used for managing a programme made up of different types of related systems projects while the bootstrap algorithm is used for managing the total portfolio of programmes and projects.

Conclusions
The conclusion section starts by discussing the implications of the study for research and practice. It then indicates some limitations due to the nature of the sample studied and directions for future research.

Implications for theory and practice
The investigation has produced empirical evidence in support of the view that good methods can compensate for lack of management commitment to implement TQM-based organisational learning. Prior research has confirmed the merits of critical systems thinking (CST) for implementing TQM, but has made little attempt to address the question of what to do when there is inadequate management commitment.

As mentioned in the introduction, Flood and Jackson (1991) introduced the idea of how TQM could be implemented through CST by using the methodology of total systems interventions (TSI). This approach covers a wide range of systems methodologies for framing the problem, designing the solution and evaluating the results, assuming this can be done through the perspective of critical theory inspired by thinkers like Foucault and Habermas. However, when Flood (1993) wrote a monograph on how to use CST for implementing TQM, the basis for the implementation method was a top-down approach that assumed sustainable management commitment. Considering the CST ideals of worker emancipation from management oppression, one might wonder how efficient a management driven top-down TQM approach with such goals would be. None of the four CST-based case studies of TQM implementation that Flood refers in the book reflect on the political impact of the TQM effort.

Although the CST-driven TQM implementation in this research builds upon the work of Flood, Jackson and associates, it also builds upon a tradition of Scandinavian critical systems thinking within the field of information systems (Bjerknes et al, 1987). One of the most active areas of research for this school of Scandinavian CST for the past 20 years has been in the field of developing health information systems in the third world based on the motto “power to the users” (Braa & Sahay, 2012). One way of doing research according to this political motto has been by designing and cultivating networks of super users and observing the impacts on organisational learning (Kaasbøll, 2013). By mixing the political ideas and the technical insights from these two schools of CST, the study of CST-driven TQM implementation has shown that a good implementation method can compensate for lack of management commitment in certain environments such as those represented by the Norwegian public sector organisations mentioned in the study.

Unlike Jackson (2003), who questions the merits of TQM when he reflects upon his earlier attempt to use CST as a basis for TQM, this research continues to support the original views.
of Flood and Jackson (1991) in saying that TQM can be successfully viewed from the perspective of CST. This is done partly by focusing on how Flood (1999) applied ideas from CST and TQM in addressing system dynamics as a basis for organisational learning by focusing on complex adaptive systems (CAS), and it is done partly by focusing on how CAS has been applied in a similar manner within the Scandinavian CST tradition of information systems research (Hanseth & Lyytinen, 2010). This use of combination of insights from two different schools of CST produces an important contribution to the theory of TQM implementation in the shape of showing how a strategy for bootstrapping information infrastructure, the so-called bootstrap algorithm (Hanseth & Aanestad, 2003), can be used as a general algorithm for developing organisational learning in a manner that makes ideas suggested by Flood (1993; 1999) more easy to communicate and implement.

At the heart of how the bootstrap algorithm is used for organisational learning is the idea of identifying and cultivating networks of super users related to the various information systems used by the organisation. As information systems tend to interact with each other in various degrees and as expertise in one type of system can often be an advantage when trying to master another type of system, the bootstrap algorithm seeks to cultivate and expand the network of systems and users in a way that puts more focus on the wants and needs of the users than the wants and needs of system designers and managers. As the bootstrap algorithm puts focus on the return of the total portfolio of information systems rather than trying to control each system, the approach can be seen as a portfolio management method, just like the related genetic algorithm has been used for financial portfolio management (Jiang & Szeto, 2002). In the same way as amateur investors are sometimes recommended to diversify financial risk by investing in collective investment schemes rather than individual stocks, what the bootstrap algorithm aims to control is the risk associated with a portfolio of different improvement projects in situations where it may be risky to base the return of investment only on a single project.

**Limitations and directions for future research**

The action research study has produced data for a period of almost 20 years, but the data was primarily collected for practical reasons, not scientific reasons. Especially during the early phases of TQM implementation was it more important to have data for being able to run the decision models than to feel absolutely confident that the outcome from these models would be optimal decisions. As the TQM implementation continued, the quality of the data got better, but still there are not sufficiently long time series of high quality data to produce conclusive results. Nevertheless, the combination of quantitative and qualitative data collected as part of doing the action research suggests that CST-based TQM implementation methods may compensate for lack of management commitment in the kind of environment represented by the organisations referred to in the study.

Concerning directions for future research, part of the challenge of testing methods like the bootstrap algorithm, a method developed by use of CAS-based theory for designing adaptive systems development in complex environments, is the time frame needed for getting reliable results. While it has been suggested that successful TQM implementation with a normal amount of management commitment will take from three to five years, the CAS-based approach should be expected to take much longer time. The learning curves generated through this study suggested that it would take more than 20 years for achieving a 90% level of total organisational excellence. Getting a 90% level of excellence in leadership and sustainable management commitment was expected to take even longer.
Although the point estimates are not totally reliable, they indicate a completely different time scale than what can be found in the conventional TQM implementation literature. As a method like the bootstrap algorithm can terminate both as a result of TQM implementation failure and TQM implementation success, an important and useful design for future action research on such methods is to focus on how long the TQM implementation process can be made to survive. In order to improve TQM success rates and success rates for the implementation of organisational learning in general, there is need for further research on CAS-based TQM implementation methods in the support of CST-based organisational learning.

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