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Challenges to IS quality

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Abstract

Investing in quality was popular in the early 1990s. Several approaches were developed, but it seems that none of them provides a solution that is generally accepted and adequately detailed for both scientific and practical purposes within the IS field. We claim that most quality approaches concentrate too much on the technical and control oriented aspects of managing quality thus causing unsatisfactory results. There is a need and a demand for better quality practice that can be attained through cooperation between practitioners and researchers. This paper discusses these challenges to IS quality and presents some suggestions for bridging the gap. © 1997 Elsevier Science B.V.

Keywords: IS quality; Quality models; Quality awards; Software process

1. Introduction

Many quality concepts, models, metrics and standards stem from manufacturing industry with the need to secure that average costs, production time and quality of manufactured goods are and remain acceptable. This is the quality control approach. Intertwined with widespread interest and investment in quality the intellectual emphasis has gradually shifted from the idea of controlling quality to the idea of constantly improving performance and quality throughout the organisation—total quality management (TQM). To better serve the various needs specific quality models have been developed from more generic ones. Within IT the application of ISO 9001 to software development guided by ISO 9000-3 is one practical example. Currently there are several competing approaches on both generic as well as on IT/IS level. Yet it seems that none of them provides a solution that is generally accepted and adequately detailed for both scientific and practical purposes.

This article discusses first the relationship between generic and IT/IS quality models with implications for IT/IS quality model development. Linking IT/IS quality research with industrial practice has been a problem. In spite of their practical value IT/IS quality models are not free from their underlying premises that usually reflect the quality concepts and approaches that prevailed at the time of the model inception. Especially earlier models and standards cover only technical aspects with a quality control orientation. Unsatisfactory results and possible rejection of quality focus may follow if organisational, customer and other total quality aspects are missing. For example, most major software providers today have a certified quality management system (QMS) adhering typically to a ISO9001 quality standard. Yet these QMS do not always provide value for the customer. Also other problems with QMS are discussed with their possible consequences. We propose that better multiperspective quality models are needed for both scientific and practical IT/IS purposes. We outline some possible building blocks for such quality model development and implementation. We also present a recent undertaking of software process movement, the SPICE project as an example of successful cooperation between academics and practitioners.

2. Development of quality thinking and practice

Most quality concepts, models, standards and measures emerged from manufacturing and engineering needs. Deming [1] writes that even early pioneers, e.g. Shewhart in the thirties defined quality as a multiperspective concept, or TQM using contemporary vocabulary. Within IS/IT field the prevailing approach to quality in practice has nevertheless remained to cover mostly technical aspects. Consequently quality methods have concentrated on inspections and quality control. Manufacturing industries in the 1990s still employ quality inspectors to control that production is carried out according to agreed, measurable procedures.

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Quality control also checks that inputs and outputs, i.e. raw materials, constructed components, finished products and services, etc. meet specifications. The target is to reduce errors, costs, down-time and/or to improve the quality of products. Quality is seen as detected conformity to requirements (see e.g. Crosby [2]).

3. TQM

Quality and TQM gained rapidly wider acceptance in the 1980s with many advancements in quality concepts, models, standards and measures (see e.g. Feigenbaum [3], Ishikawa [4], Deming [1], Garvin [5], Juran [6], Garvin [7], Akao [8], Lillrank [9], Taguchi-Clausing [10]). The traditional quality approach expanded from quality control orientation to a multiperspective view of quality. For a few years in the early 1990s quality and especially TQM was one of the hot topics even in popular management literature, and top executives were suddenly seen among participants and speakers in quality conferences. With the idea of continuous, gradual quality improvements TQM was promoted as a way to enhance company profits and productivity resulting from decreased costs, higher customer satisfaction, better organisational performance and organisation learning.

The idea of Total Quality Management is largely based on the teachings of American consultants W.E. Deming and J.M. Juran. In Japan these methods were further developed and refined. TQM encompasses the whole organisation and is based on [1]Kaizen–continuous improvement. Shashkin and Kiser [11] present a definition for TQM as follows: 'TQM means that the organization's culture is defined by and supports the constant attainment of customer satisfaction through an integrated system of tools, techniques, and training. This involves the continuous improvement of organizational processes, resulting in high quality products and services.'

The three fundamental components of total quality management are as follows [12] (see Fig. 1).

1. Unit Optimization. All individuals and groups of the organisation stabilize and improve their own work independently.
2. Horizontal integration. All departments and project teams concentrate on satisfying the customer together across the functions of the organisation.
3. Vertical Alignment. Everybody understands and contributes to the few crucial goals (hoshins) of the organisation.

In the early 1990s several other rivaling concepts emerged, such as Business Process Re-engineering, Activity Based Accounting, Lean Management and Learning

[1] Kaizen means gradual, unending improvement, doing "little things" better; setting — and achieving — ever-higher standards.

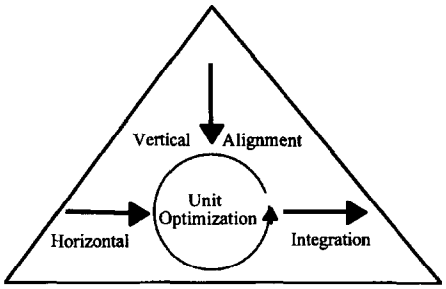

Fig. 1. The fundamental concepts of total quality management [12].

Organisations. In management literature it is sometimes argued that all the mentioned approaches share a common base, namely process orientation (see e.g. Hannus [13]). Hannus also argues that the difference between TQM and Business Process Re-engineering is in their focus. Quality improvements are seen as gradual and continuous whereas Business Process Re-engineering advocates radical improvement. Champy and Hammer [14] further argue that Business Process Re-engineering starts by assessing which processes should be re-engineered. They claim that TQM does not make these questions, and that could lead to the improvement of unnecessary organisational processes.

3.1. Process improvement takes time

For many, TQM is already 'yesterday's news' and new approaches, such as knowledge management, benchmarking and organisational learning are now gaining popularity [15]. One problem with TQM is that it requires a long-term commitment and investment which are difficult to justify for most companies in today's changing world. For example, publicly listed companies are constantly analysed on the basis of their quarterly profits. Models and methods should adapt quickly to the changing needs but what is then the alternative to TQM if the goal is to achieve lasting effects of improvement efforts? This appears to be difficult in an organisation setting where decisions are typically based on the

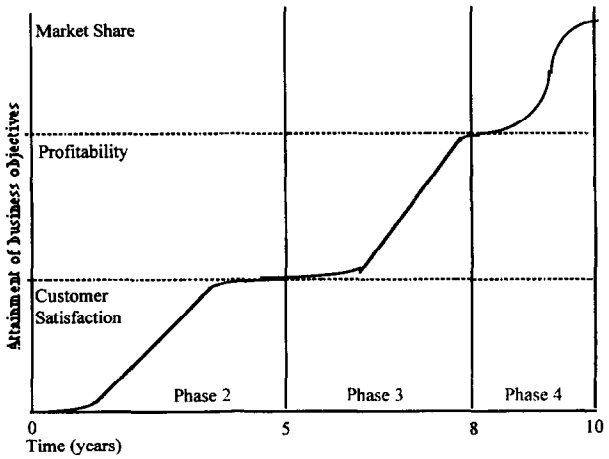

Fig. 2. Quality improvement in phases [16].

beliefs and expectations of upper management when there is no firm data available. Peter W. Moir [16] describes the temporal aspect of process quality improvement in his book 'Profit by Quality' (Laatu tulostekijana):

'Fig. 2 presents quality improvement in a typical company, which does the development, production and sales of high technology products. Year 0 marks a generally accepted situation where post-production testing is the usual quality control mechanism. This is Phase 1 of the quality improvement. During Phase 2, within five years, process control will become a norm for individual departments with the aid of quality circles. Substantial growth in customer satisfaction is achieved.

When the 'control habit' is institutionalized in all departments, the company will move to Phase 3. During Phase 3 the investment to quality begins to pay off in increasing profitability.'

Fig. 2 suggests that the time required between each phase decreases as the benefits of improved quality are cumulative. Also note that although the company's business objectives may remain the same, the focus for quality improvement changes in time.

While this example and time scale are from a large multinational company, the message is clear: process improvement takes time. Paulk et al. [17] write: 'Software organizations may take 10 years or more to build the foundation for, and a culture oriented toward, continuous process improvement'. Quality and improvement are clearly not something that can be 'taken care of' but requires a long-term commitment. As Deming [1] says, 'improve constantly and forever'.

The implication for researchers is that longitudinal approaches are needed to assess the impact of quality tools. Another implication is that much effort is needed to promote and market quality models. For practitioners and quality advocates the implication is that long term upper management support is needed. This commitment must be combined with a consideration for short term profit impacts.

3.2. Promoting quality achievement in practice—TQM awards

As discussed in the previous section, the effects of quality initiatives are often relative, subjective and difficult to measure. Formal recognition seems necessary both for motivational reasons and to distinguish quality oriented organisations. Achieving an ISO9001 certificate is often the first official recognition of quality. For evaluating quality improvement in more advanced organisations there are several TQM oriented quality awards programs that are also supported by governments and industry interest groups. To describe the evolution of modern quality models and to demonstrate how to promote quality models in practice the three most known approaches for evaluating improvement in TQM are presented. These are the Japanese Deming Prize, the American Malcolm Baldridge National Quality Award and the European Quality Award.

3.2.1. The Deming Prize

The Deming Prize was established in Japan by the Union of Japanese Scientists and Engineers (JUSE) in 1951. The Deming Prize was established to ensure that the good results are achieved through successful implementation of company-wide quality control activities. The Deming Prize Criteria has ten areas of interest many of which are mostly concerned with quality assurance activities and application of statistical techniques.

3.2.2. The Malcolm Baldrige National Quality Award

The Malcolm Baldrige National Quality Award was initiated in 1987 to promote Total Quality Management as an increasingly important approach for making North American products and services the best in the world. The Malcolm Baldrige National Quality Award Criteria [18] contains 24 items in the following seven categories: Leadership, Information and Analysis, Strategic Planning, Human Resource Development and Management, Process Management, Business Results and Customer Focus and Satisfaction. All criteria relate directly to improving business performance. The award recognises all sizes of manufacturing and service organisations that demonstrate exemplary performance in both the ways they run their companies and in the quality of their products and services [19]. The award promotes awareness of quality as an increasingly important element in competitiveness, understanding the requirements for quality excellence, and sharing of information on successful quality strategies and the benefits derived from the implementation of these strategies.

3.2.3. The European Quality Award

Responding to the quick success of the Baldrige award, the European Foundation for Quality Management was formed by 14 Western European companies in 1988. Their objective is to enhance the position of Western European businesses in world markets by accelerating the acceptance of quality as a strategy for global competitive advantage, and by stimulating and assisting the development of quality improvement activities [20]. This award incorporates the European Quality Award which is given to the most accomplished applicant, and the European Quality Prizes given to organisations that demonstrate excellence in the management of quality as their fundamental process for continuous improvement. Application for the award is through an organisation's self-assessment based on the European Model for Total Quality Management. While mostly following the Baldrige award criteria, European Quality Award takes a wider scope. It introduces criteria such as People Satisfaction and Impact on Society to promote a more holistic TQM approach.

3.3. Quality standards

Quality standards have become widely accepted also in the IS field. Probably the most widely applied is the ISO 9001 [21] standard and its application ISO 9000-3 [22] that is intended for software producing organisations and is used as one the norms for the certification of quality management systems. In the 1990s most major software providers established an ISO 9001 certified quality system and more companies are following. However, quality standards do not guarantee quality improvement. The application of the standard should always support organisational objectives. 'The golden rule for ISO 9000 is: If the process doesn't make long-term business sense, stop. The purpose of ISO9000 is to create prosperity, not engender bureaucracy' [23].

3.3.1. ISO 9000

The international standard series ISO 9000 provides a well-recognised basis for implementing and certifying a quality management system. The standards are meant to be quite generic to cater for different types of businesses. This is both a weakness and a strength.

In ISO 9000 framework (see Fig. 3), two areas are emphasised to attain quality: quality management and quality assurance which also cover operational quality control aspects.

The quality system is periodically reassessed by the certifying bodies to ensure compliance with ISO 9000. While reassessment ensures a functioning quality system, it might implicitly hinder improvement that introduces change to the quality system. Moreover, improvement induce instability before changes have been institutionalised. Thus, improving the system might lead to (temporary) suspension of the ISO certificate.

One benefit of the ISO certificate has been to assure customers the credibility of certain suppliers; a marketing advantage. Consequently when the ISO certificate is commonplace in the market this advantage is lost because 'it does not provide quantitative assessment of one supplier against another' [24].

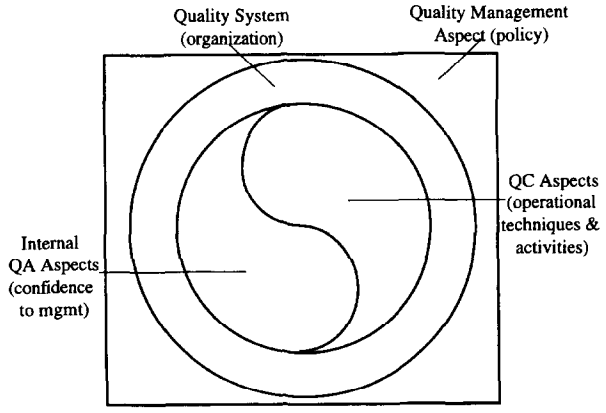

Fig. 3. The ISO 9000 framework.

Finally it should be noted that quality standards do not ensure success. There are good examples of successful organisations, notably Microsoft, that do not seem to emphasise quality focus let alone quality standards. 'There is little evidence that conformance to process standards guarantees good products' [25]. See an article by Salmela later in this issue for more discussion on business quality aspects.

3.4. Perspectives on IS quality and IS quality method development

During the past 10 years generally applied quality concepts and models have become more multiperspective. The success of international quality awards with quality measures for leadership, customer focus and satisfaction, impact on society, etc. suggest that quality is increasingly considered in a more holistic way in leading organisations. TQM has rivaled with Business Process Re-engineering and other new concepts that also seem to have had an impact on how we look at quality today. Although a multiperspective view of quality is well understood in theory, quality approaches affecting IT/IS in practice focus almost entirely on technical quality. These include standards, such as ISO 9000 [21] and methods, such as IT-STARTS [26]. For example, ISO 9000-3 concentrates to assure the quality of software development process and the focus is on technical process perspective.

Some software engineering methods also have strong quality implications though they are not quality methods as such. These include the Factor-Criteria-Metrics model developed by Boehm [27], [28] and the Goal-Question-Metrics approach (see e.g. Basili and Rombach [29], Grady [30]).

We claim that is not sufficient to regard IS quality only from the technical viewpoint. Many of the problems encountered in practice (discussed later in the article) relate to this narrow approach. There are several models and studies of more broad notion of quality. For example Braa [31] and Eriksson and Torn [32] define IS quality from three perspectives: technical quality, use quality and organisation quality. These three perspectives are interdependent and should be balanced to achieve optimum IS quality (see Fig. 4).

Relating to a multiperspective approach of quality Basili and Caldiera [33] discuss the nature of software that contributes to IS and software quality in a very significant way, and propose that their approach should be used to manage improvement in an organisational setting. They claim that the business community is aware of the problems with software (i.e. information systems) but 'does not truly understand their causes'. Basili and Caldiera criticise the software community for trying to solve the software problems with quality approaches originally developed for manufacturing processes that are fundamentally very different from software processes. For example Weinberg [34] points out that the making of software is to a large degree a development

Fig. 4. The IS quality dimensions [31], [32].

process. Bollinger and McGowan [35] agree on this and write: 'Instead of being dominated by the replication risks, software processes are dominated by design risks, which are the uncertainties associated with building anything that is new and thus at least partially unknown'. Basili and Caldiera call for acquisition of core competencies that support strategic capabilities and promote the Quality Improvement Paradigm/Experience Factory concept. This framework contains a control tool (a goal-oriented approach to measurement) and an organisational tool (an infrastructure aimed at capitalization and reuse of software experiences and products). Their improvement strategy is to develop and package reusable experiences and products. 'The experience factory organisation is the lean enterprise model for the system and software business' [33].

3.5. Implications for IS quality

At least the following conclusions can be made: (1) IS quality models should be multiperspective and linked to IS practice. (2) Concepts, models and measures developed in other fields of research could and should be utilised to get better models. (3) Cooperation with real user organisations should be more frequent to validate the models and facilitate their acceptability. (4) Prior to the development and use of IS quality tools more attention should be paid to questions like: Is IT/IS used to solve relevant organisational problems? Can the problem be solved with improved IS quality? Are we sure that we do not improve obsolete organisational processes that we should change or get rid of?

4. Challenges to IS quality

Two interesting questions arise considering the extensive theoretical work on quality models, TQM and quality awards. (1) Why does there not exist any generally accepted models, methodologies and standards which cover IS quality holistically and in adequate detail to be useful in daily work? (2) Why is it so difficult for practitioners to use existing theoretical models? These are complex issues that we do not even attempt to answer here. Instead, we would like to discuss some problems related to information systems and quality that are present in companies today. Also, to demonstrate the potentials of cooperation between researchers and practitioners we wish to bring forward as an example some of the developments that are undergoing in the software process community. Finally, we outline some possible building blocks for quality model development and implementation.

4.1. Why is quality not interesting anymore?

There are always ideas in time which promise to help and even solve some problems in organisations. Typical of these ideas is that their value is often overemphasised; we all know proposed "silver bullet" solutions, e.g. CASE-tools, OO, TQM or BPR. As the audience widens the original message is usually distorted and potentially useful solutions are misused and applied incorrectly. The interest in quality and quality management systems (QMS) has been one such victim. In the late eighties and early nineties QMS was seen as the answer to improve and maintain IS quality. Here we have tried to consolidate some claims and discussion about problems with quality and QMS that we think are typical in many organisations today:

4.1.1. 'Quality focus does not solve our problems'

Today all organisatins have to adapt rapidly to changes in the environment. This means that corporate focus and strategies change. It was believed that IT can provide help in the changing environment. Although there are successful information systems, one of the typical porpositions of re-engineering literature [14] is that some information systems promote, and even force bad organisational practices in many organisations. 'Despite years of impressive technological improvements and investment, there is not yet any evidence that information technology is improving productivity or other measures of business performance on a large scale' [36]. Companies should be asking themselves what business they are in and are they making the right products. This is also probably true within software industry. Basili and Caldiera [33] write: 'A common problem for software development companies is that they don't think software is their business. They think that they are building 'telephone systems' or 'switching systems' when they are really building telephony software and switching software'. Only after recognising the strategic capabilities and core competencies a company may start aiming at the right direction. In such situations holistic quality models can provide help. For example: 'Intel didn't adopt TQM because it was the right thing to do. Rather, TQM provided the means to Intel's quest to be the best in the chip business' [15].

4.1.2. 'A QMS is not a guarantee for (IS) quality for the procurer/buyer'

Two current IS trends are that IS departments are being outsourced and package software is used more often. Many organisations seek for strategic partnerships with their main

IT/IS vendor(s) who often have a certified QMS. QMS is not the answer but a support tool for quality assurance that can be used correctly or not. For example, user requirements may not be met if the approach of the vendor focuses only on the technical aspects of software development or package software installation. However, a QMS offers means for a capable company to demonstrate the quality of its process and products.

Technical quality or internal quality does not guarantee that user quality expectations are met. A recent survey on software excellence [37] concluded that technical software processes alone had little significance on end-user satisfaction and business results. Often the vendor focus is on managing the risks related to costs dcaused by erroneously estimated development costs and/or late delivery penalties. User organisations that in their quality systems give regard also to user satisfaction and other dimensions of quality may be disappointed and find the cooperation short-lived. In practice it also seems difficult to find a vendor as a long-term partner. For example, Finnish Export Credit (FEC) sought strategic partnership with key IS vendors for years. Success has been meagre. FEC's approach has been to involve main IS vendors in FEC's business to gain educated advice on how to develop the organisational IT and IS environments but vendors seem not to see the long term benefits. What is even worse, ISO 9001 oriented QMS seems to discourage strategic partnership relations at operational level. Another aspect pertinent to the relationship between QMS and IS quality is that quality seems to be still very sensitive to changes in technology. This may lead to distortion of the whole quality system or inapplicability of quality assurance. For example, one of the FEC's main IS vendor discontinued the use of their certified QMS when they moved from using structural approaches to object-oriented development. The development processes need to be supported by the QMS also when technology changes. This in turn requires that QMS conceptually supports change and is reviewed and updated if needed whenever there is a change in technology. Technical quality is also dependent on the maturity of the building process. In a mature process the criteria for adopting new technologies will probably address and resolve issues concerning the quality impact of technology changes.

4.1.3. 'A QMS disintegrates and is not visible to IS users'

Why is QMS sometimes regarded as not value adding? In many cases a QMS is not integrated into the organisation but stands as a separate structure adding bureaucracy. The view is most likely more positive in an organisation that has designed its processes in a manner that includes QMS as a supporting element facilitating quality work. The latter is much harder to do and might require radical changes, e.g. with a Business Process Re-engineering approach [14].

At times it seems that the quality system is not useful. Quality documentation may exist but are not used or updated as for example FEC's experiences can confirm. Critical application (tailorisation) or QMS is typical in successful projects. Companies have to survive in a rapidly changing environment and QMS has to be flexible enough to adapt to varying needs. A QMS is often too rigid to suit the real project world. However, tailorisation of standard process is a basic building block of a modern QMS (see e.g. Paulk et al. [17]). Tailorisation was also possible before but changing the standard approach was traditionally regarded as a deviation rather than an adaptation.

5. Discussion

We have tried to illustrate that many of the current problems we have seen and heard in practice regarding IS quality and QMS relate to a narrow view of quality—the technical quality. There are several reasons for the dominance of technical quality perspective. Many of them seem to be associated with general immaturity of the tradition of using and developing IS, and the related symptoms, such as short-sightedness of decisions and operations:

- Information systems development is typically still a handicraft industry compared with, say, car manufacturing. Recent figures from 176 software process maturity assessments [38] suggest that around 60% of the organisations are still at very initial level of maturity. Part of the problem is that the complexity of IS development increases rapidly as the size of the developed system and the number of developers increase. The proportion of partially or totally failed software projects is often considerable. Software engineering and quality management methods included are efforts to control, manage and decrease the inherent risks of IS development leaving little time for applying more holistic approaches.
- Although software packages are used more frequently, the risks of software development are perceived to be far greater for bespoke information systems. Substantial modifications or additions, links to other information systems, etc., are often developed on top of software packages. According to FEC's experiences most certified QMS relate to bespoke software development or to the development process of otherwise new software.
- As IS vendors software companies are often forced to commit themselves to fixed price deliveries, typically after (technical) design and prior to the start of programming. A poorly managed development effort may in the worst case jeopardise the future existence of the software company. Quality assurance and management is one of the ways to reduce internal risks of the software companies. (Note; this type of quality was labelled as internal quality, see e.g. [39]).
- The picture looks partly similar from the user organisation point of view. Although little tangible is delivered future costs are tied. The costs of not getting a software release may even be bigger than the hidden costs of unsatisfactory development. To protect themselves, US

government agencies were among the first to require standard documented software deliveries from their vendors. To reduce their risks, especially with bespoke IS, some user organisations expect or even require (e.g. in banking) that their software vendors must have certified quality management systems.

- The productivity of software development has increased slowly. In most organisations there is a huge backlog of not delivered and even not started information systems. The situation is different in many other industries with abundant, practically error-free supply of products and services, such as in consumer electronics. Within these industries customer satisfaction and other aspects of quality dominate as substantial differences to competitors can seldom be achieved with just technical quality.

What are the implications? Software developers and vendors should consider improving their products and services by concentrating more on other aspects of quality than technical quality. For example, technical quality counts only 250 points of 1000 points possible in the Baldrige Award criteria. Imagine that a software company would like to raise its quality rating by 50 points. It could be easier and cheaper to achieve that improvement by focusing on marketing, user requirements understanding, etc. compared with further improvements in software engineering practices. A natural counter-argument is that there are often more than enough of strictly technical problems. One could still ask whether the root cause of these problems is always technical by nature. Note that this example is not meant to be taken literally as comparing an exact number of points between different categories is probably not very fruitful. One can also question the validity and usefulness of a generic rating system. The point of the example is to promote the idea of multiple perspectives to practitioners.

In general, IS research does not lack efforts to develop multiperspective quality concepts and methods (see e.g. Grady [30], Eriksson and Torn [32], DeLone and McLean [39] among many others). Unfortunately most of these efforts have not produced widely shared concepts and/or are not known outside academia. It seems that IS quality modeling shares similar problems as in making a successful software product. The effort to produce a marketable product is often underestimated. Attempts to develop multiperspective quality concepts and methods should be multidisciplinary and linked to the existing practice. For example, the well-known customer satisfaction metrics and other metrics that are widely used in organisations worldwide could be added or at least mapped to IS quality models. Another idea would be to consider official recognition, such as quality awards, as a vehicle to make quality concepts known and used. At VTT Electronics, the Finnish national quality award framework is used to guide improvement after ISO 9001 certification [40]. Although there are many other issues as well, we feel that cooperation is one common ingredient for success. The following example presents a possible way to organise cooperation between different interest groups.

5.1. Example: what IS quality could benefit from the SPICE approach?

The software industry is relatively young and constantly changing but the shift from making handicrafts to producing professional software in an organisational setting has begun and is visible today. Here we bring forward selected aspects of one approach that might have contributed to this development—the software process movement. A second focus of this example is to present a possible way how to facilitate development and global acceptance of an approach or a model among both among practitioners and academics.

5.1.1. The SPICE project

Despite its successes, the application of the ISO 9001 standard was criticized as old-fashioned, inflexible and too general both among the academics and practitioners [41,24]. In the marketplace ISO 9001 has become so commonplace that it does not necessarily guarantee the credibility of suppliers. The situation has resulted in the proliferation of different assessment methodologies and—confusion. An International Standards Organization study report [42] concluded that there was a need to facilitate the repeatability and comparability of assessment results by harmonizing the currently used methodologies under a common assessment framework (see Fig. 5).

This work is being undertaken as an extensive international effort under auspices of the SPICE (Software Process Improvement and Capability dEtermination) project [43]. The more than 100 participants from over 20 countries are practitioners from industry, methodology providers and tool builders as well as academics from universities and research institutes. At the outset it was clear that the acceptance of SPICE framework would require a comprehensive process of validation through a series of academic and industry trials. The intermediate empirical results [44] from the first world-wide trial phase speak for the appropriateness of open validation.

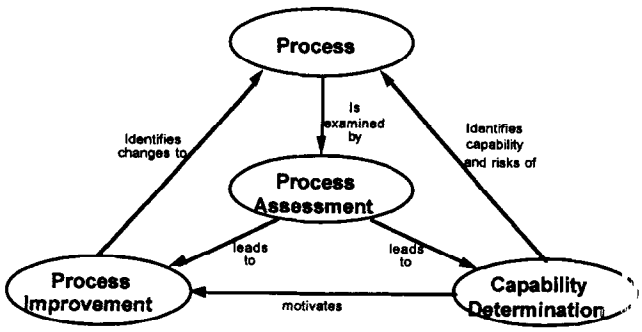

Fig. 5. The SPICE assessment framework.

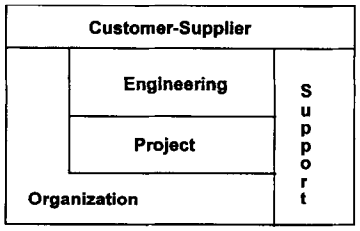

Fig. 6. SPICE Process category interrelationships.

SPICE focuses on software process issues that include people, technology, management practices, and customer support as well as software development and project management practices [43]. These process issues are addressed in five categories that define the processes and practices that are necessary for producing quality software in an organisational setting. The Customer-Supplier processes are the most important relationships which are managed within an environment where Organisational and Support processes form an infrastructure for software Engineering in Projects (see Fig. 6).

SPICE supports a layer maturity model similar to the Humphrey [45] software process maturity model that defines an improvement path for a software organisation. Each level is characterised by capabilities which a software producing organisation should attain in order to improve (see Fig. 7). The SPICE layer model provides more flexibility and resolution, particularly in the low end of software process maturity.

SPICE does not prescribe a specific methodology or approach for software process assessment. It is left to the methodology providers and tool developers to link their own methods to the SPICE framework. Thus, SPICE supports various assessment approaches, e.g. tool-based self-assessment and team-based independent assessment, the results of which may be used for software process improvement or software capability evaluation (cf. Fig. 5) [46].

SPICE is the first international effort to provide a well-defined set of process capabilities, practices and low-level indicators that can be used to assess a software process and its associated process management capabilities. Organizations can choose to perform more general assessments against all the processes in an organisation or focused process-specific assessments by choosing one or several processes to assess. SPICE can also be extended to include industry specific processes and practices. This is expected to be useful in building detailed methodologies for various application domains, such as telecommunications, banking, etc.

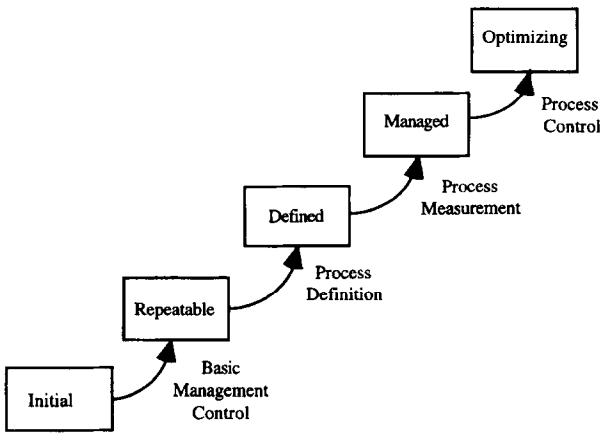

Fig. 7. The Humphrey software process maturity model [45].

The flexibility and detailedness of the SPICE framework place high demands on the assessment methodology providers and users of these methodologies. Some have even suggested that SPICE is much too complex to be acceptable in practical use. However, it is likely that there will be methods for specific assessment purposes in parallel with more general approaches.

5.1.2. Managing complexity with a development path

While the five-level software maturity model (see Fig. 7) is somewhat simplistic and certainly not fitting for every organisation, the model has created a basis for discussion. The development stages are easily communicated and propose a clear path for improving the software process. There is empirical evidence [47] suggesting that following these different stages of organisational development is useful and may result in substantial return of investment. Reducing the unarguably complex task of improving the software process into not only one but several successive scenarios responds to the needs and dynamics of most software companies. Organisations have to learn how to walk before they can run. The will and commitment are present in many companies but without concise intermediate targets and frequent (positive) feedback the search for the ultimate quality is all too often abandoned. The IS quality models should contain or at least map to possible practical intermediate goals to facilitate the usefulness of the models.

5.1.3. Added value through cooperation between practitioners and academics

There is a plenitude of quality models some of which are very comprehensive, all-encompassing representations of IS quality. Yet few of them were adapted and used in real organisations.

What characterises many of recent software process models and approaches is that they are based on inductive and empirical development. What were seen (by practitioners) as relevant and good practices were incorporated into a model or a framework with the help of academics. This approach has its strong and weak points. An example of this approach is the SPICE project that is developing a new standard for software process assessment and improvement. In the interest of validation and facilitating the acceptance of the SPICE framework, extensive field trials are being carried out world-wide. The hypothesis is that early participation of all interested parties enhances the quality and buy-in of the framework. While it could be argued that

efforts like SPICE are no more than technical by nature, the converging value of international cooperation is likely to provide at least fertile soil for new ideas and advances in research and practice. If the research phenomenon are dealing with organisations with the interest of helping them then the terms of research are at least partially dictated by these organisations. In order to attract parties with often conflicting interests there has to be value for everyone in the cooperation. On the downside of world-wide participation is that the concensus building among people from different cultures and backgrounds seems to be significantly slower. A risk is that there will be no consensus or that the end result will be diluted to a very high-level abstract construct which does not provide enough detail to be useful in practice.

6. Conclusion

There are many quality models and approaches that provide means for well-rounded treatment of quality. Yet many organisations in the mid-nineties are not satisfied with prevailing quality approaches and standards that have a more narrow focus. In practice several perspectives of quality may be considered implicitly, but the overall IS quality is today still more likely to be accidental rather than a result of systematic efforts. Among other reasons difficulties of adopting more holistic quality models seem to be related with the immaturity of the IS field in general. One direction to start improving is linking quality models with existing practice. As an example, Keith [48] describes an industrial case-study on how to integrate the MIS activities with more general quality activities. He proposes that 'MIS must be combined with TQM to create a Quality Information System'. According to Keith's practical experiences the IS professionals have a key position in quality improvement. 'Meeting the quality objectives of a Quality Information System can result in a new synergy between customers and systems personnel'.

Further, the IS exist in a multifaceted environment. It seems that no one person or group of researchers has succeeded (or even attempted) to cope with the richness and complexity of IS to provide holistic, yet detailed and usable quality methods. The mapping of theoretical quality models with the practical needs and demands of IS/IT industry is wanting and should be improved. One starting point for further research could be to analyse the various TQM awards and companies possibly with the help of researchers from other fields in order to understand the different quality dimensions and their dynamics and then try to look for IS solutions—both general and detailed. One such example is the Software Excellence Model suggested by the European Software Institute [37]. Finally, we see the cooperation between academia and industry as crucial to more multi-perspective, holistic solutions that are also widely accepted among the practitioners. The SPICE project offers an example for potentially successful global implementation of an IS quality model.

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