Improving quality assurance in large information systems departments

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ABSTRACT

The ISO standards for quality assurance have helped many organizations in setting up a quality system and thereby in improving the quality of their processes and products. However, setting up a quality system on the basis of these standards also requires interpretation and tuning of the guidelines towards the specific needs of an organization. It is this practical implementation of a quality system that we treat in this paper.

In particular, we deal with the improvement of ISO-conforming quality systems for large information systems (development) departments. It appears that these quality systems do not always work as they should and that they can often be improved.

First we describe a number of problems and possible improvements that we perceived in practice. We trace these back to mismatches between the perceived characteristics of the ISO standards for quality systems and the requirements of large IS departments. In principle that need not be a problem, because the ISO standards leave much freedom of implementation. However, the mismatches may (and often do) lead to misinterpretation or wrong tuning of the guidelines.

Then we show how that can be avoided. In order to do so, we first describe critical success factors of ISO-conforming quality systems in large IS-departments. Then we describe how a quality system can be made to conform to those success factors. We treat each of the main components of a quality system (quality planning, quality control, quality assurance and a quality information system) and show how they can be implemented more successfully by matching an organization's characteristics.

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1   INTRODUCTION

In the last decade it has become clear that quality assurance is crucial in information systems (IS) development. Especially now lately negative publicity has emerged about the performance of IS departments and the return on investment of IS's, many IS development organizations try to improve the process of IS development and thereby the quality of their products (Essink, Van Heusden & De Weger [3]).

The publication of the ISO 9000 series standards on quality assurance and quality management (ISO [5,6]) have been an important impulse for many organizations to implement a quality system. The availability of a standardized set of guidelines made this easier, especially because more and more organizations gained experience with it. Moreover, having a certified quality system has become an important and sometimes indispensable marketing tool.

Unfortunately, implementing a successful quality system that conforms to the ISO standards has appeared not to be easy for every organization. Careful matching of an organization's characteristics with those of the quality system appears to be the key to success, but at the same time not to be easy. The failure of quality projects is an underdocumented feature, because companies are not proud of failed projects. And it is our experience that even in cases where quality systems seem to work reasonable or well, they might work even better if there were a better match between the organization and the quality system.

In the past years we have carried out a number of quality assurance projects in large IS (development) departments that were usually part of large information-intensive organizations (e.g. banks, insurance companies or government departments). Based on these experiences we describe problems and traps in constructing quality systems and how to overcome them. There are a number publications that deal with the implementation of ISO-conforming quality systems (see e.g. TickIt [9]), but as far as we are aware, nowhere the possible problems, their causes and their solutions are treated systematically. In doing so, we hope to contribute both to the practice and to the theory of quality assurance.

In section 2 we describe a number of characteristics of ISO-conforming quality systems and how misinterpretation or wrong tuning of the ISO guide-

lines may cause problems. In section 3 we describe how these problems can be overcome. First we describe the critical success factors to prevent the problems of section 2. Then we describe how the components of a successful quality system can be tailored to these critical success factors. In section 4, finally, we draw some conclusions and describe further research themes.

2   POTENTIAL PROBLEMS IN SETTING UP A QUALITY SYSTEM

The ISO 9000 series of standards are meant to cover an entire scala of organizations. The ISO 9000-3 guidelines are meant for every company that produces software. This causes the standards and guidelines to be very general. In principle this need not be a problem, because implementors have enough freedom to extend and fill in the standards and guidelines, which makes it possible to tune quality systems to specific organizations. In fact, it has appeared that this tuning is very important in the success of the quality system (Rijsenbrij [7]). Unfortunately, if implementors of a quality system have too little experience or are not aware of the specific requirements of their organizations, they may misinterpret the guidelines and/or tune their quality system in the wrong direction. In this section we treat a number of characteristics of the ISO guidelines (which are often even stronger characteristics of the IEEE guidelines (IEEE [4])) and show how they can give rise to problems in setting up a quality system.

- The ISO guidelines pay a lot of attention to the identification and correction of quality problems. Obviously, this is very important in order to control the production process. However, for quality purposes it would be even better not only to identify and correct problems, but also to prevent them as much as possible. Unfortunately the ISO standards prescribe very little in this area. Therefore a company with an ISO-conforming quality system may still have high failure costs.

- A related problem is the little attention that is paid in the guidelines to quality improvement and learning. The guidelines focus on attaining a level of quality that should be defined by the users of the quality system. This has at least three negative consequences. First of all, the defined level may be very low, which means that the quality system does not result into quality at all. Secondly, if the set level of qual-

ity is not attained, the corrective actions that must be taken may remove the symptoms, whilst leaving the structural problems untouched: the guidelines offer no tools for preventing similar (but not the same) problems in the future, other than reporting problems and solutions. Thirdly, once the level of quality has been attained, there are no means and drives to continually improve quality.

- According to the ISO guidelines, the quality of products should be measured. For certain industrial products there exist well-established standards for doing so. However, for software this is still an active area of research, which makes it more difficult to implement in practice. Moreover, one should not only measure "inherent" software quality, but also the effect this has on user satisfaction and business performance.

- An often quoted disadvantage of ISO-conforming quality systems is that the "overhead" is large. Almost every (possible) process or action, problem, correction, etc., has to be documented. Even though one could argue that the ISO guidelines just call for a structured way of working, this means that especially in organizations where people often work in an unstructured way, the quality system cannot just be put "on top" of the current way of working.

- Another characteristic, which becomes apparent especially in large organizations, is that the ISO guidelines offer no tools to provide different rules and standards for different processes. A simple example is that for different types of software one needs different types of test plans. That is something that could easily be covered in a quality plan, but if one uses different types of production organization, multiple development methodologies and has different customers, quality planning can get quite complicated. Again, this is not something the ISO guidelines prevent; it is merely something they do not support.

- A final characteristic of the ISO documents is that there are guidelines for both the supplier and the purchaser of a good, but very little guidelines for the interaction between the two. According to Rijsenbrij [8], one of the main purposes of a quality system should be closer cooperation between business partners. Especially in IS development where numerous possibilities exist for the functionality (and non-functional

aspects) of a system, this requires very good communication. Also aspects like goal selection and selecting an acceptable level of risk are issues that should be covered by a quality system.

The above characteristics of the ISO guidelines make quality assurance usually work well in relatively centralized organizations that work for external customers or that produce multiple goods of the same type in a stable environment. However, nowadays most IS departments are not characterized by these aspects. Especially IS development departments within large organisations are subject to rigorous decentralization, have to cooperate closely with their customers (information management is nowadays often even transferred from the IS departments to the business departments), the produced information systems get less standard and more complex, and the environments of the IS departments change just as much as the departments themselves. The major differences between the required characteristics of quality assurance programs and the ISO guidelines may make it more difficult than necessary (see section 3) to implement an ISO-conforming quality system for these types of organizations.

3   SETTING UP A SUCCESSFUL QUALITY SYSTEM

In the previous section we showed a number of traps that may prevent an optimal implementation of an ISO-conforming quality system in large IS departments. In this section we show how these traps can be avoided and how new developments can be used to improve a quality system. In order to do so we first treat the critical success factors of quality systems for large IS departments and then show how each of the components of a quality system can be made to conform to those.

The components we treat are the following.

- Quality planning. This is a part of project planning and results in a quality plan that forms the basis of quality control.

- Quality control. This is the control of quality within a project. The most important part of quality control (namely, carrying out the primary work well, according to demands) takes place in the operational process. Quality control at a higher level controls this operational process partly on the basis of the quality plan.

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Figure 1: Architecture of a quality system.

- Quality assurance. This process should give confidence in the working of a quality system. That is done by reporting on the achieved results, but also (very important) by evaluating and improving the (structure of) the quality system on the basis of experiences, the quality policy and external influences.

- A quality information system (QIS) collects information from the above three processes and then provides it to these processes as well as to top management.

Figure 1 shows the interconnected components in an architecture for quality systems. For simplicity only the most important relations are shown. It should be noted that this architecture is based on the project paradigm, but that it is easily adapted for other forms of production organization (see Essink, Van Heusden & De Weger [3]).

3.1   Critical success factors

On the basis of the characteristics and problems of section 2, we can identify a number of critical success factors a quality system has to comply to in order

to be successful. The following list is certainly not complete, but it does provide a basis for setting up new (and evaluating existing) quality systems. The quality system should:

- emphasize the prevention of quality problems, rather than concentrate only on detection and correction of these problems;

- facilitate awareness of and learning by the users of the quality system with respect to product and process quality;

- focus on continuous quality improvement, rather than on attaining a fixed level of quality;

- make quality measurable;

- operate efficiently (and be integrated in the users' primary process) in order to prevent distortion of daily work;

- allow the users to work in a problem-specific and situation-specific way;

- give guidelines for the interaction between the supplier and purchaser of a good, both during the initial phases and during the development process.

Before defining a quality system that meets these success factors, a quality policy must be formulated as the starting point of construction. In contrast to what is sometimes stated, quality policy should not be restricted to one's vision on quality and the definition of a number of objectives. Because the critical success factors of the quality system are closely linked to the organization's characteristics (which either originate from decisions at the top level or should be influenceable by these), the quality policy has to describe these characteristics and the way the quality system should support them. Therefore the quality policy should also consider the basic structure of the quality system and its components.

3.2   Quality planning

Quality planning is the setting of quality objectives for one product and/or process and the planning of means to attain these objectives. It should be

carried for both (phases of) projects and programs of related development projects.

Because quality planning forms the basis of quality control, it must contribute to the same critical success factors as to which quality control contributes (see section 3.3). In this section we concentrate on one aspect of quality planning that is an especially important (but also difficult to implement) factor for the success of a quality system: a contingency approach. This means that quality planning should allow quality control to be carried out in a problem-specific and situation-specific way in order to prevent quality problems without overloading people with unnecessary quality control tasks.

The start of this approach is the definition of quality objectives in terms of the quality indicators of the Quality Information System (QIS, see 3.5). This makes it possible to continually evaluate performance of the project with respect to the objectives when it is carried out.

The next step of quality planning is the determination of a scenario for quality control. This is a basic set of actions that are carried out during quality control. This selection is done on the basis of the scores on the following so-called contingency factors:

- the risks of (certain aspects of) a project;

- the level of acceptance of these risks; this is determined largely on the basis of the goal and constraints of a project (the level of acceptance will e.g. be higher when quick delivery is very important and failure costs are low);

- the development method that is chosen (e.g. prototyping or a waterfall type of development);

- the type of system that is developed.

On the basis of these contingency factors a scenario should be chosen for quality control. A scenario is defined in terms of a number of scenario parameters. Scenario parameters that we have used so far are the following:

- work standards (both with respect to the process and the product);

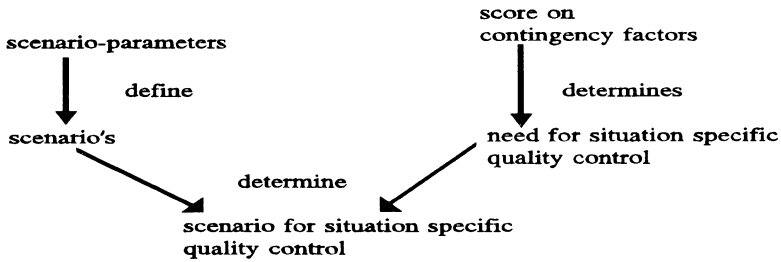- depth of quality control actions (verification and validation);

Figure 2: Contingency approach to quality planning.

- persons(s) carrying out these actions;

- frequency of these actions;

- the structure of the quality organization (the participation of the purchaser and the amount of formal authority that is actually used).

In order to be able to handle the large variety of standards and possible scenarios, it is useful to create only a limited set of basic scenarios on which variations are possible. Choosing a scenario and adapting it should be the responsibility of the project manager.

Figure 2 gives an overview of this approach to quality planning.

3.3   Quality control

Quality control is the control of quality in the primary process. Because this primary process forms the basis of an organization's performance, quality control is a crucial factor in attaining quality.

First of all, quality control should be truly embedded in the users' daily work and not be put "on top" of this. Moreover, quality control must operate efficiently. It should be treated as an instrument for effective communication and a way to control this communication. This makes problem detection easier and allows a shift in emphasis from the detection and correction of problems to the prevention of problems and quality improvement. In this respect it is very important that quick and direct feedback is given on the

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results of people's work. As is shown in section 3.5, the QIS plays an important role in that. Also the use of relatively informal instruments like quality meetings and structured walkthroughs is very significant in that respect.

Another important aspect of quality control is the cooperation between the supplier and the purchaser of a good. The ISO standards require a number of guidelines for both the supplier and the purchaser of a good. But in quality assurance it is crucial that the supplier and purchaser can not only rely on each other, but that they also cooperate. In IS development this means that a quality system should involve the customer in the development process. In the initial phases of development this part of the quality system should focus on the joint choice of a development strategy that is suitable for the project (by balancing costs, risks and time available for the project) and the definition of the product that must be constructed. In the later phases of the development process cooperation with the customer must ensure that the customer's demands are satisfied, but should also give the customer insight in the process and the product, so that (s)he understands the consequences of changes in his demands and of the introduction of the product in his organization.

3.4   Quality assurance

Quality assurance should give confidence that a product conforms to quality demands. As indicated before, a very important aspect of that task is formed by the evaluation and improvement of the (structural aspects of the) quality system. Thereby quality assurance is not only the crucial factor in showing that a certain level of quality is attained, but also in continuous quality improvement and learning about quality.

Quality assurance in this respect includes activities from the ISO guidelines like internal quality system audits and reporting. However, quality assurance should not be restricted to these activities. Quality audits are only carried out from time to time and they usually focus more on the detection of problems than on possibilities to improve the quality system. Continuous improvement of the quality system requires a continuous stream of information about product and process quality as well as about the way in which the quality system is used. Quality assurance should be about effective processing of this information. For effective quality assurance it should be possible to analyze this large amount of information in a variety of ways and to recognize trends in it. That is what a quality information system contributes

to.

3.5   Quality Information System

A quality information system (QIS) is an information system that collects information from quality planning, quality control and quality assurance, as well as from the primary process. The QIS should give insight in the level of process control and product quality.

Firstly this should be used to give quick feedback to the people that work on the project and whom the information is about. Then project management can use the information to improve process and product quality. Finally, structural information, aggregated over several projects, can be used to evaluate and improve the quality system itself. Using the quality information in this way (and in this order) contributes most effectively to the improvement of both the quality in the primary process (quality control) and the quality of the quality system (quality assurance).

The quality information system contains two basic types of information:

- Qualitative information. This information is best compared to the ISO quality records. These are records of actions with respect to quality, for example a text with conclusions of a review. According to the ISO, these records are mainly used to demonstrate the effectiveness of the quality system. However, with the extension of quality assurance to learning and quality improvement they also serve this purpose.

- Quantitative information. This is directly measurable, quantitative, information about process and product quality as well as about productivity. They are represented in so-called quality indicators. The sources of this information can be diverse: other information systems like a man hour registration system, a resource planning system or a system down database, but also user interviews, reviews (e.g. ratings given to certain aspects of a design) or function point analysis. Quantitative information has the advantage that it is more precise and that it is easier to manipulate, so that information can be aggregated over multiple projects, that trends are easily recognized, that statistical analysis becomes possible, etc.

For a complete view on the achieved quality, it is important that information from the primary process (the cause of product quality), information

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about the products that are made in a project (product quality) and infor-
mation about the effectiveness of these products in solving users' problems
(the effect of product quality) are all present in the QIS. The QIS should
also contain reference information and quality objectives that can be used to
evaluate the obtained information.

A QIS that is implemented as above contributes to most of the earlier
indicated critical success factors. It allows quality information to be fed back
to the involved people very quickly, which facilitates awareness and learning
with respect to quality. It supports quality assurance in its continuous strive
for quality improvement. It allows quick detection of problems, but the use of
structural information also supports the selection of actions to prevent future
problems. And, especially when the QIS is fully automated and connected
to other automated systems, it greatly enhances the efficiency of the quality
system.

4 CONCLUSIONS AND FURTHER RESEARCH

4.1 Conclusions

This paper was motivated by the opportunities for improvement of ISO-
conforming quality systems of large IS-departments. We analyzed the prob-
lems and described ways to overcome them. That leads to the following
conclusions:

- The ISO standards for quality assurance have a number of character-
  istics that do not directly support the needs of large IS departments.

- This is not necessarily a problem (in fact this generality is necessary
  for prescriptive norms), because the standards leave enough freedom
  for implementation. However, it may cause problems because imple-
  menters can easily tune their quality system in the wrong direction.

- These problems can be overcome by determining a set of critical suc-
  cess factors (partly based on the characteristics of the ISO standards)
  and then carefully structuring each process and function in the qual-
  ity system, such that it maximally contributes to these critical success
  factors.

Finally we should remark that this approach is not only useful in prevent-
ing problems with quality systems. By evaluating an existing quality system

(or a design for a new one) with respect to the critical success factors, even when no very apparent problems exist (yet), such a quality system can often be improved. In doing so, the description of section 3 may serve as a reference model.

4.2   Further research

This paper is a result of a project that should result in a methodology for implementing quality systems in IS development organizations. Basically the methodology should, based on the characteristics of the organization, offer a set of architectural concepts (e.g. reference models for parts of a quality system), tools and guidelines for implementing a successful quality system. In order to obtain such a methodology further research is required on a number of areas.

- Problem domain. This paper concentrated on certain types of large IS departments and contrasted their needs with the characteristics of the ISO guidelines. This also has to be done for other types of IS development organizations in order to establish the critical success factors of quality systems for these organizations.

- The reference quality system(s). Further research is going on in several areas that were described in section 3. We are currently extending our contingency approach to quality planning to make it finer-grained. In order to do so, we look among other things at a number of cases where people diverted in quality control from the quality plan, which may be a sign that more flexibility is required in quality planning.

- Also the quality information system is being developed further. We have implemented quality information systems and similar systems in a number of companies and are now trying to create an abstract architecture for both the information system and the object system in which it functions.

- A (currently) more theoretical research item concerns the dynamics of the quality system. If, as described in section 3.4, one wishes to treat a quality system as an instrument for effective communication, it is very important to be able to tune the dynamics of a quality system in terms of the communication possibilities it facilitates and the information it

provides. This research should facilitate integration of extra quality instruments (like a quality information system or quality circles) that may cause problems when their dynamics do not match those of the quality system.

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