



Installing an ISO 9001 accredited software quality management system

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ABSTRACT

In 1987 the ISO adopted five standards for quality that collectively known as the ISO 9000 series. The ISO standards have since gained much recognition and acceptance amongst countries in the world as the benchmark for quality and an important vehicle for process improvement. Over two dozen countries have now adopted their national version of these standards, and others are likely to do so. The ISO 9001 [1] has been the most appropriate and sought after quality standard in the information technology industry. In this paper an approach on how to install an ISO 9001 accredited software quality management system (SQMS) will be examined which includes a SQMS development methodology; a documentation structure needed to apply the SQMS to specific projects; and a compliance model taking a four prong strategy of quality assurance, management review, internal auditing, and certification.

1. INTRODUCTION

Poor software quality is difficult to quantify, but in 1989 the British Computer Society advised the Department of Trade and Industry that losses due to poor quality software were costing the UK £2,000 million per year. To reinforce the point, John Akers, President and CEO of IBM, has once been quoted as saying, "... quality improvement will reduce quality costs 50 percent over the years. For us that translates to billions of dollars of added potential profit". Quality, or rather the lack of it, is a

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costly business. It is therefore vital for software organisations to take a positive step towards improving the quality of its software processes and products. An essential step would be to develop and implement a software quality management system (SQMS) which covers the entire software development life cycle, including maintenance and user support. The basis for such a SQMS will best be based on some internationally accepted practices as this will give management the confidence of its successful implementation, limit risk, shorten learning curve, and give the SQMS development a headstart.

The ISO quality standards have gained much recognition and acceptance amongst countries in the world as the benchmark for quality and an important vehicle for process improvement. For instance, to do business with a major British company, it is necessary for a supplier to show compliance with the ISO 9000 standards. Under regulation already adopted, this requirement will extend to supplier of any company in the European Community starting 1992. It is highly likely that this requirement will further extend to other parts of the world. British instituted a system of "registration" which is being used whenever the ISO standards are adopted. Registration is deemed by customer as an evident that the supplier is in compliance to the ISO standards and is therefore capable of producing quality products.

This paper outlines a 3-dimensional approach to develop, install, and use a software quality management system - development, application, and compliance. Development obviously is the most visible, time consuming and costly of the three. It lays the foundation for application and compliance. The paper describes a two-cycle approach to SQMS development with feedback loop built-in to allow incremental development as well as update. However, development without application is not only an appalling waste of money, but also demoralises everyone involved in the process. Application is the necessary test for the suitability and applicability of the SQMS to software development. The paper describes how the documented SQMS can facilitate quality planning and quality control in specific project situations. This includes the evolution of documents starting from the Quality Manual and the Procedure Manual. Finally, compliance is needed to gain certification. More importantly, compliance serves to ensure that the documented SQMS and its application comply with the requirements of the ISO 9001 standard. A four-prong strategy is used for effective compliance enforcement. The four-prong strategy comprises of quality assurance, management review, internal auditing, and certification. The rest of the paper describes these three dimensions in detail.

2. DEVELOPMENT

Developing a SQMS requires senior management directing the effort with clear vision and definite purpose, careful planning and controlling by the Quality Assurance (QA) Manager, and dedicated support from staff who are involved in the process. The SQMS development lifecycle basically requires the interaction and interrelation of two sub-cycles. The first cycle involves the senior management making an action-oriented commitment. This is followed by the second cycle where QA Manager carrying through this commitment to develop and install a SQMS for the organisation. Figure 1 depicts the stages within each cycle, their interaction, the key person responsible, and the feedback loop.

2.1 Making a Commitment Towards Software Quality

The first cycle is about senior management making an action-oriented commitment to quality and to the implementation of a SQMS. The first cycle is also the most important cycle as the success and the long term viability of the SQMS depend entirely on it. Without senior management's continuous commitment, the SQMS development effort could not be sustained, neither will the installed SQMS be used as effectively as it should be. Let's face it, employees will do what they think is important to management. If management pays lip service to software quality, so will the employees. Having said that senior management should be serious about software quality, it is the QA Manager who ought to provide the impetus and education to keep management intimately interested in the development of the SQMS. The end result from this cycle is an agreed plan with committed time, money and people resources to develop the SQMS. The four stages involved in this cycle are understanding, committing, acting and evaluating.

Senior management may first be interested in quality due to peer pressure from their colleagues or external requirements from their customers. However, true, sustainable commitment comes from personal conviction and this conviction is rooted on **understanding**. Before committing the organisation to quality, management need to know what they are about to commit themselves to. The foremost important issue is to understand their responsibility in the development and installation of a SQMS. Other Issues that need to be addressed include what is quality, why quality, why now, why the need to implement an internationally accredited SQMS such as one based on the ISO 9000 series, what are the costs of implementing such a SQMS, and what are the competitive advantages of producing quality product via a systematic approach to quality. A brief overview at this stage of the ISO



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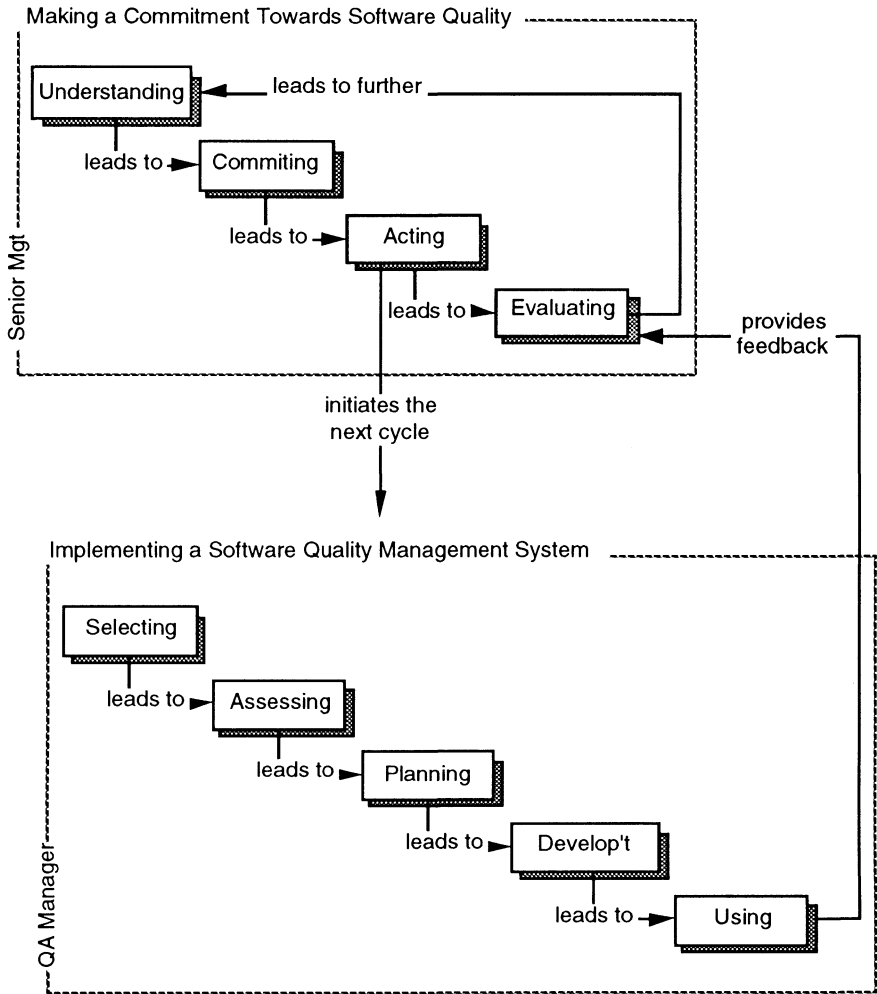


Figure 1: SQMS Development Lifecycle

9000 series to have some general ideas about their requirements will also be very useful.

Decision follows understanding. Having understood why is it crucial to the organisation to install a SQMS, it is time to make a decision to **committing** the organisation to the responsibility and costs of development. Amongst other things, the decision includes senior management's willingness to set aside time to be personally involved in the SQMS development programme, set aside money to meet the

development costs, and reorganise, if necessary, to institutionalise quality.

Decision needs to be translated into action. Quality programmes starting with this stage without first going through the understanding and the committing parts will die a natural death within the first 12 months of initiation. On the other hand, mental decision without action is wishful thinking. **Acting** upon one's commitment involves establishing the QA organisation, setting a charter for the QA function, appointing a QA Manager, and kicking off the SQMS development programme by initiating the next cycle.

Personal involvement from senior management is critical to the successful development of the SQMS. Involvement comes mainly from tracking the progress and **evaluating** regularly the worth of such a SQMS to the organisation. Tracking the progress includes determining with the QA Manager the initial scope of the next cycle, allocating and approving the resources required to develop the SQMS, receiving feedback from the development effort and making necessary resource adjustments, and making use of the internal audit to ensure compliance. Evaluating the SQMS development effort allows senior management to not only keep in control of the overall progress, but more importantly also to gain further understanding of the quality needs which will in turn lead to committing on an expanded scope of the next cycle once the first wave of development works have been completed.

2.2 Developing and Installing a SQMS

While senior management is the key player in the previous cycle, the QA Manager plays the leading role in this cycle of making the SQMS a reality in the organisation. While the first cycle enhances quality visibility, the second cycle provides evidence that the organisation is taking the first and determined step towards quality. Apart from developing and eventually installing the SQMS, the QA Manager also has the responsibility to constantly keep management informed and interested in this quest for quality. The end result of this cycle should be a well documented SQMS, ready to be applied to specific projects. The five stages involve in this cycle are selecting, assessing, planning, development, and installing.

The cycle starts with QA Manager studying the quality management standards and **selecting** an appropriate development approach that meets the business objectives of the organisation. ISO 9001 is a generic quality system meant for various kinds of industrial product development. ISO, realising that the process of development

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and maintenance of software is different, has provided an additional guidelines, ISO 9000-3 [2], for quality system where software products are involved. Standard Australia goes as far as compiling a software quality management system standard, AS 3563 [3,4], mirroring the requirements of the ISO 9001. With this differentiation in mind, QA Manager needs to study carefully the standards, the guidelines, the business objectives of the organisation, and then select the most appropriate SQMS development approach. The activities in this stage are very educational to the QA Manager. The strategy selected will form part of the input to the planning stage.

Most organisations need not develop the SQMS from scratch. They would have been developing software for some time and therefore should have in place a software development process, no matter how poorly it is being defined. Therefore, **assessing** the organisation's software process capability by the QA Manager before going into the planning stage becomes necessary. Watts Humphrey's software process maturity model [5] could be a useful tool. This assessment, apart from understanding where the organisation stands in software development, will allow the QA Manager to map ISO 9001 requirements to what the organisation has already had. It therefore helps identifying what additional standards, methods, and procedures are needed in order to comply with ISO 9001.

Equipped with the selected development strategy and an assessment of the organisation's software process, the QA Manager is ready for **planning** the development and installation of the SQMS. The SQMS development plan is the main tool for the QA Manager to manage the work required for the rest of this cycle. The contents of the plan and the planning process are similar to software project planning. Many good references are therefore available [6]. The SQMS development plan forms the basis to negotiate with senior management on resource requirements and as such, it should spell out clearly the purpose, goals, work breakdown structure, milestones, schedule and cost estimations. The plan should also identify checkpoints for management review.

After the plan has been approved by senior management, **development** work starts. Broadly speaking, the documentation of the SQMS will fall into two manuals - the Quality Manual and the Procedure Manual. The Quality Manual outlines what the organisation plans to do to comply with the ISO 9001 standard while the Procedure Manual spells out the how - methods, procedures and standards needed to achieve compliance. Since the Quality Manual involves policy statement, senior management's input is crucial. Involving senior

management in drafting the Quality Manual is also useful and educational and the involvement keeps their interest up. It is important to note that ISO 9001 quality standards addresses more than just software development and support activities, it also requires the organisation to implement procedures to control the update and maintenance of the SQMS itself as well as to deal with sub-contractors. All these development activities must be coordinated and proceeded with pace suited to the ability and experience of the personnel involved.

Installing the SQMS involves training the users (in this case the software developers) on how the system works and using past projects to test the system to see if it works. The extent of testing depends again on the maturity of the organisation's software process and the experience of the software developers. Through training and testing, the SQMS will be refined. Once the SQMS is installed, it should be applied to specific projects. Using the SQMS in the project will provide valuable feedback on its suitability and applicability to actual software development work. Moreover, accreditation body requires the organisation to show evidence that the SQMS is being used. Choosing the first development project to use the SQMS is very important. Agreed selection criteria must be established with IS management. Generally speaking, do not choose a project which is urgent as well as critical. As soon as the first project has been selected, the organisation moves from the development mode to application mode.

The activities within each cycle can be evolved and improved over time yet their relationship remains. None of the two cycles should be seen as one-off event. In fact, the feedback loop provided in the two-cycle approach to developing and installing a SQMS encourages incremental development. For instance, at the first pass a limited scope rather than the entire quality standard can be chosen for development. Once installed, the procedures can be applied to the relevant aspects of the software development. This will enable management and staff to gain confidence, knowledge and experience. These gains will be extremely useful to initiate another pass of development with extended scope. With each pass, more confidence, knowledge and experience will be obtained. This approach reduces risk, allows learning, and enables quicker payback.

3. APPLICATION

The major purpose of installing a SQMS in the organisation is to improve the quality of the software development process. To serve its purpose, the installed SQMS has to be applied to specific projects. The

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application involves quality planning and quality control (QC). These two activities are themselves cyclical. The Quality Manual is one of the major inputs to quality planning. Quality control activities, relying on the Procedure Manual, will be carried out in accordance with what have been specified in the quality plan. Monitoring the quality status will not only provide the project manager with the necessary data to examine the quality of the product and make necessary adjustment to the quality plan, it also provides feedback to the relevance and usefulness of the installed SQMS. Figure 2 shows the necessary structure of and relationship between SQMS documents and project documents

Apart from the Quality Manual and the Procedure Manual, some organisations may include a third manual - a project methodology, detailing the organisation's software process model. The need for a project methodology is not explicitly spelt out in the ISO 9001 because the Standard tells you what is required to produce quality product but does not say how it is done.

3.1 Quality Planning

One of the first and crucial tasks to be performed by the project manager is to compile a project plan and a quality plan. Since these two plans have such a close relationship with and impact on one another, they ought to be compiled at the same time. The Quality Manual provides the basis for quality planning. Based on the Quality Manual and the user's quality requirements, the Project QA Officer, with the help of the QA Manager, will proceed to develop a quality plan for the project. Amongst other things, the quality plan defines the quality control activities to be carried out in the project. However, to control quality, some other plans which have direct bearing on quality may also be required. The quality plan and the project plan together will specify which other plans are needed, when will they be compiled and when will they be executed. These other plans are such as configuration management plan, test plan, validation and verification plan, and change management plan. While the quality plan and the project plan help ensure that the project will be on time, within budget and that the product will meet the requirements of the customer, the other plans will help managing the production of the project specific deliverables.

Apart from the quality plan, the Procedure Manual should also be tailored to suit the project requirements since not all the procedures in the Manual are needed for the project. However, in some special cases, additional procedures may be required. Just as the Quality Manual spells out what the organisation intends to do to comply with the ISO 9001 standard and the Procedure Manual specifies how this

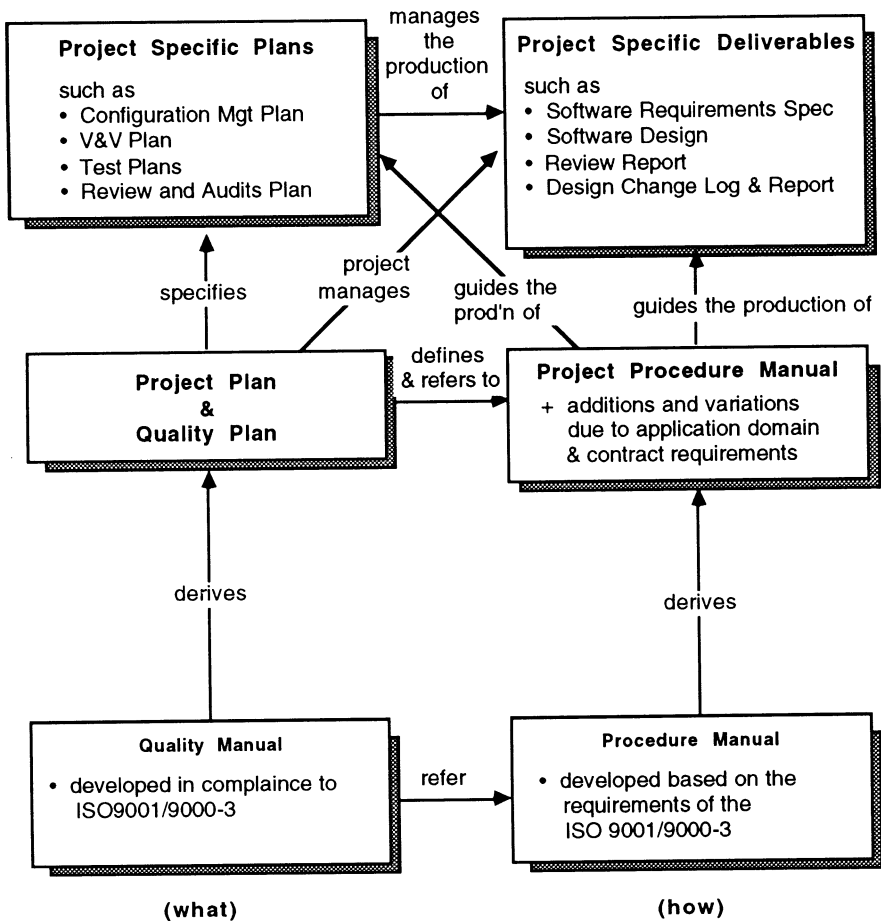


Figure 2: SQMS Application Documentation Structure

compliance will be done, the quality plan states clearly what the project will do to satisfy the customer's quality requirements and the project procedure manual on how these requirements will be met. Quality planning is the job of the Project Manager assisted by the project QA while the QA Manager can act as consultant to the project team.

3.2 Quality Control

Quality control (QC) is the quality plan in action. It has two clear goals. It ensures that the project documentation complies with the standards specified and that the software product meets the customer's requirements. It is at this stage that various quality related plans will be developed and executed, and project procedures manual will be used

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to produce project deliverables. Through the feedback from the QC activities, it may be necessary to adjust the quality plan and the project plan.

The most effective way to control quality of the product is through self control [7]. It is therefore important to stress that the job of quality assurance is to ensure that prevention and appraisal activities are in place in the project and being used. The producers however are responsible for the quality of their product. QC activities will also provide valuable feedback to the QA Manager who in turn can evaluate the usefulness of the Quality Manual and the Procedure Manual and take appropriate corrective action.

4. COMPLIANCE

Developing, installing and finally applying the SQMS to specific projects require substantial investment with a lot of people and other resources involved. In order that this investment would not be wasted, compliance must be enforced. Sometimes compliance is required by the customers and certainly by the accreditation body if the organisation wants to obtain certification. The model proposed to encourage and enforce compliance adopts a four-prong strategy - quality assurance, management review, internal auditing, and certification. The following discussion will describe each aspect in detail, highlighting the functional groups involved and their respective working relationship. In all, the QA Manager plays a central role in standard compliance. Figure 3 depicts the model graphically.

4.1 Quality Assurance

In the organisations where SQMS has been installed, two functional groups take on the role of quality assurance (QA) - the QA staff function and project QA. Obviously the QA staff function, headed by the QA Manager, is responsible for the development of the SQMS. They solicit senior management's commitment to quality and carry this commitment into developing the SQMS for the organisation. However, the application of the SQMS to specific projects is the responsibility of the project QA. The project QA is a different functional group and its personnel form part of the project team under the management of the project manager. Having the project QA as part of the team is an important concept. To be successful in introducing quality activities into project environment, QA personnel must not be seen as outsiders acting as policemen. Being part of the team helps a long way to avoiding such an unhealthy perception. Also, being part of the team and introducing quality control (QC) activities from within the team environment will reinforce the point that QC activities are part and

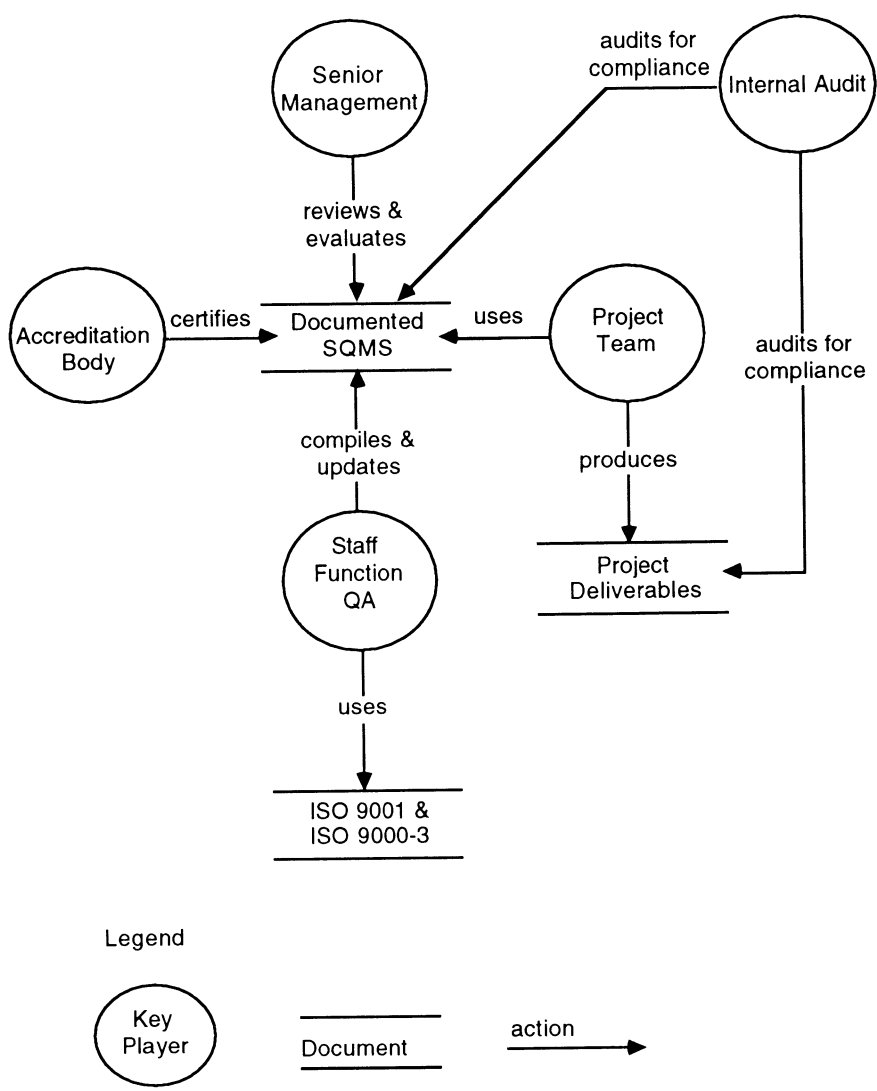


Figure 3: Standard Compliance Model

parcel of software development work. They are not activities introduced by someone from outside who try to make life difficult for the project team. Furthermore, in this arrangement the QC activities will more likely be budgeted for, scheduled, and have adequate personnel resource allocated. Once the SQMS has been installed, the staff function QA will work closely with the project manager and the project QA to help translating the Quality Manual to quality plan and tailoring the

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Procedure Manual to suit the project needs. Project QA is responsible for managing all the quality control activities in the project. They will also collect project related quality metrics.

4.2 Management Review

It has been pointed out time and again that management commitment is vital to the success of the development and installation of the SQMS. Their involvement comes mainly in the form of regular, formal and systematic management reviews. While only the management can commit the organisation towards quality, it is the staff function QA who will act as the catalyst. Management review is an important channel for staff function QA to educate management on quality as well as to keep them in touch. If management takes the opportunity through review to demonstrate that compliance to standard is vital to the survival of the business, the chances are that employees will pay much greater attention and care to the development of SQMS and its eventual use. Management review should also include assessment of the internal audit result.

4.3 Internal Auditing

Internal auditors, being the eyes and ears of management, have the responsibility to ensure that compliance is adhered to. Staff function QA should cooperate with and involve the internal auditor during development and application of the SQMS. The internal auditors must also be trained as an ISO 9001 Lead Assessor so that they have a clear understanding of the quality system requirements. What is important, however, is that the staff function QA should never fill the role of the internal auditor. They both have legitimate, separate yet complimenting function. Having both functions carried out by the same group not only creates a conflict of interest, but also makes both jobs ineffective. Compliance is needed both prior and after the SQMS has been installed. Prior to installation, compliance is needed to ensure that the Quality Manual and the Procedure Manual meet the requirements of the ISO 9001 standard. After the installation, compliance is needed to ensure that the SQMS is being used and used properly in specific projects. In the first case, internal auditor works closely with the SQA, while in the latter case the project team is included. It is at this stage the organisation will be able to know if it is ready to be certified. It is a lot cheaper to have the internal auditor sorting out the problems with staff function QA prior to certification than for the external auditor, on behalf of the accreditation body, to identify problems.

4.4 Certification

The external auditor (or officially called the Lead Assessor) normally carries

out the certification process on behalf of the accreditation body. Certification is a relatively simple process especially when the internal auditor has already done his job properly. Certification provides a definite target and sometimes can act as a positive stimulant for those involved to strive for it. It could therefore be a powerful instrument in the hand of the staff function QA to enforce compliance. Staff function QA is responsible for the certification process and he will work closely with both the internal and the external auditors.

5. CONCLUSION

One recent survey [8] of American companies shows that forty two percent of the organisations have not even begun the quality journey. Four percent rely solely on slogan while twenty four percent think that improved testing will do the trick. Only nine percent of the organisations concentrate on process improvement. To many organisations, software quality assurance is a fancy name for testing. However, any significant improvement in quality comes from improvement in the process of software development. This will only happen when everyone is following the same process in a standardised fashion. Although SQMS is not a cure for all ills, yet a SQMS based on the ISO 9001 does give a firm foundation for process improvement. The Standard itself, coming from the collected experience of many who have trod the path of quality journey, is well thought out. With people gaining experience through implementation, ISO 9001 accredited SQMS will become a force to be reckoned with.

An organisation cannot expect that quality can be bought by throwing a large amount of money into a programme and everything will work out fine. Quality quest is a journey and requires commitment and stamina. Quality does not just happen, it takes careful planning and hard work. The approach outlined in this paper indicates clearly that the successful installation of such a SQMS cannot depend on just a few selected personnel in the organisation but everyone. This paper provides sufficient details about the organisation structure, relationship amongst functional groups and their respective roles, and documentation structure needed to achieve development, application and compliance.

With the worth of world information technology market would probably reach \$570 billion (IDC Australia) by 1994, that means any company with an international perspective must take a serious look at the ISO 9000 standards. In the near future, the IS area of such companies might well be asked to show compliance.

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