ISO QUALITY MANAGEMENT SYSTEM: A LESSON FROM KLIA

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Abstract

This paper reports the ISO 9000 implementation at the construction of Kuala Lumpur International Airport (KLIA), a prestigious multibillion dollars project commissioned by the government of Malaysia, and presents a set of guidelines to effectively implement ISO quality systems in large construction projects. The study being undertaken for the past three years has been sponsored by the IRPA (Intensification of Research in Priority Areas), a premier national funding agency. The complete history of the ISO implementation in KLIA right from the inception of the project until its completion was studied through several means including a series of interviews with staff, and archival studies of quality records and voluminous implementation documents. This paper, while initially highlighting the pitfalls observed in the implementation stage and other major problems as identified from the quality records, finally proposes a set of guidelines. The guidelines are conceptual and broadly address the major issues that are critical to the implementation of the ISO Quality Management System (QMS) in large construction projects. They should be seen as an aiding mechanism to improve the quality performance of the construction participants. It must also be noted that the guidelines have been developed from the perspective of the Client (Owner).

Keywords: ISO 9000, Quality Assurance, Performance Improvement, Owner's Role, Quality in construction, Quality system

Introduction

Since the last decade, the Malaysian construction sector has been going through a radical change driven by the (ISO) quality policy of the Malaysian government. Recently, the number of contractors obtaining certification of ISO 9000 Quality Management System (QMS) is ever increasing. However, this progress seems to have been triggered by the Ministry of Works and 'quality awareness' and 'Do It Yourself (DIY)' programs organized by the Construction Industry Development Board (CIDB). However, with lack of experience on ISO quality implementation, the construction participants are floundered with several performance-related problems. As observed by Hock (2000), for instance, poor ISO quality management practices in public works in Malaysia have attributed to low productivity, cost overrun, time overrun and poor quality. His study suggested that best practices conducive to the Malaysian construction environment be developed and the present problems attributed to the ISO implementation in public works be efficiently addressed.

The pressure also comes from the ongoing process of economic globalisation. Experience of other countries such as United Kingdom, Singapore and Hong Kong revealed that QMS implementation was very encouraging at the initial stage but over a time period became burdensome to all parties involved if the right approaches were not adopted (Giles 1997; Chong 1994; Kam and Tang 1997; Low and Goh 1994). In the United Kingdom, some of the construction industry clients made it compulsory that the contractors implement ISO quality system in their organizations to qualify for bidding (Giles 1997). As a result, a tremendous impact was observed with more and more contractors seeking for ISO certification. Consequently, marketing and customers' insistence have become the key factors driving the ISO

implementation, which are generally short-lived (Pateman 1994). The quality consultants might further worsen the situation as many of them do not have construction background, hence do not understand the construction process (Giles, 1997). The organisations will normally be trapped in the vicious circle of compliance that is inflexible and put much emphasis on bureaucracy, paperwork and deficiency in quality improvement (Karapetrovic 1999). In addition, people resistance to change in implementing the new system will create more management problem (Al-Nakeeb and Mustapha 1994). As a result the implementation of the ISO system will not earn benefit to the company and neither will satisfy the requirements of the customer.

A detailed investigation was therefore required to study the major problems faced by the Malaysian construction industry in implementing ISO 9000 so that the most expedient and effective way of implementing QMS could be identified. With this backdrop, a strong research team, comprised of several leading researchers in Malaysia, studied the recent Malaysian construction project, KLIA (Kuala Lumpur International Airport), which implemented ISO quality system right from the early period of the project. It was a great challenge for the KLIA Construction Management Team to implement the ISO quality system in a large project, which involved nearly 150 major contracts with more than 110 major contractors and 1600 interfaces between participants.

The case study was accomplished using two major techniques; archival studies and interviews. Archival research was conducted by analysing monthly reports of the project, implementation documents, and quality records dealing with deviations and non-conformance. The main observation concentrated upon the actual implementation of the quality plans by the key parties

including the project manager (the Client's Representatives), the consultants and the contractors. Archival techniques have to be adopted because, except few, all consultants and the contractors were not normally available on-site as the project had been already completed. Fortunately, the project manager (KLIAB – Kuala Lumpur International Airport Berhad) was still available on site to provide all relevant information. Therefore, interviews were conducted with the KLIAB's staff and other available parties including contractors to both obtain information about the implementation and verify the archival data. Data were collected for the years 1995,1996 and 1997, covering the whole period of construction and completion. This paper reports the problems faced by the parties in the implementation process and respective remedies (guidelines) for improving quality performance.

The method and scope of the research

This research, primarily being conducted by the research team based at UTM (University Technology Malaysia) has been collaborated by the KLIAB, the client's representative of the KLIA. The case study approach has been the prime source of information for the nature of the inquisition involved in this research. The research involved three main phases: preliminary investigation, case study, and data analysis and guidelines.

Preliminary investigation

Having realized the dimension and complexity of the case project, a preliminary on-site investigation was preferred to familiarize with the case. It enabled the research team to fully observe the nature of work and functional relationships between the project participants. It further led to identify the accessibility and availability of the required information. For instance,

the sources of data collection were limited to interviews and archival techniques (i.e. content analysis of the quality records) as the case project was physically completed. The preliminary investigation also enabled to refine the research question that was initially set at the outset.

Case study

The KLIA project involved as many as 147 contracts, ranging from RM 1million to RM 162million. The total estimate of the project was approximately RM 7 Billions. More than 110 organizations were involved and 1600 interfaces between subcontractors were identified. The organizational structure of the project is illustrated in Figure 1, which shows only the structure of the project management organization. The KLIA project was comprised of more than 100 facilities divided into eight distinct groups of construction packages: passenger terminal complex; runways and aprons; earthworks and drainage; perimeter roads; central terminal area; southern support area; air traffic services; and utilities. To ensure the completion of the project, the Malaysian Government established Kuala Lumpur International Airport Berhad (KLIAB) as a project manager acting on behalf of the government. Eighteen consulting organizations were appointed to assist the KLIAB in managing the KLIA project.

(Figure 1)

Even a little conflict between parties or delay in work resulted in tremendous negative impact to the whole project schedule and made the project co-ordination and management more complex. Further, KLIAB had only 36 months to complete this construction project. Another important factor to bear in mind is the fact that this project involved more than 25000 employees from over

51 countries. Cross-culture interactions resulted in contradicting work culture, and language barrier posed many unavoidable problems.

Initially, a review of the processes and procedures involved in the management of ISO in the KLIA project led to identify the critical ISO elements in construction projects. The QMS plan implemented in the KLIA project was referred to as Project Quality Plan (PQP). The critical quality elements were identified by two investigations: the percentage use of the quality elements in the PQP of KLIAB; and the major elements that attributed to 80 percent of the discrepancies observed from the audit reports. As a result, eight critical elements were identified: 1) management responsibility; 2) quality planning; 3) resources management; 4) process control; 5) inspection and testing; 6) quality recording; 7) auditing; and 8) data analysis and report. These elements were treated as the units of analysis in subsequent case study investigations.

Further investigations were directed to identify the problems and discrepancies faced by each party in the implementation stage. This provided a basic framework for approaching the overall implementation system. Having identified the critical quality elements and observed the discrepancies and implementation problems, the appropriate constraints, methods and information required to effectively address the critical elements were identified using the delphi approach. In this approach, all relevant staff members of KLIAB were assembled where the initial findings were presented and finally, each critical elements and associated problems were discussed and appropriate measures to overcome the problems were formulated. This led to the development of guidelines for effective implementation of ISO 9000 in construction projects in Malaysia.

Data analysis

The main sources of data collection were from 'content analysis' of quality records and interviewing the key personnel of the project. As a secondary source, documents such as PQP and quality records were used to supplement the data obtained from the interviews. A demonstrable coincidence between the findings of the interviews and their occurrence in job-site was observed.

The qualitative data obtained from both the case study and the delphi approach was used to formulate the guidelines. Further the IDEF0 technique was used to develop a system that illustrates the relationship between the critical elements. IDEF0 is one of the refined approaches of the well known Structured Analysis and Design Technique (SADT) (Colquhoun et al 1993, Hassan 1996). The IDEF0 technique shows the relationship between entities, the input, constraints, mechanism and outputs for respective processes.

ISO implementation- problems and performance of the Contractors, Consultants and KLIAB (Project Manager)

KLIAB produced a detailed QMS (Quality Management System) including the PQP (Project Quality Plan) whilst all the supervisory consultants and the contractors produced their own quality plans and submitted to the KLIAB. The elements contained in the quality plans were

used as minimum requirements for the implementation of the QMS against which the consultants and the contractors were assessed for the extent of their conformance.

The Contractors

The major elements contained in the contractors' quality plans were;

- the scope and techniques to execute the work,
- testing and investigation,
- provision of qualified personnel,
- provision of fit for purpose plant and equipment, and
- documentation of the implementation.

These elements were considered to be the minimum requirements to be implemented by the contractors. At the initial stage of the construction phase, i.e. in 1995, the contractors were naïve on the implementation of the QMS. Most of the contractors did not submit the quality plan for KLIAB's approval even though it was clearly indicated in the agreement. Without this key document it was impossible to implement the QMS. Some of the quality plans submitted were incomplete and therefore were not approved by KLIAB. Consequently, many works did not meet the Contracts and KLIAB's requirements. The consultants frequently issued the Non Conformance Requirements (NCR) to the contractors for the failure and non-compliance with the stipulated QMS procedures. For instance, in June 1995, the consultants issued eleven NCRs to the contractors due to their ignorance of the procedures and in November 1995, an average of thirty Notices Of Deviation (NOD) were issued to the respective contractors.

Mainly, the NCR and NOD were issued to the contractors for the following reasons:

- the contractors did not submit or were late in submitting the quality plan,
- the works were not in accordance with the specification and KLIAB's requirements,
- the records of work were inconsistent with the work executed on site,
- non-compliance with the stipulated rules,
- non-conformance with the quality plan procedures, and
- inefficient documentation.

In 1996, the contractors were becoming aware of the importance of QMS and started to give attention to relevant procedures. Most of the contractors had submitted their comprehensive quality plans, and gained approval for the plan from KLIAB. At this stage the contractors faced several challenges to materialise the quality requirements into reality. The analysis of the contractors' performance of this particular year shows that they were having difficulties to implement the QMS in practice. The NCR and NOD reports of the concerned year indicated that the following problems still prevailed.

- non-conformance with the quality plan procedures,
- the records of work were inconsistent with the work executed on site, and
- non-compliance with the stipulated specification.

In spite of the inconsistency, the efforts shown by the contractors to fulfil the quality requirements were regarded as a positive development as they began to learn and understand the needs of implementing the QMS. The main contributing factor to the improved performance of the contractors was the training offered by the KLIAB. To ensure the continuous improvement

of the contractors' performance, KLIAB worked and monitored the progress closely with the contractors.

In 1997, the contractors' performance was much better. They began to implement most of the quality plan procedures. There remained however several deficiencies to be remedied such as non-compliance to certain procedures, poor documentation on the implementation of certain procedures and a great number of NCRs.

In conclusion, the contractors were continually learning the implementation of the QMS. They were undergoing a change process from the traditional methods of managing their construction works to an efficient and systematic way through the QMS. The contractors could not be blamed solely for the shortcomings as they had no prior experience in implementing the QMS and it was comparatively new as well to the construction industry in Malaysia.

The Consultants

Similar to the contractors, the performance of the consultants was evaluated using the requirements contained in their approved quality plan. The requirements were;

- checking the contractors' method statements and testing procedures covering all scope of works under their obligation,
- checking the contractors' corrective procedures,
- conducting audit and instigating other checks of the contractors' work to ensure that the contractors exercise quality control,

- setting up procedures to determine the conformance of the construction materials to the specification,
- develop procedures for keeping and controlling records and documents,
- develop procedures to control and handle substandard works, and
- develop control system for managing variations in works.

In the first half of 1995, only one requirement was complied by the consultants; i.e. checking the contractors' method statement and testing procedures. The consultants were inexperienced in implementing the QMS and had similar difficulties as the contractors in adopting a new system of supervising construction works. The consultants reacted positively however, to improve the situation. In the second half of 1995 they started to fulfil all the requirements by beginning to develop the procedures but as the construction work commenced, a lot of works were done without proper auditing and checking.

Auditing of the contractors' work was inconsistent, as a result, construction works were not able to be efficiently evaluated to check for the conformance of the specified requirements. Documentation systems were not properly exercised including the critical activities such as procedures for testing materials, which resulted in difficulty in checking the reference and controlling the documents. The shortcomings of the consultants had a negative impact on the total implementation of the QMS.

In conclusion, the capability of the consultants in 1996 was considered poor and the extent of the implementation of the QMS was unsatisfactory. KLIAB as the project manager who was

responsible for initiating the QMS had taken a serious effort to improve the consultants' level of understanding and awareness of the QMS by giving them regular advice, training and seminars.

In 1997, the working culture of the consultants towards the QMS had changed significantly. Their works were in accordance with their quality plans. Auditing against the contractors' works was undertaken properly. Despite the outstanding performance, there were some minor drawbacks such as poor documentation. Even though these minor drawbacks were negligible but they were fairly important to consistently achieve high quality at work. The key lesson is that it is imperative to train the consultants before they begin supervising the contractors' works because they are the critical agents to ensure the success of the implementation of the QMS.

The Project Manager (KLIAB)

The main responsibility of the KLIAB was to ensure that the QMS was executed efficiently. As a leader of the project, the KLIAB produced its quality manual before the commencement of the construction phase. The elements contained in KLIAB's quality plan were;

- clear definition of the project,
- structure of the organisation,
- the responsibility of each management level,
- the process involved,
- necessary resources,
- implementation procedures, and
- methods to ensure implementation and project control.

KLIAB had exercised all procedures stated in its quality plan, including documenting processes and procedures, auditing against the consultants, and verifying the audit done by the consultants against the contractors. Several faults, weaknesses and unnecessary procedures had been identified through this process and corrective measures were applied according to the procedures stated in the quality plan. To improve the performance of the parties, the KLIAB conducted training through a series of conferences, seminars, workshops and meetings. The purpose of the training was to educate the consultants and the contractors to appreciate the importance of the QMS, to clarify their function and the responsibility, and to guide them towards effective ways of conducting audits. The training given by KLIAB boosted the level of understanding of the consultants and the contractors on the implementation of the QMS and changed their working culture.

Notwithstanding the fact that the KLIAB had complied with all the requirements stipulated in its quality plan and had claimed considerable success in implementing their quality plan, there were few shortcomings apparent on its part as well. Through a series of interviews with the managers of KLIAB, it was found that at the initial stage the KLIAB staff were so sceptical to comply with the quality plan. However it managed to overcome the situation through the awareness programs. Even though KLIAB had planned for a matrix organizational structure, where, a quality manager should report to the project manager and at the same time to his/her head of department, in practice, it was not achieved. In practice the quality manager reported to his head of department, in turn, the head of department reported to the project manager. In addition, responsibility and decision making authority was not sufficiently delegated to the subordinate organizations, which resulted in slow resolution of even the most minor problems.

Critical elements of ISO 9000 at KLIA

KLIA's experience, as discussed above, shows that the parties finally managed to perform well by learning from their mistakes. In addition, continuous training has been vital for the parties to successfully implement QMS (ISO) in construction. However, several Malaysian companies are sceptical in adopting ISO system as they lack proper application methodologies in construction environment.

In addressing the above problem and help construction parties to efficiently implement the QMS in construction project, key measures as observed from the lessons of the KLIA were identified through the research methods as discussed early in the paper, and consequently, a generic framework along with implementation guidelines were developed.

As mentioned earlier, the critical elements were identified by assessing both the percentage use of quality elements in the PQP of KLIAB and the elements that attributed to 80 percent of the discrepancies as observed from the audit reports. To assess the percentage use all procedures in the PQP were assessed one by one as to which ISO 9000 quality clauses they were referring to. Finally, the percentage frequency of use of each clause was summarized. Figure 2a shows the percentage use of quality elements in the PQP of KLIAB. It can be noticed from the figure that six elements attribute to a sum of approximately 90 percent of the usage. They are as follows:

Clause 4.9 Process control (43.3%)

Clause 4.5 Document and data control (14.2%)

Clause 4.8 Product identification and traceability (11%)

Clause 4.10 Inspection and testing (9.4%)

Clause 4.16 Control of quality records (6.3%)

Clause 4.9 Management responsibility (4.7%)

(Figure 2a and 2b)

Alternatively, audit reports were also analysed to identify the discrepancies in the implementation of the system. The term 'discrepancy' here refers to non-conformance of quality procedures by the major parties. Figure 2b collectively illustrates the percentage frequency of discrepancies for all the three parties. It can be seen from the graph that the most critical elements that contributed 80% of the total discrepancies, in the case of PMC, were *document and data control, control of quality records, quality system, and management responsibility*. For the Supervisory Consultants, they were *control of customer supplied product, quality system, document and data control, and control of quality records*. The critical elements for the Contractor included *quality system, inspection and testing, control of quality records, and process control*. It is very clear from the above observations that most of the critical elements are common to all the three parties. If the results of Figure 2b are corroborated with the earlier findings (Figure 2a), it is evident that both concur with each other on the commonalities of the critical elements. As a result, eight elements were identified as critical in the implementation of ISO 9000: 1) management responsibilities; 2) quality planning; 3) resources management; 4)

process control; 5) inspection and testing; 6) quality recording; 7) auditing; 8) data analysis and report.

Guidelines: a lesson from KLIA

Figure 3 illustrates the framework showing the major critical ISO elements, their linkages and respective mechanisms. The framework along with the guidelines was developed from three-dimensional sources, viz. the PQP of the KLIA, critical element analysis, and expert opinion obtained through Delphi system. In the Delphi approach, five leading staff of the KLIAB who had first hand knowledge of the QMS implementation at KLIA and a representative from the external supervisory consultant of the KLIA were involved. Several rounds of discussion were performed in two sessions. This exercise much helped to develop the framework and formulate guidelines for effective implementation of ISO 9000 in Malaysia. Having this framework, one can easily understand the complete system and respective procedures and involvement of the parties. The framework shows the complex relationships between the major components of the QMS and their respective inputs, outputs, and control mechanisms. The details of the framework followed by respective guidelines are provided as below.

(Figure 3)

Management Responsibility

The role of the senior management is key to the success of the QMS implementation. Starting from the establishment of the quality policy and project specific quality plan, right through the

implementation including employee training, monitoring and until the final auditing, the management has a greater responsibility without which the success of the programme is quixotic. The key input for this process as stated above shows that at the earlier stage of the project, the management focuses all its efforts in incorporating the customer's requirements, which is available in many forms including briefing and contractual requirements. This in turn is compared with the capability of the organization as to whether the organizational resources are available to undertake the activities to achieve the client's requirements. The company QMS becomes the key to achieve the end goal and that throughout the project several coordination meetings are organized by the management to develop plans and solutions, review progress and facilitate the functioning of the whole QMS programme. The key output of this process is project programme and cost programme established in line with the project quality plan. This together with the other outputs including the service of the management, suggestions and other tangible contributions become input to both *quality planning* and *resources management*.

Guidelines – Management Responsibility

- Identify and define the client's requirements in order to establish quality policy
- Ensure that all levels of management and staff understand the quality policy
- Cross-refer the procedures within the text of the quality manual
- Define the responsibilities and authority
- Periodically review the quality system and policy whether it fulfils the intended objective
- Management reviews should be documented and the action list formulated must be implemented
- Arrange training for those who lack proper understanding and skills

Quality Planning

The senior management in conjunction with other parties such as quality consultants hold series of quality meetings to produce suitable quality plan specific to the project. Since it is a project specific plan, the plan should reflect the objective and expectations of that particular project. Therefore, project specific information including project scope, contractual requirement, and resources availability should be considered to develop the plan. Experience from the past projects becomes a valuable input to this plan development process. Customer requirements observed at the early phase are translated into quality requirements of that project, and it forms key to define quality of the particular project. The development of the plan should simultaneously consider the existing quality standards (e.g. ISO 9000) being practised in the industry. Company quality manuals, contractual specifications, project programme and cost programme all become directives, and within their context, the plan need to be developed. Otherwise, the Project Quality Plan (PQP) may not reflect and be suitable to the project requirements. The key outputs of this process are quality plan, inspection and test plan and audit plan. The content of the PQP not only dictates the quality system required of the concerned project but also it incorporates the scope and expectations of the project and the project control mechanism. The output of this process becomes input to most of the other processes including *process control, inspection and testing,* and *auditing.*

Guidelines – Quality planning

- Ensure that all relevant parties including consultants, if any, are included in the task of quality planning for the project

- Establish and define the purpose of the quality system
- The plan should as much as possible minimize the efforts required to amend copies of documents
- If required, set up a quality system development team, as it will give a sense of ownership to the team so that the team can constantly foresee opportunities to develop the quality system
- Ensure that the customer requirements are constantly focused throughout the quality planning task

Resources Management

Resources management includes identifying, analysing, deploying and monitoring the resources required to undertake the project activities. Right from the early stage of the project, resources are analysed taking into account the project and cost programme. Information related to company capability becomes key in managing resources. It includes resources availability within the organization and the capability of the resources in undertaking the work task. It is commonly understood that inefficient resource analysis leads to poor productivity and quality in the later stages of the project. Project management team or the project manager is the key person responsible for this task. Proper recruitment procedures must be adopted to recruit the right personnel and or hire right equipment and other infrastructure at right time. Resources being capable of undertaking multiple tasks are key to the successful completion of the project, therefore, all necessary measures must be undertaken to develop the resources capable of handling different tasks. Quality plan, contractual specifications and other statutory

requirements must be considered in the resource management process so that the result of that management will comply with the project requirements.

Guidelines – Resources Management

- Ensure that resources are analysed in advance onto their availability, skills and capability
- Establish programmes to develop the multi-skill of the labour resource
- Ensure that resources are properly trained to undertake the respective tasks in the project

Process control

It involves a detailed analysis of the construction business process as to the delivery, resources requirement, and value it is likely to offer to its customer. First, each process must be identified for its owner so that it will have a definite person to control it. Customers' requirement can be achieved only when the process related to the business is constantly improved. Process improvement can be effectively undertaken by adopting some established proven techniques such as SPC, business process reengineering, value engineering, and corrective and preventive actions. All process improvement and controlling efforts must be directed towards the overall achievement of the project objectives, which can be effectively achieved only when such controlling activities are done within the constraints of the PQP and the contractual specifications. The techniques as mentioned above are for the improvement of the ongoing processes, but in the long run, processes can be improved and effectively controlled by gathering data from the 'auditing' process and analyse them for the future use. Resources management initiatives as explained above are important for effectively controlling the process. The data or

the information obtained from both the on-going processes and past performance should be recorded for future use.

Guidelines – Process control

- Ensure that the work is carried out at controlled conditions
- Define the process specification and workmanship standards to be achieved
- In-process monitoring and in-process inspection and tests rather than external inspection are key to control the process
- All processes should be capable of performing the task for which they are designed.
- Train and qualify site/construction workers with required skills

Auditing

The auditing process is comprised of a series of tasks to be performed periodically throughout the project. It includes planning and preparing for the audit, doing the audit, reporting the result, and taking a follow-up action on them. PQP should set a guideline on how to perform audit. Resources required for the audit have to be provided by the process of resources management. Apart from the auditing of the relevant elements, the construction process itself has to be audited for its performance output and non-conformance. This requires the process owner to be involved in the auditing process. Audit plan and PQP will form the norms for systematically undertaking auditing. The data collected from the audit and the results obtained from the analysis will be used by several other processes for improvement including the process controlling, inspection and testing. Finally, all information including audit reports are recorded for future use.

Guidelines – Auditing

- Ensure that the auditing process is directed towards the process and performance improvement
- Ensure that the auditing process does not intend to punish the parties for failure
- Publicize the audit results so that everyone is aware of the overall outcome of the project
- Do not rely much on external consultants for quality audit and ensure that the audit is performed internally for process improvement as well

Inspection and testing

The process of observing, verifying and evaluating the completed work is called inspection and testing. The inputs required to this process are varied and originated from different sources including resources management, quality planning, and auditing. The PQP becomes the main source of procedure for inspection and testing, and the resources management being the source for the deployment of the equipment and infrastructure required for undertaking testing activity. Both the input (raw materials) and the output including final products and services are tested for conformance and requirements. Apart from this, the on-going process is continuously checked for its performance, which is called in-process inspection. Audited data on past processes forms input as a referral material for the current inspection. Contractual specifications, inspection and test plan control the 'inspection and testing' activity to ensure that testing are not unnecessarily performed and are done right towards the overall objective of the project. All data and results obtained through this process are recorded for future use.

Guidelines – Inspection and testing

- Define the criteria for acceptance of goods
- Prepare procedures for inspecting and testing of incoming goods
- Document inspections and tests
- Provide a means for improving the inspections and tests and for identifying those responsible for carrying them out
- Define what is to be inspected at each stage and identify inspection and test equipments to be used

Quality recording

Quality records containing the results of quality-related activities need to be maintained to demonstrate the effectiveness of the system and for developing strategies for performance improvement. All results and reports produced from process control, auditing and inspection and testing activities must be recorded and maintained for future retrieval. The filing system forms the main base for recording the data. However, while recording the data, the appropriate protocol as stated in the PQP and other statutory requirements must be adopted.

Guidelines – Quality recording

- Identify and decide on all quality records that are required to be documented
- Provide submission and collection instructions in relevant procedures
- Records should be filed in sequence
- Maintain the registers listing the records in numerical order
- Proper conditions of storage should be ensured to prevent loss

- Proper records disposal system should be maintained
- Security of quality records should be ensured
- Establish conventions for numbering, dating and revision status
- Users should participate in the documentation planning process
- Provide labelled binders for range of documents
- Invalid and obsolete documents should be promptly removed
- Establish standard ways for identifying obsolete documents
- Document custodians should be provided with stamps for the receipt of records and issuance of the same
- Create a formal change request mechanism for initiating changes to controlled documents

Data analysis and reporting

At every stage in the implementation of the PQP, respective data need to be collected and analysed. All data need to be analysed appropriately using the right approach and techniques. Finally, the results of the analysis should be reported to the right department or the authority. Several techniques including SPC and benchmarking can be used. One of the major objectives of this analysis is to assess the overall performance of the PQP implementation system, which can be effectively performed by reviewing the QMS collectively by having all relevant data from respective sources. PQP should have set the norms to undertake this process. Properly established reporting system should be able to channelize the documents to respective people and authority. The results of the analysis will form the basis for the overall improvement of the programme.

Guidelines – Data analysis and reporting

- Periodically, conduct survey amongst customers to assess their expectations and complaints and use the data in the overall assessment of the performance
- Establish clearly the source and sink of the results and reports that emerge out of the analysis
- Publicize the overall performance result
- Take corrective actions and formulate future improvement strategy immediately once discrepancies are identified from the analysis

Conclusion

There has been a tremendous pressure on the Malaysian construction participants to adopt the ISO quality system in construction projects. Several studies in Malaysia have highlighted the key problems as discussed earlier in this paper attributed to the ISO implementation in public works and sought for best practices specific to the Malaysian construction environment. This paper while emphasising the dimension of the problem by reporting the difficulties faced by the KLIA simultaneously reports the appropriate measures (guidelines) derived out of the lessons learned from the KLIA. The guidelines can be considered as an aiding mechanism to efficiently implement ISO quality systems in Malaysian construction environment. It is important to note here that the outcome of this study were based on the detailed investigation of the KLIA (Kuala Lumpur International Airport), the prestigious multibillion dollar project recently completed in Malaysia. Being derived out of one large project, the guidelines are subject to further scrutiny for application in a variety of environment. The framework can be flexibly used with little

modifications to design the QMS for construction projects, while the best practice guidelines can be considered for effective implementation of the QMS.

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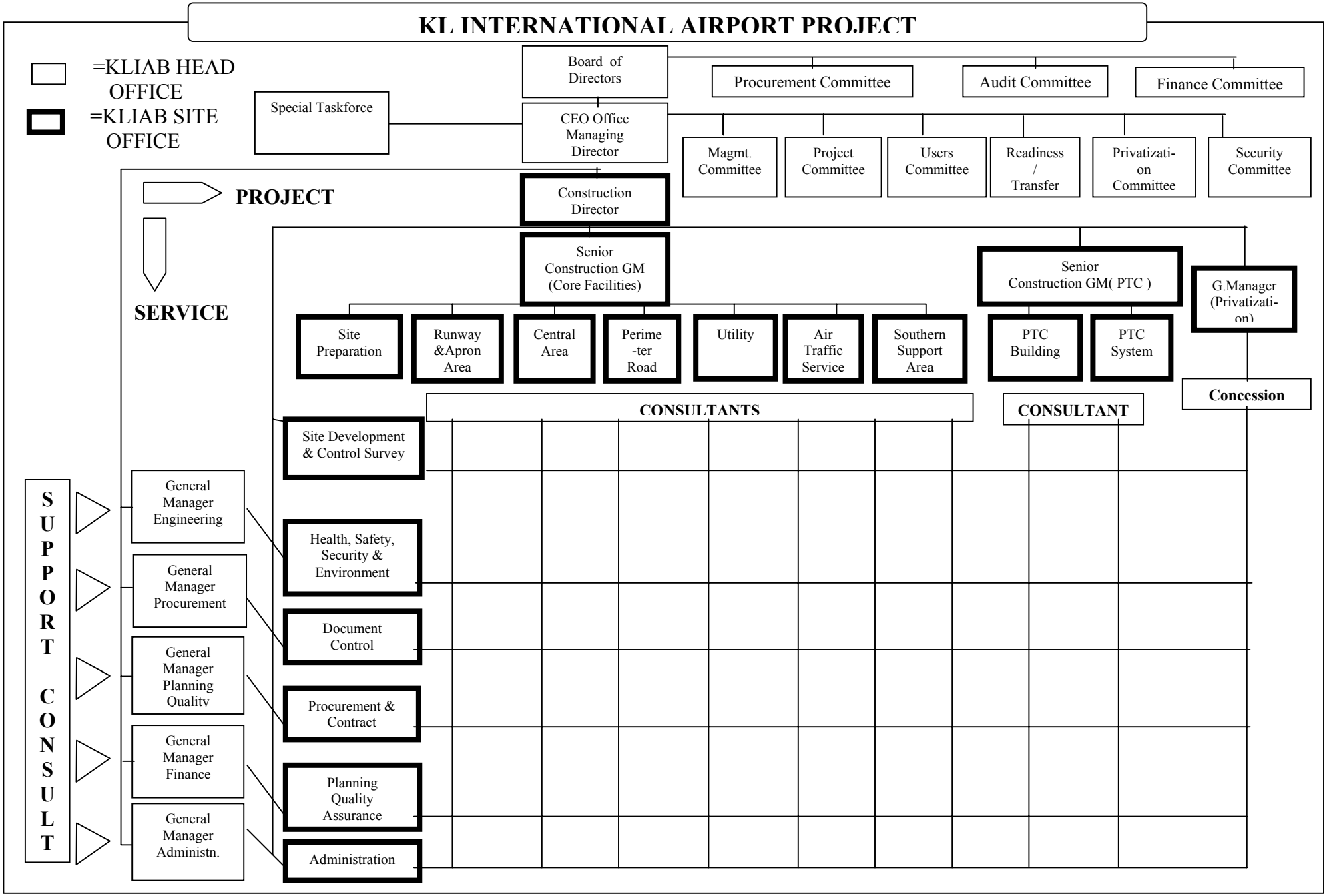

Figure 1. KLIA – Project organization

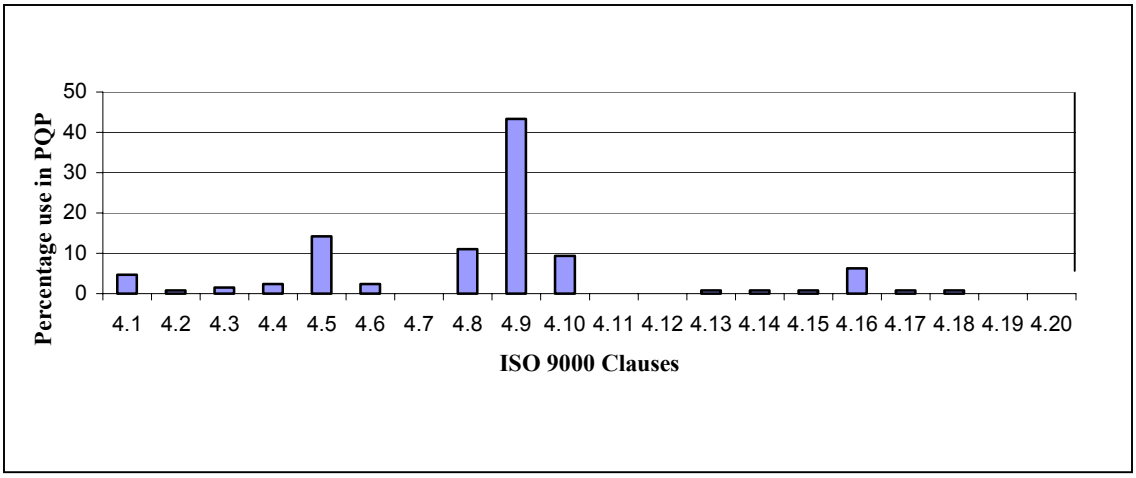

Figure 2a. Percentage use of ISO 9000 elements in the PQP of KLIA

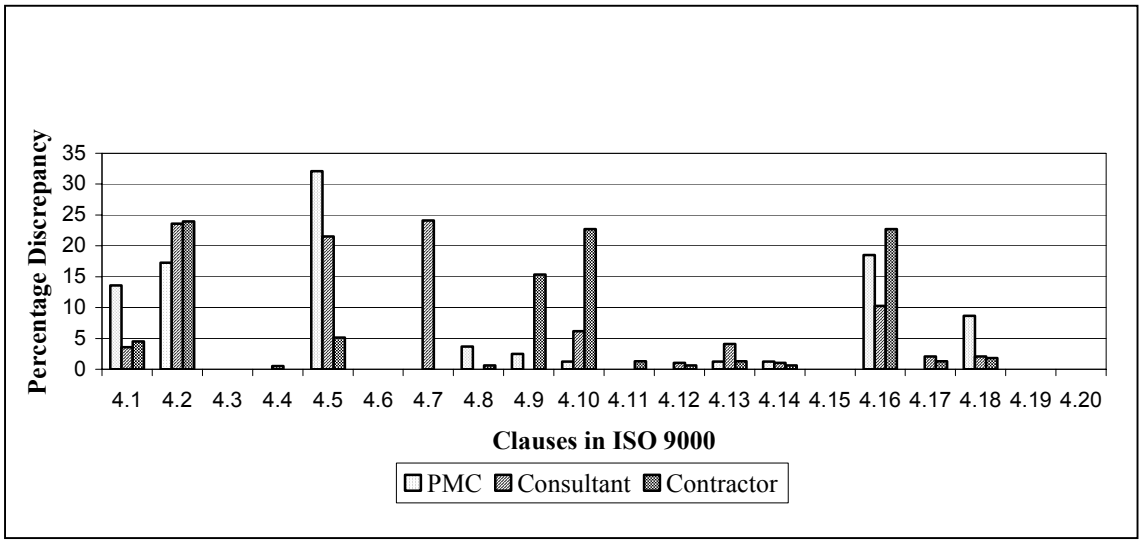

Figure 2b. Element wise discrepancies for the PMC, Supervisory Consultant and Contractors

Legend: ISO 9000 Clauses

4.1 Management Responsibility
4.2 Quality System
4.3 Contract Review
4.4 Design Control
4.5 Document and Data Control
4.6 Purchasing
4.7 Control of Customer Supplied Product
4.8 Product Identification and Traceability
4.9 Process Control
4.10 Inspection and Testing
4.11 Control of Inspection, Measuring and Test Equipment
4.12 Inspection and Test Status
4.13 Control of Non-conforming Product
4.14 Corrective and Preventive Action
4.15 Handling, Storage, Packaging, Preservation and Delivery
4.16 Control of Quality Records
4.17 Internal Quality Audit
4.18 Training
4.19 Servicing
4.20 Statistical Techniques

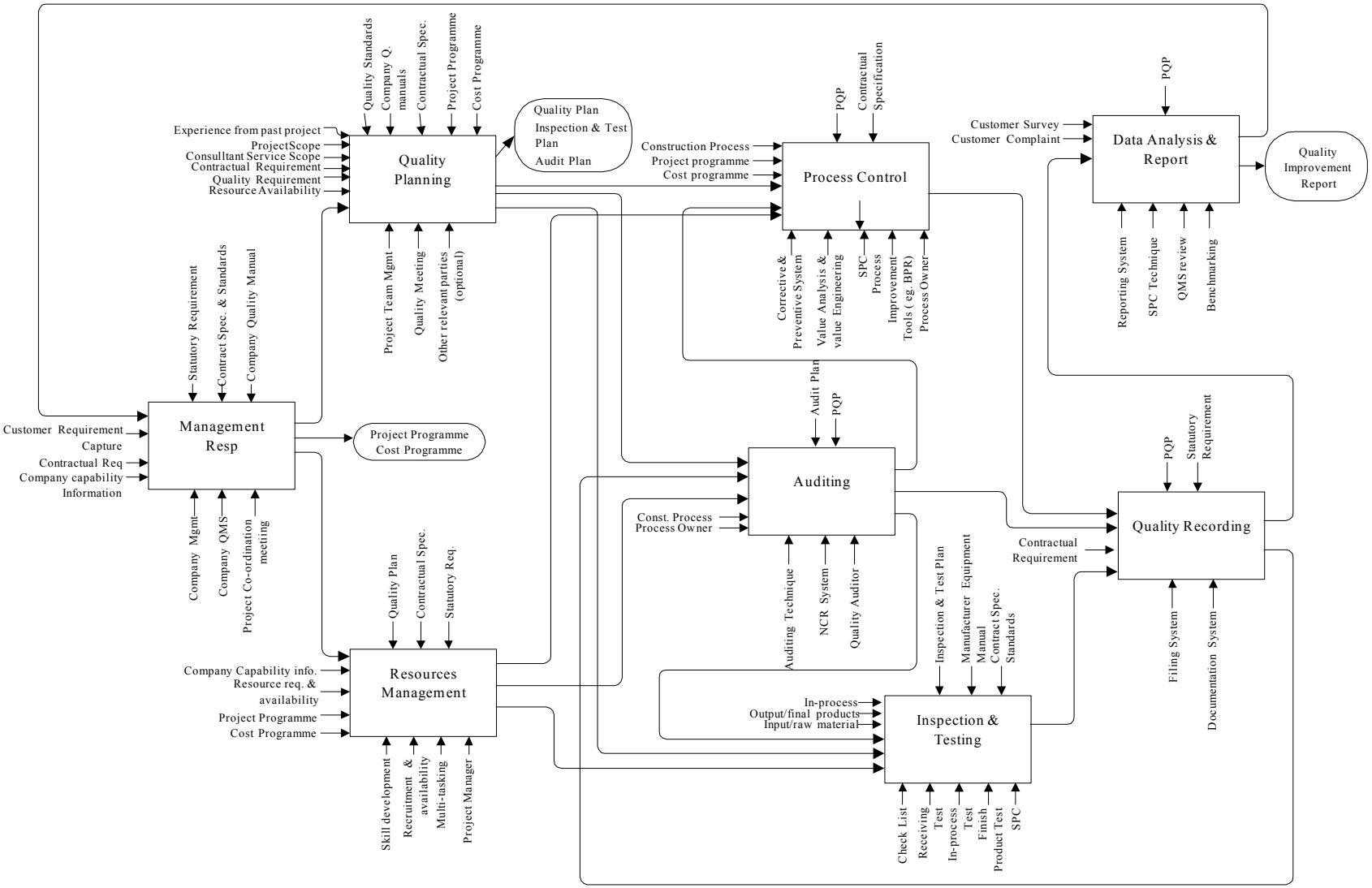

Figure 3. A Framework of QMS