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THESIS

GUIDELINES OF QUALITY MANAGEMENT FOR SMALL TO MEDIUM SIZE CONTRACTORS

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This research study was created mainly to obtain the guidelines for small to medium size contractors to effectively improve their operational management in fulfilling requirements to attain the quality of work expected from them. In identifying issues affecting the performance of these entities, interviews of key staff that have direct experience with these entities and conducting of a survey are performed in order to adequately address each specific need in terms of civil construction works.

The results from the conducted interviews and survey showed that the most important matter to be dealt with is the capacity of small to medium size contractors to provide the necessary documented procedures when required by their employers due to their limited resources resulting in their overly dependent attitude with their respective employers in preparing and providing all the needed procedures not to disregard their limited participation while works are implemented. Moreover, the results also explain the importance and influence of the documented procedures in achieving the required quality of work and how effective they are in managing works due to their methodical application.

This research study identifies the appropriate resolution for small to medium size contractors to enhance their company image not to be necessarily ISO registered but a competitive entity. This study also facilitates these entities in producing their own documented procedures through the provided templates derived from the reference company to readily deliver performance of each requirement via systematic manner. In achieving the "Quality of Work", these templates when used ascertain organized implementation of works.

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To my parents who are always my inspiration, my deepest gratitude through your encouragement, guidance and especially your love.

Peeraphan Tantisuvanitchkul

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INTRODUCTION

General

Consultant Management Organizations are usually hired to oversee big scale projects owned by government or private entities. They function as managers in controlling and monitoring the quality of works being performed under a controlled budget since profit for the project owner is a big factor to consider.

"Quality" is considered as one of the major preset conditions otherwise known as the *pre-qualification* in selecting contractors for mega-projects. As the main concern is how these contractors can provide production fulfilling requirements focusing on the quality of management in particular and the reason why ISO 9000 was created to serve as the standard to upgrade systems of management in performing tasks and responsibilities.

In Thailand, only big contractors are ISO 9000 certified because of their financial ability to cover the cost of all the improvements they need. These include personnel training, quality development programs and document control. As for small to medium contractors, certification of ISO will be of difficulty considering the cost or expenditures to be incurred since their resources are limited and very dependent on the number of projects they are handling. In this proposal, regardless of the size of the contractors, introduction of guidelines extracted from the ISO requirements will be implemented into their system of management which will ensure improvement in their operational practices.

Statement of Problems

Since most of the companies or organizations in the Construction Industry are profit-oriented, the tendency of providing less attention to the quality of their products & services is seen especially with the small to medium scale companies serving as contractors. Moreover, the proliferation of more construction contractor companies is not to be discounted as this will add up to stronger competition with the aim of earning gains with less emphasis on the quality of their works.

From this scenario, an introduction of the applicable requirements from the ISO needs to be implemented into their management system to improve their performance without the necessity of registering for ISO certification. This practice will certainly enhance their company's image regardless of its size. In this research, recommendation for the use of Quality Management is very significant to serve as the standard in providing products and services.

Concerning inspection of works, although some projects are monitored and checked in reference to international standards i.e. British Standard, AASHTO, in some cases these may not apply as some specifications are already provided or part of the requirements by the Owner/Employer or the Consultant if applicable. Some works vary depending on what specifications are to be referred to as in the case of small to medium contractors in which contracts are selective based on their available resources and/or capacities.

In this research, specifications emphasizing the Quality of work as required when performed are utilized to properly ensure that products and services meet requirements as presented in the form of guidelines referenced from an ISO registered company's on going & completed projects and from the ISO itself.

Objectives

To develop and propose guidelines of Quality Management that can be applied to small to medium size contractors to improve the quality of their system with regards to:-

1. Management aspect – Management Procedures

2. Operational aspect – Work and Inspection Procedures

Scope of Research

This research is limited to the proposal of guidelines of quality management that can be applied to construction projects mainly on civil engineering practices. Guidelines of the quality management are listed as:

1. Management Procedure: Minimum implementation of procedure/s for contractors to attain appropriate and systematic applications to construction projects.

2. Work Procedure: Minimum implementation of construction procedure/s for contractors to follow instructions on how operations are to be carried out .

3. Inspection Procedure: Minimum implementation of checking procedure/s to verify works that will be performed under controlled conditions.

For items 2 and 3, these research topics are focused on Civil and Architectural works. Electrical and Mechanical works will be presented as examples.

Projected Result

This research is expected to obtain the guideline of quality management. The guideline will be incorporated in the aspects of management and operation.

Management aspect

This concerns the provision of guidelines on how a particular process is to be carried out with the inclusion of management of records/documents that are to be maintained during the process.

It also involves the Control of the whole project through planning & scheduling of operational activities, progress reporting and Control of Equipment/Stock and Cost & Budget Control.

Operational aspect

This aspect involves work procedure illustrating the sequential application of work activities where detailed instructions & supervision are carried out accordingly as required including the setting out of inspection methods, frequencies, criteria for acceptance and records for verification that are made simultaneously with the work procedure.

LITERATURE REVIEW

ISO 8402 (1986) Quality Vocabulary gives a definition of quality: Totality of Characteristics of an entity that bear on its ability to satisfy stated or implied needs.

Freeman-Bell and Ballewill (1996) stated that quality enters all aspects of the customer – supplier relationship. In the construction industry the relationship between supplier and customer is changed to client and contractor.

In the construction industry, Oberlender (2000) stated that each project will first consist of three components: scope, budget, and schedule. When project was assigned, it is important that all these components are clearly defined but relation between these three components are quality which at the end of project should meet the owner's satisfaction. Figure 1 below shows Quality being an Integral Part of Scope, Budget, and Schedule.

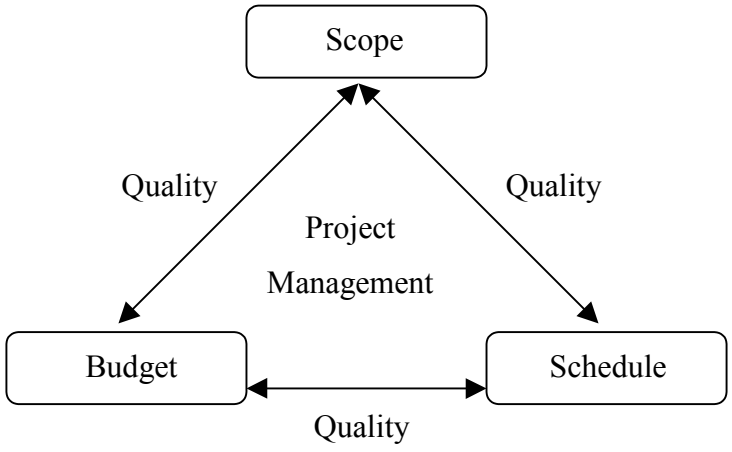


Figure 1 Quality is an integral part of scope, budget, and schedule.

Source: Oberlender (2000)

From figure 1, this means that quality enters all aspects of the system. Not only does one person or one team take responsibility for the quality, but also all participants in a project.

Freeman-Bell and Ballewill (1996) stated that the first rule for the quality management is that the quality of the goods or services being supplied must be defined. Various approaches that can be taken are classified into two categories: (1) detection of product that does not meet specification, and (2) preventing the production of product that does not meet specification. In first category there are the techniques of inspection, test, and quality control. In the second we have the quality management principles of quality assurance and total quality management. Hereunder is the meaning of these processes.

Inspection and Test: the idea of this approach is that the products are checked after production so that faulty product can be detected and rejected. ISO 8402 (1986) give a definition of Inspection which is the analysis of feature or properties of production for checking whether the production complys with the specification or not.

Freeman-Bell and Ballewill (1996) give the definition for Quality Control (QC): QC is the step up from inspection, the idea beginning that processes are monitored and controlled to ensure that they are capable of meeting requirements. Oberlender (2000) stated that the actual quality of construction depends largely upon the control of construction itself that today is referred to as quality control. The purpose of quality control during construction is to ensure the work is accomplished in accordance with the requirements specified in the contract document.

Quality Assurance (QA): QA is a method of managing all the activities that affect the quality of goods or service in order to prevent faults. QA is means of ensuring that a given system will provide assurance of the quality of the output from the system (Freeman-Bell and Ballewill, 1996).

The Vocabulary from ISO 8402 (1986) stated that the definition of quality control is the operational techniques and activities that are used to fulfill requirements for quality. For quality assurance, the definition is all those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality.

Total Quality Management (TQM) is the next step from QA. Its emphasis is on meeting all the customer needs and expectations, moving beyond the product focus. It also goes further than QA (Freeman-Bell and Ballewill, 1996).

In the definition of quality management in construction, Ortega and Bisgaard (2000) define as a systematic data collection, analysis and review to monitor progress and reduce errors. Sommerville (1994) stated that this is implementation, owner satisfaction, time management, problem solving, and effective meeting.

In construction field error means the same as defect. When the construction has been carried out and completed and it has some defects, this mean the project needs rework or remedial work to meet the requirements. The rework or remedial work will impact project in terms of cost and delay. When delay occurs the penalties from the contract will be applied and cost will impact the project budget.

Barrie and Paulson (1992) stated the quality of conformance is the degree to which the physical work produced conforms to the standard. To consider the correlation between standards for conformance and the cost of achieving those standards, the graph in figure 2 can be analyzed. When the degree of conformance is very high (low defect), the costs of failure are low but the costs of control are quite high. When the degree of conformance is low (high defect), the opposite situation exists. Thus between the two extremes, is an optimal level of conformance where total quality costs are minimized and can be applied (Schroeder, 1989).

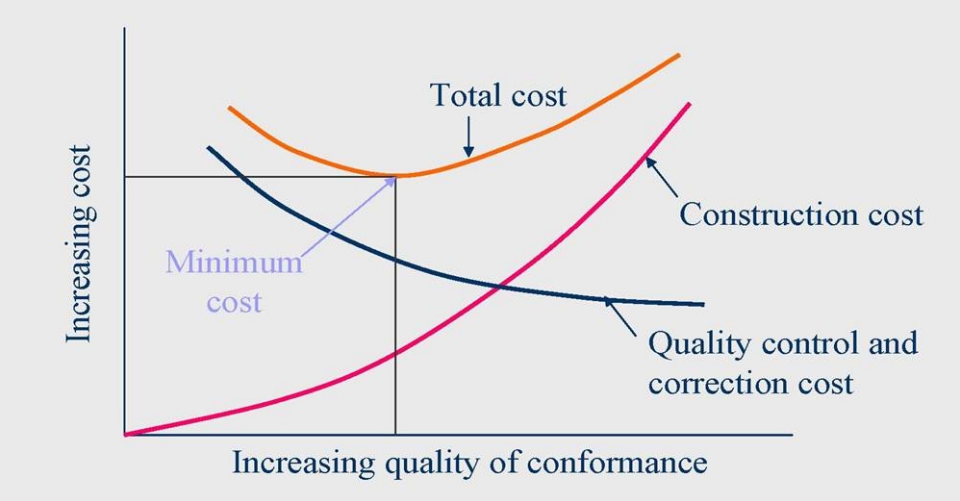


Figure 2 Economics of quality of conformance

Source: Barrie and Paulson (1992)

Note that to achieve the increasing quality of conformance directly, one must invest more money in them, and hence the direct construction cost will grow. On the other hand, as the reliability of the methods improve, less investment is required for monitoring their performance and for correcting and replacing defective work, so the cost of quality control goes down. Then to optimize costs for conforming work for a required quality, one seeks to minimize the sum of the direct cost and cost of control as shown in upper curve from figure 2.

The above mentioned is talking about quality. Nowadays, one quality management system receiving much attention is ISO 9000. The standards incorporate basic quality management principles that are similar for most industries. Note that generally the ISO standard is not created for the construction industry but the management principle can be applied. The nature of the ISO 9000 standards is to outline framework for basic quality management system. The emphasis is on management procedures. The introduction of ISO 9000 in a construction company may be difficult because the management of the company will be open to scrutiny, and criticism is often difficult for management to endure (Bray, 1996).

Wangsom and Sinthawanarong (2002) stated that at present, Thai contractors are keen and interested concerning the ISO implementation, but research for Thai contractors regarding the item is rare. An indicator based on their research after the ISO implementation is that there was an increase in expenditures on personnel, training, quality programs to name a few, but cost on construction errors or omissions are decreased.

Witchhukriangkrai (1998) stated that at present, construction industries are facing intense competition. The quality of products & services is not enough to keep up with their business in which new entrepreneurs are looking for ISO 9000 in order to remain competitive in the industry.

A concrete example as a reference is the **M.R.T. Chaloem Ratchamongkhon Line, MRTA Initial Subway Systems** which was divided into contracts namely The **South Line** by Joint Venture BCKT as the contractor (Billfinger, Ch Karnchang, Kumagai and Tokyu companies), **North Line** with ION as the contractor (Italian Thai, Obayashi and Nishimatsu companies), **The Design & Construction of the Depot** by SNMC Joint Venture comprised of Kajima, Hazama, Maeda, Siam Syntech, Mitsui and TSB Trading Company ltd, **Lifts & Escalators** by MMW Joint Venture comprised of Mitsubishi, Mitsubishi Thailand and Worachak companies and **Trackwork** by CKSL Joint Venture. **Subway Concessionaire** is BMCL (Bangkok Metro Company Limited) and CKET as their Project Manager. This project also hired joint venture consultants to oversee the project as per contract.

Works in this project were supervised and checked based on International Standards. Documentations, drawings and execution of all works were monitored closely to achieve the expected Quality through works programme and schedules that are periodically updated to show actual progress against planned and through time management to foresee events that may arise and will affect the completion of the project. Although managing these items has considerable costs, the achievement is overwhelming because of the Quality Management being applied during

processing and performing all the works. Errors and delays were controlled at minimum if compared with the allowed time to be used in completing all the contractually required works.

Quality Management System: ISO as the Reference Perspective

These days, the most favorable quality management system is ISO 9000, with its latest version of ISO 9000: 2000. Below are details showing the background of the ISO standard.

ISO 9000: Aims & Objectives

The ISO 9000 standards started in 1979 as BS 5750 (a quality standard developed in UK and published by BSI) with an aim to define a model for QA system that will be utilized in a contractual scenario between a supplier and a customer. Following this, suppliers were under pressure to take on specific quality activities to meet the needs of the particular customer. An intolerable situation could have arisen if a supplier had to deal with a number of customers each with different requirements. Thus the standard was revised in 1987 and adopted as the International Standard (ISO 9000).

The aims of the ISO 9000 are to provide a model for a quality management system in any of the following cases:

1. As guidelines for a quality management system.

2. As a contractual document between two parties; a supplier and a customer.

3. As a measure against which a supplier's quality management system can be approved or registered by a second party – i.e. a customer.

4. As a measure against which a supplier's quality management system can be certified or registered by a third party – i.e. an independent certification body.

But the overall emphasis in all these events is to satisfy the customer's needs. The model is provided by means of series of clauses with each defining a specific requirement. The requirements are such which allows an organization defining a working practice that meets the requirement and is suitable for its business activity or operation.

ISO 9000: 1994 have three major elements namely the Quality system, the Quality policy, and the Quality management. Quality management includes determination and implementation of the quality policy. The quality system includes the procedures, processes, responsibilities and organization for carrying out quality management. Quality policy includes the overall goals of the organization with regard to quality as expressed by top management. The standards consist of five documents – ISO 9000, ISO 9001, ISO 9002, ISO 9003, and ISO 9004. The actual ISO 9000 document defines key quality system elements and serves as a guideline for choosing the standard for registration. ISO 9004 provides general guidelines for internal quality management. For the ISO 9001, ISO 9002, and ISO 9003, the scope of each differs with each other with regards to application in the organization in carrying out various functions as defined below:

- ISO 9001: Quality systems – model for quality assurance in design/ development, production, installation, and servicing.

- ISO 9002: Quality systems – model for quality assurance in production and installation

- ISO 9003: Quality systems – model for quality assurance in final inspection and testing.

The major difference between ISO 9001 and ISO 9002 is the lack of design control. ISO 9002 covers quality in production and installation. ISO 9003 is appropriate when quality requirements are monitored only for final inspection. Each standard will be covered for their scope as shown in figure 3.

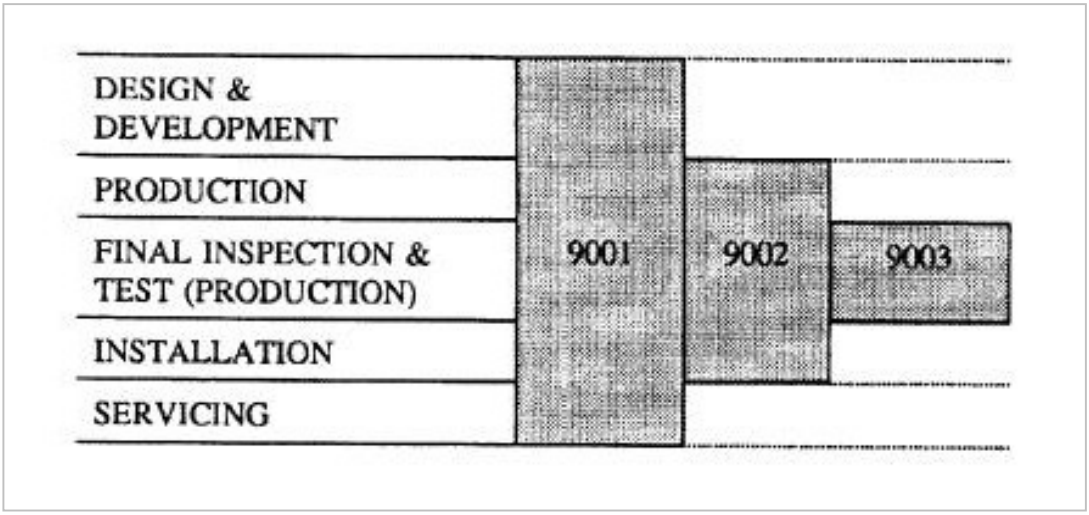


Figure 3 Scope of ISO 9000 standard

Source: Bray (1996)

As all relevant aspects are covered by ISO 9001, then this can suffice the entirety of ISO's role to an effective management system of a company. Expected Quality for the end-products are traced on the reliability of each ISO element determined by the provided specific guideline in fulfilling requirements to be fully registered by ISO. The requirements for ISO 9001: 1994 are shown in Table 1.

Table 1 Clause requirement for ISO 9000: 1994 standards

	Clauses	ISO 9001	ISO 9002	ISO 9003
1	Management responsibility	x	x	x
2	Quality system	x	x	x
3	Contract review	x	x	x
4	Design control	x	-	-
5	Document and Data Control	x	x	x
6	Purchasing	x	x	-
7	Control of customer-supplied product	x	x	x
8	Product identification and traceability	x	x	x
9	Process control	x	x	-
10	Inspection and testing	x	x	x
11	Control of inspection measuring & test equipment	x	x	x
12	Inspection and test status	x	x	x
13	Control of non-conforming product	x	x	x
14	Corrective and preventive action	x	x	x
15	Handling, storage, packaging, preservation, and delivery	x	x	x
16	Control of quality records	x	x	x
17	Internal quality audits	x	x	x
18	Training	x	x	x
19	Servicing	x	x	-
20	Statistical Techniques	x	x	x

The updated version of ISO 9000 was published on 15th December 2000 by ISO taking into account several revisions of the core series standards in the ISO 9000 family which is now called ISO 9000: 2000.

The ISO 9000: 2000 family consists of four primary standards:

ISO 9000: Quality management systems – Fundamentals and Vocabulary

ISO 9001: Quality management systems – Requirements

ISO 9004: Quality management systems – Guidance for performance Improvement

ISO 19011: Guidelines on quality and /or environmental management systems auditing (currently under development)

In the past, organizations possessing ISO certification were referred to as "suppliers" because they supplied products and services to customers. As this created confusion due to its usage, ISO has decided to use the word "organization" in its place for the ISO standards to focus on the Organization, not the supplier. The term "supplier" now refers to the organization's supplier.

The previous 1994 version of ISO 9001, ISO 9002, and ISO 9003 have been integrated into the updated version – ISO 9001: 2000 and this specifies requirement for the quality management system for any organization that is dedicated to demonstrate its ability in providing the quality product to meet its customer's satisfaction.

The standard is used for certification, registration and contractual purposes by organizations seeking recognition of their quality management system. A use of the entire family of standards is an integrated manner in order to obtain greatest value. Thus beginning with ISO 9000: 2000 and its implementation to facilitate in achieving first class level performances. Furthermore, practices of the standards contained in ISO 9004: 2000 make quality management increasingly effective in achieving the organization's business goal i.e. increased profit and market share, improvement in the quality of product.

Key Principles of Management : As a Reference from ISO 9000:2000

The eight quality management principles are defined in ISO 9000: 2000 Quality management systems' fundamentals and vocabulary. The descriptions of eight principles are as follows:

Principle 1: Customer focus

Organizations depend on their customers; therefore the organizations should understand fully the current and future requirements of their customer/s and performs extra effort to exceed customer expectations.

Principle 2: Leadership

Leaders establish unity of purpose and direction of the organization. They should create and maintain the internal environment in which people can become fully involved in achieving the organization's objectives.

Principle 3: Involvement of people

All levels of individuals are the essence of an organization and their full involvement enables their abilities to be used for the organization's benefit.

Principle 4: Process approach

A desired result is achieved more efficiently when activities and related resources are managed as a process.

Principle 5: System approach to management

The system which can be identified, understood, and managed interrelated processes contributes to the organization's effectiveness and efficiency in achieving its objectives.

Principle 6: Continual improvement

Continual improvement of the organization's overall performance should be a permanent objective of the organization.

Principle 7: Factual approach to decision making

Effective decisions are based on the analysis of data and information.

Principle 8: Mutually beneficial supplier relationship

An organization and its suppliers are interdependent and a mutually beneficial relationship enhances the ability of both to create value.

Derivatives from Clauses of ISO 9001: 2000

ISO 9001: 2000 uses a process-based structure. The 20 elements of ISO 9001: 1994 have been replaced with five of eight total clauses containing 23 elements. Clauses one through three address a variety of introductory and legalistic topics. The next five clauses are as follows:

Clause 4: Quality Management System (two elements), briefly states general requirements, including such documentation as procedures and work instructions. It establishes a general framework within which a quality management system is developed, which defines and manages process in order to deliver a good product or service.

Clause 5: Management Responsibility (six elements), under which management defines policy, objectives, planning, and quality management system requirements while providing for feedback through management review for change authorization and initiation of improvement. It addresses management's responsibility for continually meeting customer needs and expectations, even in times of organizational change/s. The responsibility includes quality objectives at each organizational function and level.

Clause 6: Resource Management (four elements), is where necessary resources, such as human resources and facilities, are determined and applied. These resources, which include new elements covering facilities and work environment, are required to implement and maintain the quality management system.

Clause 7: Product Realization (six elements), is where processes, such as customer satisfaction, design, purchasing, and production and service operations, are established and implemented. These processes are needed to manufacture product and/or services from receipt to delivery. Organizations must define and describe their unique business processes, but are not obliged to use the standard's structure.

Clause 8: Measurement, Analysis, and Improvement (five elements), is where results are measured, analyzed, and improved though internal audits, nonconformity control, and continual improvement. Organizations are required to measure and monitor product and/or service conformity and process and system performance. Collected data must be analyzed to initiate continual improvement.

Two of the most important objectives in the revision of the ISO 9000 series of standards have been, a) to develop a simplified set of standards that will be equally applicable to small as well as medium and large organizations, and, b) for the amount of detail of documentation required to be more relevant to the desired results of the organization's process activities.

ISO 9001: 2000 has significantly reduced the documentation requirements and is much less prescriptive than the 1994 version of the standard. It allows an organization more flexibility in the way it chooses to document its quality management system. This enables each individual organization to develop the minimum amount of documentation needed in order to demonstrate the effective planning, operation and control of its process and the implementation and continual improvement of the effectiveness of its quality management system. It is stressed that ISO 9001 requires a "Documented quality management system", and not a "system of document".

For the Documented procedure, ISO 9001: 2000 specifically requires the organization to have for the following 6 activities:

Clause 6.2.3 Control of documents
Clause 6.2.4 Control of records
Clause 6.7.2 Internal audit
Clause 6.7.5 Control of nonconforming product
Clause 6.8.2 Corrective action
Clause 6.8.3 Preventive action

However, in order to demonstrate the effective implementation of its quality management system, it may be necessary to develop documents other than documented procedures. The other documents specifically mentioned in ISO 9001: 2000 are: a) Quality policy (clause 4.2.1.a), b) Quality objectives (clause 4.2.1.a), c) Quality manual (clause 4.2.1.b)

Records that are specifically required by ISO 9001: 2000 are shown in Table 2.

Table 2 Records required by ISO 9001: 2000

Clause	Record required
5.6.1	Management reviews
6.2.2 (e)	Education, training, skills and experience
7.1 (d)	Evidence that the realization processes and resulting product fulfill requirements
7.2.2	Results of the review of requirements related to the product and actions arising from the review
7.3.2	Design and development inputs relating to product requirements
7.3.4	Results of design and development reviews and any necessary actions
7.3.5	Results of design and development verification and any necessary actions
7.3.6	Results of design and development validation and any necessary actions
7.3.7	Results of the review of design and development changes and any necessary actions
7.4.1	Results of supplier evaluations and any necessary actions arising from the evaluations
7.5.2 (d)	As required by the organization to demonstrate the validation of processes where the resulting output cannot be verified by subsequent monitoring or measurement
7.5.3	The unique identification of the product, where traceability is a requirement
7.5.4	Customer property that is lost, damaged or otherwise found to be unsuitable for use
7.6 (a)	Basis used for calibration or verification of measuring equipment where no international or national measurement standards exist
7.6	Validity of the previous measuring results when the measuring equipment is found not to conform to requirements
7.6	Results of calibration and verification of measuring equipment

Table 2 (continue)

Clause	Record required
8.2.2	Internal audit results and follow-up actions
8.2.4	Indication of the person(s) authorizing release of product.
8.3	Nature of the product nonconformities and any subsequent actions taken, including concessions obtained
8.5.2	Results of corrective action
8.5.3	Results of preventive action

The above-mentioned show rough details in understanding ISO 9001: 2000., and as stated, a most significant document for each company is the Quality manual that should contain, a) the scope of the quality management system, including details of and justification for any exclusion, b) the documented procedures established for the quality management system, or reference to them, c) a description of interaction between the processes of the quality management system.

CH. Karnchang Public Co. Ltd. As the Reference Company

To have a proper orientation and clearer idea on Quality Management System, this research study selected CH. Karnchang Public Company Limited, an ISO registered company as the organization to be the source of relevant information due to its Quality Management System of various construction projects and experiences of employed key individuals in dealing with their contractors or sub-contractors of on going & completed projects.

Items below are the contained details as references from the Quality Manual of CH. Karnchang Co. Ltd, an ISO 9001: 2000 registered company in which this thesis will present as an example. Other items that are mentioned are the qualifications and requirements in order to attain the projected aims in achieving the company's goals of an effective system of management in reference to the company's manual.

The items that are to be briefly discussed as the subjects of reference are:

1. Contents; describing the company's profile, & history outlining the achievements of the company.

2. Scope of implementation and application for Quality Management system certification describing the company's activities and category of work under the ISO 9001:2000 quality management.

3. The Control of Quality Manual detailing the duly authorized individuals who will approve and be responsible for the control and distribution of the manual as controlled copies to selected individuals including the records and dates of revisions, reference numbers, effective date and the relevant individual who is responsible for the preparation of the manual.

4. Requirements that are to be met to be suitably recognized as an ISO 9001: 2000 registered company by methodically applying the Quality Management principles of ISO 9001:2000.

5. Roles of Management, Relevant Individuals and Customer; elaborate the roles of significant individuals & the company management as well as the clients on their involvement in the process of implementation and application of the ISO 9001:2000 requirements.

6. Management of Resources and Planning through proper monitoring and measuring as well as analysis of data relevant to the management.

7. Constant Improvement of Management implementation through Corrective & Preventive measures.

In the succeeding paragraphs, explanation of fulfillment of the general requirements is shown on how CH. Karnchang Construction Company managed its activities and operation based on ISO 9001:2000.

Quality Management System Requirements

General requirements that were met:

The Company has established documented, implemented and maintained a quality management system and has continually improved its effectiveness in accordance with the ISO 9001:2000 requirements.

The Company has determined the processes needed, reviewed their sequences and interaction, examined criteria and methods needed to ensure that these processes are controlled and implemented effectively and made available information necessary to support and monitor these processes. In addition, the Company has also monitored, measured, analyzed, and implemented actions necessary to achieve the planned results and that has continually made improvement on these processes.

In the event that sub-contractors are required to prepare drawings or carry out construction works that will affect conformity with the requirements, the Company will follow the similar procedures for procurement, selection and evaluation of suppliers and inspection of sub-contractors' performance as those utilized for the Company's own work execution.

Out-sourcing by using sub-contractors depending on the activities of construction works involving designers, draftsmen, and sub-contractors for engineering systems or other construction works

That the Company has managed these processes in accordance with the ISO 9001:2000 requirements.

Note: In cases of any of the processes that affect the Quality Management System, but the Company has designated the concerned work unit as not being under the prescribed Quality Management System due to the customers' requirements, distance, venues or any other reasons, control is still enforced thereon through agreements or contracts.

Documentation requirements

1. General

That the Company has established, documented, implemented and maintained a quality management system and has continually improved its effectiveness in accordance with the ISO 9001:2000 requirements. The Quality Management System documents have been categorized as follows:

- *Quality Manual*
- *Quality Procedure*
- *Work Instruction*
- *Project Management Plan*
- *Method Statement*
- *Inspection and Test Plan*
- *Supporting Document & Form*

Details on document reference structure have been given in the Quality Procedure for Control of Documents.

The scope and details of the Company's documents have been defined based on the size and type of business, the complexity and interaction of processes, and the caliber of its personnel. All the Company's documents and information are in the form hard copies, electronic media or any other media used as references in the operation of works in the Quality System.

1.1 Quality manual

That the Company has determined that there shall be control of distribution of the Quality Manual under Item 3 of this Quality Manual and has included the following topics therein:

- *the scope of the Quality Management System, including details of and justification for any exclusions;*

- *references to related Quality Procedures;*

- *Flow Charts showing sequences and interaction between the processes of the Quality Management System.*

1.2 Control of documents

Documents in the Quality Management System are controlled in accordance with Quality Procedure for Control of Documents.

- *That they have been approved by authorized persons prior to issue. Details/Qualifications of the individuals having the authority to approve documents and the types of documents they are authorized to approve are given in the Quality Procedure for Control of Documents.*

- *That they have been reviewed and re-approved following revision as necessary.*

- *That they are available at all points of use and are the latest versions.*

- *That they are legible, identifiable, and readily available.*

- *Their distributions are controlled by the Quality Procedure for Control of Documents.*

- *That obsolete documents are prevented from use and that there is a suitable identification system for obsolete documents, details of which are indicated in the Quality Procedure for Control of Documents.*

- *Documents in the form of electronic media are controlled properly.*

1.3 Control of records

Records are considered to be special documents for which the control methods and processes have been defined in the Quality Procedure for Control of Records.

These records shall be readily identifiable, filed, and retrievable. They shall be protected from loss or deterioration. Retention time and methods for disposal of records shall be defined.

Records, both on paper and in electronic forms, shall always be controlled.

Management's Responsibility

Management commitment

Top management has shown its commitment to the development and improvement of the Quality Management System by;

- *Communicating to the organization the importance of meeting customer as well as statutory and regulatory requirements.*

- Establishing the quality policy and quality objectives.
- Conducting management reviews, and
- Ensuring the availability of resources.

Customer focus

To ensure customer satisfaction, the Company has considered their demands and expectations and translated them into requirements of the products and the customers. It has also ensured that the customer's demands and expectations are determined and met. Relevant laws and regulations, as well as the obligations of the Company's products/service to the customers have also been taken into consideration.

Quality policy

The Company has established the Company Policy to be appropriate to the purpose of the organization. It includes commitment to comply with requirements of customers and continual improvement, and provides framework for establishing and reviewing quality objectives. The Quality Policy is communicated to and understood by personnel at all levels within the organization to ensure that it is continually suitable. The management reviews the Quality Policy during the Management Review and the policy may be revised for appropriateness following the review.

The Company's Quality Policy has been controlled in such a way to ensure that the Quality Policy announced is the latest version and up-to-date. There are measures to control the dissemination of the quality policy within the organization.

At present, the Quality Policy is posted at different locations to be communicated continually with new and current employees.

Criteria to evaluate the results against the objectives for the purposes of analysis, correction, and prevention and the goals for continual improvement have also been established.

Attached by: Company's quality system policy

Planning

1. Quality objectives

The management of the Company has established quality objectives for processes, departments, and projects within the organization that are related to the quality management system. These objectives are measurable, consistent with the quality policy and include commitment for continual improvement. The established quality objectives are relevant and responsive to the product requirements.

It is the duty of the Executive Vice Presidents and the Project Managers concerned to establish quality objectives within their respective functions, taking into account the quality policy, and the Company's main objectives as well as other business parameters. The quality objectives will be implemented, monitored, and revised during the management review. Afterwards, the quality objectives may be revised and improved as appropriate.

2. Quality management system planning

The Company's management has determined and set forth resource planning to accomplish the established quality objectives.

The quality planning process will be reflected in the forms of quality manuals, quality procedures work instructions, project management plans, method statements, inspection and test plans and other supporting documents and forms in the quality management system such as implementation plans and quality plans of

each product group. These documents will cover the processes in the quality management system as well as exceptions that are not incorporated into the system already identified in this quality manual.

In addition, the Executive Vice Presidents and Project Managers concerned will prepare implementation plans in which responsible individuals, required resources, and dateline for completion are identified for each activity of the plans. These implementation plans shall reflect the continual improvement nature of the quality management system. There shall be follow-up on the progress of implementation plans as well as adjustment thereof where it is deemed necessary and appropriate.

The top management including the Executive Vice Presidents and Project Managers concerned shall ensure that there will be suitable planning and control of changes, so that the quality management system will be least affected during the transition, when it is integrated with other systems under the Company policy or with other international standards.

Responsibility, Authority and Communication

1. Responsibility and Authority

The Company has clearly defined the structure of the work management system as shown in its organization chart. The scope of work is defined in detail in the job description of each position. The responsibility and authority of each position as well as their relationship have been defined in different documents as appropriate, such as the organization chart, quality manuals, quality procedures, work instructions, project management plans, method statement, inspection and test plans or job descriptions.

Attached are Company's organization chart and scope of work for each department.

2. Management representative

The President appoints a member of the management to be the management representative whose responsibilities include:

- Establishing and maintaining the quality system management.

- Reporting to top management on the performance of the quality management system and any need for improvement.

- Ensuring the promotion of awareness of customer requirements throughout the organization.

- Liaising with external parties on matters relating to the quality management system, such as independent appraising agencies.

3. Internal communication

The management representative and Executive Vice Presidents concerned have the duty to effect communication within the organization about various matters including the quality policy, quality objectives, work implementation plans, and documents related to the quality management system. Communication shall reflect the status and effectiveness of implementation of various procedures. Details of matters to be communicated, communication methods as well as responsible work units will be specified in the quality procedure of each process.

Management review

1. General

Top management will review the organization's quality management system every six months as planned to ensure its continuing suitability, adequacy and effectiveness. This review includes assessing the need for changes to the quality management system, including the quality policy and quality objectives.

2. Review input – Required

The review input includes current results and room for improvement with regard to:

- *Results of audits*

- *Customer feedback, including customers' complaints, results of work inspection and approval and summary of customer satisfaction assessment*

- *Process performance and product conformity to requirements, which will be referred to in the quality objectives*

- *Resources required for the quality management system*

- *Status of preventive and corrective actions*

- *Follow-up actions from previous management reviews*

- *Change that could affect the quality management system*

- *Other information as necessary and suitable for development*

3. Review output – Management:

Following the management review, it is the duty of the Executive Vice Presidents and Project Managers concerned to take actions concerning:

- *Improvement of processes in the quality management system*

- *Improvement of products/services to conform to customer requirements*

- *Allocation of needed resources*

The President and Chief Executive Officer chair meetings the quorum of which comprises Senior Executive Vice Presidents, Executive Vice Presidents and Project Managers concerned. The Management Representative serves as the meeting coordinator who prepares and distributes minutes of the meetings, liases and follows up on the outcomes of the meetings and reports to the President and Chief Executive Officer.

Original records from management reviews are maintained by the Management Representative

Resource Management

Provision of resources

The management considers and provides in a timely manner resources needed to implement and improve the quality management system, and to enhance customer satisfaction.

It is the duty of Executive Vice Presidents or the Project Managers concerned to provide necessary resources in their respective work functions. In the

case that is necessary, they shall report to the President and request additional resources that are beyond the scope of their authority.

Human resources

1. General

Responsible personnel in the quality management system will be competent on the bases of education, training, skills and experience. Such information is indicated in the job description of each position.

The Executive Vice Presidents and the Project Managers concerned have the duty to define required qualifications and competence for each work position under their responsibility.

The President has the duty to define required qualifications and competence of Executive Vice Presidents/Project Managers.

The Human Resources and General Administration Department has the duty to compile these qualifications and incorporate them into job descriptions for further use in personnel recruitment.

2. Training, Awareness Building, and Competence:

The Company has prepared a quality procedure for training, which covers processes in identifying training needs for personnel performing work affecting quality, based on the competence needed for personnel in each work position. Training in each category will be provided, i.e., orientation, in-house training, outside training, on-the-job training, or other actions will be taken as appropriate.

Evaluation is carried out after each training program, to assess its effectiveness in actual work performance and determine whether the existing training courses and their respective participants are suitable for the activities concerned, especially in the case of courses that are directly related to the quality management system.

The Human Resources and General Administration Department is responsible for provision of quality awareness training that will ensure that all personnel in the organization understand the relevance and importance of activities they are responsible for and how they contribute to the achievement of the quality objectives.

The Human Resource and General Administration has the duty to maintain records of personnel's education, experience, training, and qualifications for each work position.

Infrastructure

The Company has determined, provided and maintained the infrastructure needed to ensure that the products/construction works conform to the requirements. This includes provision of an adequate workspace; maintenance of equipment related to production; machinery, equipment, hardware and software related to production; and other support services such as necessary transport and communication service.

Work environment

The Company has determined and managed human-related factors such as safety at work place, as well as physical work environment such as noise, lighting, cleanliness and other factors needed to ensure the product/construction works conformity to the requirements.

The Human Resources and General Administration Department and the Project Managers have the duty to coordinate with others concerning occupational safety as well as to take actions concerning the matters mentioned above.

Product/Construction Works Realization

Planning of product/construction works realization

The Company has planned the construction processes to achieve the products/construction works. These processes are consistent with the quality management system and have been documented in various formats such as quality procedures, work instructions, inspection and test plans and other supporting documents appropriate for the Company's operation.

The Company has considered the following as information in its planning processes:

- Quality requirements or objectives; scope of quality of products/ construction works

- The need to establish processes and documents

- Allocation of resources and facilities needed

- Determination of activities specific to the products with regard to verification, validation, monitoring, inspection and test activities

- Clear-cut criteria for product acceptance

- Relevant quality records needed as evidence of conformity to customer requirements

Moreover, the Company has also prepared project management plans, work instructions, and inspection and test plans that provide explanations on production processes and product inspection by the product group.

Customer-related Processes

1. Determination of customer requirements

The Company considers the customer requirements based on:

- *Product requirements specified by the customer, such as the quantity, handing over, and other supporting activities including the requirements for delivery and post-delivery activities*

- *Requirements not stated by the customer but necessary for specified or intended use*

- *Statutory and regulatory requirements related to the products*

- *Any additional product requirements determined by the Company*

2. Review of product/construction works requirements

Review of requirements will be conducted as soon as a customer has expressed interest in the Company's product, e.g. making contact to secure construction projects, design, tenders, contract execution, including amendment of agreements/contracts.

The Company has clear, written agreements with customers concerning product/construction works requirements. In the case of verbal confirmation by a customer, the agreements are recorded by relevant work units within the organization and confirmed to the customer. Also, the Company takes into account

its ability in various aspects such as quality, quantity, and delivery, among other things, before confirming to the customers.

Records of results of the review and follow-up actions will be maintained and controlled. In the event of changes in product requirements, after relevant documents have been amended, such changes will be communicated to internal functions concerned for acknowledgement.

Note: In the case of acceptance of orders or agreements via the internet, it cannot be used as official confirmation thereof, unless the customer otherwise determines that it can serve as official confirmation.

3. Customer communication:

The Company has prepared a quality procedure for this purpose and has implemented communication with customers on matters relating to:

- *Product/construction works information*

- *Replies to inquiries, preparation of construction contracts, and amendment of agreements/contracts*

- *Acceptance of complaints, including customer feedback, and communication with customers with regard thereto*

Design and development

At present, the Company is not doing its own design works, but engages external parties to do design works as required by clients. However, the Company has its means to determinate design planning, joint design reviews, design verification and design validation, to ensure that the product meets the customer requirements.

In case of the need to change or revise the design, evaluation of the effect on the product will be conducted, together with verification and validation as appropriate. The variation or revision will also be approved prior to implementation and records of review results, revision and monitoring activities will be maintained.

Purchasing

1. Purchasing Control:

The Company has established control for purchasing/procurement processes to ensure that the products purchased/procured conform to the specifications agreed upon. The processes include local and oversea purchasing as well as purchasing of all kinds of raw materials and products related directly to quality and procurement of sub-contractors.

The Company has established criteria for selection of new suppliers/sub-contractors and criteria for evaluation of current suppliers/ sub-contractors. Arrangements have been made to maintain records of results of selection and evaluation of suppliers/ sub-contractors as well as follow-up activities.

2. Purchasing information:

Information concerning purchasing will be clearly defined in purchasing/procurement orders to ensure that the following procurement information has been reviewed and approved before delivery to suppliers/ sub-contractors:

- *Requirements for approval of products, procedures, processes and equipment*

- *Requirements for qualifications of personnel*

- *Quality management system requirements*

3. Verification of purchased products:

The Company has established clear criteria and methods for inspection or verification of purchased products.

In a case that the Company intends to inspect the purchased products at the supplier's premises, the criteria for inspection and release of the purchased products will be defined in the purchasing orders.

Production and service provision

1. Control of implementation:

The Company controls the construction process through:

- *Implementation plans*

- *The availability of documents and information about the products*

- *The availability of quality procedures as necessary*

- *The use and maintenance of suitable machinery and equipment*

- *The use and availability of measuring devices*

- *The implementation of monitoring activities between processes and final inspection*

- *The implementation of release, delivery, and after-sale service activities (if any)*

2. Validation of processes:

This is for the case of special processes that the Company monitors and validates to ensure their capability through the following measures:

- *Validation of the process capability against the defined criteria*

- *Validation of the ability of machinery and personnel. Machinery will be continually repaired and maintained and personnel performing the work will be trained, to be able to carry out these activities*

- *Provision of and compliance with specified documents*

- *Provision of records*

- *Revalidation where necessary*

3. Identification and Traceability:

The Company has identified raw materials, products in process, and finished products by using appropriate methods during each stage, from acceptance of raw materials to the construction process and delivery. Responsible personnel and related documents have also been identified.

In addition, the Company has identified the inspection and testing status of raw materials, structures in process, and finished structures by using suitable methods in order to determine their status as awaiting inspection, passing the inspection, or failing the inspection.

The Company controls the traceability up to the construction process, including related responsible parties and documents.

4. Control of customer property:

If customers/clients have brought materials, constituent parts, or existing construction works of which they have ownership to the Company for the purposes of production and incorporation, the Company will arrange for control of identification, verification, inspection, storage, and use thereof, as well as for maintenance thereof while they are in the Company's possession. In the event of no special requirements from customers, the Company will handle them in the same way it handles its own raw materials and products.

In the case of damage to, loss of, or unsuitability for use, reports will be prepared to notify the customers in writing. Actions implemented and agreements reached will be documented and records thereof will be maintained.

5. Preservation of products:

The Company looks after the products from the stage of acceptance of raw materials and constituent parts through the stages of production and other relevant process until they become finished products and are delivered to customers.

Control of Monitoring and Measurement Devices

The Company has determined the measuring system and measuring devices and has conducted tests to ensure their measuring ability and conformity to the requirements.

The Company has determined control measures over measuring devices for the following activities:

- Calibration and verification at specified intervals, or prior to use, against measurement standard traceable to international or national measurement standards.

- Where no such standards exist, the basis used for calibration or verification shall be recorded

- Safeguard from adjustments that will invalidate the measurement results

- Protection from damage and deterioration during handling, maintenance and storage

- Records of calibration results

- Demonstration of assessment of validity of previous measuring results in the case that inaccuracies have been found, including considerations for rectification of the problems

The Company has determined that the ability of software used for measurement and monitoring must be verified before its initial use and requires that verification be repeated on a regular basis.

Measurement, Analysis and Improvement

General

The Company has defined, planned and implemented activities related to measuring and monitoring, as well as necessary and improvement of processes, to ensure compliance to customer requirements and the established quality management system, and the effectiveness of the quality management system has been improved continually. These activities include identification of needs and suitable application of statistical techniques.

Monitoring and Measurement

1. Customer satisfaction

The Company has gathered information concerning customer satisfaction and dissatisfaction, including complaints from customers and communities around construction sites by conducting customer satisfaction surveys. Improvement is made following the results of customer satisfaction assessment. Methods for data collection, analysis and improvement have been defined in detail.

2. Internal audit

The Company has prepared and complied with the Internal Audit Quality Procedure, which specifies that internal audits shall be conducted at least every six months to determine whether the quality management system conforms to the ISO 9001:2000 requirements, and whether it is implemented and maintained effectively.

The audit plan defines the frequency in accordance with the status, the importance of activities and the areas to be audited. The results of previous audits are also reviewed.

Internal audits are conducted by personnel not responsible for activities being audited. The scope, frequency, and methods have been defined. Responsibilities, records of audit results, related documents used for the audit process have been identified and the outcome has been reported to the management concerned.

The management concerned will immediately take action to resolve the problems or rectify deficiencies detected from the audit process. Afterwards, the auditor will conduct follow-up on the results to verify whether corrective activities have been carried out effectively and will report on the follow-up results.

The Management Representative has the duty to present the summary of the audit results to the management's meetings.

3. Monitoring and measurement of processes

The Company has prepared a suitable method for monitoring and measurement of processes in order to achieve the products. This method is in the form of assessment whether implementation achieves the defined quality objectives of each function, in order to determine correction and prevention in the event that the assessment shows that the established objectives are not achieved.

4. Monitoring and measurement of products/construction works

The Company has determined that there shall be monitoring and measurement of products/construction works to ensure that their characteristics conform to the requirements. Inspections and tests are carried out at each appropriate stage of the process. Records of results of the inspections and tests against the defined acceptance criteria have been maintained.

The persons authorizing release of the product for each stage of inspection and testing have been identified.

The Company will not deliver a product/construction work until it is confident that every procedure defined in the quality management system has been implemented, unless otherwise approved by the customer/project owner as a special case.

Control of Nonconforming Products

The Company has prepared a quality procedure for control of the product/construction works that does not conform to requirements to prevent its use or delivery.

Non-conforming products/construction works will be corrected and inspected again.

In the case that a non-conforming product/construction work is found after its delivery or use, the Company will take appropriate action with such nonconforming product.

In the event of a previous agreement with the customer/client, owner or of applicable regulations of the authorities, adjustment or revision of the nonconforming product/construction work will be reported to the customer/client or the authorities concerned.

Analysis of Data

The Company has collected and analyzed appropriate data to demonstrate the suitability and effectiveness of the quality management system and to determine framework for improvement. Data to be analyzed include those on:

- *Customer satisfaction and/or dissatisfaction*

- *Conformity to customer requirements*

- *Characteristics and trends of processes and products*

- *Suppliers previous achievements*

- *The responsible persons, methods for analysis, and post analysis improvement have also been determined.*

Improvement

1. Continual improvement planning

The Company has planned and implemented necessary procedures for continual improvement of the quality management system through the use of information on the quality policy, quality objectives, audit results, information derived from analysis of data, corrective and preventive action and management reviews.

2. Corrective action

The Company has prepared a quality procedure for correction to eliminate the cause of nonconformities. Corrective activities have been reviewed to be appropriate to the probable effects of the problems encountered.

The quality procedure concerning corrective activities covers the following:

- *Review of nonconformities (including complaints from customers/ communities around construction projects)*

- *Determination of assessment of the causes of nonconformities*

- *The need for action to ensure that nonconformities do not recur*

- *Implementation of corrective activities needed*

- *Records of the results of action taken*

- *Review of effectiveness of corrective activities*

Preventive action

The Company has prepared a quality procedure concerning action to eliminate the causes of potential nonconformities. Preventive actions have been reviewed to be appropriate to the effects of the potential problems.

The quality procedure concerning preventive activities covers the following:

- *Determination of potential nonconformities and their causes*

- *Determination and implementation of preventive activities needed*

- *Records of the results of action taken*

- *Review of preventive activities*

Brief Summary of the Significance of the References

Provided with all the necessary references both from the ISO 9001: 2000 and CH. Karnchang Construction Company for this research as explained prior to this paragraph showed that all aspects play considerable roles. All parts are essential as they are implemented sequentially and produce results precursor to other activities until the objectives of the management are achieved.

Since specific requirements are already outlined, identification of the needed resources & formulating of a plan for the timely execution and completion of works can be performed with ease. Moreover the control of activities can guarantee good results.

When evaluating the structure of the Quality Manual of the reference company compared with that of ISO conditions, similarities are found to be comprehensible but varied with the goals & objectives of the company thus this

assessment presented a concept and reference to create a Quality Manual to be an important document for the realization of the project/s they the companies are involved with.

RESEARCH METHODOLOGY

The Questionaire

Development of the Questionaire

Questions were created in reference with the interviews of selected staff holding key positions in CH. Karnchang Public Company Limited concerning their experiences in dealing with their sub-contractors including the company's management of selected projects that were completed and are on going. This was simultaneously made with the inclusion of the relevant requirements & clauses from ISO that are appropriate references in creating the questions.

The flowchart below demonstrates how the questions were formed for the respondents to answer.

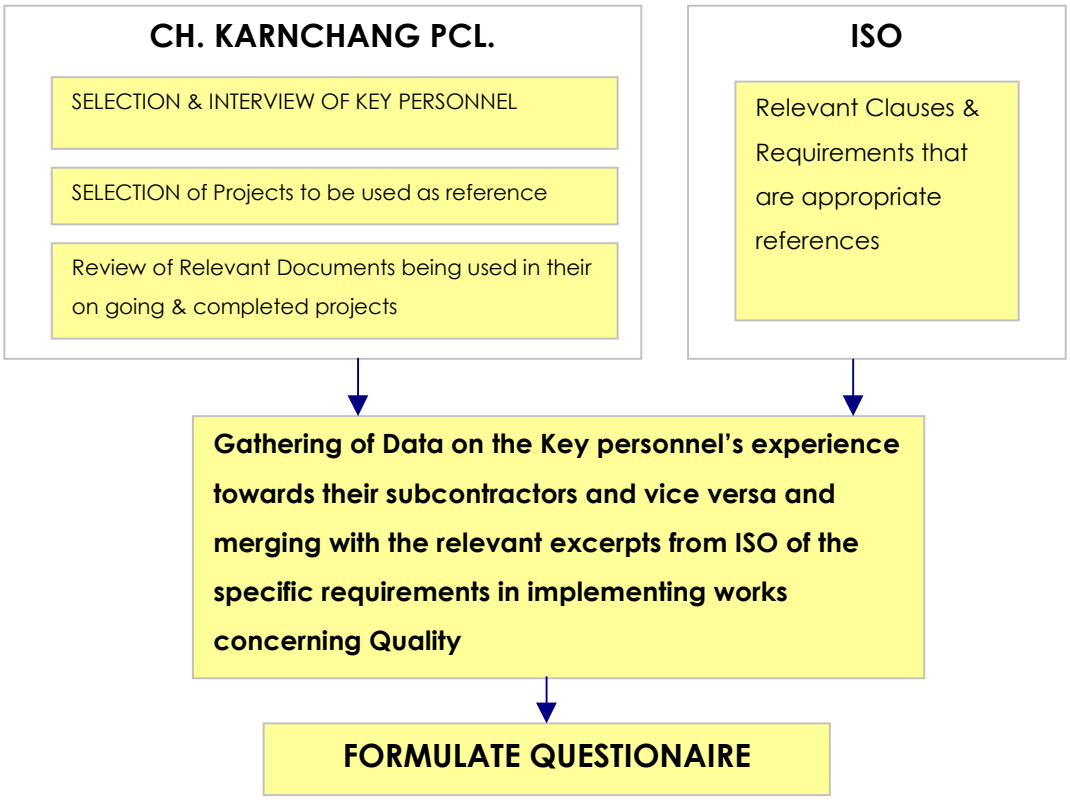


Figure 4 Development of Questionaire Flowchart

Contents of The Questionaire

The questionaire is divided into two parts. Part 1 is comprised of questions on respondents' general information whilst Part 2 is divided into two categories namely:

a) Group of questions answerable by "Yes" or "No" that were established on direct experiences & impressions of the respondents towards their sub-contractors during implementation of work.

b) Questions representing the weighing of the "Influence & Importance" documented procedures concerning the Quality of Work. Outline of the contents of the Questionaire are as follows:-

Refer to item a), Question Part consisting of nine questions namely:

1. Do you have a quality manual which indicates details as per requirement of the quality management system?

2. In your project, do you use a quality management system as indicated in the quality manual to apply for the work?

3. In commencing the work, do you have any preparation works under the quality management system as the following?

3.1 Preparation of information for bidding and Review of the agreements

3.2 Prepare the budget for the project

3.3 Prepare the master documented procedure

4. In your project, do you have a document related to quality management system?

Master Documented Procedure (Existing Company Manuals)

4.1 Quality Manual

4.2 Quality Procedure

Document which apply to specific projects

4.3 Quality Procedure or Management Procedure

4.4 Method Statement (Work Procedure)

4.5 Inspection and Test Procedure (Inspection Procedure)

5. Do the sub-contractors have the ISO registration?

6. Do the sub-contractors have the knowledge about quality management system?

7. Concerning documents which support the quality management system that can be divided into 2 parts; First part is documents that directly influence the work such as Method statement and Inspection & Test Procedure. Second part is documents that are in aid to support to your work such as Document Control procedure or Purchasing procedure. Do the sub-contractors have these kinds of documents?

7.1 Document Procedure (Direct Influence to the work)

7.2 Document Procedure (Aid to support the work)

7.3 If they have – Do the sub-contractors use the document during working?

8. In case of sub-contractors that do not have the documents as the above-mentioned. Do they have the capacity to create these documents by themselves? (Do not include cases when you provide for them)

9. Do you think that if the sub-contractors can follow instructions as stated in the documents will improve their work to be a systematic and the quality of work will be improved?

Refer to item b), represents the documents relevant to the influence and importance of the "Quality of Work" i.e. Work Procedures, Inspection Procedures, Management of Filing & Correspondence et al.

See Appendix A for the complete set of the Questionaire.

Selection of Respondents

Since CH. Karnchang Company is the reference organization, currently employed staff holding key positions that are directly involved with sub-contractors were chosen to obtain first hand information regarding their experiences and recommendations in order to achieve the required Quality of Work.

Refer to Result and Discussion for more information on the respondents.

Methodology of the Research Data

Information on quality management procedures was gathered from on going and completed construction projects of CH. Karnchang PCL. The projects are:

- BCKT: Underground South Structures of the MRTA Subway Systems

- CKET: Project Manager of BMCL –Concessionaire of the MRTA Underground Train Systems

- CH. Karnchang PLC.: Depot Buildings & its Facilities for MRTA Underground Train Systems

- CH. Karnchang PLC.: BMCL Administration Building

- CH. Karnchang PLC.: Map Tha Put Feeder Line Project

- CH. Karnchang PLC.: Additional LLK Jet A1 Tank Project

- CH. Karnchang PLC.: SBIA Hydrant Network

- CH. Karnchang PLC.: Platinum Fashion Mall

Steps in gathering data for this research study are as follows:

1. Data collection from construction projects focusing on the quality management procedures. Main information is acquired from the MRT. Chaloem Ratchamongkhon Underground Systems. Other data are obtained from construction site of companies that were certified internationally on their quality management system.

2. Data Review and selection of appropriate procedures based on problem/s concerning issues on management that contractors normally experience. The scenario is derived from study of the problem in construction industry and through interviews from experienced individuals regarding the topic.

3. Provide suitable references for work and inspection procedures.

4. Create guideline of quality management and discussion of the results.

5. After discussion of the results and agreement on the guideline, this will be followed by creation of a digital template to facilitate the user in applying the functions of the documented procedures for construction projects.

6. Conclusion and final discussion of the results

RESULTS AND DISCUSSION

Analyses of the Survey

In this thesis, a questionaire is used to substantiate the need of small to medium sized sub-contractors of the guideline to improve their works in order to be systematic and to ensure improvement of the quality of their works. The questionaire is divided into 2 parts namely; Part 1 - General questions, and Part 2 – Question analyses of contractor's impression categorized into question parts and weight due to importance of the procedure. The results from the questionaire of 32 respondents are presented in the following order:

Part 1: General information of the respondents

1. Gender classification comprised of 32 males (100%), and nil (0%) for female.

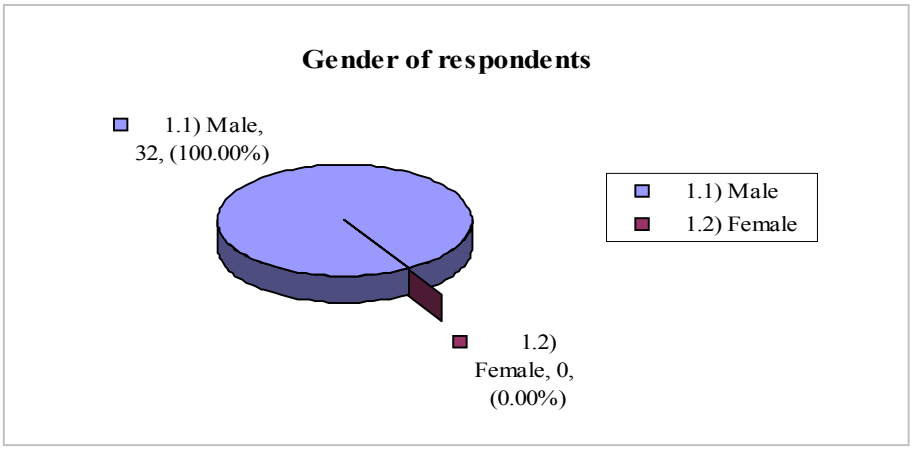


Figure 5 Pie chart showing gender of respondents

2. Years of age, categorized into 4 ranges from 21-30 years comprised of 3 respondents (9.37%), 31-40 years for 15 respondents (46.88%), 41-50 years for 10 respondents (31.25%), and over 51 years for 4 respondents (12.50%).

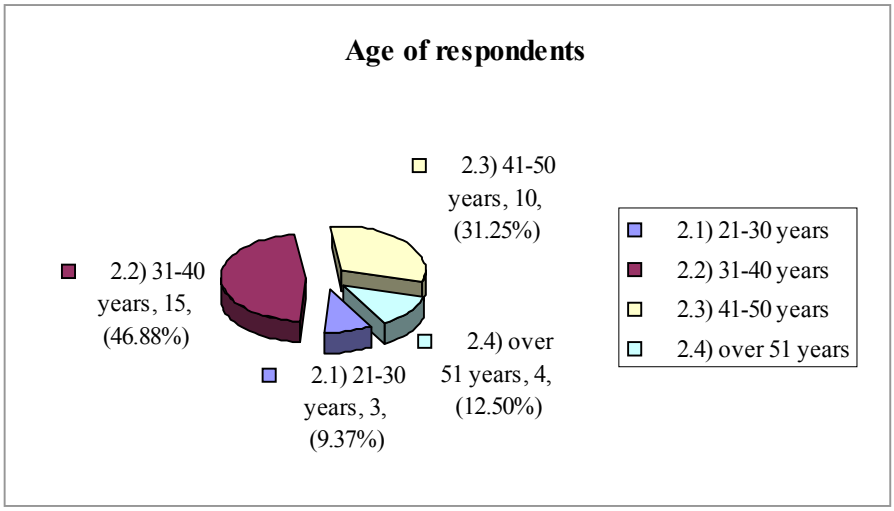


Figure 6 Pie chart showing Years of Age of respondents

3. Years of experience in the field of construction, categorized into 4 levels from 1-5 years for 3 respondents (9.37%), 6-10 years for 6 respondents (18.75%), 11-20 years for 15 respondents (46.88%), and over 21 years for 8 respondents (25.00%).

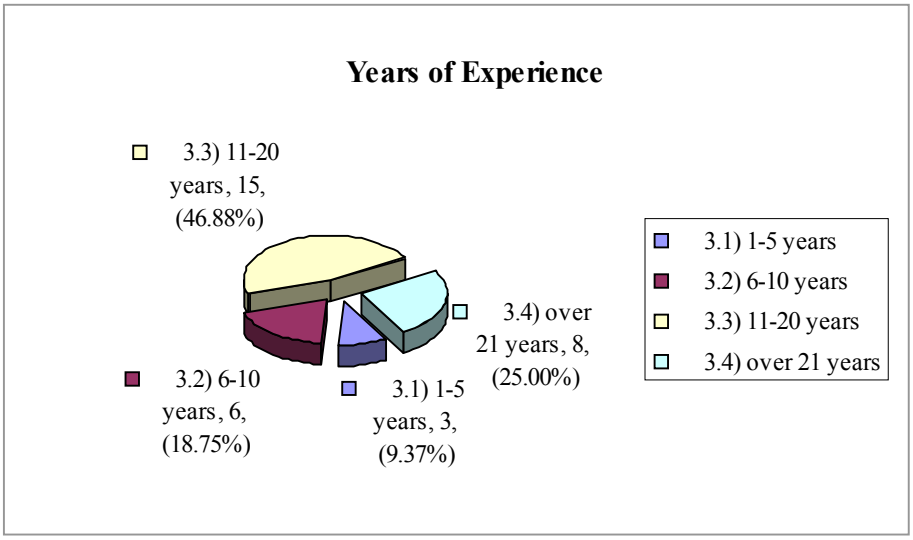


Figure 7 Pie chart showing Years of Experience of Respondents

4. Educational attainment categorized into 4 section comprising of vocational at 0%, high vocational 0%, 21 respondents for bachelor degree at 65.63%, and 11 respondents for master degree at 34.38%.

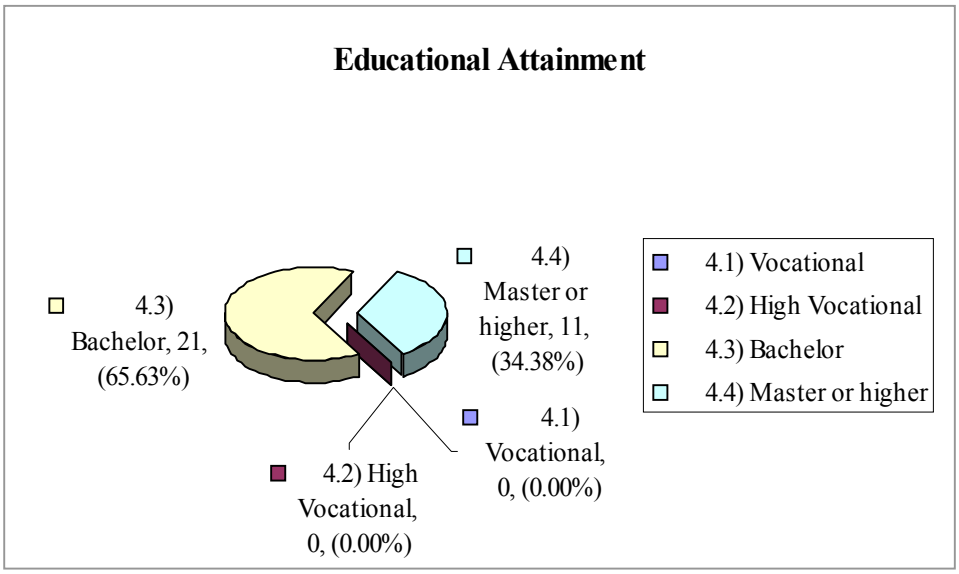


Figure 8 Pie chart showing Educational Attainment of Respondents

5. Position of the respondents are categorized into 4 levels comprised of 6 (six) Project Managers at 18.75%, 12 (twelve) Division Managers at 37.50%, 8 (Eight) Senior Engineers at 25.00%, and 6 (six) Engineers at 18.75%. Related fields of expertise of respondents are categorized to civil, electrical, and mechanical. Below shows Table & graphical representations of the respondents.

Table 3 Respondents Position and Related Field

Position	Frequency		
	Civil	Electrical	Mechanical
Project Manager (Total = 6 persons)	5	1	0
Division Manager (Total = 12 persons)	6	3	3
Senior Engineer (Total = 8 persons)	1	6	1
Engineer (Total = 6 persons)	1	0	5

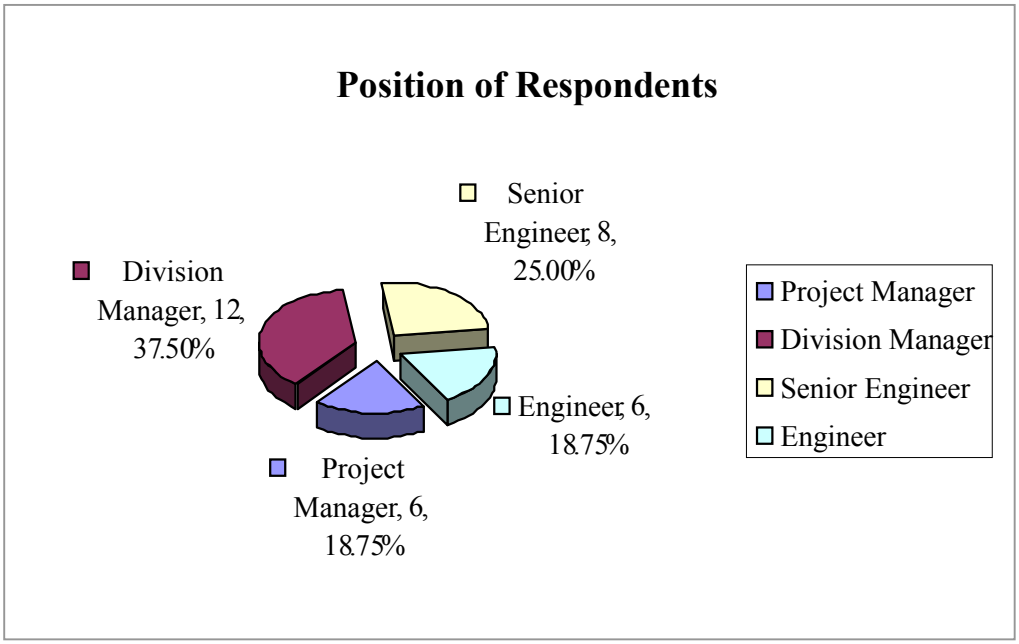


Figure 9 Pie chart showing Key positions of Respondents

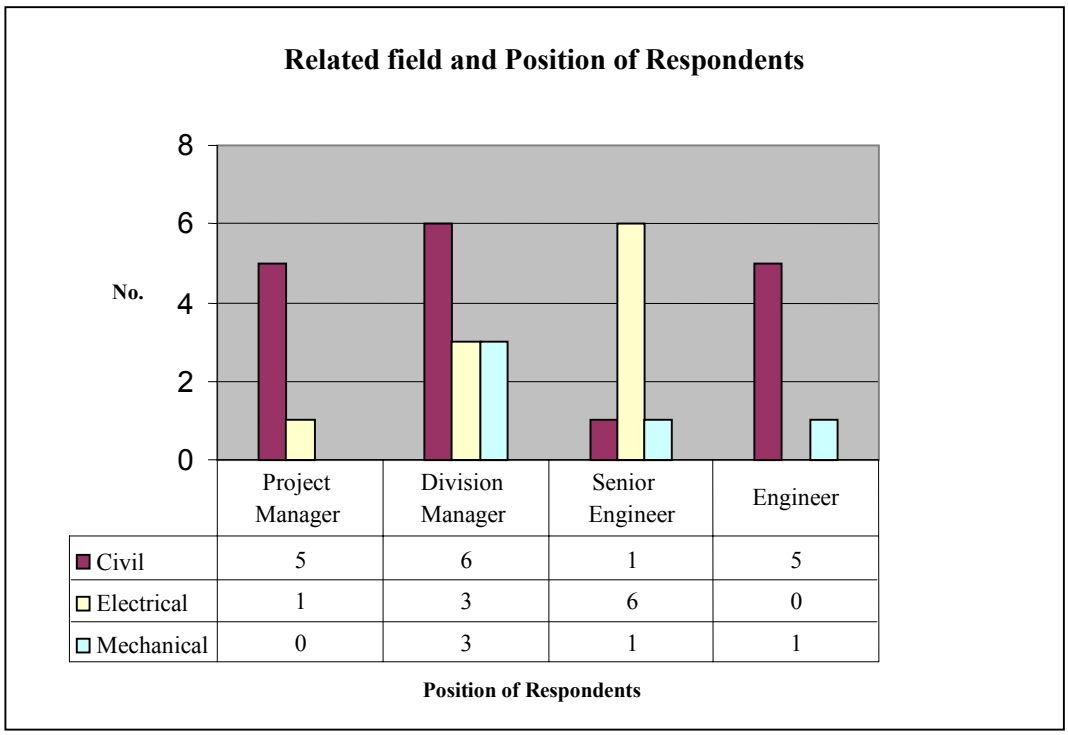


Figure 10 Bar chart showing Related Fields of Expertise & Positions of Respondents

Part 2 Section 1: Question Analyses of Contractor's impression on Sub-contractors

Table 4 Question Analyses Result from the Respondents

Item	Question	YES		NO	
		Frequency	%	Frequency	%
1	Do you have a quality manual which indicates details as per requirement of the quality management system?	32	100.00%	0	0.00%
2	In your project, do you use a quality management system as indicated in the quality manual to apply for the work?	32	100.00%	0	0.00%
3	In commencing the main work, do you have any preparation works under the quality management system as the following?				
	3.1 Preparation of information for bidding and review of the agreements	32	100.00%	0	0.00%
	3.2 Prepare the budget for the project	32	100.00%	0	0.00%
	3.3 Prepare the master documented procedure	32	100.00%	0	0.00%

Table 4 (continue)

Item	Question	YES		NO	
		Frequency	%	Frequency	%
4	In your project, do you have a document related to quality management system? * Master Documented Procedure (Existing Company Manuals)				
	4.1 Quality Manual	32	100.00%	0	0.00%
	4.2 Quality Procedure	32	100.00%	0	0.00%
	* Document which apply to specific projects				
	4.3 Quality Procedure or Management Procedure	32	100.00%	0	0.00%
	4.4 Method Statement (Work Procedure)	31	96.88%	1	3.13%
	4.5 Inspection and Test Procedure (Inspection Procedure)	31	96.88%	1	3.13%
5	Do the sub-contractors have the ISO registration?	4	12.50%	28	87.50%
6	Do the sub-contractors have the knowledge about quality management system?	15	46.88%	17	53.13%

Table 4 (continue)

Item	Question	YES		NO	
		Frequency	**%**	**Frequency**	**%**
7	Concerning documents which support the quality management system that can be divided into 2 parts; First part is documents that influence the work directly such as Method statement and Inspection & Test Procedure. Second part is document which is in aid to support your work such as Document Control procedure or Purchasing procedure. Do the sub-contractors have these kinds of documents?				
	7.1 Document Procedure (Influence the work directly)	11	34.38%	21	65.63%
	7.2 Document Procedure (Aid to support the work)	8	25.00%	24	75.00%
	7.3 If they have – Do the sub-contractors use the document during implementation of the work ?	15	93.75%	1	6.25%

Table 4 (continue)

Item	Question	YES		NO	
		Frequency	%	Frequency	%
8	In case of sub-contractors that do not have the documents as the above-mentioned. Do they have the capacity to create these documents by themselves? (Do not include cases when you provide for them)	2	6.25%	30	93.75%
9	Do you think that when the sub-contractors follow instructions as stated in the documents, will make the implementation of their work to be systematic and the quality of work will be improved ?	32	100.00%	0	0.00%

The result of part 2, section 1 from the questionaire shows the percentage in bar chart as shown in figure 11.

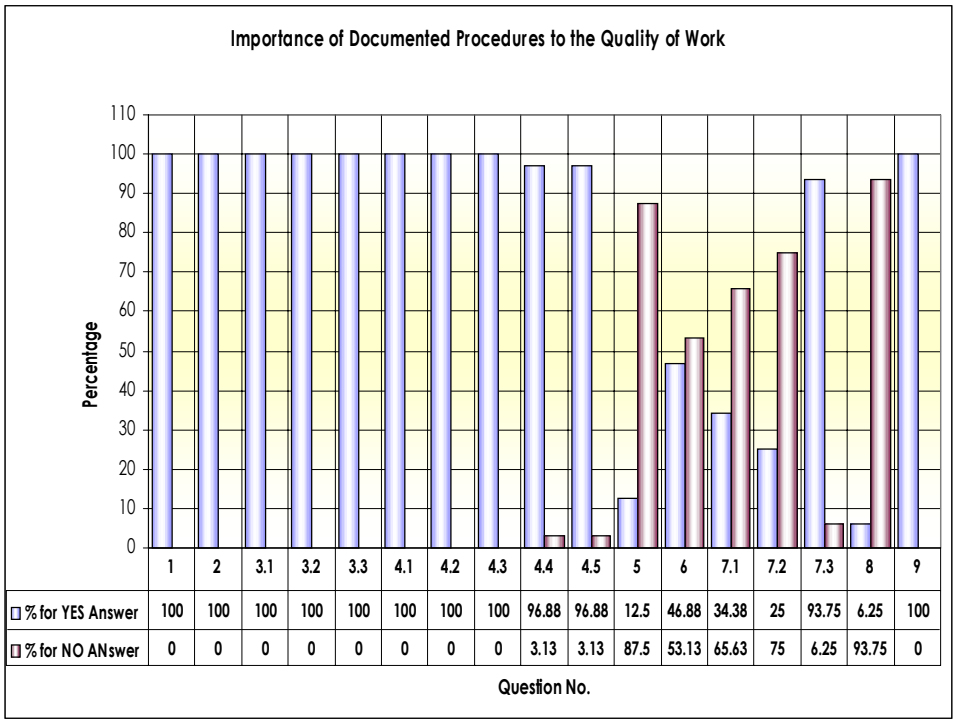


Figure 11 Graphical representation on Importance of Documented Procedure

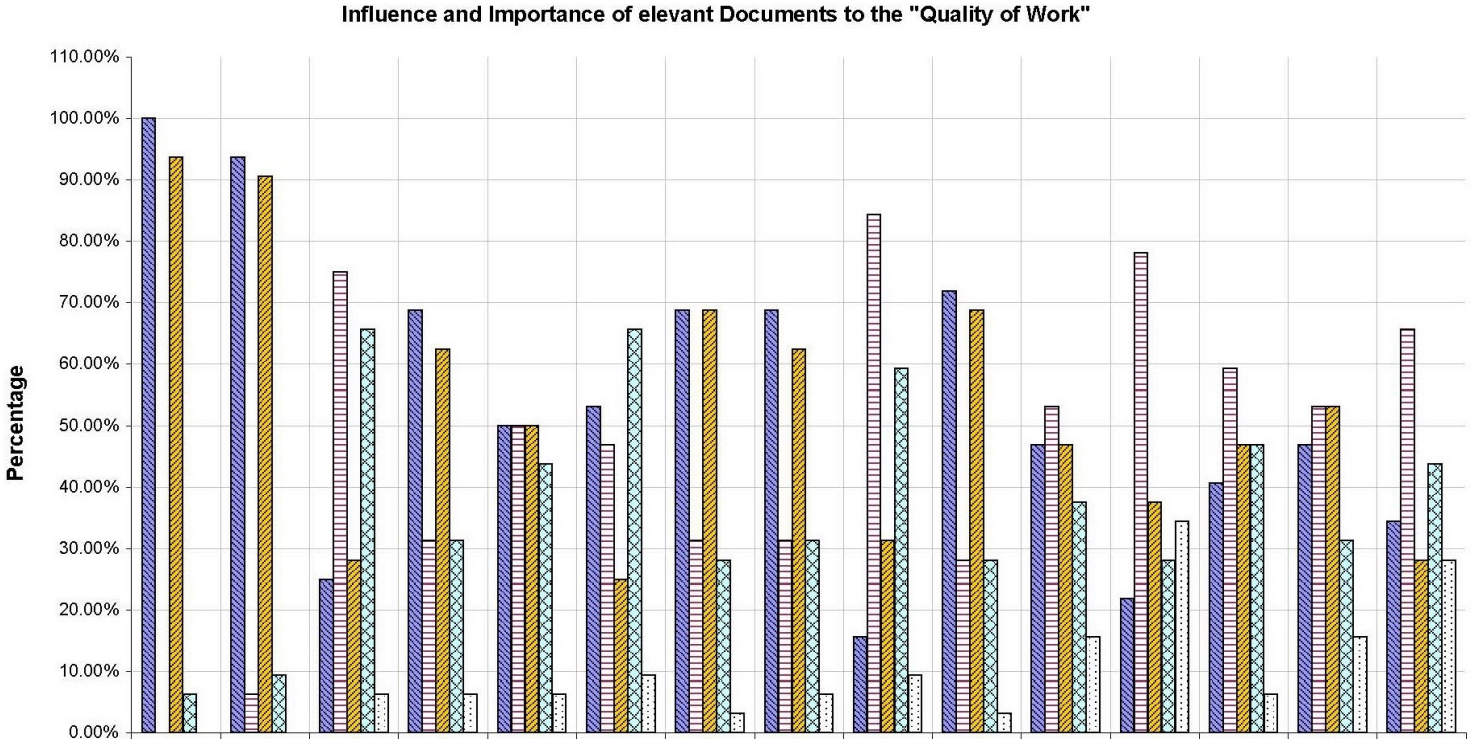
Part 2 Section 2: Influence & Importance of a Documented Procedure

The second section of part two is the weightings of the influence of procedure to the quality of work categorized as direct or in aid of support and the importance of procedure to the quality work.

Table 5 Result from Question Analyses due to Influence & Importance of a Documented Procedure

Respondents **32** **Persons**

Item	Type/Description of Documents	Influence to the works				Importance to the "Quality of Work"					
		Direct	%	Supportive	%	High	%	Medium	%	Low	%
1	Work Procedure/Sequence of the Work	32	100.00%	0	0.00%	30	93.75%	2	6.25%	0	0.00%
2	Inspection Procedure of the work	30	93.75%	2	6.25%	29	90.63%	3	9.38%	0	0.00%
3	Management of Filing & Correspondence in the project	8	25.00%	24	75.00%	9	28.13%	21	65.63%	2	6.25%
4	Verification & coordination on Design matters	22	68.75%	10	31.25%	20	62.50%	10	31.25%	2	6.25%
5	Review of conditions in the contract and other agreements	16	50.00%	16	50.00%	16	50.00%	14	43.75%	2	6.25%
6	Control of equipment and measuring of the test equipment	17	53.13%	15	46.88%	8	25.00%	21	65.63%	3	9.38%
7	Non-conformities of works performed through reports	22	68.75%	10	31.25%	22	68.75%	9	28.13%	1	3.13%
8	Acceptance Test & taking Over Procedures	22	68.75%	10	31.25%	20	62.50%	10	31.25%	2	6.25%
9	Internal Audit	5	15.63%	27	84.38%	10	31.25%	19	59.38%	3	9.38%
10	Safety Guidelines	23	71.88%	9	28.13%	22	68.75%	9	28.13%	1	3.13%
11	Environmental Management	15	46.88%	17	53.13%	15	46.88%	12	37.50%	5	15.63%
12	Staffing	7	21.88%	25	78.13%	12	37.50%	9	28.13%	11	34.38%
13	Procurement	13	40.63%	19	59.38%	15	46.88%	15	46.88%	2	6.25%
14	Budget Control	15	46.88%	17	53.13%	17	53.13%	10	31.25%	5	15.63%
15	Financial	11	34.38%	21	65.63%	9	28.13%	14	43.75%	9	28.13%



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
% Direct Influence	100.00%	93.75%	25.00%	68.75%	50.00%	53.13%	68.75%	68.75%	15.63%	71.88%	46.88%	21.88%	40.63%	46.88%	34.38%
% Supportive	0.00%	6.25%	75.00%	31.25%	50.00%	46.88%	31.25%	31.25%	84.38%	28.13%	53.13%	78.13%	59.38%	53.13%	65.63%
High Importance	93.75%	90.63%	28.13%	62.50%	50.00%	25.00%	68.75%	62.50%	31.25%	68.75%	46.88%	37.50%	46.88%	53.13%	28.13%
Medium Importance	6.25%	9.38%	65.63%	31.25%	43.75%	65.63%	28.13%	31.25%	59.38%	28.13%	37.50%	28.13%	46.88%	31.25%	43.75%
Low Importance	0.00%	0.00%	6.25%	6.25%	6.25%	9.38%	3.13%	6.25%	9.38%	3.13%	15.63%	34.38%	6.25%	15.63%	28.13%

Figure 12 Graphical Representation of Importance & Influence to the Quality of Work

Summary of Findings from the Survey

Collected data from the survey showed favorable results in creation of documented procedures for sub-contractors to utilize in their work application.

The conducted survey and interviews results show that:

In general, sub-contractors do not have the capacity to produce documented procedures when required by the Owner/Employer for implementation of works.

Their resources are very limited to fulfill requirements as evidently shown by their dependence on the Owner/Employer's decisions and provision of necessary documents and procedures.

Close supervision of the sub-contractors is very necessary when implementation of works is being performed

Works & Inspection procedure documents are very important and have direct influence during implementation of works.

The outcome of the survey and interviews clearly showed that most documents relevant to the sub-contractors' works are prepared and provided by their employers. Their dependence on their employers or main contractors is practically the same in their very small participation in decision making. Close monitoring is always applied while works are being implemented to check methods & conformities against the provided standards or requirements.

The results also demonstrate that Works & Inspection procedures are given the most importance and influence because they serve as a guideline in implementing and achieving the required quality of work and that these documented procedures are very effective in managing works due to their methodical application.

It is therefore imperative for small to medium scale construction companies and family owned businesses of the same scale to be required to create these documented procedures relevant to every project that they will be potentially involved with. It recommended that they be provided a guideline to improve their management system of works.

Guidelines In Creating The Documented Procedures

This study is made to raise the standard of the sub-contractors' performance of works and capability in the field of construction through the use of documented procedures.

Involvement with Design matters is limited due to their role of implementing the "Good for Construction" drawings or as per instruction issued to them by the Owner/Employer.

The guidelines contained in the documented procedures are classified in to two namely Management and Operational aspects which include work procedure and inspection procedure. The Table is shown below of the documented procedures that are relevant to management in obtaining the required Quality of Work derived from the results of the survey & interviews of key staff.

Table 6 Documented Procedures to serve as guideline in Management aspect

Items as per Documented Procedure		Relevance	Remarks
1	Correspondence and Filing	**LS**	An existing procedure is
2	Document Control	**LS**	acknowledged and used in the process.

Table 6 (continue)

Items as per	Documented Procedure	Relevance	Remarks
3	Design Coordination	**HR**	Impact occurs when implementing "Good for Construction" drawings on site as per instruction.
4	Design Verification	**HR**	
5	Contract Review and Variations	**LS**	Supportive
6	Equipment and Stock	**LS**	The control of utilization & maintenance of equipment to minimize wastage
7	Cost and Budget Control	**LS**	Expenditures are maintained at a minimum or contained within the allocated budget.
8	Purchasing	**LS**	Supportive.
9	Financial Management	**LS**	Supportive
10	Planning, Scheduling and Progress Reporting	**LS**	In line with the Construction Management due to the timely execution and completion of work activity
11	Personnel	**LS**	Supportive
12	Non Conforming Work	**HR**	Impact occurs when works are performed at unacceptable standards
13	Measuring and Testing Equipment	**LS**	See Item no. 6

Table 6 (continue)

Items as per Documented Procedure		Relevance	Remarks
14	Safety Management	**HR**	Compliance on Safety regulations when performing works
15	Environmental Management	**LS**	Supportive
16	Audit	**LS**	Supportive
17	Site Acceptance and Work Hand-Over	**HR**	Acceptable End product as the execution of works & materials used conforms with the set standards

LEGEND:	
Highly Relevant	**HR**
Supportive or Less Significant	**LS**

Concerning the Operational aspect the relevant documents that will comprise of the procedures are the Work and Inspection procedures. The areas of work procedures and inspection procedures are the following.

1) Survey
2) Piling
3) Bored Pile (Dry Process)
4) Excavation
5) Reinforced Concrete
6) Concrete Repair
7) Structural Steel
8) Wall Finishing
9) Floor Finishing
10) Ceiling
11) Door and Window
12) Painting

13) Electrical Works – show as sample
14) Sanitary, Drainage and Water System – show as sample
15) Air Conditioning System – show as sample

Documented procedures are comprehensively shown in the attachments (see Appendix B) outlining the scopes & purposes, actions to be taken as shown in flowcharts and concerned responsible or authorized individuals or organizations. The attachments are appended with the relevant forms to be used in tracking the actions of the processes.

Documented procedures related to E&M activities are from the completed projects of CH. Karnchang PCL that are presented as samples for information and references only.

It is to be noted that all codes and forms that are used in the appendices are purely examples or proposals for identification purposes and convenience on how the processes are made. In a case the company referred to as the Contractor already has an existing system, they may utilize or revise at their own discretion for easier understanding of involved individuals or organizations.

As described and used as examples, four entities namely the Owner/Employer, the Consultant, the Contractor/Company and the Sub-contractor are used to properly present their respective roles and responsibilities in each documented procedure. As shown below, an organization chart is made as a reference on how authority in terms of procedural documents is delivered from top to bottom.

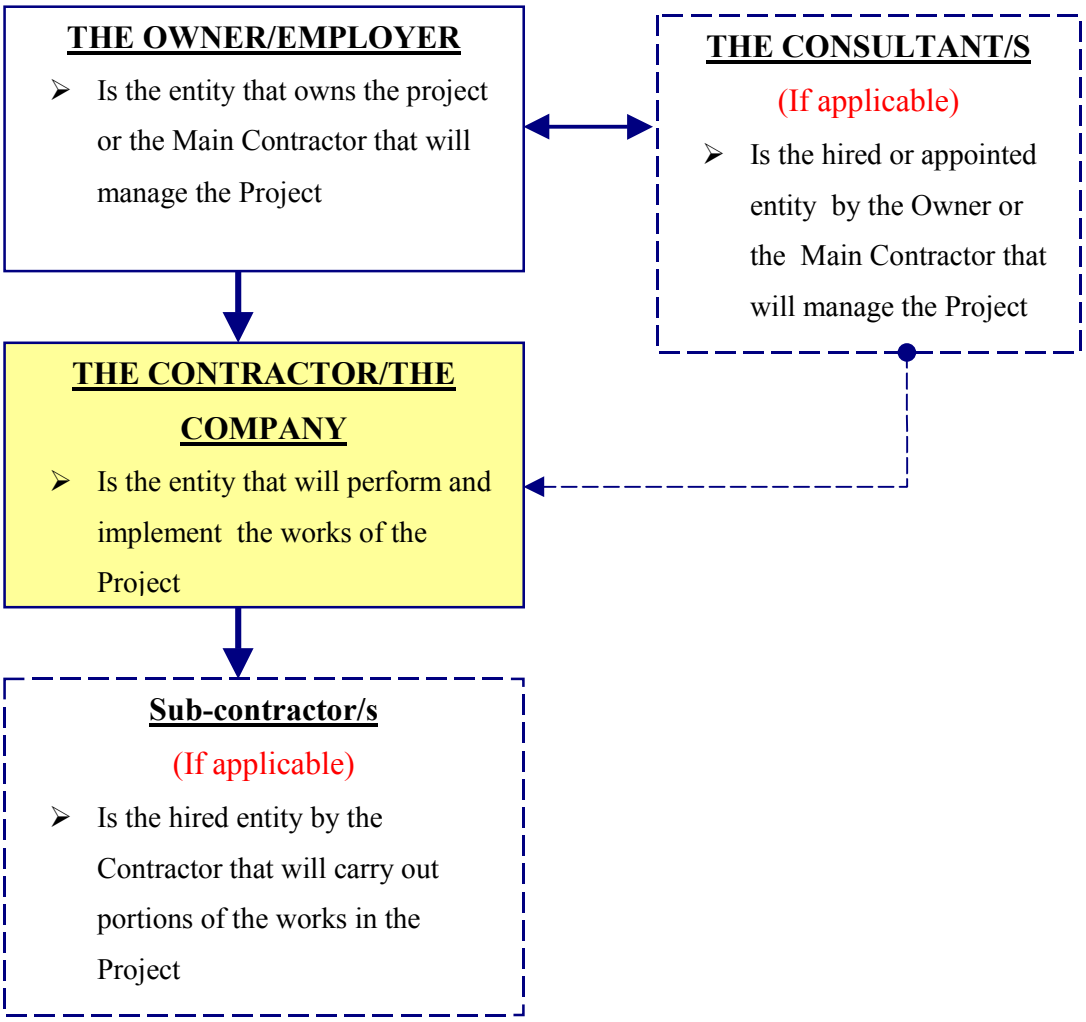


Figure 13 Line Type Organization of the Entities used in the Appendices.

Another chart that is also used as a reference to show the flow of authority in terms of approval and transmittals are shown below into two levels. The typical divisions in a construction company exercise their specific roles & responsibilities as described in the appendix for the assessment of progress against payments or vice versa.

Concerning progress of works for payment or vice versa purposes, measurements are made through job phase/activity codes as shown in the sample documented procedure wherein the company or the Contractor has careful

judgment on what bases are to be referred to i.e. Work Breakdown Structure or Stages of Work. In addition, individuals that are involved in the Company's part depend on the company's authorization to duly sign or carry out agreements with the Owner/Employer.

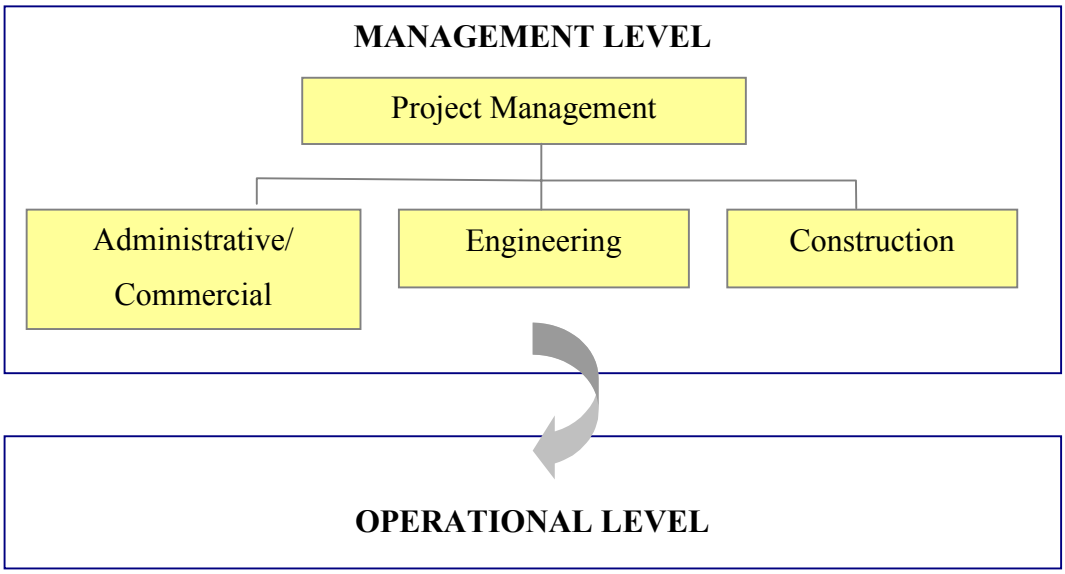


Figure 14 Typical Divisions in a Construction Company

In conjunction to the abovementioned information it is recommended that the provided sets of information are to be used to properly manage required works at a controlled level in fulfilling the objectives of providing guideline to sub-contractors. Moreover also shown in the attachments, is a complete outline of the necessary documented procedures to acquire an effective management system of works prior to their implementation and completion and similarly with the required Quality of work.

In addition, this research is provided with the digital template of the documented procedures contained in a CD-Rom to facilitate the user in creating the procedures intended for their potential or existing projects. Each specific procedure is arranged in a folder to easily identify the document for each specific work.

The steps in using the provided template in the CD-Rom are shown in the

following figures.

Step 1: Install the CD-Rom; there are two folders contained in the CD-Rom as shown in figure 15

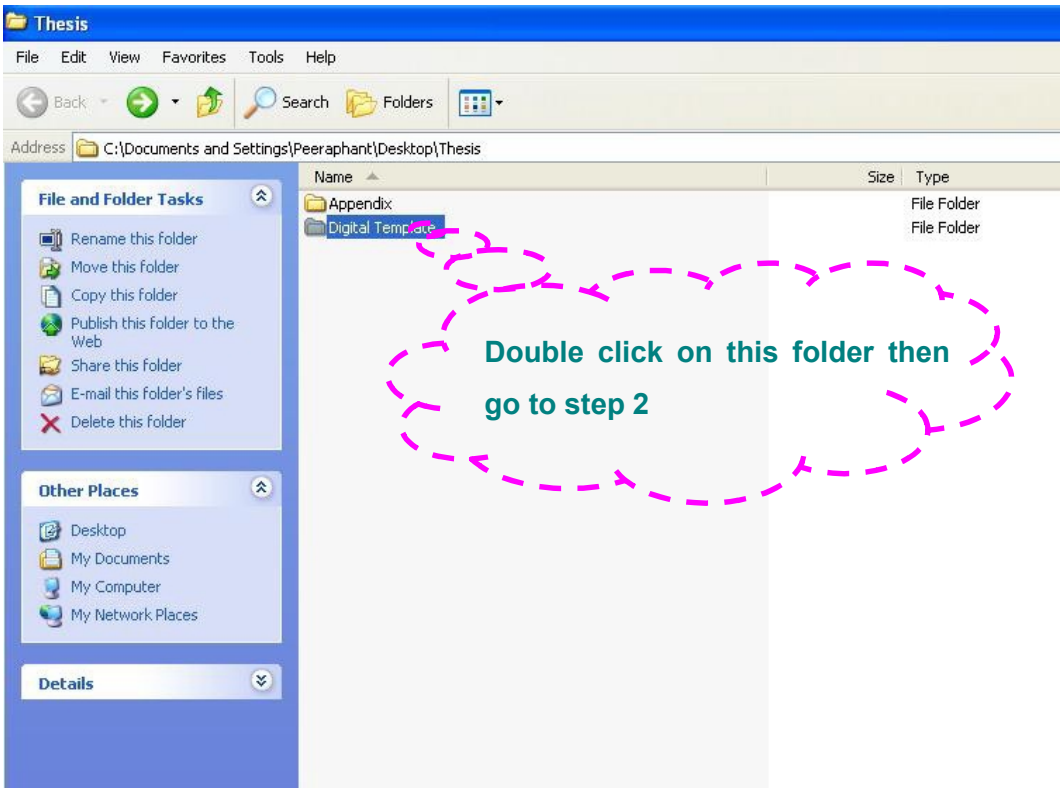


Figure 15 Screen output for Step 1

Step 2: After double click on the Digital Template folder, the result is shown in figure 16 for your selection of each kind of procedure

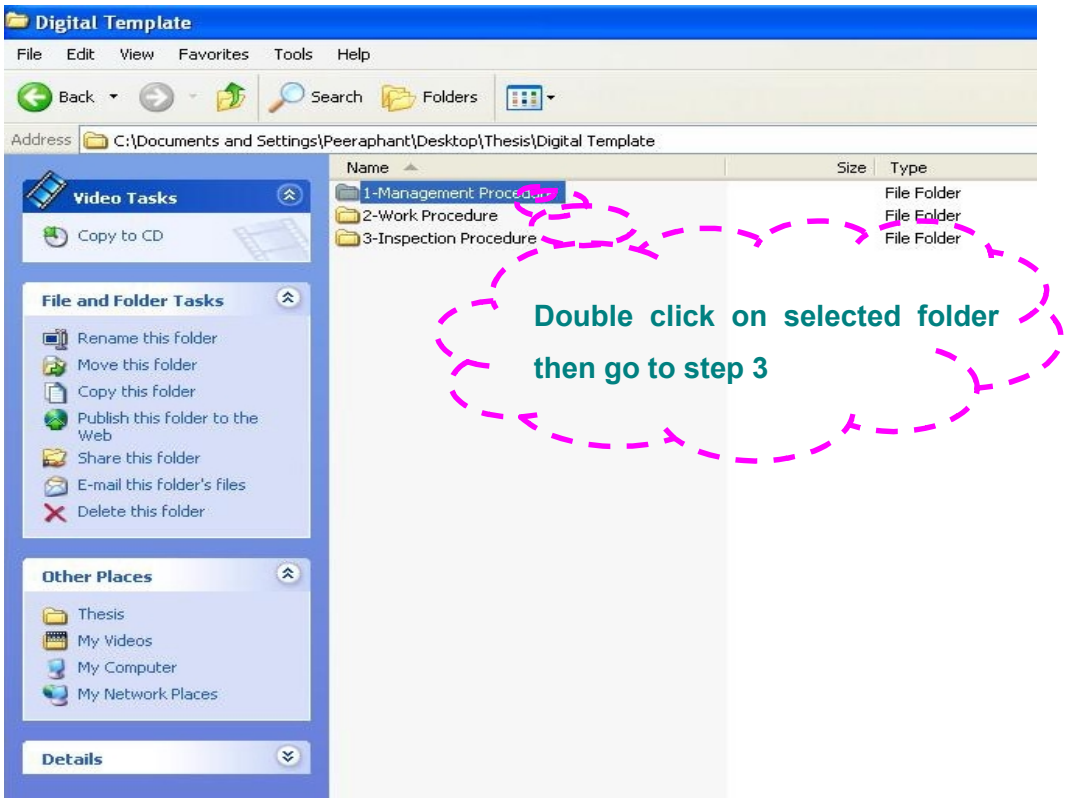


Figure 16 Screen output for Step 2

Step 3: After double click on selected folder, the result is shown in figure 17 for your selection of each procedure

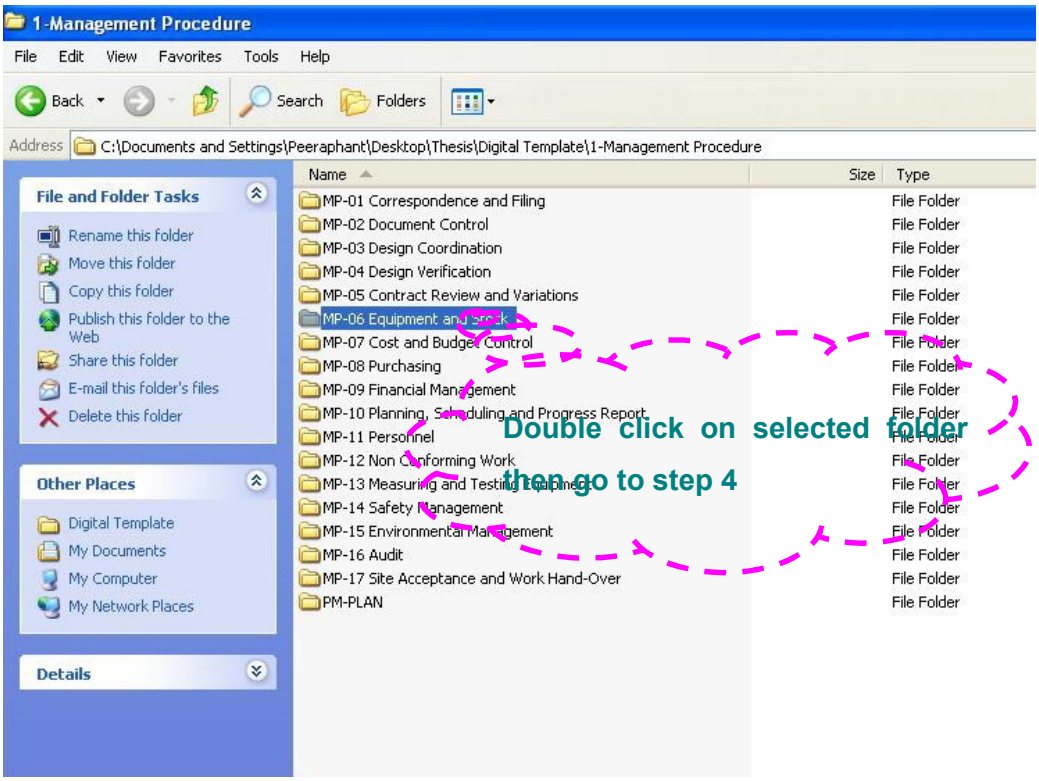


Figure 17 Screen output for Step 3

Step 4: After double click on selected folder, the result is shown in figure 18 for your selection of each procedure

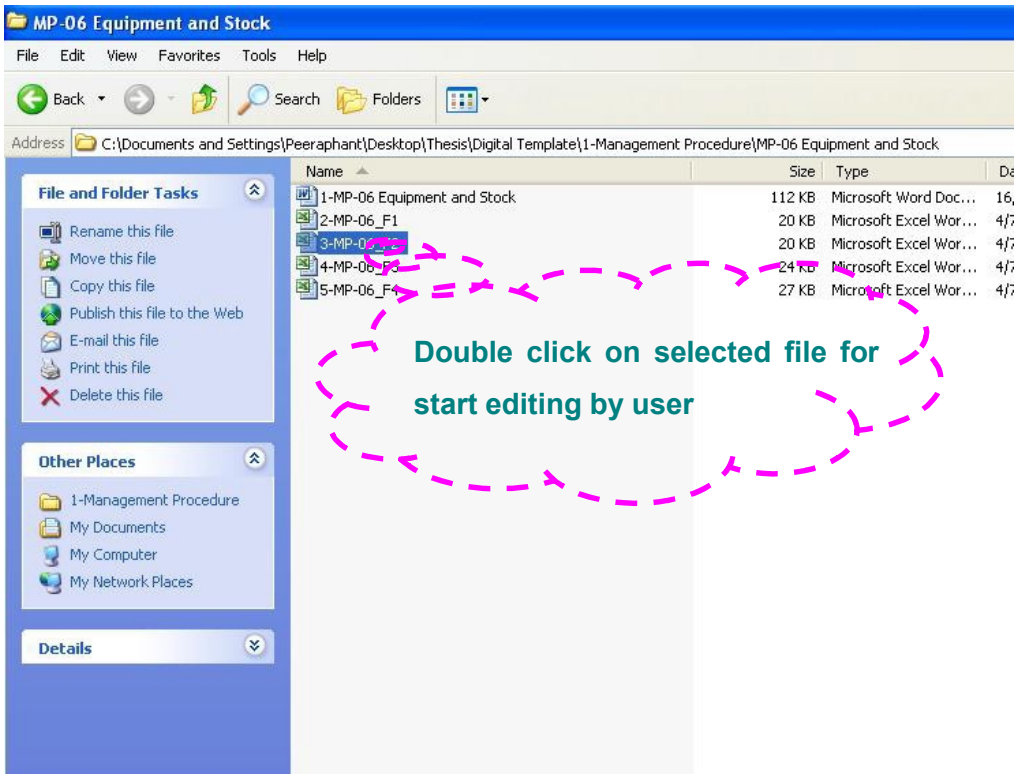


Figure 18 Screen output for Step 4

CONCLUSION OF THIS RESEARCH

The purpose of this study is to develop guidelines of Quality Management that can be applied to small and medium size contractors, or any contractors which do not have sufficient quality management system, to improve the quality of their construction works.

The survey was carried out with staffs of the reference company to determine the availability of Quality Management for sub-contractors, which normally are small to medium size contractor not a big company that are registered by ISO standard.

Areas for improvement have been identified & analyzed from the collected information of the conducted research, interviews, and relevant references taken from on going and completed projects of CH. Karnchang Public Company Limited. Formation of guidelines of Quality Management System has been prepared to serve as the proposal to suitably resolve the identified areas for improvement in managing works. Creation of a database comprised of documented procedures developed from the documented procedures of the reference company also has been made. These documented procedures show the outline of all the necessary items i.e. scopes & purposes, key individuals or organizations, flowcharts and processes to facilitate users for an effective management system to acquire the expected Quality of work.

Below are the aspects that are certainly improved when sub-contractors put the guiding principles into use in projects.

Tools and Methodology Aspect

Provided with documented work and inspection procedures as the guiding principles to each specified work, fulfilling requirements imposed by Employers to contractors can be attained with ease as they are purposely structured to be

performed in a systematic manner due to the clarity of the indicated requirements and sequences.

The substantial effect on the Quality of works can be confirmed through the application of the Works and the ITP procedures. As outlined in the Works procedure, sequence of works is presented in an orderly manner with specified resources i.e. equipment, and responsible persons in charge to supervise the tasks to be implemented systematically in carrying out the works. In support of the task in acquiring the required “Quality of Work” is the Management Procedure detailing the process of Document Control, progression of Procurement & Deliveries of materials, financial aspects incorporating cost accounting and budget control.

The Guiding principles will also act as a tool in identifying risks and the timely execution of works based on site conditions and in reference with the requirements from Employer/Owner/Contractor through a detailed program that can be derived from Works procedures outlining all the possibilities affecting the completion of works presented as the critical path.

In aid of communication with the Owner/Employer through its properly structured Project Management Plan and policy and provided with the necessary information allows better understanding that will ensure reliability in reporting the status of each work.

Moreover during the process of a work since careful planning is utilized, errors that may incur additional costs/time/resources are minimized. Forecast of events that may arise affecting the execution and provision of budget for contingencies are also taken into account to readily address emergencies. Systematic application of works as outlined in the works procedure can ensure the timely completion of each item of work hence the impact of achieving the planned profits against the expenditures during operation can be considerable.

Competence

As this is an assurance of an effective system of management, improvement of the company's credentials is certain. Since most of the owner/employer of projects are focusing on the quality of work. Establishing a Quality Management of works as the guiding principle in carrying out tasks is very necessary in order to be the set standard to be referred to as a measuring tool for the owner/employer to employ competitive contractors with achievements focusing on Quality in their projects.

Quality of Work as the Primary Concern

Although very important, the requirements set for companies to be ISO registered are too enormous in level for small to medium construction entities as well as family owned businesses of similar scales. Limited resources are the main reason considering the size of projects they are involved with.

As all ISO requirements are essential, the vital issue for these sub-contractors is to introduce into their system the "Quality of Work" because the scope is reasonably manageable and confined to provided standards by the Owner/Employer or their respective consultants. Generally all employers, clients or customers' main objective is the Quality of works performed thus it is deemed necessary to contain the relevant points derived from the ISO 9001:2000 in attaining the set requirements by these companies with regards to Quality.

Firstly, the Works Procedure as an effective tool in determining the lifeline of the project where sequential application of activities, sets of equipment to be utilized including the manpower to perform the works are contained will serve as the overview for the company to forecast the timely completion of each activity and of the project. Secondly during operation in which the control of each work item is applied under time constraint where workmanship is highly regarded and thirdly is the application of the test procedures to confirm the quality of the works performed.

Minimum Guideline (Recommended by this research)

From the conducted survey, Work and Inspection procedures, Verification & Coordination of Design Matters, Non Conformities of Works performed, Acceptance Tests & Taking-Over Procedures and Safety Guidelines are the main documents that are recommended to be used as minimum guidelines in performing each specific task due to their direct influence and weight of importance to the "Quality of Work". Creating these documented procedures has to be the standard requirement for contractors and/or sub-contractors to effectively manage their works as they are purposely structured to be performed in a systematic manner due to the clarity of the indicated requirements and sequences.

Recommendation

The issue of this proposal is drawn out from the interviews made with the selected respondents concerning their impressions & experiences towards sub-contractors and observations made by the researcher that are simplified into a questionaire. The gathered information does not exactly represent the entirety of the sub-contractors' traits & characteristics when dealing with them. Therefore it is deemed necessary that a further study will be made to pinpoint other issues that need improvement in managing their works concerning "Quality".

This proposal is to be actually implemented by the sub-contractors to show how a documented procedure is useful when applied during the carrying out of works. More so the significance of the outcome is worth the very purpose of this study.

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APPENDIX

The Appendix contains 3 parts which are the following.

- Appendix A – Questionaire
- Appendix B – Documented Procedure
  - Divided into 3 sections
    - Section 1 – Project Management Plan and Management Procedure
    - Section 2 – Work Procedure
    - Section 3 – Inspection Procedure
- Appecdix C – Digital Template of Documented Procedure

The detail of appendix is shown in CD-Rom.