A STUDY ON QUALITY MANAGEMENT SYSTEM (QMS) APPLIED IN CONSTRUCTION PROJECT

THONG MEI POH

UNIVERSITI TUNKU ABDUL RAHMAN

A STUDY ON QUALITY MANAGEMENT SYSTEM (QMS) APPLIED IN CONSTRUCTION PROJECT

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A project report submitted in partial fulfillment of the requirements for the award of the degree of Bachelor of Science (Hons.) Construction Management

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DECLARATION

I hereby declare that this project report entitle “A Study on Quality Management System (QMS) Applied in Construction Project” is based on my own original work except for the citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institution.

Signature : _____

Name : _____

ID No. : _____

Date : _____

APPROVAL FOR SUBMISSION

I certify that this project report entitle **"A STUDY ON QUALITY MANAGEMENT SYSTEM (QMS) APPLIED IN CONSTRUCTION PROJECT"** was prepared by **THONG MEI POH** has met the required standard for submission in partial fulfillment of the requirements for the award of Bachelor of Science (Hons) Construction Management at Universiti Tunku Abdul Rahman.

Approved by

Signature : _____

Supervisor : Prof. Dr. NAOTO MINE

Date : _____

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ABSTRACT

Construction projects are limited by time, cost, resources and quality performance specifications which are designed to meet client requirements and customer satisfaction. This paper is discussed regarding quality management system implementation. Nowadays, quality was become a strategic weapon in the competition for market shares and improved profitability. Quality Management System (QMS) has established a structure, includes documentation and procedure. Over the years, QMS practice has been on a growing trend in Malaysian Construction Industry. QMS has led to positive transform on Construction industry project in Malaysia. Insufficient QMS lead to poor productivity, as well as rework and repair the defect. Hence, the study was to investigate the successful key issues in Quality Management System, where to identify critical factors influencing application of QMS, benefits that encouraging in QMS implementation and requirements or needs of QMS implementation. This study was quantitative research, where the data was collected from G7 Contractor Company in Johor Bahru area. There are total 180 questionnaire survey have been distributed. However, there are 72 sets useable survey questionnaire returned (response rate 41.1%) and 2 sets uncompleted survey questionnaire. The results obtained indicate that top critical factors influencing QMS practice is top management commitment, top benefits that encourage implement is enhanced image, increase competitive and reputation of organization as well as top requirement of QMS are Project Quality Plan and staff training for QMS.

Keywords: Project management, success criteria, Quality Management System

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CHAPTER 1

INTRODUCTION

1.1 General Introduction

My research aims to identify the keys of successful in implementing Quality Management System. Chapter one is focused on introduction regarding my research topic which includes overview of research background, problem statement, research aim and objectives. Last part of this chapter, I discuss the significant of study, scope and limitation of study and a flow chart as outline of the research.

1.2 Research Background

Research background is an overview of quality issue in construction as well as introduction of quality management system and history of quality management.

1.2.1 Quality in construction

Construction industry is a hazard and huge industry that consist of wide range of activities such as planning, design, construction, building maintenance and demolition. It plays a critical role in the Malaysia's economic activity for creating wealth. The large and complex construction projects are getting harder to complete successfully in developing countries (Swan & Khalfan, 2007). Construction projects are limited by time, cost budget, resources and quality performance specifications which are designed to meet client requirements and customer satisfaction. There is no denying the fact that a success project is complete on time without delay within the budget and achievement of quality standard. Time and cost concerns on a project are important. However, quality has become an increasingly important to compete in the world market and also become a strategic weapon in the competition for market shares and improved profitability (Bergman & Klefsjo, 1994). Efficient quality implementation has become an issue in Malaysian construction industry which related to business building performance as well as construction final products to achieve client's requirement and customer satisfaction.

1.2.2 History of Quality

From the recorded history of humans, quality is a matter and issues of greater concern throughout any fields in worldwide such as construction industry. During the 4000-5000 ago which was a New Stone Age, emerge several culture or civilizations, quality skills were focused in construction industry. In Egypt, the pyramids were built Before the Common Era 2589-2566. According to recorded history, Hammurabi, who was the king of Babylonia in the decade before the Common Era 1792-1750, arrange the laws and rules into a systematic code which mentioned that the builders had a responsibility for

ensuring the quality of the project. Besides, if any accident occurred such as their building structure collapsed and result as their occupants were killed there were given the death penalty (Rumane, 2011).

1.2.2.1 Birth of Quality Control

Among the middle ages, the guilds and governments implemented the quality control and quality inspection informally throughout history. Their hierarchy comprise of three classified of workmanship which were master, journeyman and apprentice. They executed to manage the quality within the era from Middle Ages to the Industrial Revolution. In the mid-19th century, the Industrial Revolution initial in European state (Rumane, 2011). During this period, the factories were constructed for increasing the productivity and reducing the costs expenses. It generated by individual craftsman which consider as a skill worker especially for individual customer. Under the factory system, skilled workers should ensure the quality in factory by supervision of the foreman and the inspector should audit the quality. The economics of the industrial revolution was mass production at the lower costs and it changed the situation to manufacturing.

1.2.2.2 Birth of Scientific Management

During the era in late 19th century, Fredrick Taylor's system which included "Scientific Management" had been born and with its goal was to raise the production (Rumane, 2011). Besides, the purpose of this management was achieved to allocate the

programming by expert engineers and executed by supervisors and workers. In order to increase the production, the quality managers of the factory established the inspection departments which were developed as quality control departments in present. The starting of the 20th century had concerned on process in quality practices. During up to early 1950 known as World War I, quality was viewed as arranging systematically good things from bad and quality control principles were emerged.

1.2.3 Total Quality Management

Furthermore, the additional of quality assurance principles were appeared, for instance the cost of quality and total quality control in a period from the early 1950 until the late 1960. For example, in 1965, Toyota Motor Co. Ltd won the Deming Application Prize which was a global quality highest award for their contributions to the field of Total Quality Management (TQM) and their businesses have implemented TQM successfully (Toyota, 2011). Besides, the Japan Quality Control Award in 1970. W. Edwards Deming who was established the Deming Prize and dedicated greatly to Japan's growing of the statistical quality control which was after World War II. Statistical quality control was used of statistical methods in the controlling and guaranteeing of the quality of products or services. Harold Kerzner (2001) has further explained that strategic quality management was emphasized nowadays.

1.2.4 Quality Management System

For the past decade, it has been experience go through an alteration operated by the ISO quality policy of set out by the Malaysian government in construction sector. Nowadays, construction team members had realized the significant of Quality Management System contributed in the sector of construction industry. Quality management system operated in construction project which is included the variety activities of the overall project management intention that to evaluate the quality policy statement, quality objectives, construction player's responsibilities or duties, and carried out the action such as quality planning, quality controlling, quality assurance and quality improvement according to quality standard and system.

1.2.5 Quality Planning and Quality Control in construction

Quality planning (QP) of the project is being designed and developed a program by the contractor in design stage based on client's specification (Rumane, 2011). The purpose of quality planning is to assure the organization management and technical responsibilities for achieving effectively quality product. Quality Control (QC) is the specific practice of the quality assurance procedure and related variety activities. Effective quality control had ability to reduce the likelihood of alternatives, errors and negligence, which also is possible to solve the fewer debates and controversy (Rumane, 2011). On the other hand, Quality Assurance (QA) of a project is a sequence for covering intentions essential to generate quality in the work in order to meet the project requirements (Rumane, 2011). It involves creating the project related policies, work procedures, quality standards, workmanship training, quality guidelines, and quality system essential to emerge. Determining the construction's project focus on the factors

would enhance the construction project quality in Malaysia. Identify the critical factors influencing quality in construction industry is a basic or first step towards generating ways for an actual improvement of construction quality project.

1.3 Problem statement

Problem statement as a brief description of regarding issues has written in this research.

1.3.1 Quality problem in construction

During the past ages, it have been indicated the problem in construction industry that the poor quality fulfilment or performance and productivity in conjunction to other industries (Alarcon & Ashley, 1992). One of the problems is noticed that poor quality control will generate a lot of problems in the construction project, and the circumstance is alike to getting worse. Poor quality management may lead to rework in consequent to increase the budget and delay the work. Most seriously, poor quality management, which include poor quality materials, workmanship, maintenance and management from start to end stage, cause building defect and failure even collapse (Nur Diyana, 2009).

1.3.2 Actual examples caused by poor quality control

Two actual examples are Second Penang Bridge Ramp and Sultan Mizan Zaimal Abidin stadium.

1.3.2.1 The case of Second Penang Bridge Ramp

On June 2013, a tragedy that the Second Penang Bridge ramp, which connects Batu Kawan to Batu Maung, was collapsed during that bridge was still under construction. Based on the star news online, a person was dead and three persons were injured in this accident (Lim, 2014). Datuk Dr. Johari Basri as a director of the Occupational Safety and Health had investigate this accident and he mentioned that it was caused by lack of quality standard requirement and negligence of the contractor who intend to lessen the cost of the construction and modified the design of scaffolding (The Stars, 2013). Another reason of this tragedy is that the contractor of the package 3A of the Second Penang Bridge did not register the “Green Card” for their workers with the Construction Industry Development Board (CIDB) (News Straits Times Online, 2013). Quality of materials and workmanship are client’s requirements and expected that will affect the quality of project and inadequate quality may cause the rework result in delay work even structural collapse.

1.3.2.2 The case of Sultan Mizan Zaimal Abidin stadium

Another tragedy occurred in Kuala Terengganu in June 2009, the roof of Sultan Mizan Zainal Abidin stadium had collapsed. According the investigated report, the committee, Ahmad mentioned that the collapse of the stadium's roof was a no quality work which did not meet the specifications, safety or design factors and was not built correctly by the contractor. It was not only quality control no being implemented but also the weak of supervision as well as lack of skilled workers during the construction process which had led to the collapse. Besides, five workers had injured while they were dismantling the roof structure during the work to re-construction the stadium in February 2013 (The Star, 2013). The cost of repair was RM1.7 million and stadium collapsed result in damages around RM 15 million and RM 25 million which were bear by the contractor and there were incurred losses in the incident (Malaysiakini, 2013). There are undoubtedly that poor quality management will increase the extra cost to repair and rework.

1.3.3 Problem in implementing quality management system in construction

Moreover, quality management system (QMS) plays a vital role in a construction project as a quality standard to ensure higher quality work. Insufficient quality may lead to poor productivity, as well as reconstruct and repair the defect. Besides, if the failure construction happened, those will loss of the company's reputation and also further impact to loss in market share. Poor quality management may cause project late, over cost and endure from poor materials and workmanship. However, current problems of execution of QMS application in general are too complex of implementing and lack of knowledge in the ISO 9001 standard of quality. According to a study on Kuala Lumpur International Airport project application of quality management which conducted by

Mohammed (2008), some problems mentioned that lack of experience in execution of QMS, exceeding dependence on construction traditional management method, passive behavior towards on new way and misunderstanding of the QMS application. At the same time, Said et al (2009) discovered the problems of organization implementing QMS in Malayisa Construction Industry are lack of benefits' consciousness of QMS and lack of exposure in application of QMS among labours.

1.4 Aim and Objectives

The aim of this research is to investigate the successful key issues in Quality Management System. The objective of this research as following is:

i.) To identify critical factors influencing application of quality management system in construction projects.

ii.) To identify the benefits that encourage in implementing Quality Management System.

iii.) To identify requirements of implementation of Quality Management System.

1.5 Significance of study

Quality is playing a vital role in construction industry from inception stage to project completion or handover even building maintenance. It is possible to handle the quality problems by understanding the quality criteria for the building construction project and

its impacting factors. Due to lack of quality control, conflict is increasing, resulting in litigation and arbitration with depressing regularity. Hence, identification the critical factors influencing and investigation the benefits and requirements of quality management system in construction industry are important to explore.

1.6 Scope and Limitation of study

Due to time limitation, this study is majority concerned on quality management system at the construction stage for improve the quality control of construction project. Besides, this study emphasizes the construction parties on contractor and customer satisfaction for improving the quality of a project through quality management system application. However, there did not focus on all key stakeholders who involved in construction project.

Besides, questionnaires survey on site have a limitation which choose the construction companies focused on the state which are more project site over there and more main construction companies such as Johor Bahru area, Malaysia. The limitation is this questionnaires survey no focus on other state. On the other hand, the rates of return of the mailed questionnaires are usually low.

1.7 Outline of report

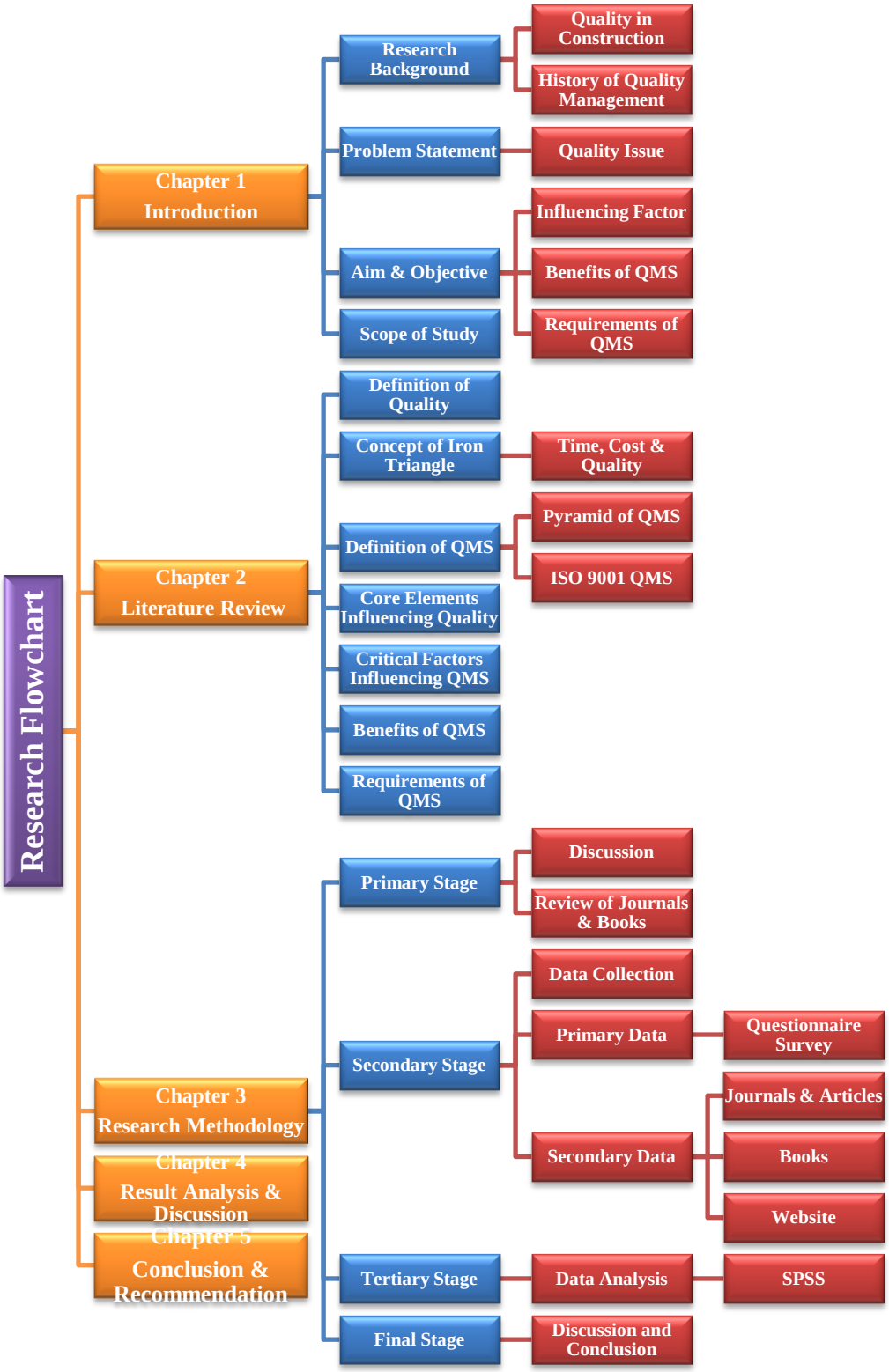

Figure 1.1 Outline of Report

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review established the theoretical knowledge and methodological contributions to concern on my study. This chapter is stated to discuss the issues regarding of aim and objective and my study field. There are highlighted the definition of quality in construction, concept of Iron triangle, definition of QMS, core elements influencing quality, critical factor influencing QMS in construction industry, benefits of QMS and requirements.

2.2 Definition of quality

Quality has different definition from different writers. Over the past few decades, the quality is defined by writers such as Joseph M. Juran, W. Edward Deming, Philip B.

Crosby, Armand V. Feigenbaum, Ishikawa, Taguchi and others in the area of quality management.

2.2.1 Definition by Joseph M. Juran

"Fitness for use" is defined by Joseph M. Juran. According to Juran's Quality Handbook, quality had two meanings which are defined by the father of quality, Joseph M. Juran. Quality defines as those features of product which to meet the satisfactions and needs of customer in order to increase the market share or provide sales income. Higher quality provides greater customer satisfaction and increases income. However, higher quality requires an investment and usually costs more. Another meaning of quality is defined on Juran's Quality Handbook. Quality means freedom from deficiencies or freedom from errors such as reduce rework, avoid customer dissatisfaction and improve delivery performance (Juran & Godfrey, 1998).

2.2.2 Definition by W. Edward Deming and P. B. Crosby

Furthermore, quality is defined by W. Edward Deming who is the founder of quality management that quality ought to consider and plan into the product as well as the process of project. As for a further explained by him, good quality represents a foreseeable level of consistency and reliability with a lower price and a quality standard acceptable to the customer and market (Chandrupatla, 2009). Philip B. Crosby who is "quality guru" defines quality as conformance to requirement (Crosby, 1979). Quality

can be calculable and obviously listed terms in order to take action in organization according to targets, rather than experience or opinions. Management measured the quality by cost of doing things wrong that as price of nonconformance (Aole, 2013).

2.2.3 Quality from the viewpoint of engineering

Armand V. Feigenbaum defines quality as the product and service features of marketing, engineering, manufacture and maintenance based on the customer's actual experience against the expectations of the customer and requirements (Aole, 2013). Besides, Ishikawa defines quality as the design, development, production and service of a product which is more useful and economical, and usually meet the requirements of consumer (Greg, 2004). Taguchi who emphasizes an engineering quality approach defines the quality as loss a product such as failure to meet the customer's requirements affects to the society from the time after being shipped (Aole, 2013).

2.2.4 Quality in construction

Quality in construction industry is the performance of project duties in the delivery of products and services in a way that achieves the listed requirements and expectations of the client, design professional team and project constructor. Their duties and responsibilities according to the missions that players are expected to fulfill the completion of project overall activities identified by contractual agreement as well as applicable legislation and licensing requirements, codes, prevailing industry standards

and regulatory framework guidelines. Under Construction Industry Master Plan (CIMP) in a period from 2006 to 2015 and done by CIDB, the issues of quality in construction project are high lightened. The highest standard of quality also elaborates in occupational safety and health, and environmental practices.

2.3 Concept of the Iron Triangle

Project success can be different between short-term and long term successful way. Criteria connected to the iron triangle to achieve the delivering project within budget, time, objectives and project specification which measured on process or before project closure. Long-term criteria such as providing benefits and customer's satisfaction are often measured after project closure. Generally, iron triangle defines as project management triangle and consists of time, cost and quality which are usually used to measure the success of a construction project (Woodward, 1997). The time, cost and quality are interrelated based on triangle demonstrates. A success project involves achieving the project objectives on time and within specified cost, quality standard and performance in all aspects such as the planning, monitoring and control and the motivation. Rwelamila and Hall (1995) further explain that a successful projects when there have balanced the iron triangle and to practice time, cost and quality management as activity system in a construction project.

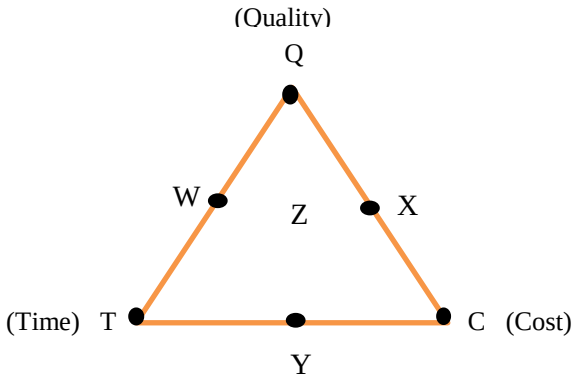

Figure 2.1 Iron Triangles (Woodward, 1997)

Based on Figure 2.1, the diagram can be interpreted in relevance of the marking point as following as below:

- Q is entire concern of quality
- T is entire concern of time
- C is entire concern of cost
- Z is three factors have balance weight
- W is less concern in cost, but dominate of time and quality
- X is less concern in time, but dominate of cost and quality
- Y is less concern in quality, but dominate of time and cost

2.3.1 Method for utilization of the Iron Triangle

In the three-way interaction between time, cost and quality, a project should be placed somewhere which near the point Z. It is because a reasonable quality standard is required, cost should be affordable and project can rarely being delay. Nowadays,

quality is one of concerning element and must be predominant criterion such a project being placed near to point Q in order to continue allocating adequate resources by client and give customer a good quality of the output. Furthermore, project being near to point T and the time of project is concerned by contractor because if delay work, the contractor should suffered in liquidated damages. In another field such as museum would be marked near to the line between Q and W, obviously showing the concern which more focus on quality and some focus on time, however also a willingness to hand over the corresponding cost of the project (Woodward, 1997).

2.3.2 Usage in construction

Concern on quality and cost, there are possible be a conflict between the cost and the performance of a project during the briefing and design stages (Woodward, 1997). Specified of the decisions on quality standard will have cost implication. During quality control process, there is no doubt that there are the sum total of inspection costs which including tests and reports, the overhead costs of maintaining and spend excessive time and cost on operating a quality management system. The interaction of quality and cost not only refers to the usage of the actual materials but also the performance of the completed building in relation to its use, maintenance and life.

Concern on quality and time, there is possible and expectable on a construction project (Woodward, 1997). However, there also had been planned and avoid taking too over longer time on work being done. A project is expected as quickly as possible to focus on critical path and resolve the problem faced. Undoubtedly, it is a necessary to expense more time to meet the quality required standard and client's requirements.

2.4 Definition of Quality Management System (QMS)

Quality system is a quality management's framework in order to enable the organizational conformation, procedure, and process to comply quality management. There are judged by the company's compliance to specific or relevant standards (Rumane, 2011). Furthermore, quality standard are useful to many sectors such as industrial, business organizations, government, regulatory bodies, professional, suppliers and customers of products and services in either public or private sectors. Besides, there have critical economic, social reflection and offering governments with a technical base for safety, health and environmental regulations.

Management system had defined by ISO 9000:2000 as a series of interrelated guidance or components to conduct policy, objectives and to achieve it (Hoyle, 2009). Quality Management System (QMS) has been widely known and implemented in an organization within construction industry particularly the companies who have ability to handle complex and mega projects (Tiong, et al., 2014). A Quality Management System (QMS) has established a structure, includes documentation and procedure, which ability to delivery of products and services to be supervised and controlled for satisfaction of the specified needs systematically.

2.4.1 PDCA Cycle

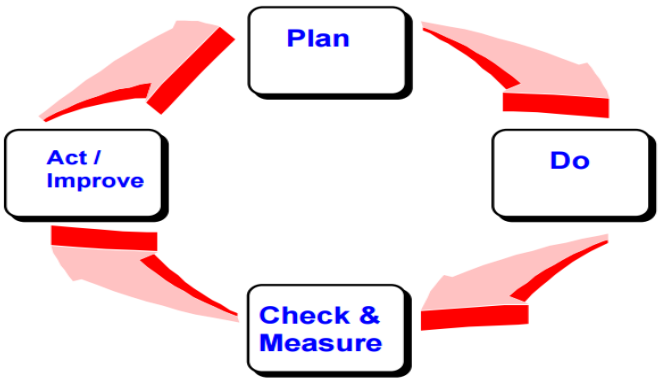

Figure 2.2 PDCA Cycle (Rumane, 2011)

PDCA Cycle is the basic concept of quality management system. Beginning step is planning which used to establish the scope of project. The following step is doing which constructed with following procedure. Next step is checking which measure the process and check the record. Last step is acting which used to continual improvement for implementing of QMS and as quality assurance (Rumane, 2011).

2.4.2 Pyramid of Quality Management System

Figure 2.3 Pyramid of Quality Management System (Rumane, 2011)

Quality policy is on the top of quality management system pyramid, which sets out the management requirement, objective and goal to achieve in order to make sure quality management system (Rumane, 2011). The following level of QMS pyramid is quality manual, which stating the framework or management's intentions and detail of the work to be operating the quality system.

Underneath the quality manual are Project Quality Plan which includes work instructions and procedures which are determined by the size of project and complexity of the team. Project Quality Plan is designed by project manager to ensure the project meet the standard quality requirement. The contents of this plan includes the objective and policy statement, list of subcontractor and supplier, basic requirement for architectural work, inspection and test plans form and checklist, alternative procedures, preventive action, and progressive decisions to improve the quality of the project. The procedures mostly discuss the work to be completed, completion date, inspecting or testing involved and prevent action (Rumane, 2011).

Beneath project quality plan is quality forms and records that are used to note down the history of routine activity for ensuring the quality of the project (Rumane, 2011). At last, the bottom level of pyramid is checklist, which used for quality assurance and prevention for reduce failure of quality management system.

2.4.3 ISO 9001 Quality Management System

ISO is the International Organization for Standardization and ISO 9001 is a certification for the companies who have implemented the Quality Management System and follow

the guideline of Quality Management System to carry out the work. ISO 9001 Certification will provide the benefit to organization such as the better customers' satisfaction, player motivation to manage quality work and improvement continually.

2.4.3.1 Process-based Quality Management System

Model of Process-based Quality Management System is defined as a process approach which is one of the basic of quality management system. This model indicated on above (Figure 2.4) identifies four types of process which are management responsibility, resource management, product realization and measurement analysis improvement.

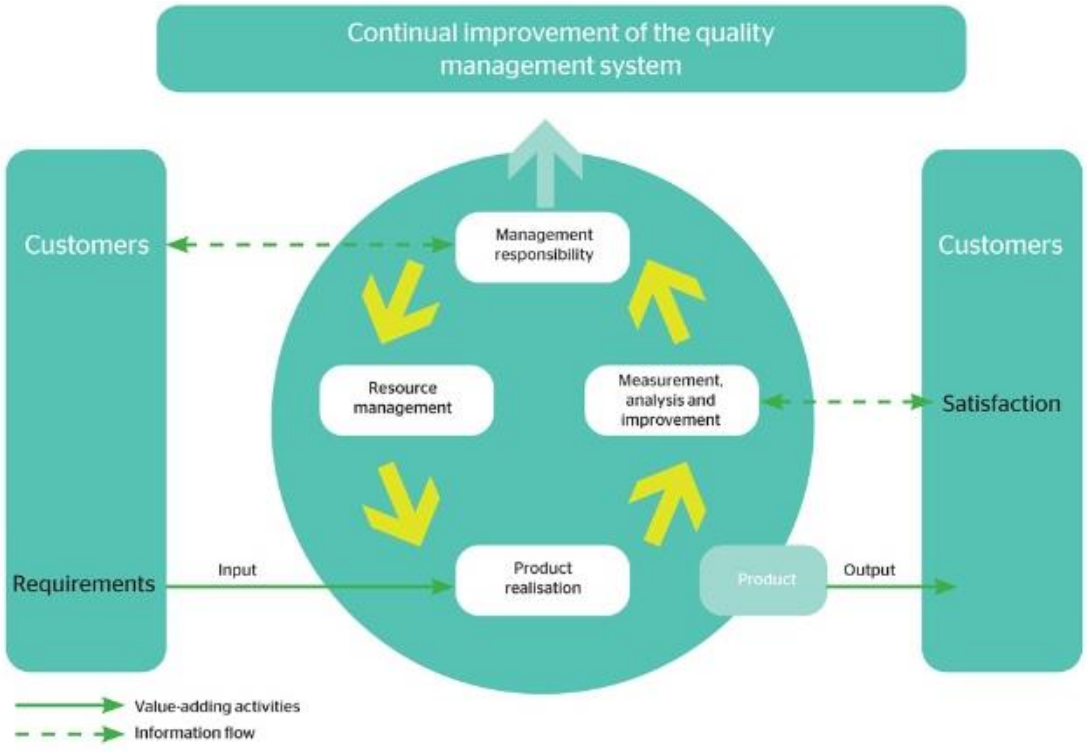

Figure 2.4 Model of Process-based Quality Management System (Charterd Quality Institute, 2012)

In the case, the outcome of this model as an output is to maximize the customers' satisfaction with the effective and efficiency of the organization according the input as well as customers' requirements and their expectations of the product through the process (Badreddine, Romdhane & Amor, 2009). The organization was encouraged to refer this model as process approach in order to implement effectively the quality management system.

The foremost process is management responsibility. There is no doubt that the organization has the responsibility to set up the quality policy and objectives as a goal of the project for enhancing the effectiveness of quality management system. Subsequently, the management team player has a duty to review the quality policy and analyze specification as well as management review meeting regarding the performance and improvement of quality management system processes. The management team player must ensure the established quality systems have to determine and fulfill the customers' requirements (Charterd Quality Institute, 2012).

Secondly, resource management includes human resource and physical resource. Human resource such as employees should be qualified and trained by required training such as on-the-job training, group training or individual training to obtain the experience for the work and increase the quality of workmanship. Furthermore, physical resource such as materials, machinery, plant and equipment should be used to produce the quality work.

Thirdly, product realization is introduced to describe the task and control process that was developed and delivered by the organization. The organization should follow the instructions and procedures as well as the product realization process should be planned and controlled to achieve quality work consistently.

Lastly, the organization will execute inspection and testing to measure and analyze as well as improvement of quality work for continually improving the quality management system. Furthermore, corrective and preventive action system should be considered by all players to identify problems and prevent from potential problem. Corrective action is as a movement to solve a problem that has happened and prevent this problem from occurring once again (Rumane, 2011). On the other hand, preventive action applied in a probability problem and prevent the problem occurred.

2.4.3.2 Steps of quality management system according to the process

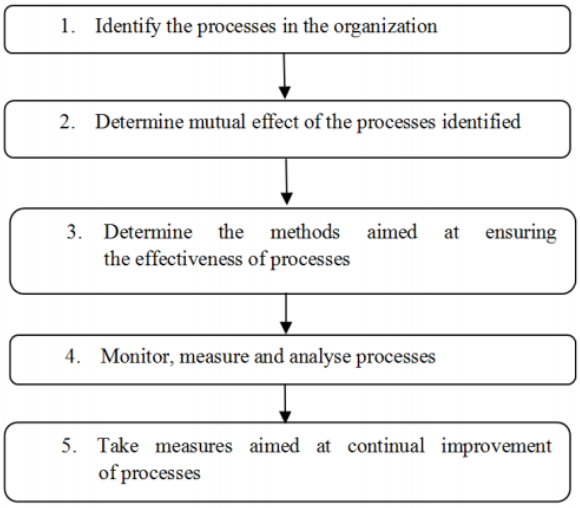

Figure 2.5 Execution of QMS based on process (ISO 9001, 2015)

The Figure 2.5 is indicated at above that the fundamental for formation of the quality management system is process. Based on the interpretation, a process defines as a connection of activities targeted at establish of values that correspond to customer needs. Process is also considered as a set of mutually connected resources and activities which change input into output.

2.5 Core Elements Influencing Quality

The process of construction project involves three processes, namely input, process and output. Input of construction includes resources and players, processing is execution of the project and the output of construction project is project completed which require to have expected outcome and quality product (Razek, 1998).

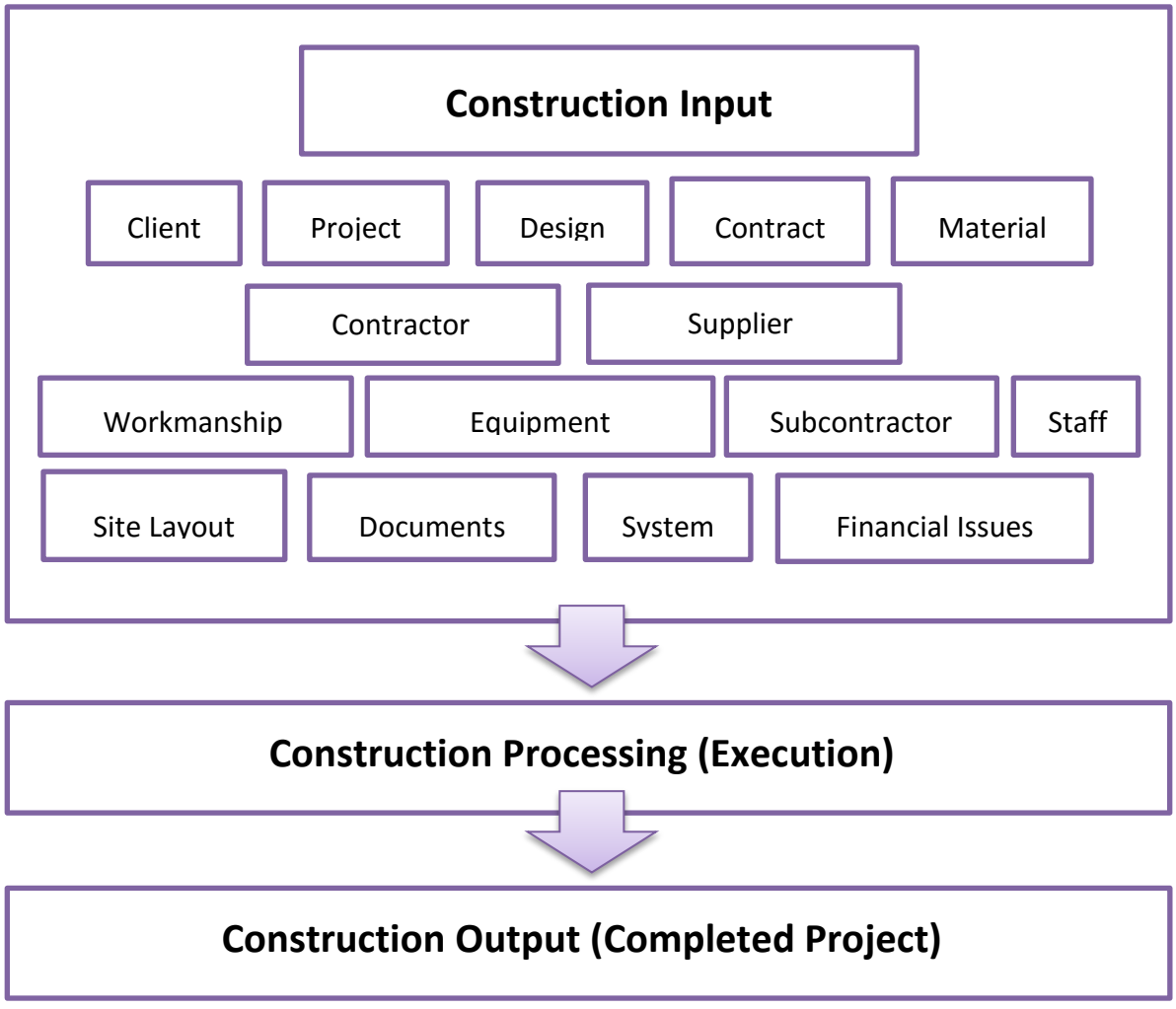

Figure 2.6 Concept of the Construction Process (Razek, 1998)

Table 2.1 Core Elements Influencing Quality (Razek, 1998)

No	Elements	Factors Influencing Quality in Construction Project
1.	Client	• Conciseness of project mission and scope • Brief, make decision and define roles of team players • Emphasis on quality requirement
2.	Project	• Type of project and characteristics • Location of the project • Duration of the project • Site possession, site access, site condition and site coordination
3.	Design	• Integrated and consistency of design • Prepare the detail of drawing • Conformance to law and conformation standard • Coherence to specifications • Accuracy of bill of quantity
4.	Contract	• Collaboration between parties involved in contract • Clearly written contract to communicate • According a standard agreement • Types of awarding tender
5.	Material	• Effective and efficiency of material management system • Collaboration between contractor and supplier • Supplier good quality of materials • Available of storage and handling system
6.	Contractor	• Capability of contractor • Cooperation and communication between consultant and subcontractor as well as supplier • Monitor and responsible for temporary work on site • Skill of managing site access and safety
7.	Supplier	• Supply good quality materials • Skill and capability of supplier • Supply materials on time and avoid delay
8.	Workmanship	• Effective and efficiency of human resources management • Available of skill and good experience worker • Motivation system to increase productivity • Training courses to increase knowledgeable worker • Reasonable income and wages of worker
9.	Equipment	• Plant and equipment management system • Calculate of equipment productivity • Right utilization of equipment • Maintenance of equipment
10.	Subcontractors	• Selecting capability of subcontractors • Good communicate and collaboration between main contractor and subcontractors

		• Standard assessment to evaluate subcontractors performance • Good and fair condition of subcontract
11.	Site Layout	• Size of site layout • Organize and plan the site layout • Materials storage area • Detail of the site layout and housekeeping
12.	Systems	• Computer software applications • Quality control system execution and quality assurance • Work Programme and time scheduling • System of cost control • Health, Safety and Environment system
13.	Staff	• Collaboration and communication between parties • Capability and experience of staff • Understanding of drawing, contract administration, instruction, safety and quality issue
14.	Document	• Construction project procurement delivery system execution • Inspection testing execution • Prepare and manage shop drawings • Detail of procedure to execute activities on site
15.	Financial Issues	• Clearly statement of cash flow • Interim payments issue (Avoid late payment and non-payment)

2.5.1 Factors Influencing Quality focus on Construction stage

This table is grouped the elements influencing quality of the building construction project into eight quality criteria with factors influencing quality (Tan, 1995).

Table 2.2 Factors influencing quality of a construction building project (JHA & IYER, 2006)

No	Quality Criteria	Factors influencing Quality
1.	Construction players qualified to reach project task, needs and objective	▪ Skill of project manager ▪ Skill of consultant staff ▪ Skill of contractor staff ▪ Skill of foreman
2.	Legislations and standards consistently	▪ Client's willingness to undergone quality by the consented rules and standards ▪ Utilization of the right edition and articles ▪ Conformity of the rules and system standards
3.	Requirements of client consistently	▪ Accurateness of client's law and regulation requirement ▪ Detail explanation of client's requirements ▪ Changes and alternates to client's requirements
4.	Process and procedures of design consistently	▪ Integrity of engineering design handbooks, and guidelines of process and procedures. ▪ The effectiveness of implementing quality control system ▪ The executions of engineering alter control.
5.	Schedule requirements consistently	▪ Monitoring and control of timeline in construction project with observe of its performance. ▪ Figure of engineering design alters. ▪ Reasonableness of the schedule.
6.	Cost requirement uniformity	▪ Due to figure of engineering challenges. ▪ Clearly statement of the scope of work regarding cost requirement. ▪ Cost estimates and budget reasonability.
7.	Integrity of and uniformity to output standards	▪ Integration of figure, information and data. ▪ Clearly statement of drawing and specifications. ▪ Conformity of the details accurateness of the data and methods.
8.	Constructability	▪ Timeliness and completeness of provision of resources such as materials, machinery, plant and equipment. ▪ Application of general and systematized construction methods and resources. ▪ Constructability through audit of design.

2.6 Critical Factors influencing Quality Management System in Construction Projects

The critical factors influencing quality management system application can divide by two parts which are success factors and failure factors. To identify the critical attributes for improving the construction companies that achieving a desired of quality management system application is success factors and adversely influencing the quality management system is the failure factors.

2.6.1 Success factors

Based on a study conducted by Nursyamimi, et al. (2014), there are summarized that six critical success factors influencing the quality management system (QMS) implementation are the process management, commitment of top management, integration of the quality plan, training and education programme, measuring and enhancement, teamwork and skill of communication and usage of Information, Communication and Technology (ICT).

2.6.1.1 Process Management

The processes of construction project involved the organization's day to day work and activities on site. Hence, the outcomes of quality work should be ensured through the

quality management processes and quality control leading to the day to day work consistently and regularly (Willar, 2012). Quality management system (QMS) is one of standards to support the action for processes and the organization has designed and determined the types of documentation for the process method. Thus, the project process management is established for corporating the requirements and top driven to achieve high quality of project with desired customer's satisfaction.

2.6.1.2 Top management commitment

Client, as a employer role in the project and employ the parties such as consultant and contractor, who represents the top management of the organization in a construction project. At the project beginning, the client plays a vital role in making decision and sets out the goal with quality expected level for players to achieve. The client's commitment is very important in implementing quality management system (QMS). According to the study, the researcher summarized the practice QMS affected by top management's commitment, which are as below as following (Nursyamimi, et al., 2014):

a. The preparation and execution of QMS are provided condition by client in the contract document to all the players involved during the construction project ongoing.
b. For create the awareness and understanding of quality on project QMS regarding it process and procedures, campaigns and trainings related to QMS is held by client to the players especially for the management level parties to foreman level parties.
c. The supported adequate resources regarding to QMS such as cost budgets, engagement of the right selection for quality manager or consultant and motivation for achieving quality of construction project.

d. Competent and qualifying project team players are appointed by client and lead the players to achieve the quality of construction project through QMS.
e. It is necessary for client to highlight on quality issues, occupational safety and health administration (OSHA) and environmental issues.

2.6.1.3 Project Quality Plan integrated

Another success factor that introduce to execute quality management system (QMS) is integration of project quality plan. Integration of project quality plan is the effort to meet the demands among the stakeholders such as client, consultant and contractor which have to integrate the roles and duties of players, facilitate teamwork and link to the client quality expectation with the specification and objective as well as process. According to study conducted by Pheng and Hwa (1994), integration of project quality plan for good QMS application have a benefit to prevent overlapping and neglecting from the scope of the project or activities and dispute of quality. These integrations are maintained for properly complete, certain practices should be followed which listed by Abdullah (2012) as below as following:

a. It is necessary to prepare the project quality plans based on ISO 9000, specification of the project and the requirements of contract.
b. The competent quality manager or consultant has to prepare and integrate the project quality plan.
c. All relevant players should be connect to project quality plan for accomplishing and equilibrium the requirements of the project, lists the specific roles and duties of the player to consider the functions and mediates management and contract.

2.6.1.4 Training and Education Programme

Concept of quality management system is not stated clearly and lack of awareness in construction industry. One of the factor influencing quality management system (QMS) application is training and education programme regarding QMS. The insufficient of training and education of QMS will affect playes of construction being negative behaviour and attitude due to misconceptions and lack of understanding as well as commitment in quality system and programmes. The initial stage of QMS application in Singapore construction industry, there is necessary to enhance and propose a nationwide quality training for all team members in the construction industry (Asmonia, et al., 2015). Proper training and education is useful to transfer knowledge of QMS in delivering a expected quality for project. Through the training and eduction of QMS, some practices should be followed as below as follow (Nursyamimi, 2014):

a. All the players of construction will increase the understanding about the quality standard requirements and raising the awarencess of quality as well as fundamental of QMS.
b. Overall level of workmanship and management team which at least spread to foremen level requires to update and upgrade their knowledge through providing training of QMS.
c. Specification of training is required to conduct work-area teams and entitle the workforce for quality control. The circle of quality control present to overall levels for looking for chance to improve and facilitate learning of project organization.
d. Resource management enhance the training and education for improving quality in project.

2.6.1.5 Measurement and Enhancement of performance

Based on the study conduct by Nursyamimi (2014), the critical factor of the measurement and improvement will influence successful of project quality management system (QMS). Measuring of performance in construction project is one of general practical in construction industry and it included collecting data, figure used to analyze and present to top management level with a reasonable manner. The purpose of this factor is required to make continuing improvement in QMS application. It is important for enhancing the strength and weakness of quality system and evaluating whether it perform effectively in order to maintain the requirements of standard which are be measured and analyzed for focusing on the customer satisfaction and client expectation (Asmonia, 2015). Some practices indicated by researcher that (Nursyamimi, et al., 2014):

a. Audit includes internal and external which are created for measuring the performance the QMS implementation and identified for being improvement.
b. The quality manager or consulted created the review of management as planned to judge the areas for quality improvement according to audit records or audit reports indicated by the ISO 9000 standard.
c. Client expected the performance of QMS during issuing the interim certificate and incentives contribution.
d. The competent of personnel is higher to judge the performance during construction project.

2.6.1.6 Teamwork and skill of Communication

According to ISO 9001, clause 5.5.3 and clause 7.2.3 which respectively is internal communication and customer communication. Further mentioned by ISO 9000, there are related to teamwork with the communication's clause. In fact, teamwork and communication is vital roles and one of factors influencing QMS application to ensure QMS being successful. Moreover, based on a study conducted by Holyle (2009), he mentioned that the effective and skill of communication is the main issue to success QMS application. It should be avoided the mistake happening such as transfer wrong information, fail to convey the right information, the wrong people obtaining the right information, the right people getting the wrong information, the correct information delay to convey to the right people, lack of skill to communicate cause not be understood and undesired outcome. Besides, the key issues for having powerful teamwork and effective communication that:

a. Construct a structure of guiding committee and comprise of overall parties concerned such as client, consultant team such as architect and consultant engineer, contractor to establish a gerate goal and cohesiveness with each other.
b. Well-planned team structure is expected through quality training and quality briefing to ensure togetherness.
c. Powerful informal connection between the players through skill of communication.

2.6.1.7 Information, Communication and Technology (ICT)

Nowadays, technology advance has been presented and introduced for greater challenge in the channel we stay. Many researcher recommended using of concentrated electronic

documents for quality management system (QMS) with the rapid expansion of ICT (Asmonia, 2015). However, the major problems is information be managed properly due to many participants handling the information without standardized techniques to manage the records and documents. According to ISO 9001clause 4.2.2 and 4.2.3 which are respectively control of document and control of record, there is require to approve, circulate, store and recover the controlling the documentations and records. Furthermore, using ICT has a lot of advantages that it is useful to optimize and minimize the requirements of documents, ICT has ability to fast accessibility of records and greater coherence to ISO 9000 standards. There are several issues to practice for using of ICT in QMS application as below as following:

a. Ensuring of electronic document of QMS and web-based processing to establish of quality controlling eletronic-based document.
b. Connection between QMS requirement and information technology. ICT and eletronic document control system used to manage the information, there are vital consideration to the participants' willingness, basic knowledge and understanding as well as skill in processing the ICT. Therefore, it is necessary provide proper training and workshop to resist the change of management in using ICT.

2.6.1.8 Influence Strategic advance factor

The sticking point that the satisfaction of customer and success in competitive has been exposed to be determine for increasing and reaching a satisfying quality of product and service. Quality defines as a tactical competitive device and it cannot be omitted in strategy position. The important factor influencing quality management system (QMS) applied in construction project is fully commitment by top management or senior management to produce the advantages of strategic perspective and capability on

competitive. This is be proved that top management plays an important role in execution of QMS application as a driver through the way to provide resources properly and the main point to continuous improvement for creating of values, mission and standard. It has the possible to increase the satisfaction of customer and enhance the quality performance of construction project.

The quality standard of QMS emphasizes the control by top management through the documentation such as quality manual, sequence of activities, instruction as well as systematization. The strategic orientation is as a facilitating factor that influencing the connection between quality plan such as QMS and the financial performance of the organization. Thus, the project manager of management should cautiously plan and manage the QMS application for carried out the strategy. With a well-executed of QMS, the project is assured to fulfill the advantages of competitive and high performance.

2.6.1.9 Influence Motivation factor

Quality management system (QMS) application such as ISO 9001 certification has external and internal advantages. The factors of influencing QMS are team work as well as the performance and communication of the organization that are related to internal benefits otherwise the external benefit relates to the marketing aspects for increasing the satisfaction of the customer also will be one point to be consider by organization applied QMS. Moreover, the style of leadership has possibility to affect the performance of QMS. It is being guaranteed that a support to carry out the QMS by leadership styles is authorization and team player motivate. Other motivation factors influencing are regarding higher profits gained and greater practical archived to drive the organization to implement this QMS application.

According to literature review conducted by Kaziliunas (2010), a powerful relationship between the motivation factor of organization's certification and the performance gained was ascertained. It can be short summary of this journal that powerful internal motivation is able to increase the organization's quality for help to create a QMS that causes to internal and external benefits for improvement of the organization's reputation in the market position.

2.7 Advantages of Quality Management System

According to ISO 9001, quality management system (QMS) application has several potential advantages for organization (ISO 9001, 2015):

2.7.1 Consistently

QMS has capability to establish and produce the products and services consistently through quality system and quality standard. QMS application also has benefit to indicate the data consistently with the specified QMS requirements. There could lead to meet the satisfaction of customer and appropriate statutory and regulatory requirements. (ISO 9001, 2015)

2.7.2 Customer satisfaction

For achieved a certain level of customer's satisfaction, the organization should be pay effort in implementing QMS. Hence, customers have benefit through obtaining the products and services that are complying with the requirements, faithful and reliable, accessible when need and maintainable as a longer lasting.

2.7.3 Risks minimize

Implementing QMS is possible to address the risk and chance related with its objective. In construction project, the contractors have advantages through using QMS application for minimizing the defective works; reconstruct work and rejection (Ivan W, et al., 2012).

2.7.4 Increase competitive and reputation of company

Implementing QMS is ability to integrate the value with well documented process and as evidence of quality assurance in order to increase reputation of company and increase competitive. Moreover, clients and stakeholders have advantages such as increase return on investment, market share and profit as well as improve the operation outcome.

2.7.5 Improving resource management

QMS have clearly stated duties and responsibilities of parties that is ability to provide a better process flow and quality control in order to increase their job satisfaction. It is also able to provide better working condition, health and safety of worker and reduce the environmental impact.

2.7.6 Financial performance

There are significant to determine the multiple of variables which will reflect the consequence of quality management system (QMS) application over the organization's performance of financial. There is directly relationship between QMS such as certification of ISO 9001 and improvements of financial performance (KAZILIŪNAS, 2010).

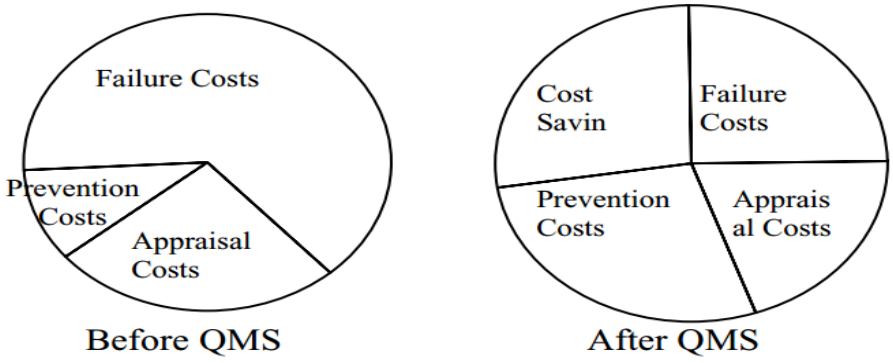

Figure 2.7 Cost Savings of QMS (KAZILIŪNAS, 2010)

Based on Figure 2.7 indicated the cost savings of QMS, the QMS is possible to assist the organization reduce the cost of failure in order to perform effectively financial. The impact of QMS is decrease the inefficiencies and waste cost in order to improve the

quality of project, morale and the chance for a greater outcome which are accomplish through the process, documents and players to carry out QMS application. It should be aware of failure preventive action that will have benefit to costs saving as well as increase the customer satisfaction.

2.7.7 Continuous improvement

The organization implement the quality management system (QMS) in order to achieve a desire continuously improvement and gain a long term benefits. The organization is willingly to execute the QMS due to have strong positive attitude of improving organization performance rather than customer pressure. It has a benefit of promoting and facilitating the culture of quality in a project.

2.7.8 Quality Auditing and Assurance

For increasing the capability to reveal conformity and the value of output, quality auditors are play a powerful role in impact of quality management system (QMS) implementation. Creating quality audit has impacted to gain the accurate input for making decisions of management and produce the data using in granting a qualify certificate for improving the documentation and enforcing consistency as well as achieving a quality project assurance.

2.8 Disadvantages of QMS

Disadvantages of quality management system include too much paperwork and time consuming.

2.8.1 Too much paperwork

According to study conducted by Anup (2015), the biggest obstacle is too much of paper work in implementing quality management system (QMS). Too much paper work will lead to employee unwilling to adopt QMS. The documentations or paper works include work procedures, quality periodly records, work instruction and checklist form which may daily usage on site (Anup, et al., 2015).

2.8.2 Time consuming

Ensure quality through implementing quality management system (QMS) is need time to operate and put effort in the work.

2.9 Requirements

General requirements used to identify and describe the process which include establish, implement, maintain and improve quality management system regarding the specific project.

Table2.3 Requirements for Implementation of Quality Management System

Requirement	Description
Documentation	• QMS requires a lot of documentation as a guideline and record • Statement of quality policy and quality objective which are set by top management • Quality manual and project quality plan are prepared by site contractor for achieving quality work on site • Procedures and work instruction • Quality records and checklist for quality assurance and continual improvement of QMS
Management responsibility	• Organization should defined scope of QMS, well documented and publicized the quality policy • Prepare and executive effectively documented procedures • Prepare project quality plan • Interrelation of parties and communicate organization's responsibility and authority • Efficiency and adequate resources are identified and provided • Employ quality manager to emphasize on quality monitoring • Review and check quality system regularly
Leadership	• Identify needs of staff and provide training • Supervise and order instruction clearly
Planning	• Planning for address risks and opportunities • Carried out in planned manner for changes which include consequence of changes and available resource • For achieve quality objective, organization requires to prepare clear, measurable, monitored, communicated, updated and resourced plan
Support	• Resources • Competence • Awareness • Communication
Operation	• Conducting of beginning inspection and testing of incoming materials • Conduction of in-process inspection and testing of semi-finished work based on project quality plan • Maintain signed-off recording and testing • Indicate, separate the conformance or nonconformance of work • Verify the work meets specified requirement • After repair, inspect and test again
Performance evaluation	• Schedule of internal quality audits • Independent personnel is assigned to carry out internal audits • If necessary, follow-up audits are conducted
Improvement	• Using statistical techniques to identify the need in quality control for improving new project

2.9.1 Documentation Requirements

Implementation quality management system (QMS) requires a lot of documentation as a guideline and record. Documentation requirements include statement of quality policy and quality objective which are set by top management. Besides, quality manual and project quality plan are prepared by site contractor for achieving quality work on site. Construction organization is necessary to ensure the effective and efficiency planning, execution and process control through the procedures and work instruction. Quality records and checklist are documentation requirements for quality assurance and continual improve of quality management system (Watson & Howarth, 2011).

2.9.2 Management Requirements

Management requirements include management commitment, customer focus, quality policy, planning, responsibility, authority, communication and management review (Watson & Howarth, 2011). Construction organization illustrates the commitment to achieve quality and instills the importance of quality to team members. For enhancing customer satisfaction, construction organization identifies the requirements of customer. Moreover, quality policy is core heart of organization to serve its as overall purpose and improve the effectiveness of implementation QMS. Project manager or quality manager planned the establishment, documentation and implementation of QMS regarding every specific project.

Duties and responsibilities are clearly stated in organization and every team member is expected to liable their work to ensure higher quality work with legal

authority. Thus, effective communication has been established within the organization. For continual improvement of QMS, construction organization needs to review the overall implementation of QMS and examine the effectiveness of QMS (Watson & Howarth, 2011).

2.9.2 Resource Management Requirements

Resource management requirements include provision of resource, human resources, infrastructure and work environment. Companies are required to implement, maintain the resources and continually improve QMS practice.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

Methodology of research is a study of the framework, logical creation, ways and tools of a systematic activity or approach. In the chapter 3, my research is designed as a systematic planning to study the quality management system applied in construction industry. There is a necessity that few of the process should be design as well as consider in this chapter for used to collect data or information and data analysis. The rationale of chapter 2 and 3 is offers this study to become object of perception, learning outcome and systematization in the generation of questionnaire survey. It is vital in any research due to make sure the process of study going smoothly and achieve the effectiveness.

This research applied a mixed method approach which includes quantitative as well as qualitative and its data can provide a good understanding of critical factors influencing the quality management system in construction project to achieve the quality performance success fully applied in construction industry. Data collection of the

research came from questionnaire surveyw as well as the literature reviews which include journals, academic book, newspapers online and internet web sites.

3.2 Research Strategy of Data Collection

Data collection is the vital stage to achieve the desired objectives within the scope of work. The task in this stage is to identify project data and to conduct study for further details of the research. The data sources were classified into primary sources and secondary sources**.**

3.2.1 Primary Data

Primary sources provide data and information from using questionnaire survey for the research. A total number of 80 closed-ended questionnaires send out by email and distributing in construction site is at location Johor area.

3.2.1.1 Questionnaire survey

One of quantitative research method is established through questionnaire survey that has two types of question, namely open-ended question and close-ended question. The respondents are expected and required answering the set of questions which are written

and prepared by the researcher. Open-ended question is a set of questions without provide possible answer and allow respondents to write out his or her opinions. On the other hand, close-ended question is provided with the option with according to level of measurement such as nominate, ordinate, interval and ratio options and the respondents require ticking the answer. It is important to have clarity in the questions, easy to read and follow. Three types of methods conveying the questionnaire to respondent are mailed questionnaire, collective questionnaire and distributing in public. Refer to Choudhury (2015) and Baker (2007), the advantages and disadvantages of questionnaire survey are listed and summarized on table 3.1 and which separated by type of questionnaire.

Table 3.1 Advantages and disadvantages of Questionnaire

Type of Questionnaire	Advantages	Disadvantages
Mailed Questionnaire & Telephone Questionnaire	• Economical • Rapidity & Time saving • Easiest method • Less Pressure on the Respondents • Consistency • No distance barriers & ability to send almost anywhere in the world • Cheaper • Greater Validity & Reliability • Allow for collecting sensitive information • Large population & wide variety of potential respondents	• Low response rate • Lack of personal contact • Incomplete information due to problem of language, use of abbreviations and ambiguous terms • Useless in depth-information
Collective Questionnaire	• Consistency • Greater Validity & Reliability • On-time collection of vary data • Extremely quickly with low error rates analysis	• Limited Response • Useless in depth-information • Time consuming
Distributing in Public Questionnaire	• Randomly • Anonymity • Flexible tool for data collection • Wide Coverage	• Improper representative part of respondents • Lack of personal contact • Poor Response

3.2.1.2 Target Respondents

The questionnaires are distributed by the researcher for focusing on site staffs which are working on Contractor Company in Johor Bahru. G7 contractor companies are targeted respondents in this research where the located at Johor Bahru which found that 331 companies had registered as G7 contractor companies in CIDB (CIDB, 2016). The reason of choosing G7 Contractors firm as my research's target respondents is they require having implementation endeavors of ISO 9000 QMS in construction project in Malaysia. Due to larger population, questionnaire survey is the better way to collect my data for identifying the requirements and factors influencing QMS implementation as well as investigating the advantages and disadvantages of QMS. Using questionnaire survey, it is possibility to collect the data and analyze data through reliability and validity test to show out the relationship between.

3.2.1.3 Questionnaire Design

Questionnaire consisted of two parts in which the first part is to indicate the introductory part of the respondents and the second part is to list out critical factor influencing quality management system applied in construction industry which include success factors and failure factors. The scale of measurement is a Five-point Likert Scale: 1=Not Very Important factor influencing the quality/Strong disagree, 2=Not Important factor influencing the quality/disagree, 3=moderately important factor influencing the quality/Neutral, 4=Important factor influencing the quality/Agree and 5=Very Important factor influencing the quality/Strongly agree. In essence, it can provide a hierarchical ordering in order to identify what is the major factor influencing quality, benefit and requirements regarding application QMS in construction industry.

For setting up the question for questionnaire, there are several fix questions:

a. Section A: Participants' basic information
b. Section B: Factors influencing QMS application in construction
c. Section C: Benefits of Implementing QMS in construction project
d. Section D: Documentation Requirements and Other Requirements of implementation of QMS

3.2.1.4 Sample Size

Sample size is significant for an efficiency research and as minimum set numbers of survey questionnaire distribute by researcher (Scott Smith, 2013). If sample size is wrongly determined, it is possible to cause the research finding lower accuracy. It can be determined according to population, margin of error, confidence level and standard of deviation. Krejcie and Morgan (1970) had calculated the number of sample size by formula and summarized the data in table depend on population to determined sample size by researcher easily and accurately. The population of target respondents are estimated around 331. Based on formula of sample size, the sample size is around 178. Hence, 180 sets of questionnaire survey will be distributed by researcher to the target respondent.

Formula 3.1 of sample size (SS),

$$\text{Sample Size}=\frac{\frac{z^2*p(1-p)}{e^2}}{1+(\frac{z^2*p(1-p)}{e^2N})} \qquad (3.1)$$

Where:

Z = 1.96, 95 % confidence level

p = percentage picking a choice (50 %)

e = margin of error (5 %)

N = Population

3.2.2 Secondary Data

Secondary data is written or collected by other researcher such as journal, academic book, newspaper and report. Secondary data is saving time to analyze as well as providing larger database and understanding to researcher before researcher plan to collect primary data.

3.3 Data Analysis

Along with data collection has completed, data analysis will be next stage for analyzing and comprehending the data by using SPSS software. Data analysis is the application of statistic systematically and logically which is as a technique to explain and evaluate data as well as present through table, bar, chart and graph.

3.3.1 Description Analysis

Description analysis is expressing the data through pie charts, line graphs and bar charts. The purpose of this analysis is to analyze the data about information of respondents in a sample or population. It can make the raw data into a form for reader's understanding and comprehension. The transformation of raw data is to rearrange order and manipulate data to create rational descriptive information. It applied for data in Section A of questionnaire survey by measuring the average, frequency distribution percentage of respondents' data.

3.3.2 Reliability Analysis

Reliability analysis is carried out to measure the consistency of ranking scale data or ordinal data which under section B, C and D in survey questionnaire. Reliability analysis used the Cronbach's alpha to measure data in SPSS.

3.3.2.1 Cronbach's Alpha Test

Cronbach's alpha test is the most common of reliability test which able to measure the scale of internal consistency and significant for designing questionnaire survey. Alpha is a vital theory to evaluate the assessments in questionnaires survey. It is normally applied when the questionnaire using Likert Scale such as this research in order to determine the

reliability of data and accurate as well as free from random error. Table 3.2 shows the Cronbach's Alpha Value Coefficient Range.

Table 3.2 Cronbach's Alpha Value Coefficient Range

Cronbach's Alpha range	Internal Consistency
$\alpha < 0.6$	Poor Reliability
$0.6 < \alpha < 0.7$	Acceptable Reliability
$0.7 < \alpha < 0.8$	Good Reliability
$0.8 < \alpha < 0.9$	Very Good Reliability
$\alpha > 0.9$	Excellent Reliability

3.3.3 Factor Analysis

Factor Analysis is used to analyze and indicate the measurement of a group variable. It is able to decrease large amount numbers of variable to a specified group or smaller numbers as a method of data reduction. The purpose of this analysis is to disclose and summarize the internal correlation among the variables. It also can assist to restructure the data by reducing the number of variables (Robin, 2012). In my study, it is consist of Kaiser-Meyer Olkin (KMO) and Bartlett's Test, Communalities and Rotated Component Matrix to data reduction and analysis validity of my research.

3.3.3.1 Kaiser-Meyer Olkin (KMO) and Bartlett's Test

The Kaiser-Meyer Olkin (KMO) is conducted in this research to examine the appropriateness of factor analysis and measure of sampling adequacy. It depends on the index analyzed by SPSS software. The higher value of index indicates that factor analysis is having high level of adequacy and appropriate. Based on Kaiser (1974), he suggested that value for KMO has a minimum requirement which is above 0.5. Values of the index below 0.5 imply that the factor analysis may be deducted and unaccepted. Furthermore, Bartlett's test is used to indicate the strength of relationship among the variables and determine the identity matrix.

Table 3.3 KMO Value Coefficient Range

KMO Measure	Internal Consistency
Less than 0.5	Unacceptable
0.5 - 0.6	Acceptable
0.6 - 0.7	Mediocre
0.7 - 0.8	Good
0.8 – 0.9	Great
Above 0.9	Excellent

3.3.3.2 Communalities

Communalities is used to single observe the each variable among all of the variables by extraction value (Field, 2005). Extraction is measure of variables as linear combination. According to Chetty and Datt (2015), the communality value or extraction value should be consider that more than 0.5 in order to further analysis. The extraction value less than

0.5, it consider to deduct the variable in further analysis. Communalities are analyzed for critical factors, benefits and requirements of implementing QMS.

3.3.3.3 Rotated Component Matrix

Rotated component matrix is the main output of PCA. It includes appraise and estimate the correlations between every single variables. Next, it can be grouping each variable into few components (Chetty and Datt, 2015). The correlation between variables is based on component loading computed by SPSS. It is allow researcher to name the component for interpreting the result. Rotated component matrix is used to classify amount of variables which are benefits and requirements of implementing QMS.

3.3.4 Pearson Correlation Coefficient

Pearson correlation coefficient is used to determine and measure the strength of two or more variables and its relationship. R value as correlation coefficient is used in Pearson correlation analysis and commonly used to measure bivariate correlations in SPSS. The closer of r value is to 1 or -1, the stronger relationship in the linear correlation. Interpreted of r value is indicated in table 3.4 as below.

Table 3.4 R Value Correlation Coefficient Range

R value	Linear correlation
0.10 to 0.35 or -0.10 to -0.35	Low correlations
0.36 to 0.67 or -0.36 to -0.67	Moderate correlations
0.68 to 0.90 or -0.68 to -0.90	Strong correlations

3.3.5 Agreeable Index

Agreeable index is conducted to determine the weight of variables and to rank which most important or most agreeable from respondents. Agreeable index is conducted to rank the critical factors, benefits and requirements of implementing QMS. It is require to allocated based on weight from higher to lower score.

Formula of Agreeable index is indicated as below:

$$\text{AI} = \frac{5N_5+4N_4+3N_3+2N_2+1N_1}{5(N_5+N_4+N_3+N_2+N_1)} \qquad (3.2)$$

Where:

N5 = Number of respondents with Strongly Agree/ Very Important

N4 = Number of respondents with Agree/ Important

N3 = Number of respondents with Neutral

N2 = Number of respondents with Disagree/ No Important

N1 = Number of respondents with Strongly Disagree/ Very Not Important

3.4 Research Methodology framework

A detailed research framework is necessary to proper design for obviously indicate the methodology of this study. Thus, for attaining the aim and objective of this research, research framework is as a guideline for highlighting the right procedure to conduct my research successfully. The flowchart indicated in chapter one Figure 1.1.

3.4.1 Primary Stage

Primary stage includes first discussion and study literature review which is the most initial of the research.

3.4.1.1 First Discussion

The first discussion in primary stage involves the overall review of the problem statement and contemporary quality if it is significant study to construction industry. Moreover, I discuss the challenges regarding this research topic and its limitation with my supervisor Prof. Dr. Naoto Mine when the initial of preparing this research as he provided direction and guided me in accomplishing this study.

3.4.1.2 Study from Literature Review

Literature review is an important part of research which possible to build a theoretical framework regarding my topic to strengthen the point and prove the area of research. The researcher is encouraged to read certain amount of appropriate information and he may realize the knowledge on the subject. It is undoubtedly that the researcher should describe, summarize, examine and clearly explain the point of literature review. In order to achieve the aim and objective as well as scope of study properly, literature review should be structured properly to enhancing in order to reasonable the flow of my study. This review is possible come from academic book borrowed from library; online various sources, article and journal toward to increase the quality of my study and fulfill the fact as well as used to summarize my understanding to develop the chapter 4 research finding and data analysis.

3.4.2 Secondary Stage

Secondary stage includes research design and method of data collection.

3.4.2.1 Data Collection from Questionnaire Survey

Develop questionnaire, which must be reliable and valid, need to refer back to the aim and objectives for starting to ask specific and related questions.

3.4.3 Tertiary Stage

Tertiary stage includes data analysis by SPSS which is used to analyze data collected by researcher and for further discussion as well as analyze the relation between variables.

3.4.3.2 Data Analysis

Data analysis of this research is by using Statistical Package for the Social Sciences (SPSS) software which is window based software. This software will used to carry out the data entry, analysis and present result through tables and graphs (Perner, 1990). SPSS is suitable to this research due to able of processing large number of data which data collected by questionnaire survey. In my research, few types of data analysis carried out by SPSS are description analysis, factor analysis and reliability test.

3.4.4 Final Stage

Final stage is to conclude a research which includes summary research findings and write up the conclusion.

3.4.4.1 Summary research findings and Conclusion

This is last stage of research which writes up the research findings based on data collection and analysis. The final writing should be explained and summarized the research findings and come out with a conclusion which is the most important of this stage. It requires to clearly statement in Chapter 5. Furthermore, researcher allows to recommendation for next research.

CHAPTER 4

DATA ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter of study is to analyze the collecting data by the way of questionnaire survey and to interpret my result by using SPSS software and Microsoft Excel. It is includes preliminary analysis, description analysis, reliability and validity test of measurement and ranking of factors, benefits and requirements of QMS.

4.2 Preliminary Analysis

180 sets of survey questionnaire were distributed by using online survey and hand delivery survey to G7 contractor in Johor Bahru. However, there are 72 sets useable survey questionnaire returned and 2 sets uncompleted survey questionnaire. The percentage (%) of response rate is 41.1%.

Table 4.1 Preliminary Analysis

Description	Quantity	Percentage (%)
Questionnaire was distributed	180	100%
Questionnaire was returned	74	41.1%
Useable questionnaire	72	40.0%
Incomplete questionnaire	2	1.1%

4.3 Respondent Demographics

In the questionnaire, respondent demographics are respondent's information background which include gender, job position, working experience, type of project involved, company size and status of QMS practice.

4.3.1 Gender

Frequency for gender of respondent is indicated in Table 4.2 and figure 4.1 as below.

Table 4.2 Frequency for Gender of Respondent

No	Gender	Frequency	Percentage (%)	Cumulative Percentage (%)
1	Female	28	38.9	38.90%
2	Male	44	61.1	100.00%
	Total	72	100.00%	

There are 38.9% (which has 28 respondents) of female and 61.1% (which has 44 respondents) of male respondents in this data collection.

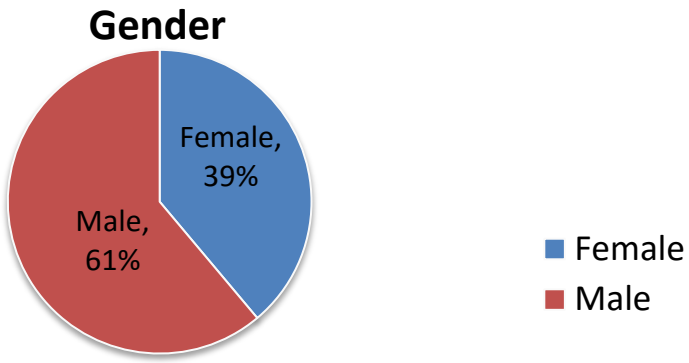

Figure 4.1 Percentages of Respondents' Gender

4.3.2 Job Position

Table 4.3 and Figure 4.2 indicate the job position of the respondents in G7 contractors.

Table 4.3: Frequency for Job Position of Respondents

No	Job Position	Frequency	Percentage (%)	Cumulative Percentage (%)
1	Project Manager / Construction Manager	14	19.4	19.4
2	Quality Manager / QAQC Department	22	30.6	50.0
3	Architect	2	2.7	52.8
4	Site Engineer	12	16.7	69.4
5	Quantity Surveyor	8	11.1	80.5
6	Site Supervisor	10	13.9	94.4
7	Other	4	5.6	100
	Total	**72**	**100%**	

According to the table 4.3 and figure 4.2, there is the highest percentage 30.6% which have 22 respondents as quality manager or site staff working in quality assurance quality control department. Next is project manager or construction manager with 14 (19.4%) respondents. Site staff includes site engineer, site supervisor, quantity surveyor, architect and safety staffs which have lower percentage 16.7% (12 respondents), 13.9% (10 respondents), 11.1% (8 respondents), 2.7% (2 respondents) and 5.6% (4 respondents). Due to lack of collaboration of some of individual company and respective individual, it leads to disproportionate distribution of the questionnaire in job position.

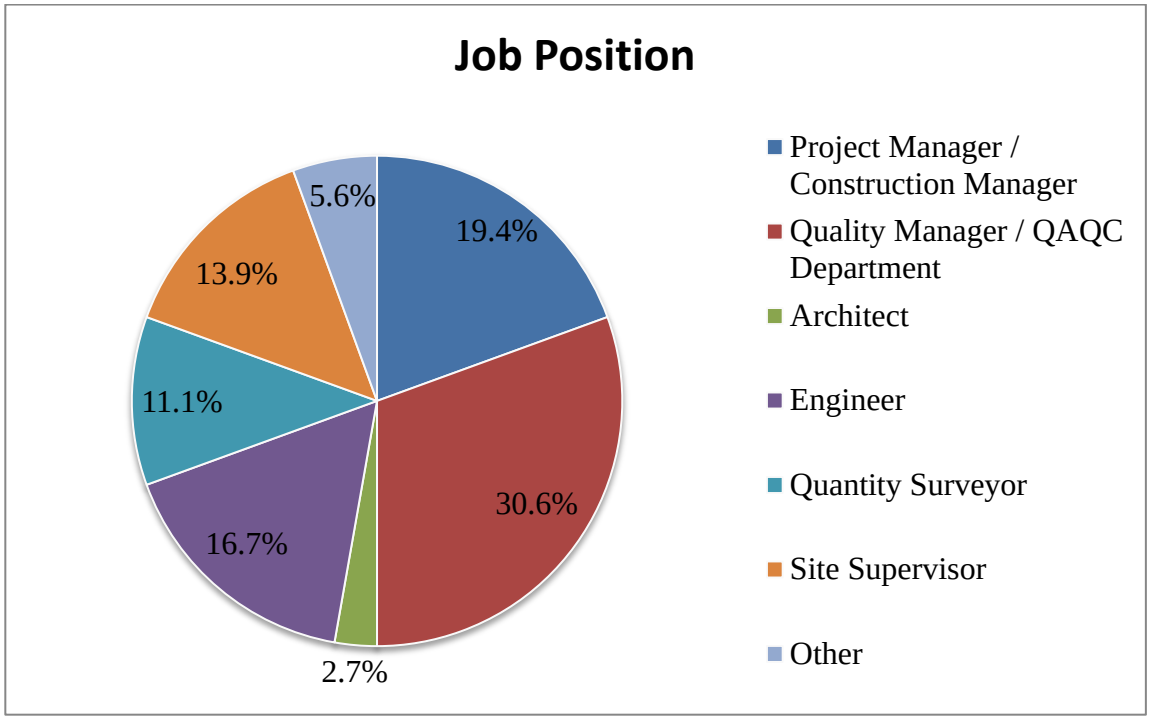

Figure 4.2 Percentages of Respondents' Job Position

4.3.3 Working Experience

Frequency for working experience of respondents is indicated in Table 4.4 and figure 4.3 as below.

Table 4.4: Frequency for Working Experience of Respondents

No	Working Experience	Frequency	Percentage (%)	Cumulative Percentage (%)
1	<5yrs	22	30.6	30.6
2	5-10yrs	16	22.2	52.8
3	10-15yrs	12	16.7	69.4
4	>15yrs	22	30.6	100
	Total	**72**	**100%**	

Based on Table 4.4 and Figure 4.3, there are same percentages 30.6% (22 respondents) with “less than 5 years” and “more than 15 years” working experience and both of it has ranked as highest percentage. Next is working experience between 5 to 10 years which has 22.2% (16 respondents) and between 10-15 years which has 16.7% (12 respondents).

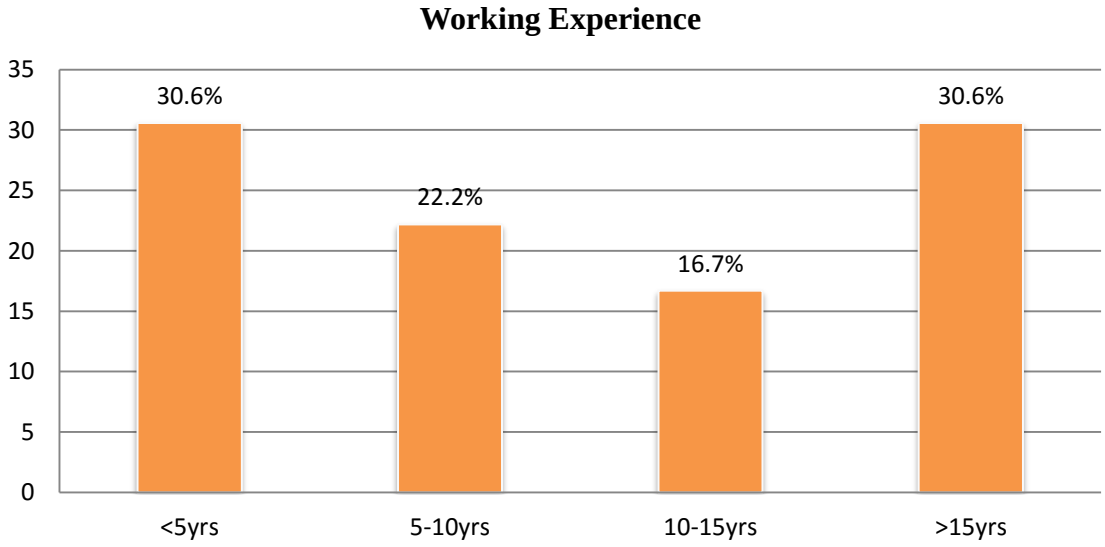

Figure 4.3 Percentages of respondents’ Working Experience

4.3.4 Type of Project

Frequency for type of project involved is indicated in Table 4.5 and figure 4.4 as below.

Table 4.5: Frequency for Type of Project Involved

No	Type of Project	Frequency	Percentage (%)	Cumulative Percentage (%)
1	Building	56	77.8	77.8
2	Infrastructure	14	19.4	97.2
3	Industry	2	2.8	100.0
	Total	72	100.00%	

Based on Table 4.5 and Figure 4.4, building project is the highest percentages 77.8% (56 respondents). Next is infrastructure project which has 19.4% (14 respondents), and industry project 2.8% (2 respondents).

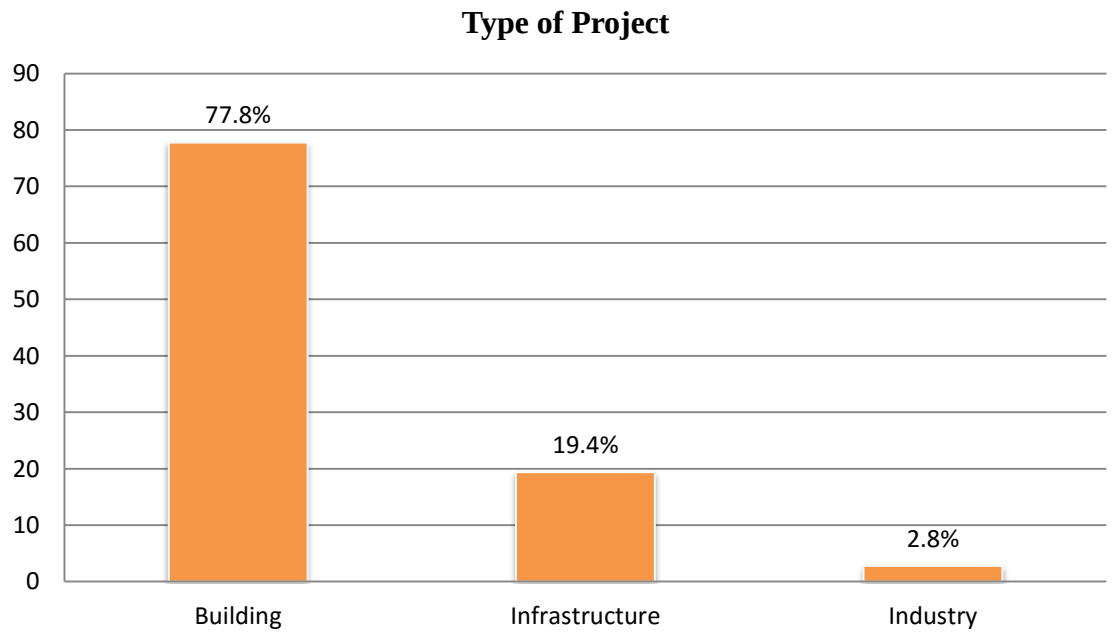

Figure 4.4 Percentages of Type of Project Involved

4.3.5 Company Size

Frequency for company size is indicated in Table 4.6 and figure 4.5 as below.

Table 4.6: Frequency for Company Size

No	Type of Project	Frequency	Percentage (%)	Cumulative Percentage (%)
1	<5 employees	2	2.8	2.8
2	5-50 employees	10	13.9	16.7
3	51-100 employees	16	22.2	38.9
4	101-150 employees	8	11.1	50.0
5	>150 employees	36	50.0	100
	Total	**72**	**100%**	

Based on Table 4.6 and Figure 4.5, the highest percentages is 50% (36 respondents) which company size is more than 150 employees. Next is company size around 51-100 which has 22.2% (16 respondents). Besides, other company size includes 5-50 employees, 101-105 employees and less than 5 employees which the following percentages are 13.9% (10 respondents), 11.1% (8 respondents) and 2.8% (2 respondents).

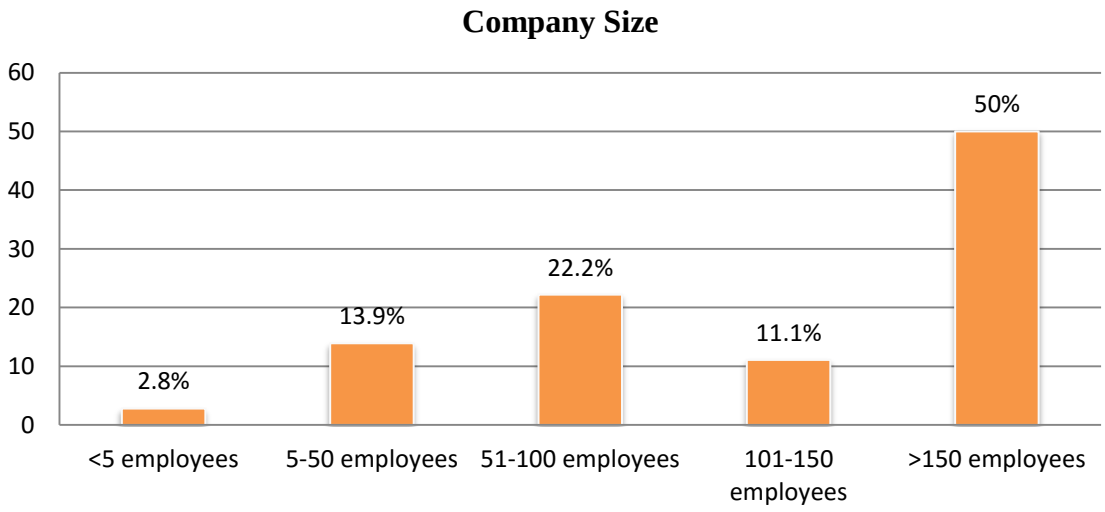

Figure 4.5 Percentages of Company Size

4.4 Status of QMS Practice on Site

Frequency for QMS practice by contractor on site is indicated in Table 4.7 and figure 4.6 as below.

Table 4.7: Frequency for QMS practice by Contractor on Site

No	Type of Project	Frequency	Percentage (%)	Cumulative Percentage (%)
1	Yes	52	72.2	72.2
2	No	20	27.8	100
	Total	72	100%	

According to the analysis indicated in table 4.8 and figure 4.6, 72% respondents (52 respondents) companies are implementing Quality Management System practice on site while 28% respondents (20 respondents) are not implementing this practice on site. However, it can be predicted that there are more respondents in actual practice. The reason is the target respondent set as G7 contractor which is required or expected to good performance in quality. Based on study from Said, et al. (2009), QMS practice have been on growing up trend in the Malaysian Construction Industry.

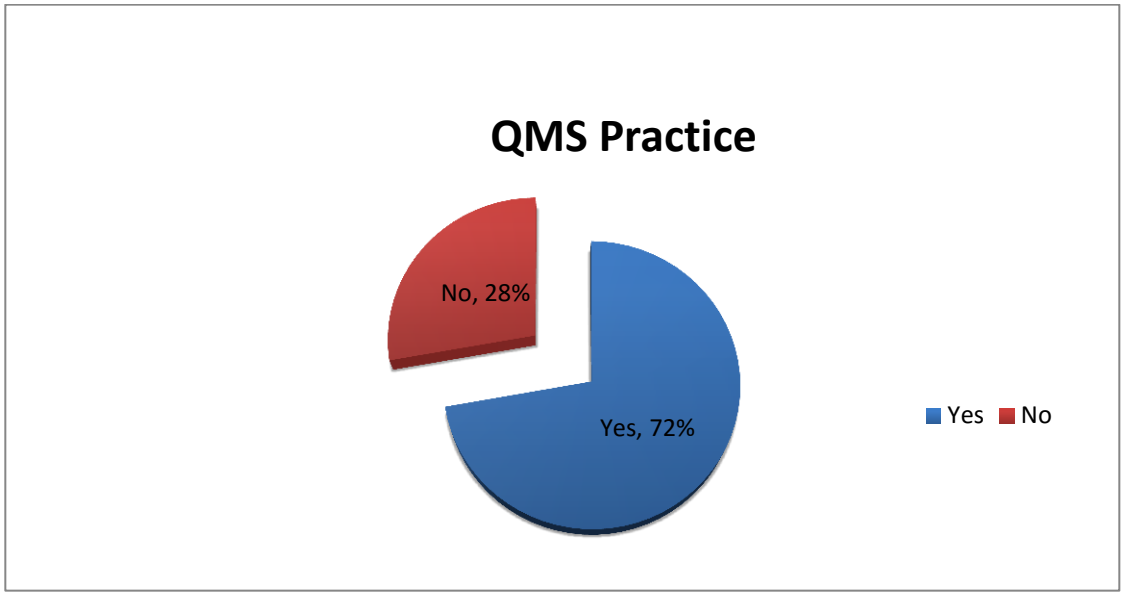

Figure 4.6 Status of QMS Practice

4.5 Reliability Test of the Measurement

Based on Table 4.8, 7 items of the critical success factors (Section B) and 15 items (Section C) of benefits are passed with acceptance value of 0.7 which Cronbach's Alpha values are 0.826 and 0.874 that indicate very good reliability. The section D indicates two parts which are 16 items of documentation requirements and 7 items of other requirements also have the higher Cronbach's Alpha value which are 0.913 and 0.863 respectively.

Table 4.8: Reliability Test

Section	Objective	Cronbach's Alpha	Internal Consistency	Number of Items
B	Critical Success Factors	0.826	Very Good Reliability	7
C	Benefits	0.874	Very Good Reliability	15
D1	Documentation Requirements	0.913	Excellent Reliability	16
D2	Other Requirements	0.863	Very Good Reliability	7

4.6 Factor Analysis

In my study, it is consist of Kaiser-Meyer Olkin (KMO) and Bartlett's Test, Communalities and Rotated Component Matrix to data reduction and analysis validity of my research.

4.6.1 KMO and Bartlett's Test of Sphericity

Based on table 4.7, all sections which are critical success factors, benefits and requirements passed the acceptance value in KMO and Bartlett's test of Sphericity, where value of KMO above 0.5 and p value or significant value of Bartlett's test less than 0.01.

Table 4.9 KMO and Bartlett's Test of Sphericity

Section	Objective	KMO	Bartlett's Test of Sphericity		
			Approx. Chi-Square	Sig	df
B	Critical Success Factors	0.732	239.739	0.000	21
C	Benefits	0.686	546.437	0.000	105
D1	Documentation Requirements	0.726	801.147	0.000	120
D2	Other Requirements	0.794	244.458	0.000	21

Other requirement has the highest KMO value is 0.794 while critical success factors, documentation requirements and benefits which values are 0.732, 0.726 and 0.686 respectively.

4.6.2 Communalities

According to Table 4.8, all of the variables were examined by SPSS 16. The extraction value is acceptable when the value is above 0.5 (Chetty & Datt, 2015).

Table 4.10 Communalities

Code	Section B: Critical Factor	Extraction
CF1	Process Management	0.588
CF2	Top Management commitment	0.720
CF3	Project Quality Plan integrated	0.843
CF4	Training and Education Programme	0.768
CF5	Measurement and Enhancement of performance	0.720
CF6	Teamwork and skill of Communication	0.666
CF7	**Information, Communication and Technology (ICT)**	**0.699**
Code	**Section C: Benefits**	**Extraction**
B1	Enhanced image, increase competitive and reputation of organization	0.545
B2	Performance continuous improvement	0.561
B3	Increase customer satisfaction	0.565
B4	Clear line of duties	0.774
B5	Facilitates access to certain market	0.600
B6	Increase chances to be award the tenders / contract	0.381
B7	Improved relationship and cooperation between parties	0.655
B8	Establishing clear documented procedures and instructions	0.796
B9	Consistency in quality of project	0.804
B10	Efficiency of operations in construction site	0.565
B11	Reduction of quality cost and risk minimize	0.845
B12	Prevention of errors at the earliest stage of the project	0.614
B13	Project completion within the stated period of time	0.802
B14	Quality Auditing and Assurance	0.659
B15	Improving resource management	0.684

Table 4.10 Communalities (continued)

Code	Section D (1): Documentation Requirement	Extraction
DR1	Quality Policy Statement and Quality Objective	0.616
DR2	Quality Manual and Procedure	0.853
DR3	Project Quality Plan	0.677
DR4	Preventive Action	0.802
DR5	Corrective Action Request (Inclusive control of Non Conformance	0.822
DR6	QLASSIC / CONQUAS (Quality Standard Assessment System)	0.538
DR7	Inspection Test Plan	0.797
DR8	Incoming Material Inspection	0.645
DR9	Quality Monthly Report	0.690
DR10	Resources Plan	0.609
DR11	Checklist	0.761
DR12	Audits (Internal and External)	0.687
DR13	Meeting Records and Review Meeting	0.610
DR14	Control of Documents	0.670
DR15	Control of Records	0.774
DR16	Customer Satisfaction Survey	0.782
Code	**Section D (2): Other Requirement**	**Extraction**
OR1	Staff Training for QMS	0.667
OR2	Planning for address risks and opportunities	0.650
OR3	Interrelation of parties and communicate organization's responsibility and authority	0.887
OR4	Employ quality manager to emphasize on quality monitoring	0.756
OR5	Review and check quality system regularly	0.700
OR6	Supervise and order instruction clearly	0.752
OR7	Using statistical techniques to identify the need in quality control for improving new project	0.557

Extraction Method: Principal Component Analysis

Based on table 4.8, benefit 6 “Increase chances to be awarded the tenders and contract” which under section C variables of benefits has communalities or extraction value of 0.381. This element did not pass the acceptance value of 0.5. This could be estimated that the respondents misunderstood chances of award the tenders or contracts due to QMS with this variable is an indirect relationship. Quality Management System on site is for improving quality of ongoing project but the “chances of award tenders or contracts” is for the new project.

On the other hand, the variable under section B critical factors which has highest communalities value of 0.843 is “Project Quality Plan integrated”. This can be interpreted that there are well represent the variable in extracted components. It means most of respondents agreed that project quality plan integrated as useful factors in this study. This match with the study from Abdullah (2012) statement that integration of project quality plan for success QMS implementation for have a benefit to prevent overlapping and neglecting from the scope of the project or activities and dispute of quality.

At the Section C benefits variables, the variable “Reduction of quality cost and risk minimize” has the highest communalities value of 0.845. It can be interpreted that this variable is sufficiently well representated. This match with the study from KAZILIŪNAS (2010) which is stated that it should be aware of failure preventive action and will has advantage to cost saving as well as customer satisfaction.

At the Section D part 1 Documentation requirement variables, the highest communalities value of 0.853 is the variable “Quality Manual and Procedure”. It means most of respondent agree the Quality Manual and Procedure as a valid factor of documentation requirements. This match with pyramid of quality management system mentioned by Rumane (2011) which is as a framework or management’s intentions to be operating the quality system.

At the Section D part 2 Other requirement variables, the variable “Interrelation of parties and communicate organization’s responsibility and authority” has the highest communalities value of 0.887. It indicates the variable is well represented in feedback from respondents. This is match with ISO management responsibility requirement and study from Watson & Howarth (2011) with statement that the effective communication has been established within the organization for successful implementing of QMS.

4.6.3 Rotated Component Matrix

4.6.3.1 Benefits

Table 4.11 means rotated component matrix for benefit variables that analyzed by SPSS.

Table 4.11 Rotated Component Matrix

	Component			
	1	2	3	4
B9	.855			
B8	.807			
B12	.651			
B10	.644			
B7	.629			
B5		.724		
B2		.705		
B1		.562		
B6		.558		
B4			.817	
B3			.710	
B14	.414		.676	
B11				.838
B13				.829
B15	.435		.464	.516

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 8 iterations.

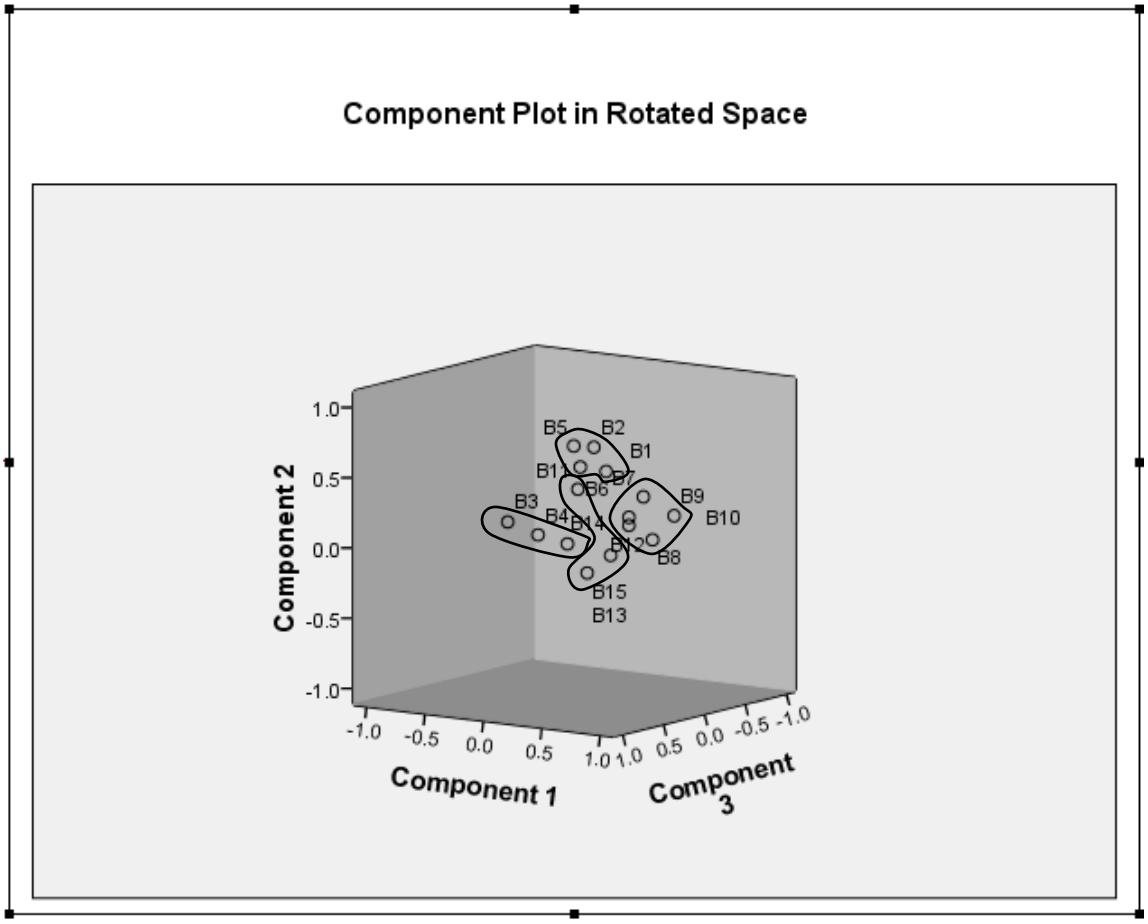

Figure 4.7 Component Plot for Benefits in Rotated Space

Based on Table 4.9 and Figure 4.7, 15 items of benefit variables under section C can be included in four components. First component includes B9, B8, B12, B10 and B7 which are "consistency in quality of project", "Establishing clear documented procedures and instructions", "Prevention of errors at the earliest stage of the project", "Efficiency of operations in construction site" and "Improved relationship and cooperation between parties". They can be concluded that is performance benefits component. This component has matched with journal article by Ivan, et al. (2012), it was concluded that implementing of QMS has advantaged to improve the performance and productivity of construction project which practice through the quality system and quality standard.

Next, second component includes B5, B2, B1 and B6 which are "Facilitates access to certain market", "Performance continuous improvement", "Enhanced image,

increase competitiveness and reputation of organization" and "Increase chances to be award the tenders / contract". They can be grouping into market competitive benefits components. Based on study from Willar (2012), implementing QMS based on ISO 9001 are vital in growing up construction companies become strong market competitve.

Furthermore, third component includes B4, B3 and B14 which are "Clear line of duties", "Increase customer satisfaction" and "Quality Auditing and Assurance". It being computed by SPSS and estimated that have similar correlation between this three variables. They can be concluded into staff and customer benefits component. QMS have internal and external audit as well as clearly stated duties and responsibilities of staff that is ability having a smoothly flow chart of task in order to increase their job satisfaction and increase project quality for customer satisfaction following increase (ISO 9001, 2015).

Last component of benefit includes B11, B13 and B15 which are "Reduction of quality cost and risk minimize", "Project completion within the stated period of time" and "Improving resource management". They can be judged into time, cost and quality benefits component. According to Nand (2016), the scope of implementing QMS is greater that will lead to shorter time frame of implementing, reduce the cost of failure and improve resource management.

Table 4.12 Name of Component for Benefits

Name of Component	Code	Benefits
Performance	B9	Consistency in quality of project
	B8	Establishing clear documented procedures and instructions
	B12	Prevention of errors at the earliest stage of the project
	B10	Efficiency of operations in construction site
	B7	Improved relationship and cooperation between parties
Market Competitive	B5	Facilitates access to certain market
	B2	Performance continuous improvement
	B1	Enhanced image, increase competitive and reputation of organization
	B6	Increase chances to be award the tenders / contract
Staff and Customer	B4	Clear line of duties
	B3	Increase customer satisfaction
	B14	Quality Auditing and Assurance
Time, cost and quality	B11	Reduction of quality cost and risk minimize
	B13	Project completion within the stated period of time
	B15	Improving resource management

4.6.3.1 Requirements

Table 4.13 means rotated component matrix for requirements variables that analyzed by SPSS.

Table 4.13 Rotated Component Matrix

	Component			
	1	2	3	4
OR3	0.853			
OR4	0.793			
OR5	0.709			.544
OR7	0.686		.522	
OR2	0.683			
DR16	0.632		.561	
OR6	0.625			
DR13	0.617	.415		
DR2		0.841		
DR1		0.808		
DR7		0.758		
DR3		0.690		
DR11		0.620		
DR9		0.555	.503	
DR12			0.699	
DR6		.438	0.685	
DR14			0.683	
DR15			0.573	
DR10		.470	0.474	
DR8			0.444	
DR5				0.752
DR4				0.678
OR1				0.566

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 9 iterations.

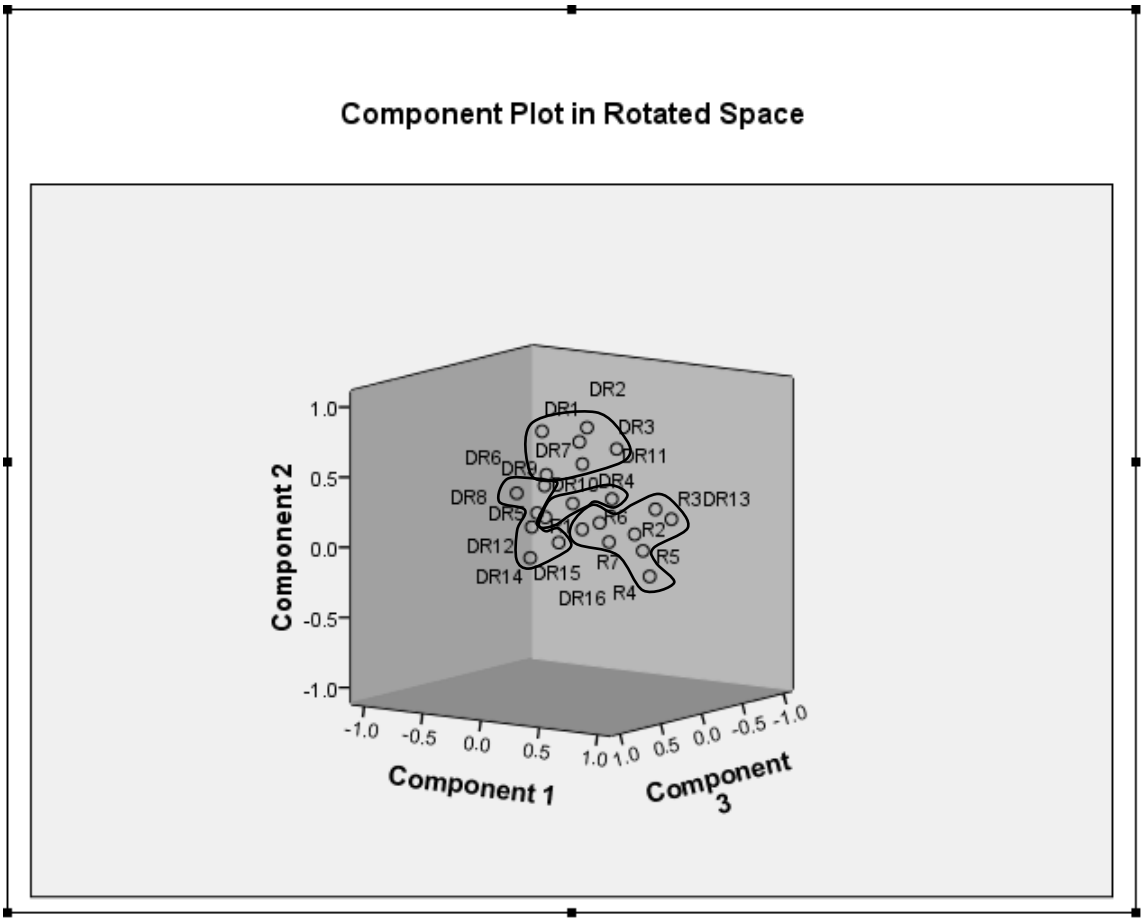

Figure 4.8 Component Plot for Requirements in Rotated Space

Based on Table 4.10 and Figure 4.7, 16 items of documentation requirements and 7 other requirements variables under section D can be included in four components. First requirements component includes DR2, DR3, DR1, DR7, DR11 and DR9 which are "Quality Manual and Procedure", "Project Quality Plan", "Quality Policy Statement and Quality Objective", "Inspection Test Plan", "Checklist" and "Quality Monthly Report". The variables in this component have correlated and this component is matched with pyramid of quality management system (Figure 2.3). According to Rumane (2011), QMS has established a structure which includes policy, objective, documentation, manual or procedure and checklist.

Next, second requirements component includes OR3, OR4, OR5, OR2, OR7, DR16, OR6 and DR13 which are "Interrelation of parties and communicate

organization's responsibility and authority", "Employ quality manager to emphasize on quality monitoring", "Review and check quality system regularly", "Planning for address risks and opportunities", "Using statistical techniques to identify the need in quality control for improving new project", "Customer Satisfaction Survey", "Supervise and order instruction clearly" and "Meeting Records and Review Meeting". They can be concluded into Management responsibility requirement component. According to Watson and Howarth (2011), management requirements consist of management commitment, customer focus, communication, management review, planning and responsibility.

Furthermore, third requirements component includes DR14, DR12, DR6, DR10, DR8 and DR15 which are "Control of Documents", "Audits (Internal and External)", "QLASSIC / CONQUAS (Quality Standard Assessment System)", "Resources Plan", "Incoming Material Inspection" and "Control of Records". These 6 variables of requirements can be grouping into performance control requirements.

Last requirements component includes DR4, DR5, and OR1 which are "Preventive Action", "Corrective Action Request (Inclusive control of Non Conformance" and "Staff Training for QMS". These three variables can be group into Prevention Error component. Staff was being trained by organization to have clearly practice of QMS and reduce mistake while implementing of QMS.

Table 4.14 Name of Component for Requirements

Name of Component	Code	Requirement
QMS Pyramid Requirement	DR2	Quality Manual and Procedure
	DR3	Project Quality Plan
	DR1	Quality Policy Statement and Quality Objective
	DR7	Inspection Test Plan
	DR11	Checklist
	DR9	Quality Monthly Report
Management Responsibility	OR3	Interrelation of parties and communicate organization's responsibility and authority
	OR4	Employ quality manager to emphasize on quality monitoring
	OR5	Review and check quality system regularly
	OR2	Planning for address risks and opportunities
	OR7	Using statistical techniques to identify the need in quality control for improving new project
	DR16	Customer Satisfaction Survey
	OR6	Supervise and order instruction clearly
	DR13	Meeting Records and Review Meeting
Performance Control	DR14	Control of Documents
	DR12	Audits (Internal and External)
	DR6	QLASSIC / CONQUAS (Quality Standard Assessment System)
	DR10	Resources Plan
	DR8	Incoming Material Inspection
	DR15	Control of Records
Prevention Error	DR4	Preventive Action
	DR5	Corrective Action Request (Inclusive control of Non Conformance
	OR1	Staff Training for QMS

4.7 Pearson Correlation Coefficient

Respondents' information such as working experience of respondents, type of project and company size is tested with QMS practices by executing bivariate analysis. It used to determine whether respondents' information will affect the respondents in implementing of QMS. According to table 4.13, it indicates that QMS practice with working experience of respondents has low correlation between them with the Pearson Correlation value of -0.241 and p value less than 0.05. It means the increase of working experience will slightly influencing implement of QMS practice. However, respondents are come from different background like education level and job position that will not lead to have strong correlation between them.

Furthermore, there are not correlations between type of project and QMS practice due to Pearson Correlation Coefficient value of 0.063 and p value more than 0.05. Every type of project such as building project, infrastructure project and industrial project is require to have quality management system for improving quality performance of the project.

Based on table 4.13, Pearson Correlation Coefficient value was determined the correlation between QMS practice and company size which is -0.612 and p value less than 0.05. It can be interpreted that there has moderate correlation. Based on CIDB category of contractor, grades from G1 to G7 is based on capital of contractor's tendering and paid-up. G7 contractor is qualified by experience and performance, financial capacity, personnel resource and additional requirements. G7 contractor is required to have numbers of full-time employees with qualifications (Appendix of contractor registration criteria, 2006). The statement shows that company size will influence the QMS practice but not at all.

Table 4.15 Pearson Correlation

		QMS Practice
QMS Practice	Pearson Correlation	1
	Sig. (2-tailed)	
	N	72
Working Experience of Respondents	Pearson Correlation	-.241*
	Sig. (2-tailed)	.041
	N	72
Type of Project	Pearson Correlation	.063
	Sig. (2-tailed)	.600
	N	72
Company Size	Pearson Correlation	-.612**
	Sig. (2-tailed)	.000
	N	72

*. Correlation is significant at the 0.05 level (2-tailed).

4.8 Agreeable Index and Ranking

Agreeable index ranking is conducted to analyze objectives of the study which are critical factors, benefits and requirements in implementing of QMS.

4.8.1 Critical Factors Influencing QMS Implementation in Construction projects

For study critical factors influencing success implementation of QMS, all of the respondents are required to rank the questionnaire by Likert scale for identify which factors are important be successful implementing of QMS. In the table 4.14, NVI means Not Very Important, NI means Not Important, IONI means Important or Not Important, I means Important and VI means Very Important.

Table 4.16 Agreeable index for Critical Factors influencing Success Implementation of QMS

Critical Factors	NVI	NI	IONI	I	VI	AI	Ranking
Process Management	0	2	4	38	28	0.856	4
Top Management commitment	0	0	4	28	40	0.900	1
Project Quality Plan integrated	0	2	6	30	34	0.867	3
Training and Education Programme	0	4	8	34	26	0.828	5
Measurement and Enhancement of performance	2	4	8	34	24	0.806	6
Teamwork and skill of Communication	0	0	8	22	42	0.894	2
Information, Communication and Technology (ICT)	2	6	18	32	14	0.739	7

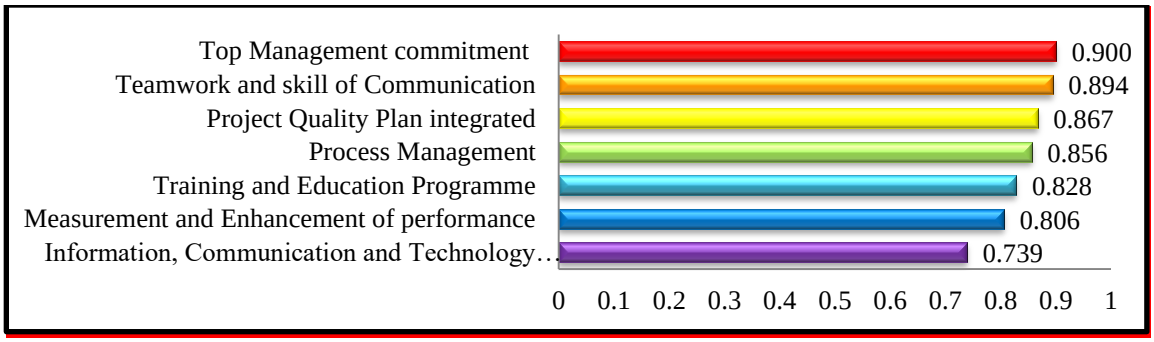

Figure 4.9 Ranking for Critical Factors influencing Success Implementation of QMS

4.8.1.1 Top Management Commitment

Based on table 4.14 and figure 4.9, the highest agreeable index is “top management commitment” with value of 0.90. It can be concluded that top management commitment is as vital important factor for successful implementing of QMS. At the project beginning, the top management plays a significant role in making decision and sets out the goal with quality expected level for parties to achieve (Abdullah, et al., 2015). Quality expected can through the implementing of QMS to be obtained. According to Nursyamimi, et al. (2014), the preparation and implementing of QMS are provided condition by client which is represented top management in the contract document to all the parties involved during the construction project ongoing.

4.8.1.2 Teamwork and skill of Communication

Next, the second higher agreeable index is “Teamwork and skill of Communication” with value of 0.894. According to ISO 9001 clause 5.5.3 and clause 7.2.3 which respectively is internal communication and customer communication and there are related to teamwork with communication clause. The effective and skill of communication is the main issue to success QMS implementation due to avoid the mistake happening in transfering , conveying the information among team members (Hoyle, 2009).

4.8.1.3 Project Quality Plan Integrated

Furthermore, “Project Quality Plan integrated” is way that ranked number 3 and has an agreeable index of 0.867. According to study from Pheng and Hwa (1994), integration of project quality plan for good practice in QMS has advantage to prevent overlapping and neglecting from the scope of project or activities and dispute of quality. Integration of project quality plan is the effort to meet the needs among the stakeholders which have to integrate the roles and duties of parties, facilitate teamwork and connected to client’s expectation on quality with the specification and objective as well as process.

4.8.1.4 Process Management

The following factors “Process Management”, “Training and Education Programme”, “Measurement and Enhancement of performance” and “Information, Communication and Technology (ICT)” have agreeable index of 0.856, 0.828, 0.806 and 0.739 respectively. For the factor “Process Management”, the processes of construction project involved the organization’s day to day work and activities on site. The outcomes of quality work should be ensured through the QMS process and quality control lead to day to day work consistently and regularly.

4.8.1.5 Training and Education Programme

For the factor “Training and Education Programme”, it matched with previous study. As previous study from Abdullah, et al. (2015), there is necessary to enhance and propose a nationwide quality training for all team members in construction industry. The insufficient of training and education of QMS will affect team members of construction being negative behavior and attitude due to misconceptions and lack of understanding as well as commitment in QMS (Nursyamimi, et al., 2014).

4.8.1.6 Measurement and Enhancement of performance and ICT

For the factor “Measurement and Enhancement of performance”, it is required to make continuing improvement in QMS implementation by measuring and enhancing the quality performance (Nursyamimi, et al., 2014). For the factor “Information, Communication and Technology (ICT)”, it is be recommended that using of electronic documents for QMS with the rapid expansion of ICT (Asmonia, et al., 2015).

4.8.2 Agreeable Index and Ranking for Benefits that encourage in QMS Implementation in Construction projects

For study benefits of implementation of QMS, all of the respondents are required to rank the questionnaire by Likert scale for identify which benefits that encourage in

implementing of QMS. In the table 4.16, SD means Strongly Disagree, D means Disagree, N means Neutral, A means Agree and SA means Strongly Agree.

Table 4.17 Agreeable index for Benefits that encourage to implement Quality Management System practice

Benefits	SD	D	N	A	SA	AI	Ranking
Enhanced image, increase competitive and reputation of organization	0	0	2	30	40	0.906	1
Performance continuous improvement	0	0	4	30	38	0.894	2
Increase customer satisfaction	0	0	2	42	28	0.872	4
Clear line of duties	0	2	6	36	28	0.850	7
Facilitates access to certain market	0	0	18	40	14	0.789	11
Increase chances to be award the tenders / contract	0	0	14	38	20	0.817	9
Improved relationship and cooperation between parties	2	4	14	34	18	0.772	13
Establishing clear documented procedures and instructions	0	0	10	32	30	0.856	6
Consistency in quality of project	0	0	4	36	32	0.878	3
Efficiency of operations in construction site	0	0	6	38	28	0.861	5
Reduction of quality cost and risk minimize	0	4	16	28	24	0.800	10
Prevention of errors at the earliest stage of the project	0	0	10	36	26	0.844	8
Project completion within the stated period of time	6	12	14	26	14	0.683	15
Quality Auditing and Assurance	2	6	8	38	18	0.778	12
Improving resource management	4	6	10	38	14	0.744	14

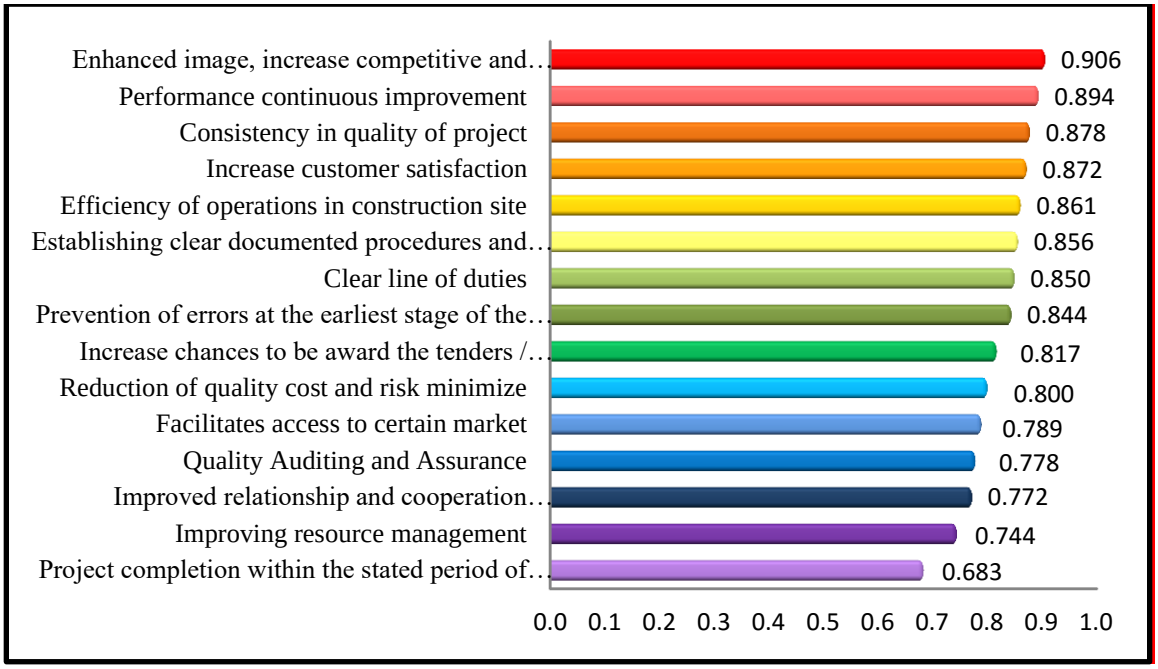

Figure 4.10 Ranking for Benefits that encourage Implementing of QMS Practice

Based on Table 4.17 and Figure 4.10, all of benefit variables are higher than 0.6 which indicates that most of respondents are agreed the benefit that encourage implementing QMS practice.

4.8.2.1 Enhanced Image, Increase Competitive and Reputation of Company

The highest value of agreeable index is the benefit variable "Enhanced image, increase competitive and reputation of organization" with a value of 0.906. This result matched with the study from Said, et al. (2009). Implementing of QMS is able to integrate the value with well documented process and as evidence of quality assurance for increasing competitive and reputation of organization.

4.8.2.2 Performance Continuous Improvement

The second higer value of agreeable index with 0.894 is the benefit variable "Performance continuous improvement". QMS implementation executed by organization for achieving a desire continuous improvement and obtaining a long term benefits. The organization is willingly to implement the QMS practice due to have strong positive attitude of facilitating and improving organization performance rather than customer pressure. This two benefits are included in market competitive benefit component which are stated in Table 4.10. In short, implementing of QMS is able to increase the market competitive and it can be a tool of market to increase reputation of organization.

4.8.2.3 Consistently in Quality of Project

Next, top 3 benefit is "Consistency in quality of project" with a high agreeable value of 0.878. QMS has capability to establish and produce the ongoing progress work consistently through quality system and quality standard (Hoyle, 2009). On the other hand, implementing of QMS has requirements to ensure the quality project consistently. This benefit is under performance component which is focused on site progress work and make the work smoothly as well as being successfully.

4.8.2.4 Increase Customer Satisfaction

Furthermore, fourth high agreeable value is "Increase customer satisfaction" with a value of 0.872. For achieved a certain level of customer's satisfaction, the organization is required to pay effort in implementing QMS for complying with the requirements, faithful and reliable, accessible when need and maintainable as a longer lasting. According to Table 4.10, this benefit is under staff and customer component.

4.8.2.5 Project Completion within the Stated Period of Time

On the contrary, the lowest agreeable value is "Project completion within the stated period of time" with a value of 0.683. It is possible to able high quality and saving cost but it expense of time. It can be concluded that ensuring high quality is need time to complete procedure of QMS such as checklist and inspection test. However, the organization implemented QMS practice rather than failure and reconstruct work which will waste the cost and time as well as lost reputation of organization. This benefit is under time, cost and quality component which is concept of the iron triangle (Figure 2.1).

4.8.3 Requirements or needs of QMS Implementation in Construction projects

4.8.3.1 Documentation Requirements

For study requirements of implementation of QMS, all of the respondents are required to rank the questionnaire by Likert scale for identify which requirements that need in implementing of QMS. In the Table 4.18 and Table 4.19, NVI means Not Very Important, NI means Not Important, IONI means Important or Not Important, I means Important and VI means Very Important.

Table 4.18 Agreeable index for Documentation Requirements of implementation of QMS

Documentation Requirements	NVI	NI	IONI	I	VI	AI	Ranking
Quality Policy Statement and Quality Objective	0	0	6	32	34	0.878	3
Quality Manual and Procedure	0	0	4	38	30	0.872	4
Project Quality Plan	0	0	4	26	42	0.906	1
Preventive Action	0	0	4	46	22	0.850	6
Corrective Action Request (Inclusive control of Non-Conformance	0	0	10	34	28	0.850	7
QLASSIC / CONQUAS (Quality Standard Assessment System)	0	0	14	28	30	0.844	8
Inspection Test Plan	0	0	2	38	32	0.883	2
Incoming Material Inspection	0	6	12	44	10	0.761	13
Quality Monthly Report	8	12	16	26	10	0.650	16
Resources Plan	4	8	18	30	12	0.706	14
Checklist	0	2	8	28	34	0.861	5
Audits (Internal and External)	0	2	10	44	16	0.806	11
Meeting Records and Review Meeting	6	10	16	30	10	0.678	15
Control of Documents	0	2	6	42	22	0.833	10
Control of Records	0	0	8	42	22	0.839	9
Customer Satisfaction Survey	0	2	12	44	14	0.794	12

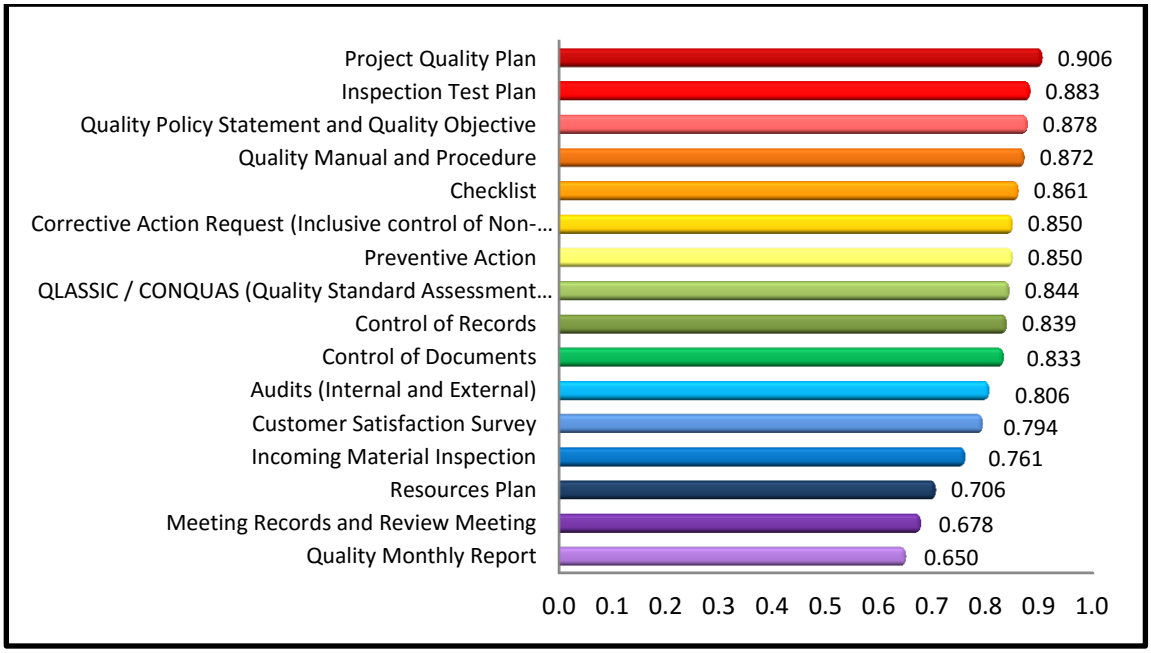

Figure 4.11 Ranking for Documentation Requirements in implementation of QMS

Table 4.18 and Figure 4.11 indicate the documentation requirements in implementation of QMS and it showed that most of respondents are agreeable due to pass an agreeable value of 0.6.

The top 5 variables ranking of documentation requirements are “Project Quality Plan”, “Inspection Test Plan”, “Quality Policy Statement and Quality Objective”, “Quality Manual and Procedure” and “Checklist”. These top 5 documentation requirements are under the component of QMS Pyramid Requirement and they play as vital role in QMS practice. Organization is necessary to ensure the effective and efficiency planning, execution and process control through the procedures and work instruction with QMS Pyramid requirements.

The highest value of agreeable index is the “Project Quality Plan” with a value of 0.906. It indicates that the most of respondents agree project quality plan is most

important documentation requirements in implementing of QMS. It is because project quality plan as QMS guideline which includes work instructions and responsibility. Furthermore, inspection test plan is ranked top 2 with an agreeable value of 0.883. Inspection test plan is set out the critical control at construction stage within a process. The organization is instructed according to inspection test plan to monitor the process and measure the inspection test for verifying the requirements have been met. The third highest documentation requirement is quality policy statement and quality objective with a value of 0.878. Quality policy and quality objective is set by top management which is requiring achieving in construction project. It is as a goal of quality management system and plays a vital document in implementing of QMS.

Meanwhile, the lowest agreeable value is “quality monthly report” with a value of 0.650. Quality monthly report is as a quality assurance which is prepared by quality manager and presented to project manager. It used to record the activity which is required in QMS practice such as daily inspection test and checklist. However, some organization is omitted quality monthly report due to directly record through the inspection test and checklist. On the other hand, Table 4.19 and Figure 4.12 indicated that agreeable index and ranking for other requirements in implementation of QMS.

4.8.3.2 Other Requirements

Table 4.19 Agreeable index for Other Requirements in implementation of QMS

Other Requirements	NVI	NI	IONI	I	VI	AI	Ranking
Staff Training for QMS	0	0	2	38	32	0.883	1
Planning for address risks and opportunities	0	4	10	30	28	0.828	4
Interrelation of parties and communicate organization's responsibility and authority	4	4	10	32	22	0.778	6
Employ quality manager to emphasize on quality monitoring	4	6	18	28	16	0.728	7
Review and check quality system regularly	0	2	4	42	24	0.844	3
Supervise and order instruction clearly	0	2	4	38	28	0.856	2
Using statistical techniques to identify the need in quality control for improving new project	2	2	8	38	22	0.811	5

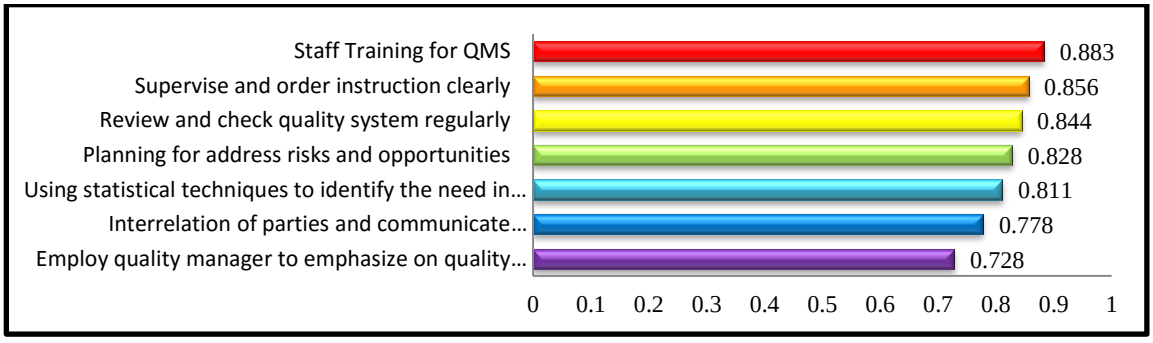

Figure 4.12 Ranking for Other Requirements in implementation of QMS

Based on Table 4.19 and Figure 4.12, the highest agreeable value is "Staff Training for QMS" with a value of 0.883. According to ISO 9001, the organization's team members are required to attend the training of QMS in order to understand and prevent the error from rework and work smoothly. This requirement is under the component of prevention

error requirement. Next is Supervise and order instruction clearly which with an agreeable value of 0.856. According to Table 4.14, this requirement is under component of management responsibility. Duties and responsibilities such as supervise and order instruction are clearly stated in organization and each team member is required to liable their work to ensure higher quality work with legal authority through implementing of QMS practice.

On the contrary, the requirement of “Employ quality manager to emphasize on quality monitoring” has a lowest agreeable value of 0.728. Quality manager is required or employed for emphasizing on quality monitoring who is able to focus on quality issue in the project. However, some company is used the site supervisor or site engineer to ensure the quality of project in order to save cost of quality manager employment. Moreover, the other requirements also are agreed by most of respondent with a value of passing 0.6.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 General Introduction

Chapter 5 covers the summary of findings and draws the conclusions with specific reference to the study objectives. Besides, this chapter also will include the recommendation for future study.

5.2 Conclusion

Over the years, QMS practice has been on a growing trend in Malaysian Construction Industry. According to current quality survey from SIRIM (2014), it is forecasted that more than 10,000 organizations have been certified ISO 9001 through QMS practice which is compare to 1987 that Quality management systems standard is first introduced in Malaysia. Nowadays, QMS has led to positive transform on Construction industry project in Malaysia. In this research, the aim is to investigate the successful key issues in QMS practice.

From this study, there are seven main critical factors influencing the quality management system in construction project which are (1) Top Management Commitment, (2) Teamwork and skill of communication, (3) Project Quality Plan, (4) Process Management, (5) Training and Education Programme, (6) Measurement and Enhancement of Performance and (7) Information, Communication and Technology (ICT). Critical factors are identified and attributed for improving the construction companies that can achieve a desired of QMS application.

For second objectives, the main benefits are identified. There are (1) Enhanced image, increase competitive and reputation of organization, (2) Performance continue improvement, (3) Consistency in quality of project, (4) Increase customer satisfaction, (5) Efficiency of operation in construction site and (6) Establishing clear documented procedures and instruction. Besides, 15 benefits are identified and group into four benefit components which are market competitive, performance, staff and customer and time cost quality components. QMS practice is a flexible quality management tool which can increase reputation and enhance the image of company that can used to achieve their goal, efficiency and profitability. Moreover, QMS implementation can affect the company to improve desired performance for increasing customer's satisfaction.

For third objectives, the main requirements are identified. There are (1) Project Quality Plan, (2) Inspection Test Plan, (3) Quality Policy Statement and Quality Objective, (4) Quality Manual and Procedure and (5) Checklist. According to Pyramid of quality management system, documentation is playing a vital role as daily usage on site. Furthermore, other requirements such as management responsibility requirements are identified. There are (1) Staff Training, (2) Supervise and order instruction clearly, (3) Review and check quality system regularly, (4) Planning for address risks and (5) Interrelation of parties and communicate organization's responsibility and authority. 16 requirements and 7 other requirements are identified and concluded into four requirements components which are QMS Pyramid Requirement, management

responsibility requirements, performance control requirements and prevention error requirements.

5.3 Recommendation for future study

Upon accomplishing this research, there are have some potential issues can be improved and further discuss regarding the field of quality management system practice. The recommendations that can be creating for further study are listed as below:

- To investigate the failure factors influencing application quality management system.
- To identify the barriers of implementing the QMS in construction project.
- To determine the solution that can overcome barriers of implementing the QMS in construction project.
- To investigate other grade contractor company's status of implementation the QMS in construction project.

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APENDIX A QUESTIONNAIRE

Questionnaire

Quality Management System applied in Construction Industry, Johor

By Thong Mei Poh

In Malaysia have facing poor quality issue due to lack of knowledge about Quality Management System (QMS) and negligence quality practice on site. Therefore, it is possible to reduce productivity or poor performance of project. This research is to identify requirements and critical factors affecting implementing QMS practices in construction industry, Johor and also determine the benefits for encouraging implementing QMS practices and increasing knowledge about QMS. Please help answer this questionnaire, all the responses are confidential. Your assistance and cooperation is highly appreciated. Thank you.

Section A: Respondents Information

Please tick your answer.

1) Gender: ☐ Female ☐ Male

2) Job Position:
- ☐ Project Manager / Construction Manager
- ☐ Quality Manager / QAQC Department
- ☐ Architect
- ☐ Engineer
- ☐ Quantity Surveyor
- ☐ Site Supervisor
- ☐ Others (please specify :_____)

APENDIX A QUESTIONNAIRE

3) Working Experience: ☐ 1-5 years ☐ 5-10 years

☐ 10-15 years ☐ 16 years and above

4) Types of construction project involved: ☐ Building

☐ Infrastructure

☐ Industrial

5) Company size: ☐ Less than 5 employees

☐ 5- 50 employees

☐ 51-100 employees

☐ 101-150 employees

☐ More than 150 employees

6) Do you have implementing Quality Management System practices on site?

☐ Yes ☐ No

APENDIX A QUESTIONNAIRE

Section B:

Critical Factors Affecting Quality Management System in Construction Projects

This section concerns your opinion on critical factor that affecting success implementation Quality Management System. Please tick your answer.

7) Scores of the critical factors affecting Quality Management System Implementation

	1-Not Very Important	2-Not Important	3-Neutral	4-Important	5-Very Important
Process Management					
Top Management commitment					
Project Quality Plan integrated					
Training and Education Programme					
Measurement and Enhancement of performance					
Teamwork and skill of Communication					
Information, Communication and Technology (ICT)					
Critical factors affecting success implementation Quality Management System					

APENDIX A QUESTIONNAIRE

Section C: Benefit of Implementing Quality Management System

This section concerns your opinion to rank the benefits that encourage in implementing Quality Management System. Please tick your answer.

8) The Ranking of the benefits that encourage you to implement Quality Management System practice in construction industry

	1- Strongly Disagree	2- Disagree	3- Neutral	4-Agree	5- Strongly Agree
Enhanced image, increase competitive and reputation of organization					
Performance continuous improvement					
Increase customer satisfaction					
Clear line of duties					
Facilitates access to certain market					
Increase chances to be award the tenders / contract					
Improved relationship and cooperation between parties					
Establishing clear documented procedures and instructions					
Consistency in quality of project					
Efficiency of operations in construction site					
Reduction of quality cost and risk minimize					
Prevention of errors at the earliest stage of the project					
Project completion within the stated period of time					
Quality Auditing and Assurance					
Improving resource management					
Benefits that encourage in implementing Quality Management System					

APENDIX A QUESTIONNAIRE

Section D: Requirements for implementation of Quality Management System

This section concerns your opinion to score the requirements or needs of implementation of Quality Management System. Please tick your answer.

9) Documentation Requirements

	1-Not Very Important	2-Not Important	3-Neutral	4-Important	5-Very Important
Quality Policy Statement and Quality Objective					
Quality Manual and Procedure					
Project Quality Plan					
Preventive Action					
Corrective Action Request (Inclusive control of Non-Conformance					
QLASSIC / CONQUAS (Quality Standard Assessment System)					
Inspection Test Plan					
Incoming Material Inspection					
Quality Monthly Report					
Resources Plan					
Checklist					
Audits (Internal and External)					
Meeting Records and Review Meeting					
Control of Documents					
Control of Records					
Customer Satisfaction Survey					

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10) Other Requirements

	1-Not Very Important	2-Not Important	3-Neutral	4-Important	5-Very Important
Staff Training for QMS					
Planning for address risks and opportunities					
Interrelation of parties and communicate organization's responsibility and authority					
Employ quality manager to emphasize on quality monitoring					
Review and check quality system regularly					
Supervise and order instruction clearly					
Using statistical techniques to identify the need in quality control for improving new project					