

DEVELOPMENT OF QUANTITATIVE QUALITY COST MATRIX FOR
MALAYSIAN CONSTRUCTION QUALITY MANAGEMENT SYSTEM

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Dedicated to my sweet-heart and beloved wife

Saniyah Abdullah

who I owe her so much for her

Everlasting love, inspiration and encouragement

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ABSTRACT

One of the key areas being emphasized in ISO 9001 Quality Management System (QMS) is performance measurement towards achieving continual improvement. Currently most of the quality performance indicators devised by ISO 9001 certified contractors are the physical parameters such as list of defects, number and category of nonconformances (NCR), number of customer complaints and scoring from customer feedback forms. However, these parameters are unable to be linked with the project cost performance. In view of the problem this research is carried out with the aim to develop a measurement tool that can be used to measure the project quality performance by ISO 9001 certified contractors with respect to cost. The objectives of the research are to evaluate the current knowledge and practice on quality cost, to identify construction activities affecting quality, and to develop the quality cost matrix that can serve as an effective tool to analyze quality cost in construction projects. The research was carried out in four distinct stages and employed two main instruments of data collection i.e. questionnaire survey and semi-structured interview with the experts. The results from the exploratory survey revealed that lack of knowledge on quality cost prevails among the project management team. This leads to low practice of quality cost in our construction industry. However, majority of the respondents agreed that quality cost can be a good quality performance indicator. The proposed quality cost matrix utilized the Preventive Appraisal Failure (PAF) model. Based on the results from the survey and semi-structured interviews a quality cost matrix that tailored to the local working environment was developed. The breakdown of the main components in the matrix is in accordance to QLASSIC basic assessment structure i.e. structural, architectural, M & E, and external work. In addition this matrix also includes other failure cost which comprises of wastage of material, Liquidated and Ascertain Damages (LAD), regulatory penalty, and miscellaneous expenditure. In terms of causes of failure the research has grouped failures into four Ms i.e. material, method, machine and man. The developed matrix was validated through special focus group workshop which consisted of experts from the quality consultancy companies. One of the significant contributions from this research is that the quality cost matrix can be used to measure the effectiveness of the established quality plan for a given project. Furthermore the output of the research would enable to improve on data analysis by ISO 9001 certified contractors.

ABSTRAK

Salah satu penekanan dalam Sistem Pengurusan Kualiti (SPK) ISO 9001 ialah pengukuran prestasi pencapaian kearah penambahbaikan berterusan. Pada masa kini kebanyakan petunjuk yang digunakan oleh kontraktor ISO 9001 adalah petunjuk fizikal seperti senarai kecacatan, bilangan dan jenis ketakuran (NCR), bilangan aduan pelanggan, pemarkahan dari borang maklumbalas pelanggan. Walaubagaimanapun petunjuk-petunjuk ini tidak dapat dikaitkan dengan prestasi kos projek. Sejajar dengan itu tujuan utama penyelidikan ini ialah untuk membangun satu kaedah penilaian untuk kontraktor ISO 9001 mengukur prestasi kualiti projek pembinaan berdasarkan kos. Objektif kajian ini ialah mengkaji tahap pengetahuan dan amalan kos kualiti dalam industri, mengenalpasti aktiviti-aktiviti pembinaan yang mempengaruhi kualiti, dan membangunkan matriks kos kualiti yang boleh digunakan untuk membuat analisa kos kualiti bagi projek-projek pembinaan. Kajian telah dijalankan dalam empat peringkat dengan menggunakan dua instrumen utama untuk pengumpulan data iaitu soalselidik menggunakan borang soalselidik dan temuduga dengan pakar. Hasil dari soalselidik yang dilaksanakan memaparkan bahawa pasukan pengurusan projek kurang berpengetahuan mengenai kos kualiti. Ekoran dari hal tersebut telah menyebabkan penggunaan kaedah kos kualiti dalam industri pembinaan berada pada tahap yang rendah. Sungguhpun begitu kebanyakan responden bersetuju bahawa petunjuk kos kualiti boleh menjadi petunjuk prestasi kualiti projek yang baik. Matriks kos kualiti yang dicadangkan mengguna model 'Preventive Appraisal Failure' (PAF). Berdasarkan hasil soalselidik dan temuduga dengan pakar maka dibangunkan matriks kos kualiti yang menjurus kepada persekitaran kerja tempatan dibangunkan. Struktur asas matriks dipecahkan mengikut struktur penilaian QLASSIC iaitu struktur, arkitek, elektrik & mekanikal dan kerja luaran. Pada masa yang sama matriks ini turut mengambil kos-kos lain seperti pembaziran bahan, gantirugi tertentu dan gantirugi yang ditetapkan, denda perundangan dan pelbagai belanja. Manakala klasifikasi punca kecacatan dibahagikan kepada 4 M iaitu 'material', 'method', 'machine' dan 'man'. Matriks ini telah disahkan melalui seminar kumpulan fokus yang terdiri dari pakar-pakar dari syarikat perundangan kualiti. Salah satu sumbangan yang ketara dari kajian ini ialah matriks tersebut boleh digunakan untuk mengukur keberkesanan plan kualiti yang telah diwujudkan. Tambahan lagi hasil daripada kajian ini akan dapat mempertingkatkan keupayaan kontraktor ISO 9001 untuk menjalankan penganalisaan data.

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LIST OF ABBREVIATIONS

BQ	Bill of Quantities
BSI	British Standards Institution
CIDB	Construction Industry Development Board
CIMP	Construction Industry Master Plan
CIS	Construction Industry Standard
DLP	Defect Liability Period
DSM	Department of Standards Malaysia
IRCA	International Registered Certified Assessor
ISO	International Organization for Standards
ITP	Inspection and Test Plan
LAD	Liquidated and Ascertain Damages
MS	Malaysian Standard
NCR	Nonconformance Report
NETI	National Electronic Tendering Initiatives
PAF	Preventive Appraisal Failure
PCM	Process Control Method
PMBOK	Project Management Body of Knowledge
PQP	Project Quality Plan
QLASSIC	Quality Assessment System in Construction
QMS	Quality Management System
TQM	Total Quality Management
VO	Variation Order

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The Ninth Malaysia Plan (9MP), was finally tabled by our honourable Prime Minister on 31st March 2006. The public development has been allocated about RM 200 billions which is 18 % higher than the previous five years plan. This huge allocation couple with significant participation from the private sector would primarily enable to boost the construction sector to meet the targeted construction gross domestic product (GDP) growth of 3 %. Based on Bank Negara Economic Report, in second quarter of year 2007, construction sector has registered a 4.8 % growth which is the highest since 2001 (New Straits Times, 30th August 2007). If that momentum is able to sustain, then 9MP is enable to keep the contractors busy for the next five years. However from previous records, depicts that poor quality of the construction works still prevailed. For instance, townhouse under construction collapses, killing one in Jalan Klang Lama, Kuala Lumpur (The Star, December 15th, 2004), concrete floor collapse in Shah Alam (News Straits Times, April 3rd, 2005), roof of new school hall collapses due to aluminium supporting structures fall down (News Straits Times, October 8th, 2005), House buyers win case – Court orders

developer to pay damages for defective homes (The Star, 19th January, 2006) and JB hospital 'sick' again - This time it's structural defect (The Star, 20th April 2007).

In view of the above scenarios, essentially warrants Construction Industry Development Board (CIDB) to take a more aggressive measure in an effort to address the said issues. As a result, CIDB has issued a circular dated 2nd December 2006 to all G7 contractors which stated that they need to be certified with ISO 9001:2000 by the end of the year 2008. Even though G7 contractors which are the highest grade of contractors represent approximately about 10% of the total contractors population nevertheless CIDB's circular indicated that our local contractors should adopt TQM approach in their quest to deliver quality construction works. One of the useful measurement tools in implementing TQM is cost of quality. Generally the concept of cost of quality is relatively new and not well implaced in our construction landscape. Hence one of the primary outcomes of this research is to promote the usage of quality cost measurement tool among contractors in their concerted effort in continually improve their quality performance.

1.2 Problem Statement

One of the key areas that have been emphasis in ISO 9001:2000 Quality Management System (QMS) is performance measurement. This is stipulated under clause 8.4 of ISO 9001:2000 requirement which underscore on the importance of performance measurement through data analysis. Performance measurements can be financial or non financial (Tsai, 1998). Presently the general practiced by our ISO certified contractors employed non financial parameters for performance measurement in particular the quality performance. This perception was based partly from the result of the survey on ISO contractors carried out by Chen (2007).

Based on the outcomes from the questionnaire survey performed by Chen (2007), unveiled several findings pertaining to quality performance measurement by ISO certified contractors in Malaysia as follows:

- i. Quality performance data analysis rarely associated with cost. Figure 1.1 exhibits some of the common data utilized by ISO certified contractors for analysis i.e. masterwork program, testing and commissioning results, number and type of NCR, records on rework etc.
- ii. Used mainly physical metrics parameters in measuring their quality performance such as % of project delay, % on breakdown of NCR, % of material wastage, lost time accidents (LTA) etc. Figure 1.2 illustrated few of the parameters used by our ISO certified contractors.

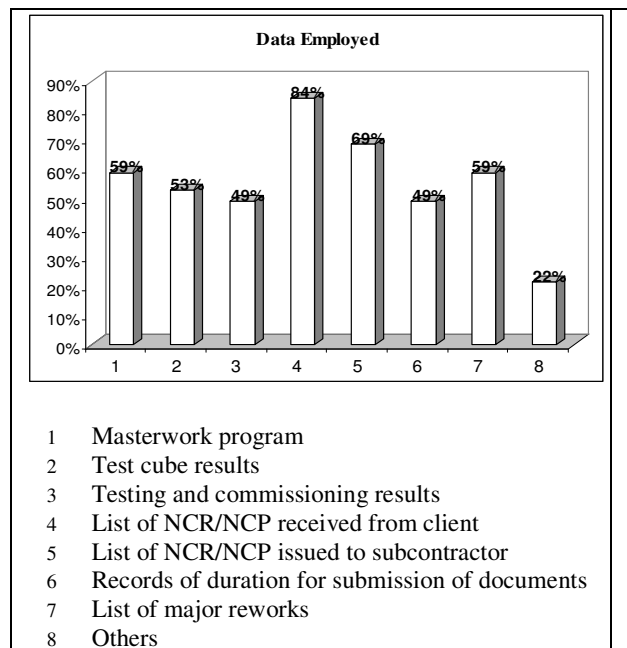
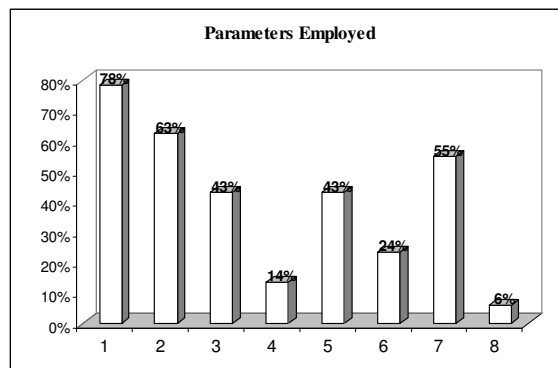


Figure 1.1: Data employed by ISO contractor
(Survey by Chen, 2007)



- 1 % of project delay
- 2 % of breakdown of NCR/NCP
- 3 % of material wastage
- 4 Ratio of NCR/NCP to RFI
- 5 Lost time accidents (LTA)
- 6 Ratio of number of accidents to total of site workers
- 7 Cost effectiveness
- 8 Others

Figure 1.2: Parameters by ISO contractors for quality performance
(Survey by Chen, 2007)

The above findings explicitly demonstrated that the ISO certified contractors were hardly tried to relate the quality performance with associated cost. These findings portrayed that majority of our ISO certified contractors were lack of knowledge about the existence of measuring tool that can be used to assess quality with respect to cost. Nevertheless quality cost is an instrumental measuring tool for quality performance. In quality management the use of cost to measure quality performance has been recognized and this is usually known as the cost of quality or quality cost (Abdul-Rahman, 1993). Cost of quality is considered by many researchers as the primary quality measurement tool (Crosby, 1984; Juran, 1988; Love et al 1999 and Low and Yeo, 1997). Laszlo (1997) mentioned that one of the most important tools necessary for the successful implementation of a quality program such as ISO 9000 or TQM is quality cost (Laszlo, 1997). Indeed Project Management Body of Knowledge (PMBOK, 2004) has reckoned that quality cost as a tool and technique for three management processes out of a total of forty four management processes. The quality cost approach involves the process of identification, monitoring and balancing of all these components with goal to optimize the total quality cost (Laszlo, 1997). The cost of quality is one type of

measurement that can provide the user with information about rework and activities designed for its prevention (Love, et al, 1999).

The quality cost concept is an effective tool that can be used to express the value of the quality aspects of the operation in terms of money so that monitoring and analysis of investments and savings in that area can be readily evaluated using the language of business: money (Laszlo, 1997). From the literature review it is clearly shows many quality gurus recommended quality cost as a measuring tool in quality management system. All these statements tend to construe that quality cost is one of the effective tools in measuring quality performance. However it is not widely used in the Malaysian construction industry. One of the probable factors that lead to poor practice of quality cost in our construction fraternity is lack of knowledge in the field of quality cost among the project management team. It is an accepted fact that, knowledge has always been the driving force for any industry to practice any appropriate management tools. As such it is very timely that concerted effort to be made in exploring the potential as well as promoting quality cost approach in Malaysian construction landscape in particular to the ISO certified contractors.

Quality costing in the manufacturing industry had proved successful and it is believes that this can serve as a model for the construction industry (Aoieong, 2004). Thus the concept of cost of quality tends to attract the interest of cost-conscious construction industry and it has already been applied to a number of construction projects (Ledbetter, 1994). According to Aoieong (2004), a survey carried out in construction industry in Hong Kong by Ahmed and Aoieong (1998), indicated that close to 60% of the respondents did not measure costs related to defects. This scenario is likely to prevail in our construction realm. Apparently this is one of the areas of study that this research is going to explore.

Many researches have been made abroad that focused on measuring quality cost in construction as listed by Aoieng (2004) as shown below:

- USA - Farrington, 1987; Davis, 1987
- UK - Abdul-Rahman, 1993; Barber *et al.*, 2000; Hall and Tomkins, 2001
- Australia - Love and Li, 2000b; Love and Irani, 2003
- Scandinavia - Josephson, 1994; Josephson and Hammarlund, 1999
- Turkey - Muhsin and Oztas, 2002

However based on literature review made, it was found that not many of such studies have been undertaken locally considering the suitability of our local working environment.

Taking into considerations of all the above discussion has raised several issues that need to address by this research. Firstly is poor practice of quality cost in the industry due to lack of knowledge among the project management team. Secondly not much research has been made locally to develop a tool that can facilitate the industry in capitalizing quality cost approach. These two issues have prompted the effort to undertake this research related to quality cost in construction. Generally this research entailed in ascertaining the current situation in the industry, explored its potential in the future, observed the possibility of utilizing the existing quality records and eventually introduced a matrix that is envisaged to facilitate the industry in implementing quality cost approach. Basically the proposition of the matrix is an alternative to the existing assessment tools employed by our ISO certified contractors in continually improving their quality performance.

Apart from the above, this research is also expected to contribute in improving the current practice on data analysis by ISO certified contractors. This is basically to comply to clause 8.4, ISO 9001:2000 requirements. Based on the survey result on ISO certified contractors by Chen, 2007 (see Figure 1.3) exhibited that 43.0 % of the respondents agreed the current practice on data analysis by ISO contractors is not systematic or rather fragmented. About 4.0 % disagreed and 53 %

have no idea. This result might not be conclusive however it provides an indication where there is room for improvement in the aspect of data analysis. Therefore the output of this research can partially improve the current practice of data analysis by the ISO certified contractors.

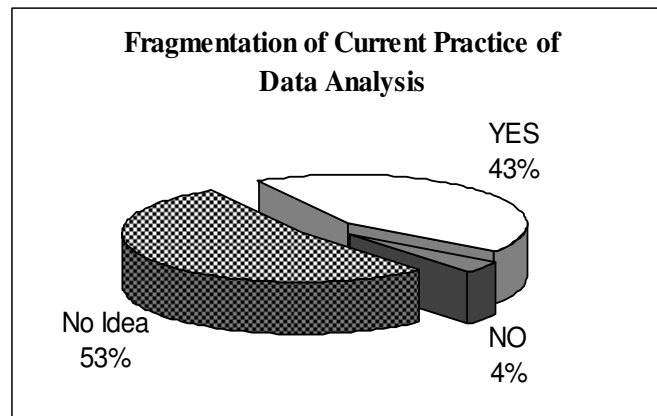


Figure 1.3: Breakdown of answers on fragmentation of current practice on data analysis

(Survey by Chen, 2007)

1.3 Aim and Objectives Of The Research

The aim of this research is to develop a quality cost measurement tool that can be used by contractors to measure the quality of their project performance. The objectives of this research are as follows:

- i. To evaluate the current level of knowledge and practice by the local construction project management team on using cost of quality.
- ii. To investigate the suitability of the current quality records that can be used to quantify the quality cost.
- iii. To identify construction activities affecting the quality of project performance.
- iv. To assess the degree of importance of construction activities affecting the quality of project performance.

- v. To develop the quality cost matrix that can serve as a tool to effectively analyse the quality cost for a construction project.

1.4 Research Scopes and Limitations

The scopes of this research shall be confined to the followings:

- i. This study will focus on building construction works using conventional method of construction as well as on the method of procurement.
- ii. The cost referred in this research is the direct cost related to executing construction project which do not include the overhead cost of the organization.
- iii. The collections of data were randomly made on active contractors that are registered with CIDB as well as PKK and confined to those contractors that are certified with ISO 9001:2000.
- iv. This study does not cover other factors that may have influence on the quality of the project such compliance to legislative requirement, methods of selection for procurement and health safety environment (HSE) management.
- v. The respondents may adopt a lackadaisical approach in completing the questionnaire forms
- vi. Discussion on common terminologies related to quality system will be limited to quality and quality management system (QMS)

1.5 Research Methodology

The methodology of the research consists of steps as briefly explained below (Refer to Chapter 3 for detail methodology):

- i. Gathered information from journals, technical papers, books, and internet.
- ii. Literature review on matters related to construction project management, quality management, performance indicator, performance measurement and quality cost.
- iii. Designed questionnaire form to ascertain the level of knowledge and practice on quality cost in construction industry.
- iv. Conducted pilot survey to the selected personals from G7 construction companies
- v. The response obtained from the pilot survey participants and their comments were then reviewed to develop the empirical research questionnaire.
- vi. Conducted the survey based on the revised questionnaire throughout the country using the avenue CIDB National Electronic Tendering Initiatives (NETI) road shows.
- vii. Analyzed data using SPSS software. Chi-square analysis was employed to evaluate the level of knowledge and practice of quality cost in construction industry.
- viii. Designed the interview form which was intended to obtain experts opinion with regard to matters in identifying quality related activities and categorized these activities according to PAF model. The targeted interviewees were quality consultants that are providing professional services in establishing the required QMS.

- ix. Conducted interviews to randomly selected quality consultants in the region of Lembah Klang area.
- x. The information from the expert opinions was then examined. Subsequently clustered all the identifying activities according to PAF model.
- xi. Using the above information then designed the questionnaire survey form which was intended to rank the degree of importance of these identified quality management activities.
- xii. Conducted the survey based on the developed questionnaire to randomly selected contractors attending under CIDB DIY ISO 9001 training programs
- xiii. Data collected from the above exercise were then analyzed quantitatively using SPSS software. The result from this analysis was used to rank according to the importance of the identified quality management activities.
- xiv. Designed the interview form which was meant to evaluate the suitability of the several existing quality records and anticipated constraint in implementing the quality cost in construction project. The targeted interviewees were QMR, AQMR, QA/QC Managers of ISO contractors.
- xv. Visited randomly selected ISO contractors' premises through out the country to execute the above interviews.
- xvi. Consolidated all the relevant information from the above interview exercises to develop the proposed quality cost matrix.
- xvii. Developed the proposed quality cost matrix taking into account all the supporting data that had been analyzed
- xviii. Organized expert focus group workshop to validate the developed quality cost matrix.
- xix. Prepared and submit the research report.

1.6 Significance of Findings

This study is very timely because it is inline with CIDB plan to emphasis on the contractors to adopt QMS in managing their construction projects. One of the important focus areas in QMS is performance measurement and one of useful measuring tool is quality cost. In fact most of the quality experts have acknowledge the usefulness of quality cost measurement tools. Thus the output of this research i.e. quality cost matrix is expected to be very useful for the contractors to measure their project quality performance with respect to cost. It helps the contractors to identify the major failure cost and consequently develop the preventive actions which can lead them to continually improve their future undertaking of similar project scope. Furthermore this research may lead to enhance the awareness of the importance of quality cost and assist in shifting the mindset of our project management team of using quality cost approach in managing their respective construction projects.

Notwithstanding the application of quality cost has proven as a successful measurement tool in manufacturing sector there are several countries have shown great interest in capitalising it in construction industry e.g. USA, UK, Australia, Hong Kong and Singapore. Therefore this research is expected to pave a way to attract more local researchers to further explore the potential benefits of using quality cost approach in our local construction industry. Indeed this area of research would compliment CIDB crave to propagate quality so as to address several prevalent quality related issues surfaced in our construction landscape.

1.7 Report Structure

This research which is the result of a master's project is arranged as follows:

a. Chapter 1: Introduction

This chapter has covered the introduction of the problem of the project quality performance measurement that has prompted to this study. It states the objectives, scopes, methodologies used. It also deliberates on the significance of the findings and describes briefly the report structure.

b. Chapter 2: Literature Review

This topic presents the findings based on the literatures (journals, research papers, internet, mainstreams media etc) gathered. Among the areas covered are related to the fundamental of quality management system (QMS), its importance in construction, the changes in ISO version 2000 compared to ISO version 1994, briefly touches the QLASSIC, the development of quality cost concept, its importance as measurement tool, its impact to construction project and role of quality cost in project management. Effort was also made to review several existing research on quality cost models that have been undertaken abroad.

c. Chapter 3: Research Methodology

This section generally described the methodology adopted in executing this research to achieve the prescribed objectives. It explains the methodology for literature review and illustrated slightly detail on the research operation framework in conducting this research. It also entails the design of the questionnaire survey forms, design of the interview forms and describing different statistical methods of analysing the collected data. Subsequently it discuss the approach taken in developing the cost matrix and finally elaborated on the validation of the proposition

d. Chapter 4: Preliminary Assessment On Quality Cost In Construction Industry

This chapter deliberated on the outcomes of the exploratory survey meant to ascertain the level of knowledge and practice in the construction industry. The data collected were analyzed using SPSS software. The findings presented an overview on the status of the subject matter in the construction industry. It also illustrated the reasons for the current status and explored the potential of practicing quality cost in the future. The findings of this survey will be used to support the intention of the author to embark the research on the development of quality cost matrix.

e. Chapter 5: Some Observations On Quality Cost Related Practices In ISO Certified Contractors

Generally this chapter discussed on the findings of the second interview with 10 ISO certified contractors. The primary objective of this survey was to validate some of the main findings in exploratory survey. In addition the author shared his findings on the practice of engaging domestic sub-contractors, its elements of control and also practice in controlling on material wastage.

f. Chapter 6: Development Of Quality Cost Matrix

The process related to the development the proposed matrix is accounted in this topic. It describes the in-depth interviewed carried out among the quality consultants which can be considered as expert opinion. The output from this interview was the classification of the quality management activities according to PAF model. Subsequent interview was performed to investigate the suitability of the available records that can used to capture quality cost e.g. non-compliance report (NCR), NCR log, site diary,

inspection report and several accounting supporting documents. Further to that the author would also identify the possible constraints in implementing quality cost in construction. The information from the conducted structured interviews was then analysed. The feedbacks received will provide the basis to formulate the said matrix which later was tabled for their acknowledgement.

g. Chapter 7: Validation On The Developed Quality Cost Matrix

This section deliberated on the process of validation on the developed matrix. The author adopted expert focus group. The experts were the professionals from the companies providing consultancy services in quality management. In deed few of them were registered auditor with IRCA. The process of validation was executed through a workshop. A feedback form was designed to assist the experts to record their corresponding comments. Amendments were accordingly to their comments.

h. Chapter 8: Conclusions and Future Recommendations

This chapter primarily concludes the overall findings and summarises the strategies employed in the course of executing the research. Essentially recommendations for future work are briefly discussed.

1.8 Summary

This whole chapter outlines the introduction to the problem and justify the need to conduct this research. It states the objectives, scopes and research methodology adopted. Furthermore it also elaborates the significance of the findings and the structure of the report. The output of this research is quality cost matrix. It would provide a useful mean to our local contractor to use quality cost approach in measuring their project quality performance especially for ISO 9001:2000 certified

contractors. Since quality cost has been acknowledge as one of the effective measuring tool to measure the efficiency and the effectiveness of the established QMS. Moreover this model was developed based on our local working environment. This research hopefully enables to promote of using quality cost as one of the measuring tool by our ISO certified contractors in performing data analysis.