A STUDY OF THE CONTRIBUTION OF QUALITY CONTROL TOWARDS RESIDENTIAL BUILDING CONSTRUCTION IN MALAYSIA

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A thesis submitted in partial fulfillment of the requirements for the award of

Master of Project Management

Faculty of Engineering and Science

Universiti Tunku Abdul Rahman

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DECLARATION

I hereby declare that the dissertation is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UTAR or other institutions.

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APPROVAL SHEET FOR SUBMISSION

I certify that this project report titled "**A STUDY OF THE CONTRIBUTION OF QUALITY CONTROL TOWARDS RESIDENTIAL BUILDING CONSTRUCTION IN MALAYSIA"** was prepared by **YONG SHYN YING** has met the required standard for submission in partial fulfillment of the requirements for the award of Master of Project Management at Universiti Tunku Abdul Rahman.

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ABSTRACT

A STUDY OF THE CONTRIBUTION OF QUALITY CONTROL TOWARDS RESIDENTIAL BUILDING CONSTRUCTION IN MALAYSIA

Yong Shyn Ying

The quality control of building construction is a major concern for construction industry. Quality control is not only an action to be taken but is a transforming of human behavior. None construction personnel (eg. Property investors) always concern with the growth of market value of their invested properties and this has caused quality control exercise become an important role to help to reduce the defects of residential buildings and to minimize the future maintenance costs of residential buildings. The methods to reduce defects of residential building in Malaysia and the techniques to minimize future maintenance costs of residential building in Malaysia were being studied in this research. The questionnaire was distributed to 100 persons and received responses from all the 100 persons which 30 persons from developer; 30 persons from consultant; 30 persons from contractor and 10 persons from non-construction personnel (This 10 persons only take part for the question of Section A). An average of 5% to 10% of growth market value of properties which analyzed from the data collected from the 100

respondents. Few methods should be implemented to reduce the defects of residential building in Malaysia which are design coordination meeting among consultants, peer review for design, sufficient timeline for design, design clarification meeting with contractor, value engineering program, weekly site inspection for quality control, and lastly invite representative from manufacturer for guidance of new building technology. Last but not least, few techniques need to be executed to minimize the future maintenance cost which are less complexity of building design, cost allocation for future maintenance during design stage, life cycle cost technique, employ skilled workers during construction, standardize specification of materials used for construction, as-built drawing and operation manual to be given to building user and lastly conduct quality assessment with aim for high score.

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APPROVAL SHEET

This dissertation/thesis entitled "**A STUDY OF THE CONTRIBUTION OF QUALITY CONTROL TOWARDS RESIDENTIAL BUILDING CONSTRUCTION IN MALAYSIA"** was prepared by YONG SHYN YING and submitted as partial fulfillment of the requirements for the degree of Master of Project Management at Universiti Tunku Abdul Rahman.

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SUBMISSION OF THESIS

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I understand that University will upload softcopy of my thesis in pdf format into UTAR Institutional Repository, which may be made accessible to UTAR community and public.

Yours truly,

_____
(*Yong Shyn Ying)*

DECLARATION

I hereby declare that the dissertation is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UTAR or other institutions.

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
ANOVA	Analysis of Variance
BCA	Building Construction Authority
BRE	Building Research Establishment
CCC	Certificate of Completion and Compliance
CF	Certificate of Fitness
CIDB	Construction Industry Development Board
CIS	Construction Industry Standard
CONQUAS	Construction Quality Assessment System
CPC	Certificate of Practical Completion
DLP	Defect Liability Period
GFA	Gross Floor Area
GDP	Gross Domestic Product
HDA	Housing Development Act
IT	Information Technology
MHLG	Ministry of Housing and Local Government
MS	Malaysia Standard
PMBOK	Project Management Body of Knowledge
PQP	Project Quality Plan
QAQC	Quality Assurance and Quality Control

Abbreviation	Meaning
QLASSIC	Quality Assessment System for Building Construction Work
QP	Qualified Person
SPA	Sales and Purchase Agreement
SPSS	Statistical Package for the Social Science
UBBL	Uniform Building By-Law
VP	Vacant Possession

LIST OF APPENDICES

CHAPTER ONE

INTRODUCTION

1.1 Background

People had started to get involved in building construction since centuries ago. However, there are a lot of improvements of history in building construction from thousand years ago until now. Firstly, they had tried to improve the durability of the building. As the human from primitive were not educated and their objectives is just to give themselves a shield to prevent from attack of wild animals, therefore, the materials used to construct a building in early time were easy to decay like leaves, sticks, and skins of animal. After that, some of the human are educated and more innovative then they were trying to use last longer materials like stone, clay, and timbers, and lastly they were using more complex materials like concrete, brick, metals and plastic until now. Secondly, their controls in building air flow, humidity, brightness, sound level and indoor temperature were getting more accurately to suit the comfort ability of human. Last but not least, they have tried to get change in the construction process from fully man power until the development by using machinery nowadays. The Pyramid of Giza in Egypt is one of the oldest building listed in “Seven Wonders of the Ancient World” and the only one still remain completely until now has showed the talent of human for 3800 years ago. It is the tallest man-made structure in the world

which has 160 meters tall. The building was constructed by using 5.5 million tonnes of lime stone, 8,000 tonnes of granite, and 500,000 tonnes of mortar. The Pyramid of Giza has proved the success of human in building construction thousand years ago (Joshua, 2009).

1.2 Problem Statement

The construction industry can be considered as a major contributor to the economy which also can create career opportunities as well as prosperity. However due to time and budget constraint, many projects have faced the defect problems. Although the members of project team nowadays are trained with the knowledge of project management skill such as Project Management Body of Knowledge (PMBOK), the construction works still cannot run out from the defect liability due to quality of work is not up to the satisfaction. From the Annual Report 2013 announced by Construction Industry Development Board (CIDB), the average score for Quality Assessment System for Building Construction Work (QLASSIC) is 72 and there is no one of the constructed building can score more than 85 marks. Therefore, every completed building should have a minimum 12 months of defect liability period (DLP) from main contractor started after the issuance of certificate of practical completion (CPC). This is to make sure that the contractor still have chances to rectify their defects which can only be realized after vacant possession (VP).

A research had been carried out by Building Research Establishment (BRE) has mentioned that 90% of building failure are due to the problems

caused in the design and construction stages. Although the people now are well educated, defect works still occur because of there may have mistake done in design stage, different materials used from the one stated in specification, and the careless work of workers. The defects can be classified as obvious (can be seen) or hidden (cannot be seen). The obvious defect of works can be found out easily whereas the hidden defect of works may only be found after few years such as the cracking of building due to the foundation work is not done properly. Sometimes human are greedy, contractors always try to find a way to minimize cost of materials and maximize their own profits to finish their works and ignore the standard of procedure (SOP). Moreover, some of the consulting firms are hiring some fresh graduate to become design engineer and they are lack of experience to handling project but only can use what they have studied to apply on works and hence caused the mistake done at design stage. Therefore, there are always some unexpected defects happened during construction stage like window size cannot fit into the window, insufficient reinforcement bar concrete cover, wrong position or missing of power socket and so on. This will reduce the market value of the building when the owner decide to sell it off as well as the owner may need to spend portion of money for maintenance in future.

1.3 Aim & Objectives

The aim is to study on the contribution of quality control towards the construction of residential building in Malaysia.

The objectives to carry out this research are:

- To identify methods of reduce defects in the residential building.
- To identify techniques of minimize future maintenance cost of the building.
- To determine the increase of market value of the residential building.

1.4 Scope of Research

Quality control of residential building is very important for not only the developer but also the purchaser. Although quality control exercises have been carried out in many ways, there are still some defects detected for the new build residential building. The research is mainly focus on developers, consultant and contractors to understand the different points of views from different categories of construction professional. The data of questionnaire survey will be collected from at least 30 people from different background.

1.5 Significance of Study

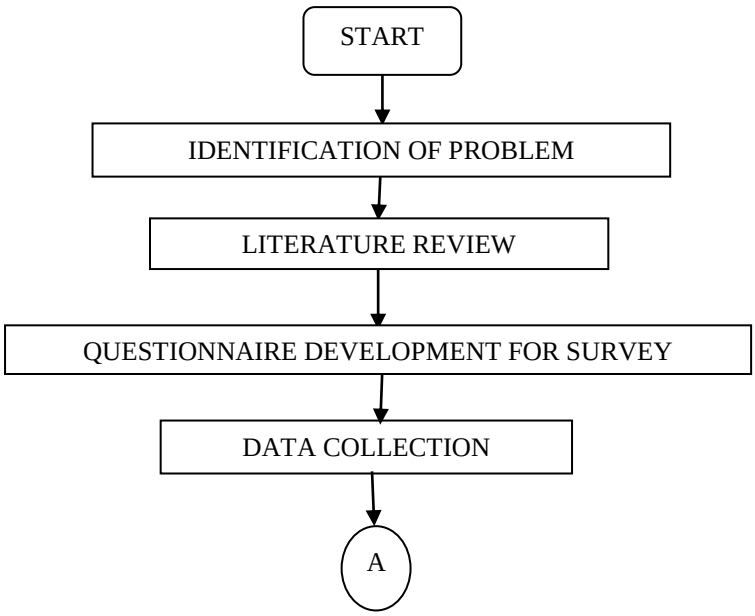
This research is to understand impact of quality control upon the construction of residential building in Malaysia and the major reasons that cause the defects works. After this research, there can have some improvement and awareness on handle defects works in future projects and hence increase the rate of successfulness in completion with better quality of works.

Furthermore, this may help on some cost saving if all the site construction personnel do the right thing at the first time (no rework).

1.6 Research Methodology

The first of research is start from literature review of the journal, thesis, and scholarship articles which are relevant to the research topic. From the literature review, some of the questions of survey questionnaire can be brainstormed easily.

The research is based on quantitative approach. Quantitative survey is done from data collection of survey questionnaire and analyzed by using IBM SPSS software and few tests are carried out by this software such as Cronbach's Alpha Reliability test, Analysis of Variance (ANOVA) test, Kruskal-Wallis test, Correlation analysis and so on. The questionnaire will be distributed to target audiences from residential building construction industries. The questions will be prepared and sent to the target audiences by hand or emails.



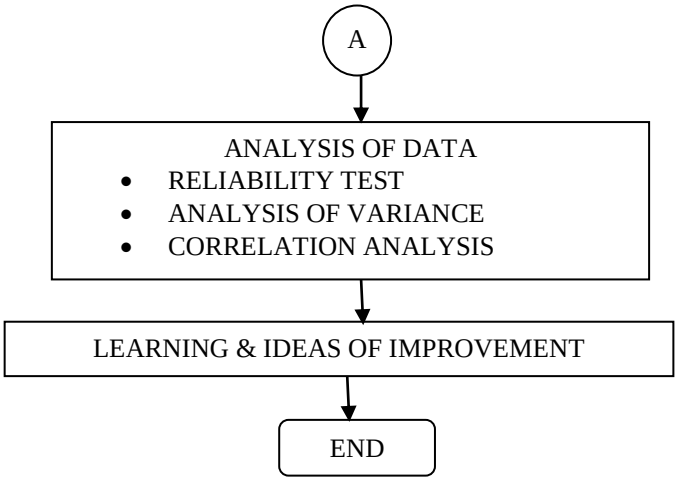


Figure 1.1: Flowchart of Research Methodology

1.7 Dissertation Structure

1.7.1 Chapter 1 – Introduction

The first chapter of the report is Introduction which include the background of building construction, problem statements of quality control of construction works, aim and objectives of research, scope of research, significance of study, research methodology and dissertation structure of report.

1.7.2 Chapter 2 – Literature Review

The second chapter of the report is concentrated on the literature review of the journals, articles, thesis and online database which are related to this research. A better understanding of the topic can be easily done by literature review and therefore the research can be done more easily too.

1.7.3 Chapter 3 – Research Methodology

The third chapter of the report is mainly focus on the methods of carry out the research and data collection. The result or outcomes of this research can be easily get from this chapter.

1.7.4 Chapter 4 – Results & Discussion

The fourth chapter of the report is the analysis of the data collected from Chapter 3. By using the analysis of the data can easily look into the outcome of this research and the defects can be identified easier. Then, the results are discussed based on the data collection.

1.7.5 Chapter 5 – Conclusion & Recommendation

The last chapter of the report is to analyze the conclusion have meet the objectives stated in Chapter 1 after the research is completed and some recommendations are given to improve the future projects.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Most of the research and journal previously done by others were more related on the defects of the commercial buildings or housing from other countries other countries. From the all the information given, a research on reduce defects and maintenance cost of residential building in Malaysia need to be done from this thesis.

Furthermore, the previous studies done by other researchers are more on reduce defects general construction and most common happen mistake that have to spend more maintenance cost in future. They have also did some research on the standard quality test that can be applied to check on the quality of construction done by contractor. From this thesis, we can sort out the methods to reduce the defects and maintenance cost of residential buildings in Malaysia and the techniques to minimize the future maintenance cost of residential buildings.

2.2 Growth of Building Construction in Malaysia

Malaysia is a middle-revenue developing country which has changed from a supplier of raw materials into an economic country with different sector of industries with higher technology. Malaysia can be said as one of the country of trading among 20 largest in the world and it has a strategic location which is at the centre of South-East Asia enables all the investors to do their trading for the product for regional and international markets (Wood, 2014).

The construction industry of Malaysia can be divided into two parts which are general construction and trade works. The general construction include residential, commercial, industrial and other civil construction whereas trade works includes the activities of electrical works, metal works, sanitary and sewerage works, plumbing works, air conditioning and refrigeration works, painting, tiling, flooring works and so on. In year 2010, although the construction industry gave around only 3% of Gross Domestic Product (GDP), it still can be said as an important part to the economy of Malaysia as the relationship with other industries like cable and pipe manufacturing industry, tile manufacturing industry, as well as the industry of tourism. Therefore, construction industry can be said as a large contribution towards economy of Malaysia. The Construction Industry Development Board (CIDB) had handed in a descriptive master plan in 2007 to allow the construction industry of Malaysia able to compete in worldwide. However, according to the "Market Watch 2012" by DE International, construction industry of Malaysia in non-residential is predicted to increase slightly followed by property of commercial and industrial as well as hotels. The development of residential in Klang

Valley has become higher among the construction activity in Malaysia (Wood, 2014).

On the other hand, due to the program of earth-saving and environmental friendly is established globally, 'green technology' that appeared in Malaysia this few years have caused many foreign investors to take part in the construction activity of Malaysia which focus on the technologies of green building development. The introduction of 'Green Building Index' has lead Malaysia to the way of green technology and energy efficiency of building is expected to become more advance in future. Due to the improvement of construction activity, the implementation of information technology (IT) has also played an important role in maintain the growth of the construction industry.

2.3 High-Rise Residential Property in Malaysia

Government of Malaysia think that housing is a human necessity and also an important part of country's economy. There is always three primary focus to be concerned in construction industries and the management of property in so many years. Firstly, the building design and the management of work after completion is the most important issue to the property managers. Secondly, the construction work of the building such as duration of works, budget of works, and the structural design of works is also very important to the developers and the contractors. Thirdly, the economics of property in current year as the property owner may try to observe the economics which is the cost of building operations over the life of building (Dunk, 2004).

The development of high-rise residential in Malaysia are implemented by private and public sector. It has become a trend or lifestyle to stay in high-rise residential within the urban area in Malaysia as high-rise residential have many facilities for the tenants to enjoy themselves within the building area. The demand of high-rise residential have added year by years as the remaining of land area has become lesser compare to pass few years. However, the efficiency of management for high-rise residential building are under expectation as the tenants complained the unsatisfied service for the public facilities management for example the lift is not working properly, the rubbish is not collected by following the timetable, and other disputes and damage of public facilities. The cooperation from all the parties are needed such as the team of building management and tenants of the building to make the building to be always in good condition and healthy environment.

2.4 Real Estate Sustainability

The sustainability of real estate can help to increase the market value of a property. Every stakeholders will have different interest to look into their benefits. Therefore, they will start to blame each other when they cannot get their expected sustainability result. From the table below, there are some different point of views for sustainability from stakeholders (George, 2012):-

Table 2.1: Point of View of Stakeholders

Stakeholders	Point of Views

Property Owner	Owner wish to have a property as sustainable as possible which can reduce future maintenance cost / operating cost.
Property Investor	Investor wish to have a sustainable property so they can have higher rental and easier to improve tenant retention. However, the property price have to be affordable too.
Property Developer	Developer think that the purchaser will only care on the price of property. If they produce a sustainable building and the price will be an issue for them to sell off their property.
Property Designer	Designer think that to come out a design of sustainable building, there must be sufficient time given to them for study and research.
Property Constructor	Constructor think that they are only given instruction to produce on what developer's need. There is no point for them to lower down their profit and produce a sustainable building as the developer always want to cut their cost.

Therefore, there is a need of professional property valuation personnel to justify on the sustainability of real estate market as all the stakeholders are also not willing to give up on their profit and the advice given by the valuers

can be said as optimum and valid (Thomas, 2003). However, for a validity of valuation, the estimation of the market value of the said property have to be accurate. The valuation is normally done not only based on the sustainability of the building but also affected by the environmental issue and cultures surrounding the building. Market value can be said as the estimation of price that the property is able to sell in the market based on the condition and outlook of the building and the nature of market (eg. Potential buyers that will involve in this market). There is no harm to say that both the property owner and property investor are most concern on the resale price of the property to potential buyers or tenant. The valuer have to clearly present what is the terminology used to estimate the market value of property as this is important for the clients to understand all the information received so that they can make a proper decision for their investment plan. The most common valuation methods used is sales comparison. The property will be priced in somewhere closer to the selling price of the property surrounding within the same area. However, the valuer will still look into the age of the building, build up size, quality of work done on the building and so on.

2.5 Building Defects

Every building have occurred some different types defects no matter in any kind of forms or any age of the buildings. However, defects that occurred at new buildings may due to the non-compliance of construction standard whereas for the defects occurred at old buildings may due to the expired of Defect Liability Period (DLP) and the building age (Ojo, 2008). Furthermore,

there is also another possible reason of building defects which is poor workmanship when construction period and hence this have affected the quality of the constructed buildings. Therefore, the poor quality of buildings affect the successfulness of the project. The building defects can be categorized to two types which are structural defects and non-structural defects. The defects of non-structural work are such as defect in the arrangement of brick works, plaster works and also the dampness occurred at old buildings. On the other hand, the structural defects can be said as a common building defects such as floor slab cracked, wall cracked, insufficient of water pressure, wrong location or miss out of power point, undersized of air conditioner, insufficient electricity supply, leakage of water piping or water tank, and so on (Ali, 2011). There are many reasons cause the defects happens in building like analysis of soil condition is not carried out properly, the selection of site is not done appropriately, the use of low quality materials during construction stage and also the natural phenomenon such as condition of climate happened in Malaysia (heavy rain and hot sun in the whole year) may also cause the corrosion, paint peeling off, dampness of building and also growth of mould (Cho, 2006).

The construction industry of Malaysia need to improve in process of development. It plays a very important part and contribute in the economy of Malaysia. Department of Standard 2004 stated that "*in Malaysia, in the third quarter of 2004, the construction sector contracted by 3.0% compared to a positive growth of 2.4% in same quarter a year ago. Up to the Asia-crisis average annual growth rate of 14% and budget allocates 24 billion RM for infrastructure projects (Bank of Malaysia, 2001).*" However, construction

field of Malaysia are still lack of skilled and well-trained workers as well as the knowledgeable workers in the technology of construction industry. Although there are high demands in building construction, the quality of the project will be affected by these issues. So, the measurement of quality in the building construction need to be found out according to the factor and criteria of possible measures.

2.6 Managing and Reduce Defects in Construction Industry

Defects can usually happen when design stage and also construction stage or after completion of building. Although the professional designers (architect, consultant & etc.) are required to design and coordinate well among each other to prevent defects to be occurred when completion of building, it is still very hard to have a perfect building with free from defects. Construction defects can be said as the mistake done in design and construction stage that will cause losses to project owner's profit (Azahar, 2011).

Design defect is referred to the information and documentation which provided by the professional designers is incorrect or not complete. This defect may cause some variation order which will have cost incurred to the owner in construction stage. On the other hand, construction defects can be classified as patent defect and latent defect. Patent defect can be easily found during inspection such as wall cracking, window frame is not properly installed and others. Latent defect is the defect that occur only after some times, for example soil erosion, and concrete footing reinforcement and others. There is more and more design defects occurred nowadays because of the

modern technology. This is because the design can be done by using computer software with very attractive and trendy building layout. However, there is no detailing for the method of statement can be provided for this kind of trendy building and the designers always request the contractor to imagine themselves to make the thing become real. Besides that, all the designers are always stand on their own professional expert and reluctant to accept the opinions from other parties. Furthermore, construction defects can easily appeared are because all the contractors nowadays always aim for high profit therefore, they will try to minimize the spending cost to complete the building and they are always been requested by the developers to complete the building within the timeline given to them. From this kind of thinking, the work always cannot be done with quality assurance.

All the stakeholders actually hope to reduce or prevent to the minimum defects or free from defect in design error or construction stage. There are some steps that can be implemented to reduce defects when design stage and construction stage (Gatlin, 2013).

a. Design Stage

    i. Production Management

        All the design team member are required to gather and coordinate to complete the design with proper information to minimize the defects when design stage.

ii. Peer Review

Peer review will act like “different pair of eyes” to check on the discrepancy from the design layout and can have different ideas or innovative that can be incorporated to the design and hence help to increase the design quality for construction.

iii. Design Schedule

It is very important for the project owner to let the designer to have enough time to complete their design. A rushing design timeline will cause some design error due to the time to coordinate, review and checking on the design is not sufficient.

iv. Design and Construction Coordination

Before the construction start, it is critical for the consultant and contractor to communicate each other on the design and the problem will be facing during construction so that the consultant can look into the particular design before work done on site. This can help to correct some design errors as well as help to reduce construction defects.

v. Value Engineering

It is vital to carry out value engineering as this process can help the project owner to save some cost. However, all the proposed changes have to be studied in details so that the quality of

design will not be affected while the project owner can save a portion of money from it.

b. Construction Stage

i. Quality Management

Quality assurance and quality control (QAQC) is very important for a project during construction. When QAQC activity is carried out, the chances to gain defect for construction stage will be lesser. This is because by inspection from time to time, the work that have done wrongly can be corrected before completion.

ii. New Building Technology

Some of the contractors have limited experience for new technology and this will cause the risk to get construction defects become higher. Therefore, it is good to ask the supplier or specialist of the new technology to send a representative to site for observation and provide guidance for the contractor. This can make sure the contractor are using the right way for installation.

iii. Cross Checking of Work Done

This is something similar as the peer review in design stage which the construction personnel for a particular project can

actually invite construction personnel from different project to visit their site. Personnel from other project may help to find out the mistake they have done in construction as they don't know about the exact design of the project and just raised out the problem found merely based on their own construction experience.

Therefore, defects can be minimized by doing proper planning and design coordination. However, communication among stakeholders are also very important as they can know actually what the need of each and others is.

2.7 Impacts of New Technologies in Construction Industry

New technologies of construction industry is accelerating and can bring greater impact in construction activity in the coming years. The new technologies such as 3D-design and pre-fabrication in property construction may need the execution of new techniques or professions with the requirement of creating new training programs, so, there may form a demand of the new professions. (The Government of Western Australia, 2014) Instead of this, all the company involve in construction activity have to prepare an additional financial to spend on the new training development. However, all the new training to be given to the workers still need to depend on the motivation and attitude of the workers, therefore, they may also need a longer time for the

new technologies to get involve into the construction industry because the workers need to time accept and understand the new skills in works.

The pre-fabrication model of housing property can give the purchaser a better concept to understand the design and hence can have bigger opportunity for the purchaser to buy the property through their impression on the housing model. Furthermore, the developer can also know what to improve and amend by looking at the pre-fabrication model.

2.8 Responsibility of Consultant in Construction

Up to nowadays, actually not all the parties can completely understand the responsibility of the consultant in a project of construction. Moreover, even the consultant themselves also not totally know their roles and obligations to work with the project's owners or contractors, and thus this may cause all the parties face some conflicts or disputes that can lead to project failure. However, the contractor should understand the scope of works and schedule of works given by the consultant and the project owner as well as the arrangement of additional works which is not stated in the scope of project. As a consultant, they should know how to help the owner on matter like project cost planning and control, selection of proper site location, and study of the environmental surrounding the site. They should also take the responsibility to get the approval of design and development permit of the project from the authorities. All the impacts that may affect the cost implication of the project should also be analysed since the earlier stage so that a more accuracy cost estimation to protect the benefit of project's owner. This is because some of

the projects' owner may not have professional background which can let them to understand all the technical issues happened in the project. Furthermore, the consultant should help the owner to make sure that the contractors have worked follow the specifications and terms given in their contract and therefore, consultant need to carry out the inspection of works based on the site progress to ensure the work done is complied with the standard of quality. If the complexity of the project is higher, the risk of doing mistake in the project is also greater, so, the consultant need to put in more effort in the design stage and pay more attention when the project is under construction.

2.9 Maintenance of Residential Building

Housing development have grew rapidly and caused more and more houses being constructed and hence required more maintenance in housing construction. There is quite a numbers of people neglect on building maintenance issue because they expect the building can be sustained even without maintenance (Olanrewaju, 2009). However, if a building is not well maintain, this may cause the building looks old and decay easily and hence the market value of the building will be depreciated. Building maintenance cost can be reduced by doing the proper design in planning stage and construction stage. Moreover, the designers should allocate a cost estimation for building maintenance when planning stage so that the top management will have a clear mind set on the controllable cost have to be spend in future for maintenance (Al-Khatam, 2003). Actually to make the building maintenance cost as low as possible in future, the design of building have to be make it in less complexity

(Ahmad, 2013). If the building design is over complex, there will be difficulty to do regular maintenance. For example, the use of timber flooring may look like high class for a house, but the timber will be dropped off easily if the house owner do not use proper way for cleaning. Furthermore, it is necessary to let the owner understand about life cycle cost techniques (Dunk, 2004). This will help the project owner to come out with a most economical design and structural layout because the application of life cycle cost can help the owner to find out the saving can be done when design stage. Besides that, the use of unskilled labour in construction actually can lead to poor workmanship of completed building and this will cause the house owner to spend more on future maintenance cost. On the other hand, human behaviour is the hardest to control and which will cause to spend more repairing cost due to all those wear and tear problem. So, the contractor shall submit their as-built drawing and operation manual to the building user so that they can take some precaution on daily usage of the building components. Moreover, it is important to have a standard of specification for design a building as well as construction. If all the contractors go for the materials with lower price without quality, this will be a huge cost to spend in maintenance and repairing works.

2.10 Building Construction Quality Assessment

There are many types of assessment for the quality of building construction that can be used to evaluate whether the building is meet with the

standard of quality and requirement. Below shown are the most common used system that have implemented in the industry.

2.10.1 Construction Quality Assessment System (CONQUAS)

CONQUAS was established by Building and Construction Authority (BCA) and evaluated by a standard requirement from a meeting with the public sector developers, consultants, contractors and all the professional parties related in the construction field according to the general specifications which commonly apply in their projects. The scoring system of CONQUAS had first carried out at the trial session to make sure the consistency and accuracy of the score. CONQUAS was developed to ensure the quality of constructed works achieve the required standards and specification. There are three aspects evaluated in CONQUAS which are architectural works, structural works and Mechanical & Electrical (M&E) works. However, heavy duty works which called under sub-contract are excluded in this assessment. The assessment is done by laboratory testing, field testing and site inspection. Furthermore, the materials used on site are also tested to ensure the performance of the materials meet the standard of quality and safety issue. Therefore the CONQUAS's assessors are needed to present calibration programme and also the BCA's CONQUAS training to make sure the accuracy and competency of the assessment. The system is evaluated based on the gross floor area (GFA) of building. The scoring will be judged based on the works that were inspected on first time, so, the assessment will not be evaluated again after the rectification works has completed. This is to

encourage the contractors “doing the things right at the first time”. However, it will be considered as fail in assessment if the items does not meet the requirement.

2.10.2 Quality Assessment System for Building Construction Work (QLASSIC)

Besides that, QLASSIC is also a system that is designed to assess the quality of the workmanship apply on the building of the project according to their independence standard. QLASSIC has established as Malaysia Construction Industry Standards (CIS) by the technical members of quality assessment in construction sectors with the help of Construction Industry Development Board Malaysia (CIDB) where CIDB has acted as a moderator for the technical members in the whole process of standard development. QLASSIC is also evaluate by sampling approach method as similar as CONQUAS. The assessment of this system is also based on architectural works, external works and M&E works. Unlike CONQUAS, the assessment of QLASSIC will be carried out twice which is during construction stage and when completion of project. This is to ensure the contractor is doing their work properly from beginning until completion of works. The sampling will depends on the gross floor area (GFA) of building and 10 meter length section per location for external work. However, all the plastering works done are depends on the justification by the project Qualified Person (QP).

2.10.3 Project Quality Plan (PQP)

In some of the developers' company, they will enforce the awarded contractor to submit PQP once the commencement of work. PQP can help to understand the project quality requirement such as client's requirement, consultant requirement, local authority's requirement, legal issue and also the project specification. Below are some of the content which are listed in PQP:-

i. Scope of Works;

ii. Project Stakeholders;

iii. Project Organization Structure;

iv. Roles & Responsibility;

v. Work Programme;

vi. Project Operating System;

vii. Quality Management System;

viii. Methods of Statement;

ix. Inspection Test Plan;

x. Important Checklist; and etc.

From PQP, the contractor can know well on what they should do to achieve the goal given to them. On the other hand, the consultant and clerk of works can also monitor and make sure the work done by contractor have follow standard quality and requirement by referring to PQP.

2.11 Standard of Housing Quality

The housing development of Malaysia can be categorized to three which are statutory bodies, private developers and co-operative societies. They are administrated by the Housing Development Act (HDA) 1966 if they want to handle the development for the construction of more than four housing units (Azlinor, 2008). The purchasers of property have the right to choose for a quality house with good workmanship and the material used need to be meet with the standard of Sale and Purchase Agreement (SPA) (Schedule G and H of the HD Regulations 1989). Purchasers can claim for their remedies from the developers if they found a problem in the standard of construction which does not meet Clause 14 ("*the building shall be constructed in a good and workmanlike manner"*) of the HD Regulation 1989. There are two types of remedies in general; first is the remedies under the law of contract, second is the legislative remedies within the legislative warranty period. Furthermore, for all the low-cost housing project either is developed by public or private developer, they must comply with the guidelines set by Construction Industry Standard (CIS) 1 (for conventional units including single and double storey houses) and CIS 2 (for sub-divided units, strata buildings). The objective to set these guidelines is to guarantee that all low-costs property can be constructed by following the standard requirement that enforced by the government. There are four components need to be taken as the scope of these standards which are complete infrastructure, development of community, safety and development of physical and health. Therefore, the implementation of CIS 1 and CIS 2 can ensure the group of lower income are also given the chances to own a proper quality of house. Malaysia has three main authorities to control

the quality of building which are local authority, Ministry of Housing and Local Government (MHLG) and Construction Industry Development Board (CIDB).

2.11.1 Local Authority

First of all, the building plan need to be approved by the local authority and the local authority have to make sure the developer's submission has complied with all the rules and regulations stated in the Uniform Building By-Laws (UBBL). Furthermore, if the building plan submitted is related to low-cost housing development then the local authority should check also the compliance of plan by using Construction Industry Standard (CIS 1 and CIS 2). UBBL has stated that a qualified person to supervise and inspect the progress of the construction works is meet with the standard quality until the completion of building. Secondly, Certificate of Completion and Compliance (CCC) is introduced and it is a new method to process the issuance of Certificate of Fitness (CF). After the issuance of CCC, the responsibility of local authority will be transferred to the architect, building planner or engineer when the completion of the constructed building to check on whether it is following the plans and specification that approved by the local authority.

2.11.2 Ministry of Housing and Local Government (MHLG)

It is illegal to carry out a housing development without a license. MHLG is playing an important role for housing development of Malaysia as

the license of housing development need to be approved by the MHLG. The MHLG has the power to control all the activities carry out by the developers. They have the right to revoke the license of a developer if found that the developer has done some destructive that harm the interest of the purchasers. Instead of this, MHLG may use the Housing Development Act (HDA) to ensure the developers have comply their responsibility stated by the standard Sales and Purchase Agreement (SPA). On the other hand, three mechanisms will be used to monitor the progress of construction which are documentation, site visit, and site inspection. However, site inspection will only be carried out when there is any complaint received from the purchaser due to lack of manpower.

2.11.3 Construction Industry Development Board (CIDB)

All the contractors need to have a license by Construction Industry Development Board Act 1993 (CIDBA). CIDBA has also stipulated the responsibilities of CIDB. Unlike local authorities and MHLG, CIDB do not have direct control of the housing development, however, it is the main authority to control the activities of contractors. The quality of building in Malaysia is highly depended on the skilled workers engaged to the construction works. The skilled workers are defined as concreter, bar-bender, carpenter, bricklayer, mason, plasterer, paver, tiler, painter, joiner, metal worker, drain layer, glazier, welder, construction plant operator, plumber and electrician (Section 32(2). All the developers need to have the responsibility to make sure their contractors are engaging with skilled workers as this may

causes a significant impact on the quality of workmanship apply on the houses constructed. If the developers only look for the tenderer with lowest quotation but do not care about the contractor's skilled workers, this may causes the contractor to have poor commitment to the quality of works from their workers. The main contractors need to make sure their foreign workers who want to work in Malaysia must sit for the accreditation test before they get the certificate of "Perakuan Kemahiran Pekerja Asing" (PKPA). They are requested to sit for the accreditation of skilled process for every 3 years in order for them to apply PKPA. So, Immigration Department shall renew their working permits if the fail in the tests. Instead of this, both local and foreign workers are also encouraged to sit for the accreditation test and be awarded the "Sijil Kecekapan Kemahiran" (SKK). There are three procedures to work out by CIDB in order to accredit the test. Firstly will be short training courses, the follow by work place assessment and lastly skills test. Disciplinary action such as suspension or cancellation of licenses will be taken for the contractors who fail to comply with all these requirements. On the other hand, CIDB also responsible for the construction materials certification where the quality of the materials is dependent on whether it is certified by SIRIM Berhad. SIRIM has the responsibility to develop the standard of products, systems and services known as Malaysian Standard (MS). The standards of products are approved as MS if it follows the Standard Malaysia Act, 1996. However, CIDB need to encourage the technique and materials used in construction to be standardized but it is not strict to specify the quality of materials used in construction. Therefore, the contractors or developers can have their own choices to pick

any less expensive materials in the market instead of choosing quality materials.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

There are three types of approaches for carry out research, which are:-

- Quantitative Approach
- Qualitative Approach
- Mixed Method Approach

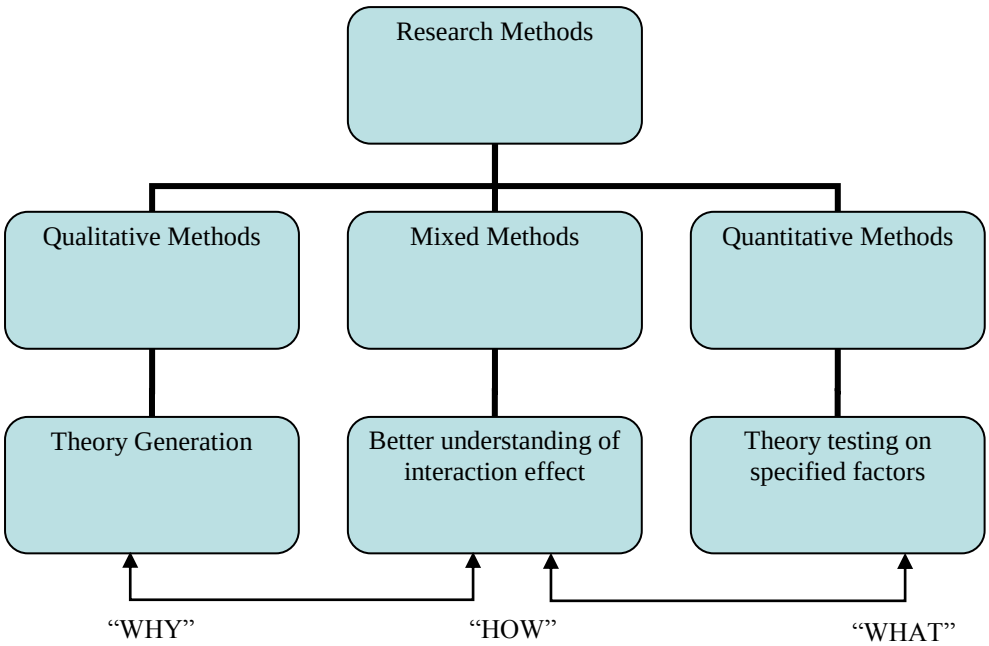


Figure 3.1: Types of Research Methods

3.1.1 Quantitative Approach

Quantitative approach is normally done by using data collection by distribute the survey questionnaire to the target audience for their opinions on the specified factors. This approach normally has a specified variables for data analysis and the data collected is measureable. Quantitative survey is a simple traditional method for a researchers to get the most wanted result with unbiased approach therefore many researchers feel more comfortable on this approach. The sample size for this approach is large. Minimum respondents of questionnaire validity test in quantitative survey are 30 numbers. (Sugiyono, 2012). There are few types of quantitative research methods:-

i. Survey research;

ii. Correlational research;

iii. Casual-comparative research;

iv. Experimental research; and etc.

3.1.2 Qualitative Approach

Qualitative survey is using open-ended questions approach like interview methods and it is used to improve understanding of particular topics. This methods required target audience with knowledge of particular research and they always bring in their personal interest into this research. The sample size for this approach is very small as all the respondents are chosen to comply the given measurement. Qualitative method is more suitable for researchers

who have more innovation and good in analytical writing. There are few types of qualitative survey methods:-

i. Case study;

ii. Grounded theory;

iii. Phenomenology;

iv. Historical; and etc.

3.1.3 Mixed Method Approach

Mixed method is the combination research method of quantitative survey and qualitative survey and therefore this method always required more time to complete because it need to analyze both types of data collected. There are few types of mixed method approach:-

i. Triangulation design;

ii. Embedded design;

iii. Explanatory design; and etc.

3.2 Design Framework

The research begins by studying common construction defects that are usually happened from a completed building. Besides that, the reason of uncontrollable building maintenance cost is also studied.

This research is established to study the contribution of quality control towards residential building in Malaysia. First of all, the methods to reduce defects from design and construction stage were identified. Next, the techniques to help on reduce building future maintenance cost were also identified. Quantitative survey is used in this research due to more convenient and saving time. The data collected from this method are measureable and easier to be analyzed. The survey questionnaire are expected to collect back from 100 target audiences for validity test. They are 30 respondents from developer; 30 respondents from consultant; and 30 respondents from contractor; and last but not least 10 respondents from non-construction personnel.

3.2.1 Questionnaire

The first question is to check the expectation from respondents on the potential growth of the property value when they are going to dispose the building if it is free from defects and less future maintenance cost. There are 4 choices to be chosen which are: less than 5%; 5% to 7%; 8% to 10%; and more than 10%. This question is expected to get the answer from public as everyone have the right to put in their own expectation of market price no matter you are working in construction industry or not.

The second question is to identify the role of respondents from construction industry. There are 3 choices to be chosen which are developer, consultant, contractor and the last one “None of the above”. This question is

expected to get equally 30 respondents from every choice (except for “None of the Above”). For those respondents who answered “None of the above” are expected to return back the questionnaire as the following questions are out of their working field or industry for those who are not working as construction industry.

The third question is to let the respondents to fill in their years of service in construction industry as different years of experience they gained will affect their point of view to the following questions. The fourth question is to check the salary range paid to the respondents by their respective company as different range of salary may affect the performance of work by respondents too.

The fifth question is to identify the most useful method that can be used to reduce the defects of residential building in Malaysia. There are total 7 methods that can reduce defects. Each method can be rated by using scale from 1 to 5. This scale is using Likert scale which means 1 is the least agree on the given method and 5 is the most agree on the given method.

The last question is to identify the most useful technique that can help to reduce future maintenance cost of residential building in Malaysia. There are total 7 techniques that can help to minimize future maintenance cost. Same as third question, each technique can be rated by using scale from 1 to 5. This scale is using Likert scale which means 1 is the least agree on the proposed technique and 5 is the most agree on the proposed techniques.

3.3 Data Analysis

The data collected from all respondents will then be analyzed by using SPSS (Statistical Package for the Social Sciences). SPSS is a very useful program which can help to analyze the data easily by using different types of statistic tests. There will be two types of hypothesis statistic test to analyze data which are parametric tests and non-parametric tests. Parametric test is mainly used to test the means of a group of data; while non-parametric test is used to test the median of a group of data. Besides that, parametric test is used for bigger group of sample size (>20 samples); while non-parametric test is used for smaller numbers of sample size (<20 samples). Below shows some of the hypothesis tests for parametric test and non-parametric test.

a. Parametric Test:-

    i. 1-sample t test;

    ii. 2-sample t test;

    iii. One-Way ANOVA test;

    iv. Pearson Correlation Coefficient; and etc.

b. Non-parametric Test:-

    i. Wilcoxon test;

    ii. Mann-Whitney test;

    iii. Kruskal-Wallis median test;

iv. Spearman's rho and etc.

There are three types of data which are commonly collected from questionnaire:-

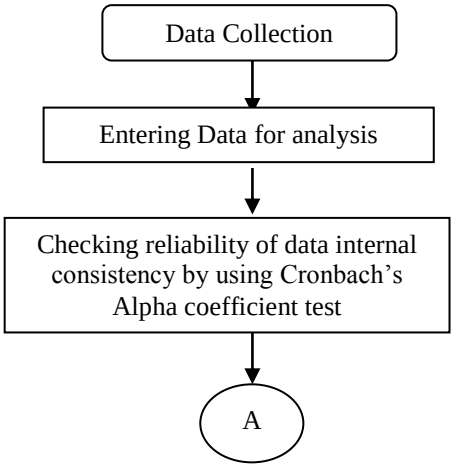
i. Interval data – can be collected by independent unit, for example: age, weight, years of working and etc.

ii. Ordinal data – can be collected by ranking scale (Likert scale), for example: the respondents are going to answer the question based on level on satisfaction (eg: 1 = least important; 5= most important).

iii. Nominal data – can be collected from qualitative statement, for example: sex, marital status, nationality and etc.

If the data collected only consist of ordinal data or nominal data, then non-parametric test can only be used for analyze the data and therefore, Question 5 and 6 will be analyzed by non-parametric test while Question 1 to 4 will be analyzed by parametric test.

Below is the flowchart to show the process of data collection to analyze data by using SPSS.



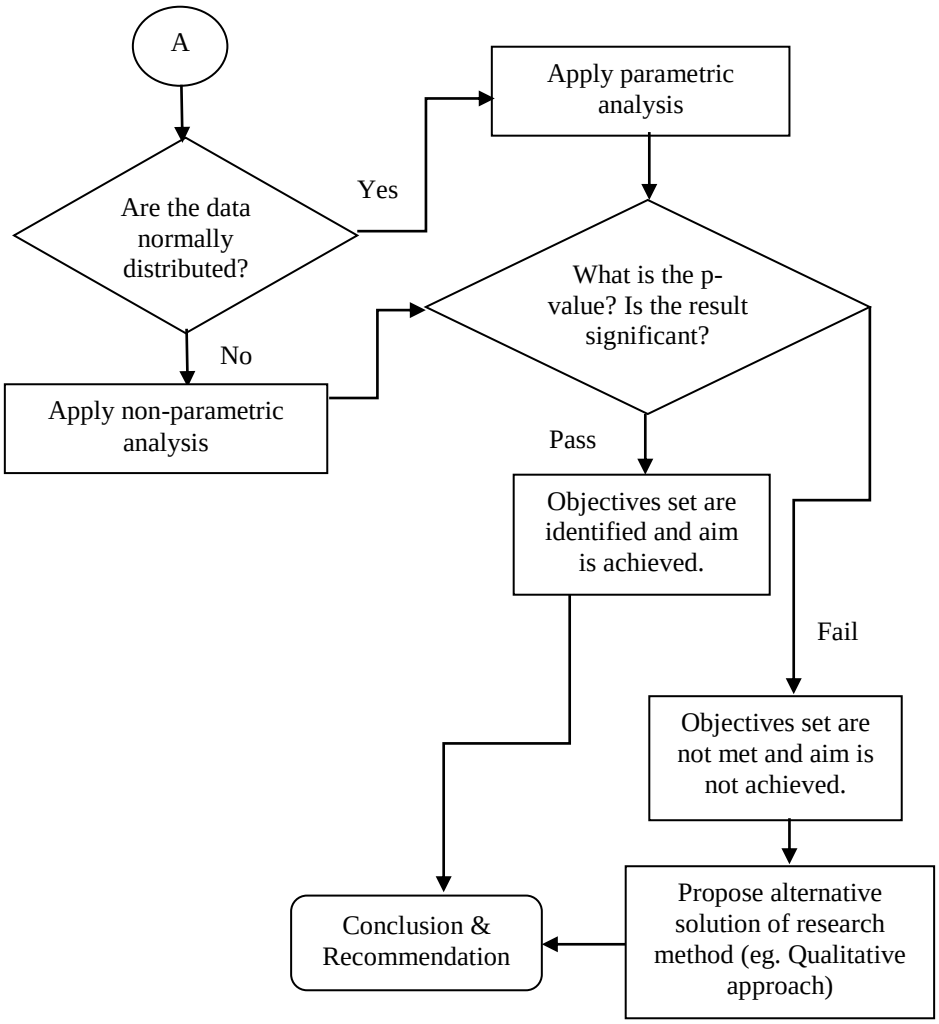


Figure 3.2: Process of Data Analysis in SPSS

The P-value will be looked into when doing sample t-test. The p-value can be classified as three conditions:-

i. When p-value is more than 0.05, the null hypothesis will be accepted but the result is not significant;

ii. When p-value is lesser than 0.05 and more than 0.01, the null hypothesis will not be accepted and the result is significant beyond 5 percent.

iii. When p-value is lesser than 0.01, the null hypothesis will not be accepted and the result is significant beyond 1 percent.

3.3.1 Reliability Test

Cronbach's Alpha test is used for test the internal consistency or reliability of multiple question with "Likert" scale. Cronbach's Alpha test cannot be said as a statistical test, however, it is a coefficient of reliability (α) test. For a set of items that are formed to rate in scale, they will need internal consistency. These all items shall pointing into same target and they shall correlated to each other. If $\alpha = 0$ then means that the questions set are all independent; if α coefficient is approach to 1 then means that the internal consistency of that set of questions set are reliable.

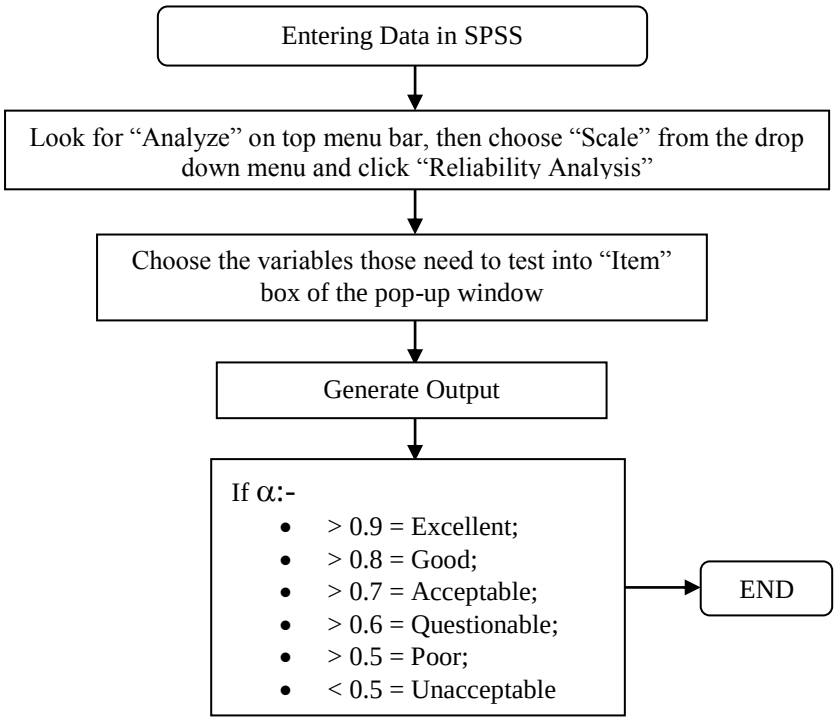
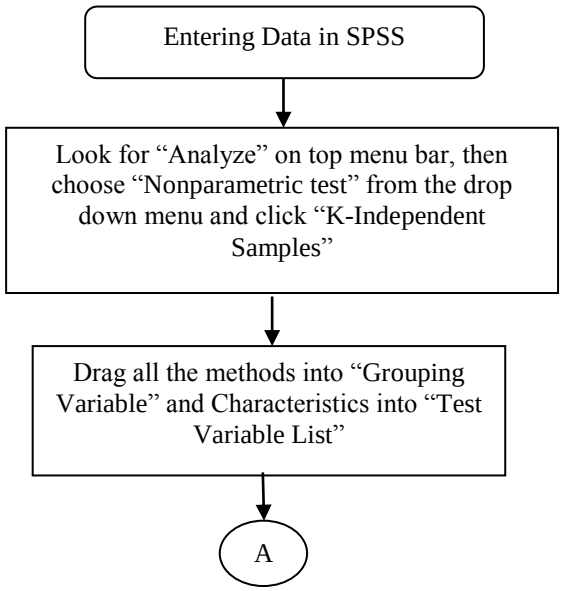


Figure 3.3: Cronbach's Alpha Reliability Test

3.3.2 Analysis of Variance Test

Generally, for parametric test one-way ANOVA test will be used; while non-parametric test, Kruskal-Wallis H test will be used. On the other hands, one-way ANOVA test is suitable to use for dependent value analysis and normally use to analyze interval data and nominal data. For example, salary given by company have to depend on the education level of a personnel, so, salary will be the dependent value and education level of a personnel will be the factor. However, Kruskal-Wallis H test is used for analyze the ordinal data (Likert scale) with two or more groups of independent variables. For example, satisfaction level of salary increment by company towards personnel of different education level, so, satisfaction level of salary increment (Least satisfied = 1 to Most satisfied =5) is the ordinal data and personnel of different education level (Degree, Master, PhD) is the independent variables. Due to the Question 5 and Question 6 (Refer to Appendix A) are considered as interval data, so, Kruskal-Wallis H-test is carried out, the mean of every test variable will be generated out. So that the null hypothesis, H_0 can be said as accepted if p-value is greater than 0.05; while can be said as rejected if p-value is lesser than 0.05.



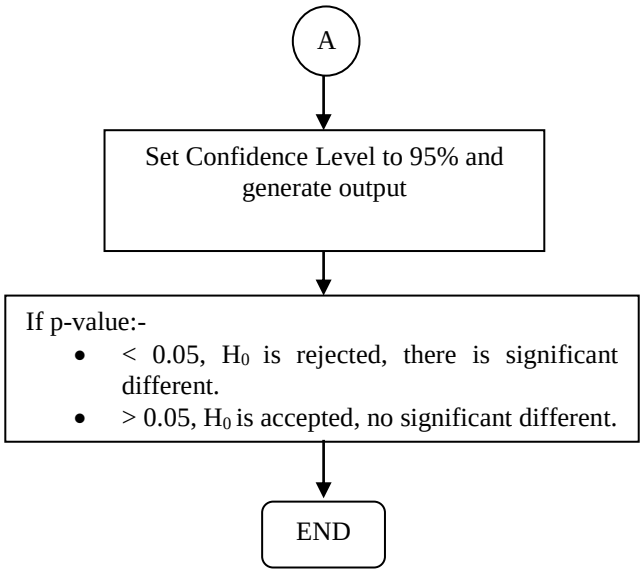


Figure 3.4: Kruskal-Wallis H Test

3.3.3 Correlation Coefficient Test

Correlation coefficient test is used to test the relationships between two variables. There are two types of correlation test which are Spearman's rank correlation coefficient and Pearson's coefficient. Spearman's rank correlation coefficient is normally used for nonparametric rank statistic test. One the other hand, Pearson's r is a statistic that can identify the strength of two variables, when r:-

- Approach to 1, this means the relationship between two variables is strong;
- Approach to 0, this means the relationship between two variables is weak;

- Positive r value, this means that the first variable increase value then the second variable also increase value;

- Negative r value, this means that one of the variable increase value, then the second variable decrease value.

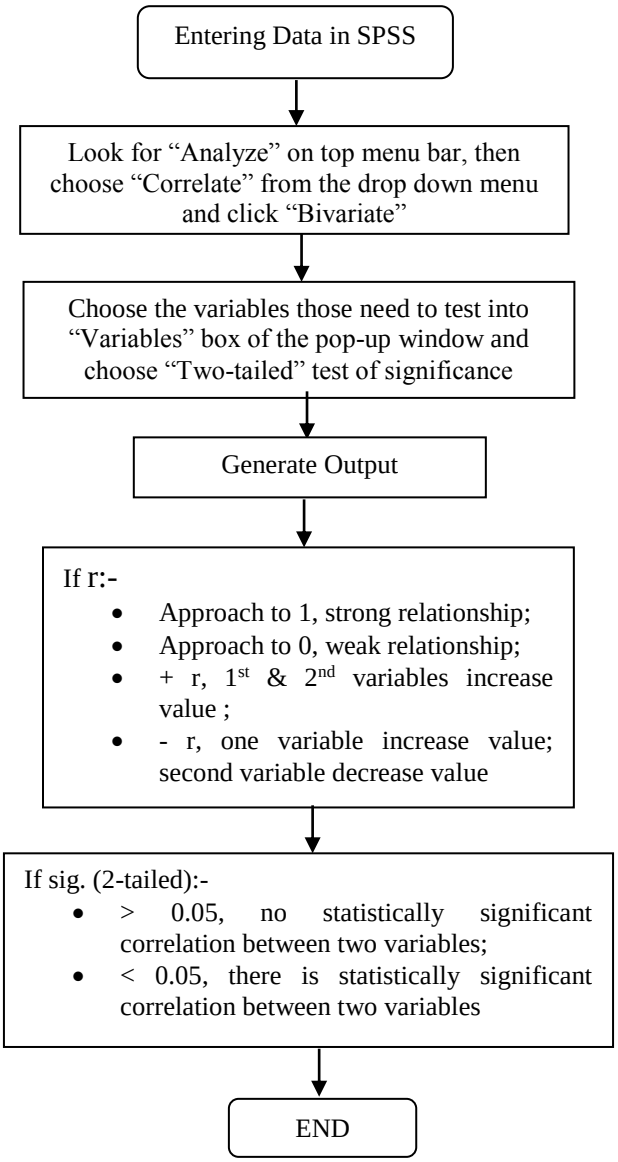


Figure 3.5: Pearson's Correlation Test

CHAPTER FOUR

RESULTS & DISCUSSION

4.1 Introduction

The impact of quality control upon the construction of residential building in Malaysia was studied and the survey questionnaire have been collected from 100 numbers of respondents. For the first question set, all the 100 numbers of respondents are taken into account. After that, remaining 90 respondents are needed to answer all the following questions. There are 30 numbers of respondents from Developers; 30 numbers respondents from Consultants; 30 numbers of respondents from Contractors. The survey questionnaire can be referred from Appendix A and it has been separated in 3 sections.

- Section A: Expectation of potential growth value of residential building when disposed.
- Section B: Profile of respondents
- Section C: Methods to reduce defects of residential building
- Section D: Techniques to reduce future maintenance cost of residential building

Table 4.1: Group of Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Consultant	30	30.0	30.0	30.0
	Contractor	30	30.0	30.0	60.0
	Developer	30	30.0	30.0	90.0
	None of Above	10	10.0	10.0	100.0
	Total	100	100.0	100.0	

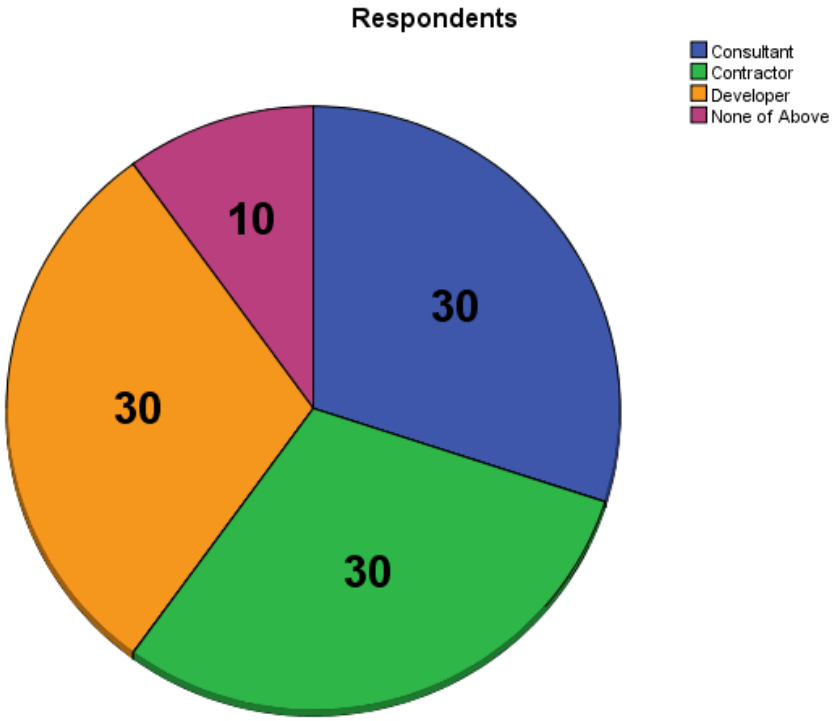


Figure 4.1: Pie Chart of Group of Respondents

4.2 Results of Section A

Firstly, the Descriptive Statistic Test by using Frequencies was done for the Section A of questionnaire which were potential growth of value for building when dispose. There are three selections of answers for this question which are 5% to 7%; 8% to 10% and more than 10%.

Table 4.2: Expectation of potential growth value of residential building when disposed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	>10%	9	9.0	9.0	9.0
	5% - 7%	43	43.0	43.0	52.0
	8% - 10%	48	48.0	48.0	100.0
	Total	100	100.0	100.0	

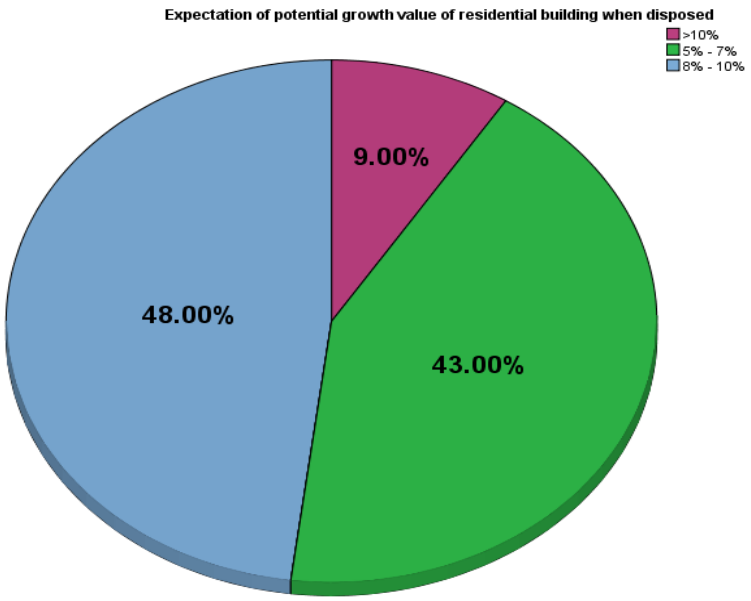


Figure 4.2: Pie Chart of Expectation Growth Value of Property

4.2.1 Discussion of Section A

From the Pie Chart above, we can see that 48% of the 100 respondents feel that there will be 8% to 10% of growth value of residential building without defects and less of future maintenance when they going to dispose the property, and then follow by 43% feel that there will be 5% to 7% of growth value and lastly followed by 9% feel that there will be more than 10% of growth value when disposed. From the result we can see that, there are only minor of respondents feel that the growth value of the disposed property can be more than 10% because there are still many other factors can affect the market value of property for a certain area. For example, development of the surrounding area which the property located at and also the reputation of developer for the property.

4.3 Results of Section B

For Section B, a graph analysis was done for years of work in construction industry from 90 respondents (30 for Developer; 30 for Consultant; 30 for Contractor). Besides that, Cronbach's Alpha reliability test and Pearson Correlation test were done for years of working in construction industry and salary range given by their respective company. There are four selections of answers for the question set for years of working in construction industry which are less than 2 years; 2 to 5 years; 6 to 10 years and more than 10 years. Next, there are also four selections of answers set for the question of salary range given by company which are less than 3,000; 3,000 to 5,000; 5,001 to 10,000 and more than 10,000.

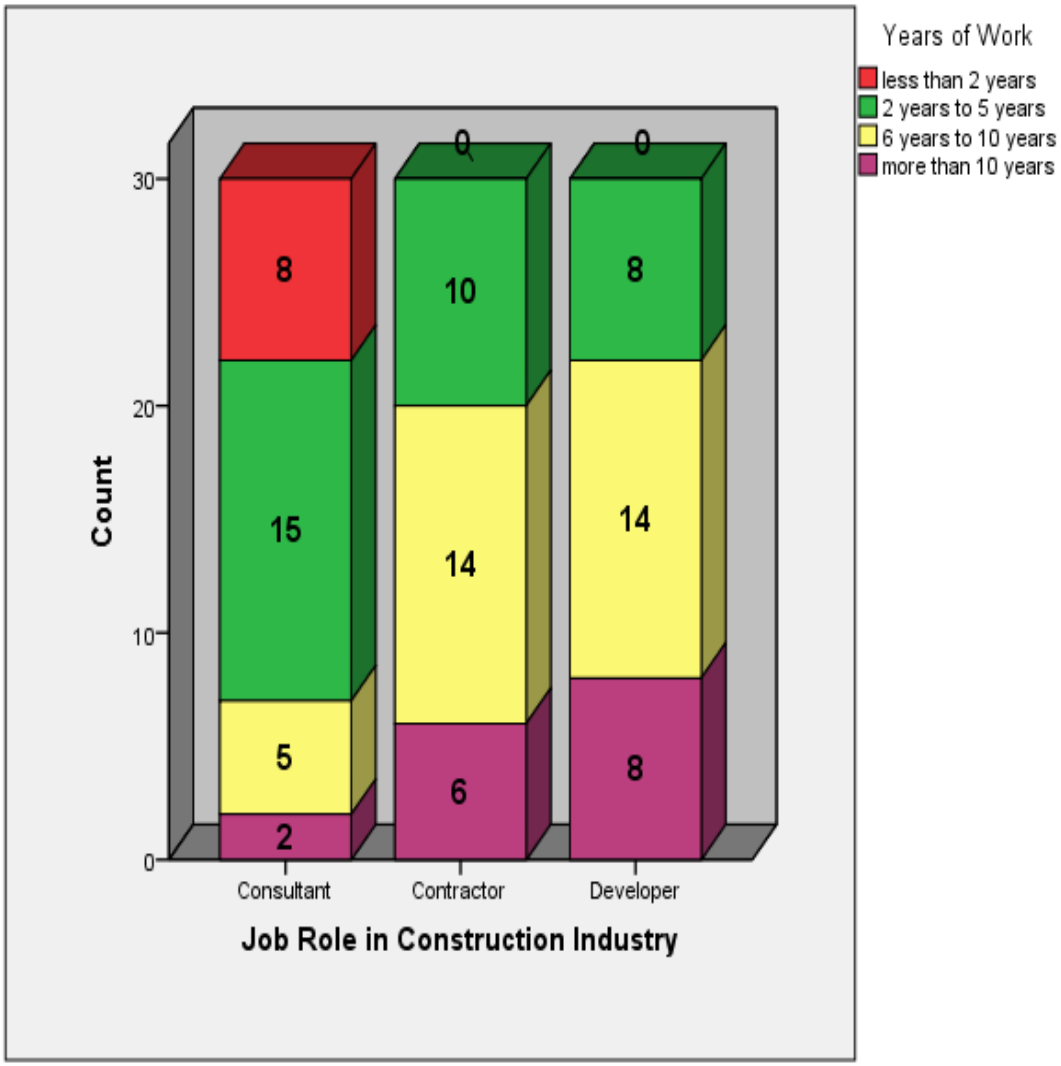


Figure 4.3: Bar Chart of Job Role vs. Years of Working

Table 4.3: Years of Working in Construction Industry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 2yrs	8	8.9	8.9	8.9
	2 – 5 yrs	33	36.7	36.7	45.6
	6 – 10 yrs	33	36.7	36.7	82.2
	>10 yrs	16	17.8	17.8	100.0
	Total	90	100.0	100.0	

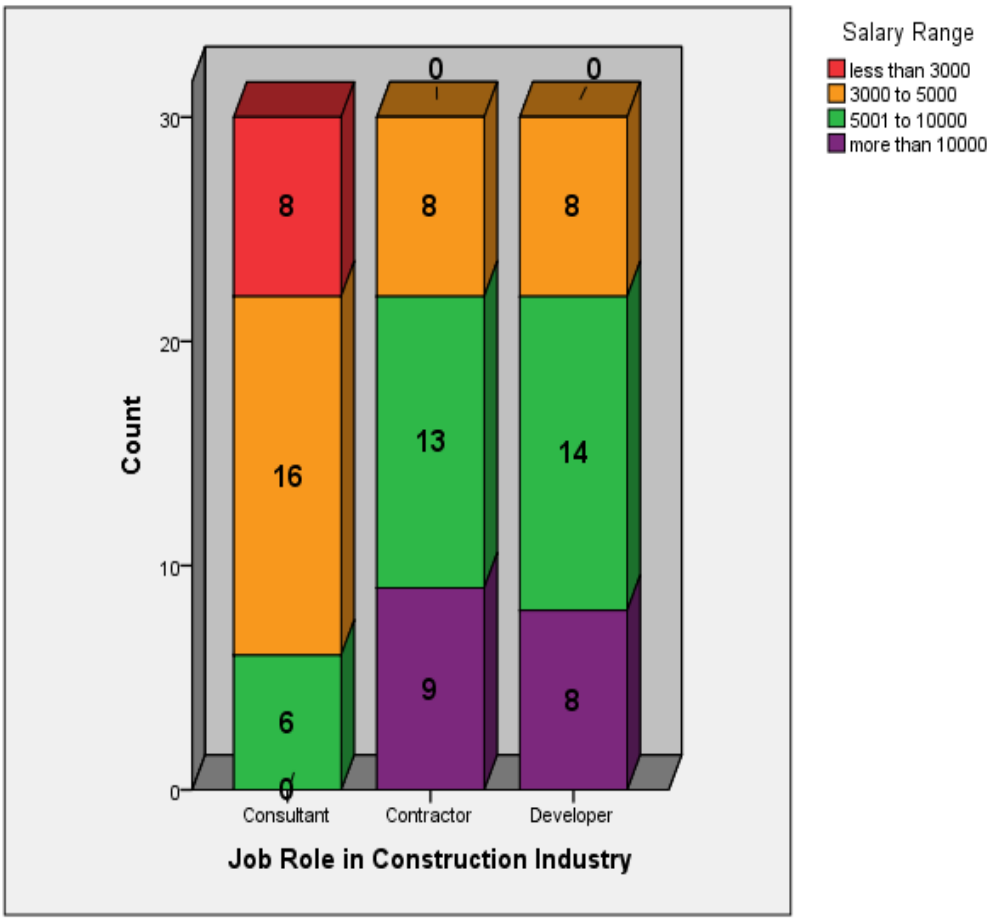


Figure 4.4: Bar Chart of Job Role vs. Salary Range

Table 4.4: Salary Range given by Company

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 3000	8	8.9	8.9	8.9
	3000 - 5000	32	35.6	35.6	44.4
	5001 - 10000	33	36.7	36.7	81.1
	>10000	17	18.9	18.9	100.0
	Total	90	100.0	100.0	

4.3.1 Pearson's Correlation Test of Section B

Table 4.5: Descriptive Statistics of Section B

	Mean	Std. Deviation	N
Years of Work	2.63	.880	90
Salary	2.66	.889	90

Table 4.6: Pearson Correlations of Section B

		Years of Work	Salary
Years of Work	Pearson Correlation	1	.943**
	Sig. (2-tailed)		.000
	N	90	90
Salary	Pearson Correlation	.943**	1
	Sig. (2-tailed)	.000	
	N	90	90

**. Correlation is significant at the 0.01 level (2-tailed).

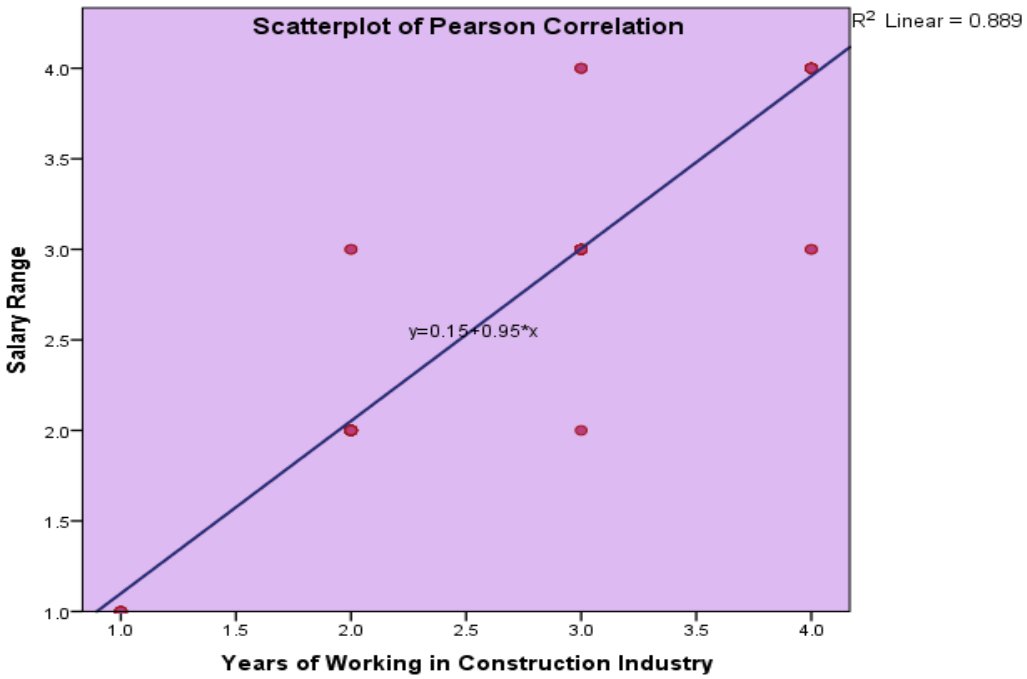


Figure 4.5: Scatterplot of Section B Analysis

4.3.2 Cronbach's Alpha Reliability Test of Section B

Table 4.7: Reliability Statistics of Section B

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.971	.971	2

Table 4.8: Inter-Item Correlation Matrix of Section B

	Years of Work	Salary
Years of Work	1.000	.943
Salary	.943	1.000

Table 4.9: Item-Total Statistics of Section B

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Years of Work	2.66	.790	.943	.889	.
Salary	2.63	.774	.943	.889	.

4.3.3 Discussion of Section B

From the bar chart shown above, there are 8 numbers of respondents working less than 2 years in construction industry who are all working for consultant. Besides that, there are 33 numbers of respondents working 2 years to 5 years in construction industry who are 15 numbers from consultant, 10 numbers from contractor and 8 numbers from developer. Next, there are also 33 numbers of respondents working 6 years to 10 years in construction industry who are 5 numbers from consultant; 14 numbers from contractor and 14 numbers from developer. Lastly, there are 16 numbers of respondents

working more than 10 years in construction industry who are 2 numbers from consultant; 6 numbers from contractor and 8 numbers from developers.

For Pearson's correlation test did and the results shown above, the r-value is 0.943 for the relationship of years of working in construction industry and salary range given by respective company and the sig. (2-tailed) value is lesser than 0.05. Moreover, from the scatterplot shown for this two variables, the r-value is 0.889. Therefore, it can conclude that this two variables have a strong relationship between each other and there is statistically signification correlation between these two variables. The positive value of r shown that when the value of first variable increase and the value of second variable also increase. From the result shown, it can said that when the years of working by respondents in construction industry, then their salaries paid by their companies are also increased. It is important for the range of salary paid by company is based on the years of working by respondents. This is because the range of salary can improve the efficiency of works by respondents as many will think that "I am working for what I have been paid". When the efficiency of work become lower, then the chances to get mistakes done in work will become higher. If the mistakes done in work become higher, then there are more chance to gain defect in design or construction period. Next, Cronbach's Alpha reliability test has been done for Section B. The α value is 0.971 and this consider as "Excellent" so it can be concluded that the internal consistency of this set of question is reliable.

4.4 Result of Section C

For Section C, a question was set to get the respondents' opinion on the methods to reduce defects of residential building in Malaysia. This question was answered by Likert scale which 1= Never Agree; 2= Seldom Agree; 3= Sometimes Agree; 4= Always Agree and 5= Completely Agree. Cronbach's Alpha reliability test, Pearson's correlation test and one-way Kruskal-Wallis H test were used to analyse this question. For Kruskal-Wallis test, a null hypothesis, H_0 has been set which are "Methods provided can help to reduce defects of residential building in Malaysia." There are seven methods provided to the respondents to rate on it, which are:-

i. Design Coordination Meeting among Consultants

ii. Peer Review for Design

iii. Sufficient Timeline for Design

iv. Design Clarification Meeting with Contractor

v. Value Engineering Program

vi. Weekly Site Inspection for Quality Assurance and Quality Control

vii. Invite Representative from Manufacturer for Guidance of Particular New Building Technology

4.4.1 Cronbach's Alpha Reliability Test of Section C

Table 4.10: Reliability Statistics of Section C

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.979	.983	7

Table 4.11: Inter-Item Correlation Matrix of Section C

	Design Coordination Meeting among Consultants	Peer Review for Design	Sufficient Timeline for Design	Design Clarification Meeting with Contractor	Value Engineering Program	Weekly Site Inspection for Quality Assurance and Quality Control	Invite Representative from Manufacturer for Guidance of Particular New Building Technology
Design Coordination Meeting among Consultants	1.000	1.000	.861	1.000	.766	1.000	1.000
Peer Review for Design	1.000	1.000	.861	1.000	.766	1.000	1.000
Sufficient Timeline for Design	.861	.861	1.000	.861	.654	.861	.861
Design Clarification Meeting with Contractor	1.000	1.000	.861	1.000	.766	1.000	1.000
Value Engineering Program	.766	.766	.654	.766	1.000	.766	.766
Weekly Site Inspection for Quality Assurance and Quality Control	1.000	1.000	.861	1.000	.766	1.000	1.000
Invite Representative from Manufacturer for Guidance of Particular New Building Technology	1.000	1.000	.861	1.000	.766	1.000	1.000

Table 4.12: Item-Total Statistics of Section C

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Design Coordination Meeting among Consultants	29.77	1.192	.986	.	.972
Peer Review for Design	29.77	1.192	.986	.	.972
Sufficient Timeline for Design	29.78	1.186	.852	.	.981
Design Clarification Meeting with Contractor	29.77	1.192	.986	.	.972
Value Engineering Program	29.79	1.180	.761	.	.991
Weekly Site Inspection for Quality Assurance and Quality Control	29.77	1.192	.986	.	.972
Invite Representative from Manufacturer for Guidance of Particular New Building Technology	29.77	1.192	.986	.	.972

4.4.2 Pearson's Correlation Test of Section C

Table 4.13: Pearson's Correlations of Section C

		Design Coordination Meeting among Consultants	Peer Review for Design	Sufficient Timeline for Design	Design Clarification Meeting with Contractor	Value Engineering Program	Weekly Site Inspection for Quality Assurance and Quality Control	Invite Representative from Manufacturer for Guidance of Particular New Building Technology
Design Coordination Meeting among Consultants	Pearson Correlation	1	1.000**	.861**	1.000**	.766**	1.000**	1.000**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000
	N	90	90	90	90	90	90	90

Peer Review for Design	Pearson Correlation	1.000**	1	.861**	1.000**	.766**	1.000**	1.000**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000
	N	90	90	90	90	90	90	90
Sufficient Timeline for Design	Pearson Correlation	.861**	.861**	1	.861**	.654**	.861**	.861**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000
	N	90	90	90	90	90	90	90
Design Clarification Meeting with Contractor	Pearson Correlation	1.000**	1.000**	.861**	1	.766**	1.000**	1.000**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000
	N	90	90	90	90	90	90	90
Value Engineering Program	Pearson Correlation	.766**	.766**	.654**	.766**	1	.766**	.766**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000
	N	90	90	90	90	90	90	90
Weekly Site Inspection for Quality Assurance and Quality Control	Pearson Correlation	1.000**	1.000**	.861**	1.000**	.766**	1	1.000**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000
	N	90	90	90	90	90	90	90
Invite Representative from Manufacturer for Guidance of Particular New Building Technology	Pearson Correlation	1.000**	1.000**	.861**	1.000**	.766**	1.000**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	
	N	90	90	90	90	90	90	90

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.14: Descriptive Statistics of Section C

	Mean	Std. Deviation	N
Design Coordination Meeting among Consultants	4.97	.181	90
Peer Review for Design	4.97	.181	90
Sufficient Timeline for Design	4.96	.207	90
Design Clarification Meeting with Contractor	4.97	.181	90
Value Engineering Program	4.94	.230	90
Weekly Site Inspection for Quality Assurance and Quality Control	4.97	.181	90
Invite Representative from Manufacturer for Guidance of Particular New Building Technology	4.97	.181	90

4.4.3 Kruskal-Wallis H Test of Section C

Table 4.15: Mean Ranks of Section C

	Job Role	N	Mean Rank
Design Coordination Meeting among Consultants	Developer	30	45.50
	Consultant	30	45.50
	Contractor	30	45.50
	Total	90	
Peer Review for Design	Developer	30	45.50
	Consultant	30	45.50
	Contractor	30	45.50
	Total	90	
Sufficient Timeline for Design	Developer	30	44.50
	Consultant	30	46.00
	Contractor	30	46.00
	Total	90	
Design Clarification Meeting with Contractor	Developer	30	45.50
	Consultant	30	45.50
	Contractor	30	45.50
	Total	90	
Value Engineering Program	Developer	30	43.50
	Consultant	30	46.50
	Contractor	30	46.50
	Total	90	
Weekly Site Inspection for Quality Assurance and Quality Control	Developer	30	45.50
	Consultant	30	45.50
	Contractor	30	45.50
	Total	90	
Invite Representative from Manufacturer for Guidance of Particular New Building Technology	Developer	30	45.50
	Consultant	30	45.50
	Contractor	30	45.50
	Total	90	

Table 4.16: Kruskal Wallis H-Test of Section C

	Design Coordination Meeting among Consultants	Peer Review for Design	Sufficient Timeline for Design	Design Clarification Meeting with Contractor	Value Engineering Program	Weekly Site Inspection for Quality Assurance and Quality Control	Invite Representative from Manufacturer for Guidance of Particular New Building Technology
Chi-Square	.000	.000	.517	.000	1.675	.000	.000
df	2	2	2	2	2	2	2
Asymp. Sig.	1.000	1.000	.772	1.000	.433	1.000	1.000

a. Kruskal Wallis Test

b. Grouping Variable: Job Role

4.4.4 Discussion of Section C

From the Cronbach's Alpha reliability test done for this question, the α value is 0.979 and consider as "Excellent" since it is more than 0.9. So, it can be concluded that the internal consistency of all these variables are reliable.

Next, from the Pearson's correlation test done, the r-value shown that all are approaching to 1 whereby it can be concluded that all the variables are having strong relationships among each other and the sig. (2-tailed) all are less than 0.05, so there are statistically signification correlation among all the variables.

After that, from the Kruskal-Wallis H test done, the p-value are all greater than 0.05, so it can be concluded that H_0 is accepted and there are no significant different among all variables. . Therefore it can be said that all the methods listed for this question are all considered as can reduce the defects of residential building in Malaysia.

From the mean report as shown above, the mean of "Value Engineering Program" is having the lowest value which is 43.50, followed by "Sufficient Timeline for Design" which is 44.50 and the rest are all having same mean value which are 45.50 and 46.50.

Although for the method "Value Engineering Program" which has mean rank of 43.50 from Developer which can be considered as high value, it is still the lowest mean among all methods. Value engineering program is a method can help to the project owner to save cost while all the proposed design will be studied before the project is carried out. However, not all the companies will carry out this process as some of the projects are awarded as "Design and Build". The normal practice of design and build is the project owner will set a budget for the project and the appointed consultants or contractors have to carry out their work within the budget. This is because some of the project owners may not have technical background on construction management so value engineering program cannot be carried out and they need to fully depend on what the consultants and contractors provided to them.

Secondly, for the method "Sufficient Timeline for Design" which has a mean rank of 44.50 from Developer. Sufficient timeline for design is actually

important for all the consultants. This is because consultants need more times to search for the design information which need to be suit for the requirement set by project owner and also they need time for feasibility study of the development for the particular area. However, the consultants are always being chased by the project owner to come out with design due to the project cannot be delayed for long time and this has caused the consultants always did some careless mistake in design due to insufficient of time for design.

On the others hand, the rest of methods are having mean of 45.50 and 46.50 which are “Design Coordination Meeting among Consultants”, “Peer Review for Design”, “Design Clarification Meeting with Contractor”, Weekly Site Inspection for Quality Assurance and Quality Control”, and lastly “Invite Representative from Manufacturer for Guidance of Particular New Building Technology”. These five methods are very important for reduce the defects of residential building too. The method “Design Coordination Meeting among Consultants” can help to reduce defects is because during the design coordination meeting, all the consultants can raise out their queries on design and voice out necessary opinion for design so that every consultants can have a very clear picture to proceed on what they should do to help each other in design but not think like “What other will do if I have designed on this way”. Two way communication is always very important for people who always need to work as a group. Therefore, they cannot assume others to follow the way they have worked. Next, the method of “Peer Review for Design” can help to minimize the mistake done in design stage as the consultants can asked their colleagues to cross checking on the design they have done as when they have faced for the same things for too long time then there are hard for them to

find out the mistake of their own design. After that, the method of "Design Clarification Meeting with Contractor" can help to reduce defects of building is due to contractor can know clearly the design before they start work and they can raise out queries if they have found any discrepancy from the design. Besides that, the method of "Weekly Site Inspection for Quality Assurance and Quality Control" can help to monitor the work done by contractor at construction site. The clerk of work can then point out the mistake done on site and give a timeline for the contractor to rectify it. This can help to ensure the quality of work and hence reduce the defects of building. Lastly, the method of "Invite Representative from Manufacturer for Guidance of Particular New Building Technology" can also help to reduce defects as some of the materials were new implemented and need to be installed by using a special skill, for example Polypropylene Random Copolymer (PPR) pipe which is currently used to replace copper pipe for hot water service. PPR pipe need a special weld & joint skill to connect the pipe. If the workers on site is not fully educated, they may spoilt the pipe or cause leakage of pipe in future as the joining is not done properly. Therefore, the contractor who proposed to use the materials can invite the supplier of this product to guide their workers for piping installation on site.

4.5 Result of Section D

For Section D, a question was set to get the respondents' opinion on the techniques to minimize future maintenance cost of residential building in Malaysia. Similar as Section C, this question was answered by Likert scale

which 1= Never Agree; 2= Seldom Agree; 3= Sometimes Agree; 4= Always Agree and 5= Completely Agree. Cronbach's Alpha reliability test, Pearson's correlation test and Kruskal-Wallis H test were also used to analyse this question. For Kruskal-Wallis test, a null hypothesis, H_0 has been set which are "Techniques provided can help to minimize future maintenance cost of residential building." There are seven techniques provided to the respondents to rate on it, which are:-

i. Less Complexity of Building Design

ii. Cost Allocation for Future Maintenance during Design Stage

iii. Life Cycle Cost Techniques

iv. Employ Skilled / Educated Workers during Construction

v. Standardize Specification of Material Used for Construction

vi. As-Built Drawing and Operation Manual to be given to Building User

vii. Conduct Quality Assessment and aim for High Score

4.5.1 Cronbach's Alpha Reliablity Test of Section D

Table 4.17: Reliability Statistics of Section D

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.965	.965	7

Table 4.18: Inter-Item Correlation Matrix of Section D

	Less Complexity of Building Design	Cost Allocation for Future Maintenance during Design Stage	Life Cycle Cost Technique	Employ Skilled/Educated Workers during Construction	Standardize Specification of Material Used for Construction	As-Built Drawing and Operation Manual to be given to Building User	Conduct Quality Assessment and aim for High Score
Less Complexity of Building Design	1.000	.788	.907	.713	.907	.713	.907
Cost Allocation for Future Maintenance during Design Stage	.788	1.000	.713	.907	.713	.907	.713
Life Cycle Cost Technique	.907	.713	1.000	.643	1.000	.643	1.000
Employ Skilled/Educated Workers during Construction	.713	.907	.643	1.000	.643	1.000	.643
Standardize Specification of Material Used for Construction	.907	.713	1.000	.643	1.000	.643	1.000
As-Built Drawing and Operation Manual to be given to Building User	.713	.907	.643	1.000	.643	1.000	.643
Conduct Quality Assessment and aim for High Score	.907	.713	1.000	.643	1.000	.643	1.000

Table 4.19: Item-Total Statistics of Section D

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Less Complexity of Building Design	29.61	1.813	.908	.	.957
Cost Allocation for Future Maintenance during Design Stage	29.61	1.836	.866	.	.960
Life Cycle Cost Technique	29.62	1.766	.901	.	.957
Employ Skilled/Educated Workers during Construction	29.62	1.811	.823	.	.963
Standardize Specification of Material Used for Construction	29.62	1.766	.901	.	.957
As-Built Drawing and Operation Manual to be given to Building User	29.62	1.811	.823	.	.963
Conduct Quality Assessment and aim for High Score	29.62	1.766	.901	.	.957

4.5.2 Pearson's Correlations Test of Section D

Table 4.20: Pearson's Correlations of Section D

		Less Complexity of Building Design	Cost Allocation for Future Maintenance during Design Stage	Life Cycle Cost Technique	Employ Skilled/ Educated Workers during Construction	Standardize Specification of Material Used for Construction	As-Built Drawing and Operation Manual to be given to Building User	Conduct Quality Assessment and aim for High Score
Less Complexity of	Pearson Correlation	1	.788**	.907**	.713**	.907**	.713**	.907**

Building Design	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000
	N	90	90	90	90	90	90	90
Cost Allocation for Future Maintenance during Design Stage	Pearson Correlation	.788**	1	.713**	.907**	.713**	.907**	.713**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000
	N	90	90	90	90	90	90	90
Life Cycle Cost Technique	Pearson Correlation	.907**	.713**	1	.643**	1.000**	.643**	1.000**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000
	N	90	90	90	90	90	90	90
Employ Skilled/Educated Workers during Construction	Pearson Correlation	.713**	.907**	.643**	1	.643**	1.000**	.643**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000
	N	90	90	90	90	90	90	90
Standardize Specification of Material Used for Construction	Pearson Correlation	.907**	.713**	1.000**	.643**	1	.643**	1.000**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000
	N	90	90	90	90	90	90	90
As-Built Drawing and Operation Manual to be given to Building User	Pearson Correlation	.713**	.907**	.643**	1.000**	.643**	1	.643**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000
	N	90	90	90	90	90	90	90
Conduct Quality Assessment and aim for High Score	Pearson Correlation	.907**	.713**	1.000**	.643**	1.000**	.643**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	
	N	90	90	90	90	90	90	90

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.21: Descriptive Statistics of Section D

	Mean	Std. Deviation	N
Less Complexity of Building Design	4.94	.230	90
Cost Allocation for Future Maintenance during Design Stage	4.94	.230	90
Life Cycle Cost Technique	4.93	.251	90
Employ Skilled/Educated Workers during Construction	4.93	.251	90

Standardize Specification of Material Used for Construction	4.93	.251	90
As-Built Drawing and Operation Manual to be given to Building User	4.93	.251	90
Conduct Quality Assessment and aim for High Score	4.93	.251	90

4.5.3 Kruskal-Wallis H Test of Section D

Table 4.22: Mean Ranks of Section D

	Job Role	N	Mean Rank
Less Complexity of Building Design	Developer	30	45.00
	Consultant	30	46.50
	Contractor	30	45.00
	Total	90	
Cost Allocation for Future Maintenance during Design Stage	Developer	30	45.00
	Consultant	30	45.00
	Contractor	30	46.50
	Total	90	
Life Cycle Cost Technique	Developer	30	45.50
	Consultant	30	45.50
	Contractor	30	45.50
	Total	90	
Employ Skilled/Educated Workers during Construction	Developer	30	45.50
	Consultant	30	45.50
	Contractor	30	45.50
	Total	90	
Standardize Specification of Material Used for Construction	Developer	30	45.50
	Consultant	30	45.50
	Contractor	30	45.50
	Total	90	
As-Built Drawing and Operation Manual to be given to Building User	Developer	30	45.50
	Consultant	30	45.50
	Contractor	30	45.50
	Total	90	
Conduct Quality Assessment and	Developer	30	45.50

aim for High Score	Consultant	30	45.50
	Contractor	30	45.50
	Total	90	

Table 4.23: Kruskal-Wallis H Test of Section D

	Less Complexity of Building Design	Cost Allocation for Future Maintenance during Design Stage	Life Cycle Cost Technique	Employ Skilled/Educated Workers during Construction	Standardize Specification of Material Used for Construction	As-Built Drawing and Operation Manual to be given to Building User	Conduct Quality Assessment and aim for High Score
Chi-Square	.419	.419	.000	.000	.000	.000	.000
df	2	2	2	2	2	2	2
Asymp. Sig.	.811	.811	1.000	1.000	1.000	1.000	1.000

a. Kruskal Wallis Test

b. Grouping Variable: Job Role

4.5.4 Discussion of Section D

From the Cronbach's Alpha reliability test done for this question, the α value is 0.965 and consider as "Excellent" since it is more than 0.9. So, it can be concluded that the internal consistency of all these variables are reliable.

Next, from the Pearson's correlation test done, the r-value shown that all are approaching to 1 whereby it can be concluded that all the variables are having strong relationships among each other and the sig. (2-tailed) all are less

than 0.05, so there are statistically signification correlation among all the variables.

After that, from the Kruskal-Wallis test done, the p-value are all greater than 0.05, so it can be concluded that H_0 is accepted and there are no significant different among all variables. Therefore it can be said that all the techniques listed for this question are all considered as can minimize the future maintenance cost of residential building in Malaysia.

From the mean report shown above, there are two techniques having the same mean of 45.00 and the other five techniques having the same mean of 45.50. The two techniques have the same mean rank of 45.00 are "Less Complexity of Building Design" and "Cost Allocation for Future Maintenance during Design Stage". For the technique "Less Complexity of Building Design" can actually help to reduce the future maintenance cost of building due to the simpler the design is, the easier the work to be done. Nowadays, all the building designed are designed by software like AutoCAD and this has caused the designers to keep on adding in a lot of trendy design which they think this is can be a trademark of building. However, after the buildings completed, there will be a lot of future maintenance issue like the materials for repairing work is not easy to get from market. Moreover, some of the special design cannot be simply done by normal human being and this will caused a lot of issue for future maintenance too. Next, the techniques of "Cost Allocation for Future Maintenance during Design Stage" can help the building owner to spend lesser for maintenance cost as the cost allocation set by the

builder can be captured inside their Defect Liability Period (DLP) and hence they can prolong their DLP to longer period.

The five techniques with mean of 45.50 are “Life Cycle Cost Technique”, “Employ Skilled / Educated Workers during Construction”, “Standardize Specification of Material Used for Construction”, “As-Built Drawing and Operation Manual to be given to Building User”, and “Conduct Quality Assessment and aim for High Score”. For the technique “Life Cycle Cost Technique” is actually help the project owner to come out an economical design for their building. They can do a feasibility study on their design since beginning of planning stage until the future maintenance stage and hence this study can help them to understand very well on what is the design can help to spend lesser for current as well as future. Next, the technique of “Employ Skilled / Educated Workers during Construction Stage” can actually help the contractor to ensure the workmanship apply to the building is up to standard and quality and hence this can help to reduce unnecessary spending of repairing cost or maintenance cost in future. Besides that, “Standardize Specification of Material Used for Construction” is very important as sometimes the contractor like to use alternative brand which can help them to gain cost saving and indirectly increase their profit margin. This is because the alternative brand used by contractor may not same quality as what have specified and when time getting longer this may cause issue for the building owner to spend their own money to change it. After that, “As-Built Drawing and Operation Manual to be given to Building Owner” is helpful due to the building owner can take extra precaution when they are using the device or products of the building. Lastly, the technique of “Conduct Quality

Assessment and aim for High Score" is actually very helpful in quality assurance of the building. Quality Assessment such as CONQUAS and QLASSIC have set a minimum score for the contractor to achieve. However, if high score is set for the contractor to achieve then they cannot simply carry out their work without any standard requirement or quality. This can help to reduce defects of building and hence to minimize the future maintenance cost of building too.

CHAPTER FIVE

CONCLUSION

5.1 Introduction

All the aim and objectives of this research are concluded in this chapter. The impact of quality control upon the construction of residential building in Malaysia was studied. The methods to reduce defects and techniques to reduce future maintenance cost of residential building in Malaysia were also discussed.

5.2 Methods to Reduce Defects of Residential Buildings in Malaysia

From the results analysed from survey questionnaire, all the methods specified in the question are considered as equally effective to help in reduce the defects of residential building. There are few can be applied during construction stage such as design coordination meeting among consultants, peer review of design, sufficient timeline for design, design clarification meeting with contractor and value engineering program. On the others hand, there are few methods can be applied during construction stage which are weekly site inspection for quality assurance and invite representative from manufacturer for guidance of new building technology. For a project to be success, it need to plan, implement and monitor by using sufficient of time and

also communication among each and others. By applying all these methods start from planning stage up to construction stage, the chances for defects to occur in building will be minimized.

5.3 Techniques to Minimize Future Maintenance Cost of Residential Buildings in Malaysia

All the techniques listed in the question are considered as useful to help in reduce future maintenance cost of residential building. Some of them can be executed during planning stage such as less complexity of building design, cost allocation for future maintenance during design stage, life cycle cost technique, and standardize specification of materials used for construction. On the others hand, there are few methods can be executed during construction stage which are employ skilled / educated worker during construction, as-built drawing and operation manual to be given to building user and conduct quality assessment and aim for high score. For contractors, if a building is constructed with quality but not quantity while for designers, if a building is designed based on reality but not imagination, then the future maintenance cost actually can be reduced a lot. The building owner maybe just need to spend a small portion of money to touch up their building appearance after many years later but not to frustrate on all the fussy things and thinking of how to maintain on it or change it. This is very important to enforce to do the things right at the first time.

5.4 Conclusion and Recommendation

Quality control is not only an action to be taken but is a transforming of human behaviour. It can be said has high impact towards the construction of residential buildings in Malaysia. This is because quality control of construction works can help to reduce the defects occur in residential buildings and minimize the future maintenance cost of buildings and therefore the market value of the property will also increase due to these factors.

This research done only shown the point of view from the 100 respondents but cannot be said as this can be represented the overall of construction industry. For future research, it is recommended the researcher can wider the area of research to do for more types of buildings such as industry, high-rise buildings and so on, however not only in Malaysia but also for other countries. Future researcher can also do on mixed approach study so they can understand better on how the methods of reduce defects and techniques to minimize future maintenance cost are actually being applied in construction industry and the constraint faced by the construction personnel when carry out the methods. From these, it can be seen clearer whether the cultures from other countries is the same as Malaysia and also the concern of different types of buildings.

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APPENDICES

APPENDIX A: Questionnaire

SURVEY: The Contribution of Quality Control towards Residential Building in Malaysia

This questionnaire consists of 4 Sections:-

Section A: The expectation growth of value for residential building

Section B: Profile of respondents

Section C: Methods used to reduce defects of residential building

Section D: Techniques used to reduce future maintenance cost of residential building

Dear Sir / Madam,

Your sincere help is much needed from me to participate in this research study about "The Contribution of Quality Control towards Residential Building in Malaysia".

Your cooperation is much appreciated.

Thank you.

Yong Shyn Ying
Master of Project Management, Faculty of Engineering and Science
Universiti Tunku Abdul Rahman
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SECTION A

1. With the defects free and the minimization of maintenance cost of residential building, what do you think is the potential growth of value when you are going to sell the building?

   (To be rated by following the percentage of purchase price)

   i. Less than 5% ☐

   ii. 5% to 7% ☐

   iii. 8% to 10% ☐

   iv. More than 10% ☐

SECTION B

2. What is your job role in construction industry? (If the answer chosen is "None of the above", please return this questionnaire to me.)

   i. Developer ☐

   ii. Consultant ☐

   iii. Contractor ☐

   iv. None of the above ☐

3. How many years have you worked in construction industry?

   i. Less than 2 years ☐

   ii. 2 years to 5 years ☐

   iii. 6 years to 10 years ☐

   iv. More than 10 years ☐

4. What is your current salary paid by your company?

   i. Less than RM 3, 000 ☐

   ii. RM 3,000 to RM 5,000 ☐

   iii. RM 5,001 to RM 10,000 ☐

   iv. More than RM 10,000 ☐

SECTION C

5. Below listed are the methods can help to reduce defects of residential building in Malaysia. (Please rate your answers by following the scale given)

   1 – Never Agree;
   2 – Seldom Agree;
   3 – Sometimes Agree;
   4 – Always Agree;
   5 – Completely Agree

Item	Description	1	2	3	4	5
i.	Design Coordination Meeting among Consultants					
ii.	Peer Review for Design					
iii.	Sufficient Timeline for Design					
iv.	Design Clarification Meeting with Contractor					
v.	Value Engineering Program					
vi.	Weekly Site Inspection for Quality Assurance and Quality Control					
vii.	Invite Representative from Manufacturer for Guidance of Particular New Building Technology					

SECTION D

6. Below listed are the techniques can help to minimize future maintenance cost of residential building in Malaysia. (Please rate your answers by following the scale given)

   1 – Never Agree; 4 – Always Agree;

   2 – Seldom Agree; 5 – Completely Agree

   3 – Sometimes Agree;

Item	Description	1	2	3	4	5
i.	Less Complexity of Building Design					
ii.	Cost Allocation for Future Maintenance during Design Stage					
iii.	Life Cycle Cost Technique					
iv.	Employ Skilled / Educated Workers during Construction					
v.	Standardize Specification of Materials used for Construction					
vi.	As-Built Drawing and Operation Manual to be Provided to Building User					
vii.	Conduct Quality Assessment with the Aim of High Score					

~ END OF QUESTIONNAIRE~

APPENDIX B: Data Collection

Section A

Job Role	Growth Value	Job Role	Growth Value	Job Role	Growth Value
None	5% - 7%	Consultant	5% - 7%	Contractor	8% - 10%
None	5% - 7%	Consultant	5% - 7%	Contractor	8% - 10%
None	5% - 7%	Consultant	5% - 7%	Contractor	8% - 10%
None	5% - 7%	Consultant	8% - 10%	Contractor	8% - 10%
None	8% - 10%	Consultant	8% - 10%	Contractor	8% - 10%
None	8% - 10%	Consultant	8% - 10%	Contractor	8% - 10%
None	8% - 10%	Consultant	8% - 10%	Contractor	8% - 10%
None	8% - 10%	Consultant	>10%	Contractor	8% - 10%
None	>10%	Consultant	5% - 7%	Contractor	8% - 10%
None	>10%	Consultant	8% - 10%	Contractor	8% - 10%
Developer	8% - 10%	Consultant	5% - 7%	Contractor	5% - 7%
Developer	8% - 10%	Consultant	5% - 7%	Contractor	5% - 7%
Developer	5% - 7%	Consultant	5% - 7%	Contractor	5% - 7%
Developer	8% - 10%	Consultant	8% - 10%	Contractor	>10%
Developer	5% - 7%	Consultant	8% - 10%	Contractor	5% - 7%
Developer	8% - 10%	Consultant	5% - 7%		
Developer	8% - 10%	Consultant	5% - 7%		
Developer	8% - 10%	Consultant	8% - 10%		
Developer	8% - 10%	Consultant	8% - 10%		
Developer	8% - 10%	Consultant	>10%		
Developer	8% - 10%	Consultant	>10%		
Developer	8% - 10%	Consultant	5% - 7%		
Developer	5% - 7%	Consultant	5% - 7%		
Developer	5% - 7%	Consultant	5% - 7%		
Developer	5% - 7%	Consultant	8% - 10%		
Developer	5% - 7%	Consultant	8% - 10%		
Developer	5% - 7%	Consultant	8% - 10%		
Developer	>10%	Consultant	5% - 7%		
Developer	5% - 7%	Consultant	5% - 7%		
Developer	5% - 7%	Contractor	8% - 10%		
Developer	5% - 7%	Contractor	8% - 10%		
Developer	5% - 7%	Contractor	8% - 10%		

Section B

Job Role	Years	Salary	Job Role	Years	Salary	Job Role	Years	Salary
Developer	3	3	Consultant	1	1	Contractor	2	2
Developer	4	4	Consultant	1	1	Contractor	2	2
Developer	3	3	Consultant	1	1	Contractor	2	3
Developer	3	3	Consultant	4	3			
Developer	2	2	Consultant	3	3			
Developer	2	2	Consultant	2	2			
Developer	2	2	Consultant	2	2			
Developer	2	2	Consultant	2	2			
Developer	3	3	Consultant	2	2			
Developer	3	3	Consultant	3	2			
Developer	3	3	Consultant	3	3			
Developer	3	3	Consultant	1	1			
Developer	4	4	Consultant	1	1			
Developer	4	4	Consultant	4	3			
Developer	4	4	Consultant	2	2			
Developer	3	3	Consultant	2	2			
Developer	3	3	Consultant	2	2			
Developer	3	3	Consultant	3	3			
Developer	3	3	Contractor	4	4			
Developer	3	3	Contractor	3	4			
Developer	3	3	Contractor	3	3			
Developer	2	2	Contractor	3	3			
Developer	2	2	Contractor	3	3			
Developer	2	2	Contractor	3	4			
Developer	2	2	Contractor	2	2			
Developer	4	4	Contractor	2	2			
Developer	4	4	Contractor	2	2			
Developer	4	4	Contractor	3	4			
Developer	4	4	Contractor	3	3			
Developer	3	3	Contractor	3	3			
Consultant	2	2	Contractor	3	3			
Consultant	1	1	Contractor	3	3			
Consultant	3	3	Contractor	2	2			
Consultant	2	2	Contractor	2	2			
Consultant	2	2	Contractor	2	2			
Consultant	2	2	Contractor	2	3			
Consultant	2	2	Contractor	4	4			
Consultant	1	1	Contractor	4	4			
Consultant	1	1	Contractor	4	4			
Consultant	2	2	Contractor	3	3			
Consultant	2	2	Contractor	3	3			
Consultant	2	2	Contractor	3	3			

Section C

Job Role	i	ii	iii	iv	v	vi	vii
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	4	4	4	4	4	4	4
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	4	5	5
Developer	5	5	5	5	4	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	4	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5

Consultant	5	5	5	5	5	5	5
Consultant	4	4	4	4	4	4	4
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	4	4	4	4	4	4	4
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5

Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5

Section D

Job Role	i	ii	iii	iv	v	vi	vii
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	4	4	4	4	4	4	4
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
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Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	4	4	4	4	4	4	4
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Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Developer	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
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Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	4	5	4	5	4	5
Consultant	5	5	4	5	4	5	4
Consultant	5	5	5	5	5	5	5

Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
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Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	4	4	4	4	4	4	4
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Consultant	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	4	5	4	5	4	5	4
Contractor	5	5	5	4	5	4	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	4	4	4	4	4	4	4
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
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Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5

Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5
Contractor	5	5	5	5	5	5	5