INVESTIGATION OF DEFECTS IN NEW BUILDINGS IN MALAYSIA

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

Faculty of Engineering and Green Technology

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DECLARATION

I hereby declare that this project report entitle" Investigation of Defects in New Buildings in Malaysia" is based on own my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

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APPROVAL FOR SUBMISSION

I certify that this project entitled **"INVESTIGATION OF DEFECTS IN NEW BUILDINGS IN MALAYSIA"** was prepared by **HONG CHIN HANG** has met the required standard for submission in partial fulfilment of the requirement for the award of Bachelor of Science (Hons) Construction Management at Universiti Tunku Abdul Rahman.

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Date : _____

Specially dedicated to

my beloved father and mother

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Throughout the beginning until the completion of this final year project, I have faced many kinds of challenges. Without the help of people around me by giving their support and guidance, it will become more harder to overcome these obstacles.

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INVESTIGATION OF DEFECTS IN NEW BUILDINGS IN MALAYSIA

ABSTRACT

Malaysia is among one of the development countries that growing rapidly in all sectors which include the sector in construction. Nevertheless, some of the new buildings are poorly constructed. One of the components that need attention is the defects in new buildings. The aim of this study is to evaluate the causes of defects and the objectives of this study are to determine the causes of defects in new buildings, to determine the types of defects in new buildings and to determine the solutions of defects in new buildings. A qualitative research was conducted by interviewing nine interviewees who have experienced in high-rise residential buildings. The results are analyzed by interpretation. According to the study, the causes of defects in new buildings are poor workmanship, work executed are not in proper manner, poor material usage and not according to specification, lack of supervision, surrounding temperature and environment, limited time, manpower allocation and not follow the method statement given. The types of defects are structural cracks like wall cracks, hairline cracks at joint of beams and columns, architectural cracks like plastering fall off and peeling paint, honeycomb, pipe clogged and cause leakage at toilet, roof leakage, hollowness at columns and floor tiles. The solutions to overcome the defects in new buildings are engage third party or an expert, revise back the method statement, ensure good workmanship, have a rehearsal before doing anything, give proper training to workers and ensure good quality of materials before usage. A conclusion was made and recommendations are included for future studies.

Keywords: Construction Deficiencies, Design Deficiencies, New Buildings Defects

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CHAPTER 1

INTRODUCTION

1.1 General

In this modern era, there are more and more-high rise buildings being developed by the clients or the contractors due to the reason of insufficient land use and high population of people. New buildings mean different thing to different people. In fact, there is not exact definition for what is meant by new building. However, the definition is centre around the age of the buildings. While some might considered building less than five years old as new building some might considered building less than ten years old as new. In this research project, new building is defined as building within the defects liability period. In Malaysia, the defects liability period is from 12 months to 24 months which is 1 to 2 years (Minter, 2016). After that, the buildings will be defined as new which is free from DLP.

A building is a place where people accommodate and work together or for an organisation to conduct its work (Seeley, 1987 in Olanrewaju & Abdul-Aziz, 2015). Moreover, the purpose of a building is to give a comfortable and healthy surrounding for people to conduct activities, to provide security, sustain load and environmental shelter or control (Olli, 2004). Besides that, buildings can be differentiated by its function, number of stories, purposes and there are various types of buildings. For example, residential building, commercial building, educational building, industrial building,

government building and etc. (De-Chiara and Chrosibie (2001) in Olanrewaju & Abdul-Aziz, 2015).

However, there is occurrence of defects and failures in the buildings due to various causes and building defects are still one of the major issue which construction industry need to deal with (Ahmad, 2004). For instance, honeycombs, hairline cracks at beams, faulty design, construction materials, structural cracks in walls, reinforcement bars of columns became rusty due to expose to sunlight and rainwater and etc. Apart from that, unnecessary effort was needed in order to correct the construction error which is rework (Josephson et. al., 2002). Rework will affect the performance and also the cost for construction industry. According to research from the Construction Industry Institute (CII), it shows that the direct costs cause by the rework is amount to 5% of total construction costs (CII, 2005).

Therefore, this research's aim is to evaluate the causes of defects in Malaysia buildings and this chapter contain the objectives which are to identify the causes, types and solutions for defects in new buildings.

1.2 Background of Study

The construction industry is getting more modern, technologies advance and growing day by day around the global including Malaysia. Construction Industry has a great impact on the economy of all countries (Leibing, 2001). According to Sun and Olawale (2010), the construction industry is contributed towards to the GDP due to continuous development. The Malaysia GDP shows that the construction has decreased by 11992 MYR Million in the fourth quarter of 2015 which is starting from 12125 MYR Million in the third quarter of 2015. The average of Malaysia GDP from construction is RM9215.79 Million from year 2010 until year 2015. The highest GDP is RM 12125 Million while the lowest record is at RM6464 Million in year 2010 according to Department of Statistics Malaysia, (2016). Besides that, the growth rate of an industry

was 5.3% and it contribute towards to GDP about 2.1% in year 2009 (CIDB, 2010). It also provides many job opportunities for more than 800,000 people which are the 8% of the total workforce (CIMP, 2005).

New buildings mean different thing to different people. In fact, there is not exact definition for what is meant by new building. However, the definition is centre around the age of the buildings. While some might considered building less than five years old as new building some might considered building less than ten years old as new. In this research project, new building is defined as building within the defects liability period. In Malaysia, the defects liability period is from 12 months to 24 months which is 1 to 2 years (Minter, 2016). After that, the buildings will be defined as new which is free from DLP.

Other than that, new buildings can be classifies into residential building, commercial building, educational building, industrial building and etc. (Olanrewaju & Abdul-Aziz 2015). In addition, construction of high-rise building is on-going in Malaysia and buildings can be classify into purposes, function, and types. The purpose of a building is to provide a comfortable working and living environment for people. In addition, the function of a building is depends on the design of a building, to conduct activities, to provide security and environmental shelter. There are many types of buildings but in terms of height, it consists of high-rise building, low-rise building, and mix-development building. High-rise building is defined as a building which it is more than 20 stories. However, various types of defects can be found inside the buildings.

A defect is generally described as deterioration, damages, default or deficiency (Olanrewaju & Abdul Aziz, 2015). According to Ahmad (2004), there are usually various causes and types of defects that affect the performance of a building. For example, design deficiencies and construction deficiencies. The defects in the buildings also includes dampness, honeycomb, roof defects, erosion of mortar joint, corrosion of reinforced steel, foundation failure, peeling paint, defective plater rendering, and timber rot. All these causes have given an impact of rework to the construction industry. Rework is meant by doing something at least more than one time due to the reason not fulfilling the requirements as stated by the Construction Industry Development Agency

(1995). In addition, the cost of rework is amount to 5% of the total construction costs (CII, 2005). For an example, the construction industry of United States expended $1,502 billion in 2004 for total construction cost (Bureau of Economic Analysis 2006) and $75 billion was wasted by rework cost in year 2004.

Besides, there are few stages of defects which are patent stage, latent stage, progression stage and recurring stage. The patent stage and latent stage defects often can be seen in new buildings and the defects occur throughout the building life cycle (Olanrewaju & Abdul-Aziz, 2015).

On the other hand, the types of defects that affect the building is poor workmanship, construction material, lack of supervision and maintenance, limited time and cost, faulty design, climatic condition, and external environment (Ahmad, 2004). The reason why defect occurs in the buildings might have due to non-compliance with the Building Code and does not follow the standard procedure when constructing the work. Therefore, maintenances are needed in order to prevent these types of defects from occurring.

Maintenance of building is essential in order to sustain and preserve the building to an acceptable condition. Acceptable standards mean to sustain the utility and value of the facility. Moreover, the purpose of maintaining the building is to retain the value of investment, maintain the building in a good condition so that it can provides its function fully and have a good appearance (Al-Hammad, 2014). However, the expenditure cost for maintaining the building is high and it will continues or even to increase the cost in the future. According to Rendeau et al. (2006); Booty (2006), it shows that 70% of the operating costs from the building is contributed towards to maintenance considering the fact that more than 90% of the life time of a building project, it requires maintenance work.

The contractor also responsible for repairing the defects that have appeared in the contractor works within 12 or 24 months from the date or practical completion (Minter, 2016). During this 12 or 24 months, any defects that occur under the contractor works, the contractor need to repair it immediately under the contractual obligations. Usually,

the defects occur in the new buildings are due to the designer latent stage defect and also the contractor patent stage defect (Olanrewaju & Abdul-Aziz, 2015).

Latent defect is meant by defects caused by failure in design, workmanship or materials. Besides, the defects are in concealed situation and not obvious and the errors will only be visible after the element is constructed and used for some time. The example of latent defects are lack of reinforcing in the concrete structural, improper installation of waterproofing system, adulterated paint and corrosion of rebar, etc. Apart from that, patent stage defects are those defects that are visually obvious and can be seen easily. The example for patent stage defects are cracking occurs at the building envelope, handrails omitted at the stairways and etc. (Frank, 2013). The patent and latent stage defects normally can be seen in the new buildings and the contractors need to rectify the defects during the liability period.

In Malaysia, high-rise buildings less than 10 years old would have structural defects that can cause danger to the residents and also to the public (Anthony, 2013). In fact, all new buildings have problems in defects like surface cracks, leakage occur in electrical riser or shortcoming in workmanship. The reason why many defects occur in the new high-rise buildings was due to poor workmanship of the labour, lack of skilled supervision and etc. The most important is many new high-rise buildings have defects from the moment of completion.

Based on the research done by Anthony (2013), he has inspected more than hundreds of old and new high-rise buildings in the nationwide and found out that many defects occur in the new buildings that they have inspected for vacant possession. Normally, there is a 24 months of liability period for the owners to submit a complaints to the developer to rectify the defects. The owners are just concern about their own units but no concern about the common facilities like elevators, swimming pool, pathway and etc. Table 1.1 shows that types of defects in new buildings.

Table 1.1 Shows the Types of Defects that are Found in New Buildings

No.	Types of Defects in New Buildings	Descriptions
1.		Foundation Failure at the Column at ground floor due to rebar not installed properly.
2.		Core tests were conducted at the lift-core wall because many structural cracks are found.
3.		Honeycombs were found at the ground floor located near carpark.
4.		Further hack at the ground floor to inspect the column stump.

No.	Types of Defects in New Buildings	Descriptions
5.		Cracks were found at the edge of the windows at 12-storey height new building.
6.		The paint starting to peeled off at the ground floor of the carpark area.
7.		Dampness are found at the ceiling of first floor of 19 storey height building.
8.		The consultant requested the worker to remove excessive of honeycombs that are found at ground floor of the building.

It is important to conduct inspection regularly to the common facilities or area, not only to own units. Besides, it is good if the owners can visually check the defects by their ownself and if find out anything that is not right, get advice from the experts. Other than that, the cost for inspect the buildings is negligible if the inspection done at the earlier stage. Besides, the rectifying cost can runs up to millions if no precaution steps are taken against it.

In a nutshell, the management of the buildings should always conduct inspection in order to prove safety for the building residents or tenants and they can identify any defects at the early stage and rectify it to provide safety and health for the residents. By thus, the purpose of this research is to determine the causes and types of defect in new buildings in Malaysia and also to determine the possible solutions for the defects.

1.3 Problem Statement

Construction deficiencies such as poor workmanship and low quality of materials, design deficiencies like not according to the specification and faulty design, limited time and cost, external environment and etc. lead to various types of defects in new buildings. In Malaysia, defects in new building are too many unabated and the impacts of defects are high maintenance costs, poor user satisfactions, dangerous to the tenants and the buildings cannot function properly. While there is information on defects in buildings in general, such is not available for new buildings, though theoretically, new buildings should be free from defects. Therefore, this research project aim to evaluate the causes defects in the new buildings.

1.4 Aim

This research aimed to evaluate the causes of the defects.

1.5 Objectives

In order to achieve the aim of this research the objective has been listed as follow:

- To determine the causes of defects in new buildings
- To determine the types of defects in new buildings
- To determine the solutions for defects in new buildings

1.6 Research Scope and Limitation

This research is mainly focus causes, types and solutions for defects in new buildings in Malaysia. Qualitative method which is interview will be used to collect the data from the interviewees. The limitation of this research is limited of time. Therefore, the interview can only be carried out at Batu Kawan which is located at Penang.

1.7 Significant of the study

Every new buildings will have issue regarding the defects that occurring inside it. All these issues have brought negative effect to the building. For example, honeycomb which is often to be seen, hairline cracks occur at the joint of the columns and beams, dampness and etc.

Therefore, the significant of this study is to find out the major causes of defects that occurring in the new buildings and determine a possible solution in order to minimize the defects. Other than that, the reason why I select this topic for my research study is because I personally interest in understanding the problems in a deeper manner and want to gain more knowledge and also experience so that it would be useful for me.

1.8 Report Organization

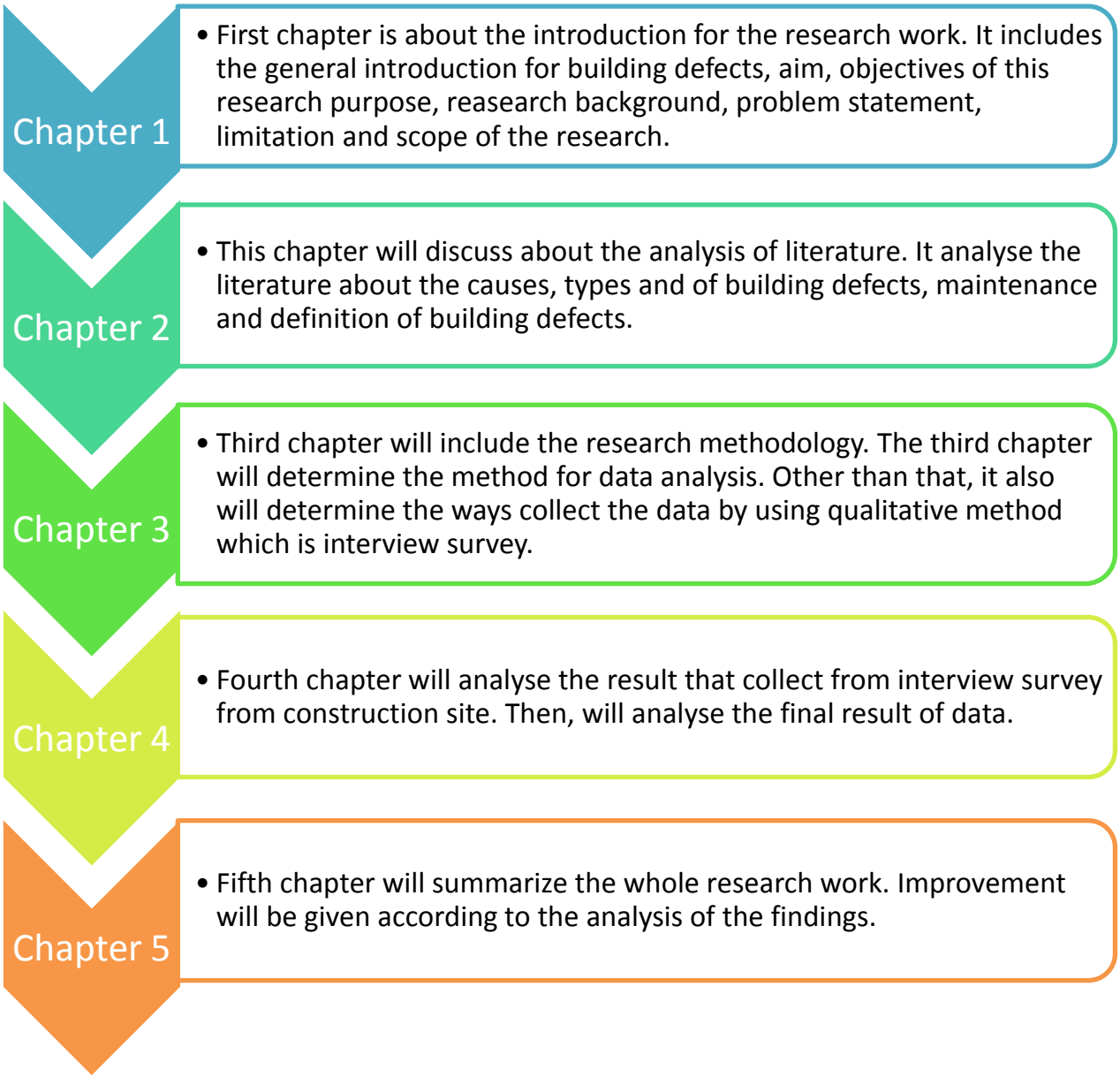

Figure 1.1 Flow Chart of the Organization

1.9 Chapter Summary

This chapter basically explain about the research background, problem statement, the aim and objectives, scope and limitation as well as the report organization. There are three main objectives in this chapter which is to determine the causes of defects in new buildings, second is determine the types of defects in new buildings and third is to determine the solutions for the defects in new buildings. The problem statement need to be clear in order to explain the situations that are facing in Malaysia new buildings.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review is the process of understanding and reading the similar topic journals or articles with this research that had been published on the websites for us to be referred. Besides that, the effort and the research shared by the author are helpful to this research. Therefore, by understanding and referring to their research journals, much information that is related to this research can be found. In this research, it will talks about the definition of defects, the causes and also the types of new building defects, building maintenance and defects liability period as well.

2.2 Definition of Building Defects

According to Webster's Dictionary, building defect is meant by missing of something important to achieve perfectness or in other words, shortcoming (Ahzahar et al., 2011). Moreover, defects also defined as improper condition that may cause impact to the building structure, leading to low quality and performance of the building

(Burden, 2004). Defect that occurred will not only cause aesthetic problems but also will affect the safety of the users (Che-Ani et al., 2011).

Besides that, defects also being defined as not perfect, faulty; and also blemish. Another meaning for defect is deficiency which does not meet its expected performance criteria. The Dictionary of Webster interprets the meaning of deficiency that will cause the quality to be affected. A building defect also can be defined as any issue that can reduces the value of the residential buildings, or home and it is dangerous to building occupants if being neglected.

Moreover, building defects can categorized into two types. First one is the defect that will eventually affect the appearance of the structure while the second one is defects that affect the performance of building structure. A building defect also is a violation of the applicable building code and violation of standard of care in community in which the project is located or violation of manufacturer's recommendations (Robert, 2007). Error in design, inferior materials, fault design, lack of maintenance and etc. can cause defects in building.

Normally the defects that occur in the buildings are structural defects that cause cracks, faulty ventilation, inadequate of fire and sound proofing, etc. In addition, timber rot, dry and wet rot, fungus and mold infection can be happen due to result of building defect. To identify the defects in a building, experts such as experienced engineer or the architects are required in order to determine the root cause of the defects.

2.3 Causes of defect in new buildings

There are many causes that lead to defects in the new buildings. The defects in new buildings are due to reason of design and construction problems which is poor workmanship, construction materials, faulty during construction, and not according to the specification, etc. Other than that, climatic condition, lack of maintenance, external

environment, limited time and cost will also cause defects to be occurred. All these causes will eventually reduce the value of the buildings and the cost of rectifying it will be expensive if the defects are being neglected by the occupants (Anthony, 2013).

2.3.1 Construction Deficiencies

According to the Building Research Establishment (BRE) in U.K., it founds out that building errors are due to the poor design stage which contributed to 50% and construction stage which contribute to 40% and another 10% is because of the product failure (Robin, 2013). According to Love et.al (2004), the main factor that affects the quality goes on to the design which is documentation that is unclear and missing, poor coordination for the design and poor workmanship.

In addition, a survey has been done that the aim is to determine the methods to enhance the quality control in the building works by using questionnaire survey. The respondents are required to review the design and structure of the survey critically. The result shows that the architects were contributed to 30%, contractor is 50% and the project manager is 20% (Love et.al, 2004). The construction defects caused by human sources are as shown in Table 2.3.1.

Table 2.1 Distribution of Human Sources of Construction Defects

Type of Sources	UK (%)	Average for the rest of the developed world
Construction ✓ Low Quality of Workmanship ✓ Lack of Supervision ✓ Vandalism	**50**	**40**
Design ✓ Inaccurate Specification ✓ Low quality of materials and design ✓ Poor Detailing	**40**	**45**
Products ✓ Faulty Manufacturer ✓ Products damaged during delivery ✓ Products damaged because lack of protection and no storage provided	**10**	**10**

Source: David, (2007)

2.3.1.1 Poor workmanship

In Malaysia Construction Industry, poor workmanship problem in site always has been a highlight is the media especially through newspaper and the result of poor workmanship and low quality of materials being used which has been identified as major causes of defects occur in construction projects when developing new buildings (Abdulrazak et al, 2010). Besides that, the factors that contribute towards the poor workmanship includes lack of supervision, lack of experience and competency from the labours, barrier in language and lack of communication are factors that causes poor workmanship as well.

According to Anthony (2013), he mentioned that residential buildings that are newly constructed experienced defects due to the reason of poor workmanship by the contractor or developer (Anthony, 2013). However, the contractor plays an important role in construction site when constructing buildings. This is because they need to supervise all the works from piling of work until completion of the project. If no proper supervision be done, the workers may simply construct the structure without the notice from the site staffs. Therefore, it is important to always supervise the workers work when concrete work takes place or when installing formwork and etc.

Other than that, lack of experience and competency from the labours also a factor that will cause poor workmanship to be occurred. According to Kasun and Janaka (2006), the productivity cannot be achieved by speed and harder work without adopting a better work practices. Moreover, the main issue that the stakeholders from the construction industry worry about is lack of skilled workers (Jorge et al., 2005). The construction company in the country of Turkey like to employ labours that are used for short-term only and most of them have no experience and knowledge about the construction work (Kazaz and Birgonul, 2005).

Besides that, barrier in language and lack of communication will cause poor workmanship in construction site. This is because of different language used by the local labours between the foreign labours. According to the research done by Augusto et al., (2009), it founds out that 82% of the respondent in the survey identified that the general

problem that they face in the construction site is the obstacle of language when try to communicate with the foreign labours. In addition, according to a survey that has done by Kasun and Janaka (2006), it shows that more than 40% of the respondent that are working in the construction industry complained about lack of communication between each other. As a result, a barrier in the communication and language will cause misunderstanding between the local and foreign labours when working and this will lead to poor workmanship.

However, there are also possible solutions in order to minimize the problem of the workmanship. For example, by giving training to the workers, have a good construction management, strict supervision and good communication among the construction parties. By providing training and provide experience to the workers, it can ensure a good quality of the project (Chan et. al., 2006). Besides that, the quality of the construction project will be satisfied by enhancing the capability of the site workers.

According to Ghaffar et. al. (2010), the supervision of the workers need to be taken seriously in the site. This is to ensure good quality of workmanship and the supervisors need to supervise the workers everyday. By doing so, the problems that arise due to the workmanship can be identified and the repair work can be done immediately. Apart from that, a good site manager need to have the ability to arrange, manage and lead the work efficiently and effectively so that it would not affect the productivity of the labours in site (Dai et. al., 2009). In a nutshell, a good management in the construction site is very important for every types of construction projects.

2.3.1.2 Construction Material

The failures and defects that occur in the building is due to material of construction whereas the behavior of the structure will be determined by the construction materials. In addition, the behavior will also determine whether there will cause any defects to be happened in the future. The effects of using low grade of materials will also

slowly start to take effect like a cancer in a concrete, maybe after one or two years time. For example, the bricks that delivered to the site might got defects or when driver deliver to site, he may no cover the bricks up and let it exposed to hot weather and rainwater condition. This may reduce the quality and lifespan of the bricks.

Sometimes, the irresponsible parties like subcontractor will have intention to lower down the quality of the materials so that they can minimize the cost for the materials. This will eventually downgraded the quality of the materials and cause defects occur in new buildings faster.

2.3.1.3 Complicated Role of the Subcontractor

According to Khalid et al. (2006), the deficiency in the construction is due to the role of the subcontractor. This is because subcontractor plays an important role in construction site. Most of the construction work is being done by the subcontractors while the main contractors are just depending on the subcontractors to done the work (Khalid et al., 2006). In addition, about 90% of the construction work is done by the subcontractors whereas the main contractor will be just focusing on the coordination and management only (Khalid et al., 2006).

Other than that, the labour of the sub-contracting also arise severe issues in the co-ordination of work and attainment of the quality standards (Chan et al, 2006). This is because there are many types of subcontractors involving in a same project and this will cause the main contractor has difficulties in inspection, supervising and also controlling the works that have done by the subcontractors. This will eventually cause poor workmanship to be occurred.

2.3.2 Design Deficiencies

A defect that occur in the design normally is due to the failure that cause by the design professionals. This is because they have failed to produce an accurate and a complete set of drawing and also the construction documents. In addition, a design defect also known as latent defect (Olanrewaju & Abdul-Aziz, 2015). The defect in the design can be classified into two types which is design error or omission or both.

An error in the design is being defined as a mistake where the elements of design was constructed or under construction and it requires replacement of the components in order to correct the error. Normally under this kind of circumstances, the cost of changing will cover by the design professionals due to the design error.

An omission of design is meant by the scope is either missing or omitted by the designers in the design stage and the construction documents but it was later discovered and being add in to the scope of work by a Change Order (Frank, 2013). Other than that, the design omission also consists of design items that are not correct but it were corrected after the award of the project and before the construction process was materially affected. Typically, it is understood that some premium costs over and above the actual cost of the changed work are paid for the work that was not competitively priced. These additional costs are directly attributable to the design professional as an omission. Typically it has been determined that 15% of the cost of the Change Order represents the premium costs that are attributable to the design professional as a result of its design omission (Frank, 2013).

This type of defect can be occurred when the people do not proceed the job with the given specification responsibly (Long & Robinson, 2014). The consequences of this will cause the structures that have completed does not follow the building code. The common design defects is the defective basement tanking that allow water to penetrate, misplaced of reinforcement bar allow the movement that cause damage to the structure, inadequate foundation that cause subsidence of the building and roof is the most common mistake for design deficiencies (Long & Robinson, 2014). Improper of design will cause leakage to be occurred.

Other than that, the design defects can be detected during the execution phase of the projects; the design problems are mainly:

1. Low quality of design: the drawings are incomplete and inaccurate. The specifications of the drawing structure are hard to handle and sometimes it is being ignored by the designers. Moreover, the design documents always have omissions and errors, and lack of clarification during the presentation. This is cause the person that in-charge would not have the information when he needed and also will have wrong information to conduct the job.
2. Low quality of design standards: The poor standards in the design stage and short suitability for the existing technology will eventually cause a low quality of standard in the design.
3. Low quality of constructability: The important issue that they found out during the construction work is due to the reason of insufficient of constructability for the design stage.

In addition, the details of the drawing that are not defined by the designers will eventually cause a problem to the contractor. This is because they need to solve it by their own and normally the problems are found out after the job has completed and before construction work start for the particular work.

2.3.2.1 Faulty Design

In every construction site, there must have a faulty design. Error in the design is often to be seen in order to save the initial construction costs. This is because construction cost plays an important role when designing the building. Besides that, faulty design that occur in the building does not represent is the poor performance of the architect or designers of the building. If there are failures happen in the design stage then it will eventually lead to deficiencies of the structure after completed the construction.

There are few factors that affect the design of the building. For example, physical geographical location, the availability of building materials, construction and building technology, availability of human resources to manage the process and lastly is the constraints of a legal framework.

Errors in design will not only give negative impact to the occupants but also cause the building safety not being guaranteed. Normally, the common design fault in construction is such as: poor detailing implementation, poor selection of materials and products, failure of design review with change of brief, and flawed structural calculation and loading provision.

All this design error will eventually affect the structure and it will cannot support the load properly and then collapse in the future. Sometimes, misjudgement for the building design will lead to assumptions or decisions that are not consistent with actual behaviour of the structure (Brown, 2001). Besides that, a faulty in the design during the construction site had mainly caused buildings to be collapsing but the legal action against the offenders through the proper investigation is being abandoned due to various types of factors. Meanwhile in Malaysia construction Industry, faulty construction is also the main causes for building defects and failure cases. Therefore, the contractors are responsible to construct the building by using better grades of materials, concrete and method that are according to the specification with permission by the client and the consultant.

2.3.2.2 Not according to the specification

The contractor should work according to the specification given by the architect and report to the architect if found out the work is not compliance with the specification. A good project has its own procedures to be followed to prevent any unwanted errors to be happened during construction work. Mostly the designer will provide the

specification to the contractor to follow but some contractor will choose to apply their knowledge and experience in the work instead of using the designer specification.

2.3.2.3 Inability to interpret construction drawing

This issue normally happens in construction site. The background of each project manager or the supervisor is different. According to Okuntade (2014), defects occur in the site is due to the contractor unable to explain the drawing to the workers because of his poor technical background. This will eventually cause faulty design to be happened and rework need to be done for it.

2.3.3 Climatic Condition

According to Dai et al., (2009), it stated that extreme weather condition is one of the factors that affecting construction labour productivity and workmanship. This will lead to the factor that cause defect to occur in new buildings. Extremely hot condition will not only affect the workmanship but also will cause crack lines to the wall that facing the sunlight under high temperature. This is because hot temperature will absorb all the moisture and water in the concrete. Example from the research of Faisal et al., (2006) found that the temperature of Saudi is hot and causes some of the construction works very hard to carry out, such as concreting has to be stopped. This will cause the quality of workmanship to be affected.

2.3.4 External Environment

Defects will not only being affected due to low quality or workmanship, wrong design in the structure and lack of proper maintenance but also will affected by the external environment condition. The building's surrounding environment will give an impact to it as well. This is because Malaysia is a hot weather country with high amount of rainfall when almost end of the year and strong with UV rays which can damage the building surface and structure seriously. Moreover, the effect will increase the rate of building defect to occur more faster than ever. The surface of the buildings constructed at different site will exposed to different temperature and the structure affected will not be the same also. According to (Seeley, 1987 in Olanrewaju & Abdul-Aziz, 2015), it shows that new buildings that constructed near to industry place will have greater environment issue compare to those buildings at modern city. Besides, high – rise building will have higher chance of risk because they expose to UV rays and acid rain first.

2.3.5 Limited Time

In construction Site, the client and contractors are emphasize on time and speed of completing the project. Contractors always speed with time by complete the project before the dateline. For the contractor, delay to the completion of the project may result in a liability for delay damages to the employer. Therefore, it caused the construction projects executed in a rushed manner. In a consequence, the quality of workmanship may be questioned by the client or the user.

2.3.6 Limited Cost

The amount of cost or budget will determine whether the site would have an adequate allocation of cost in the project. If there are limited cost, then the contractor may cut down the cost for the material and also the labour cost. This will not only affect the quality of the materials being used but also affect the labours supplied. It is because by using low quality of materials like inferior materials will lead to defects in a building. Moreover, insufficient of labours supplied will lead to insufficient time to complete the project and need extension of time (EOT) (Atkinson, 2016).

2.4 Types of Building Defects

Defects that occurring in the building are due to poor workmanship, lack of supervision and etc. There are various types of building defect can be found in the building, regardless of the age. According to Sommerville, (2007), in new build projects, we can see defects and rework happen. The example of types of defects are, peeling of paint, roof defects, dampness, damage of exterior surface, corrosion of reinforced steel, cracking, foundation failure and blemishes which is honeycomb.

2.4.1 Peeling Paint

Normally, we can see the paint peeled off from the wall, mainly is on walls that already plastered (Ahmad, 2004). Other than that, building columns and other parts of the building which expose to sunlight and rainwater also will cause peeling of paint to be occurred. Especially for the high rise buildings like hotels constructed near the sea will have higher risk of getting the paint peeled off from the surface of the walls and it will become chalky in colour. This is because it exposed to high amount of rain and sunlight.

In addition, there is another issue that cause the paint to peeled off from the wall which is the quantity of paint applied on the surface of wall. The thickness of one layer coat of the paint is roughly 0.01cm according to Miles, (1976). The thickness of the coating will affect the components of the building which the paint covers.

Other than that, quality of the paint is also important for the building as it will affect the degradation of the paint. Nippon Paint and Jotun are paints that have better quality and will keep the surface of the wall not to degrade faster (Low and Mydin, 2012). Moreover, the paint can be peeled off if using different type of painting for the wall surface. This is due to the reason every paint has different substances or chemical inside it. Therefore, it would cause the paint peeling to be occurred.

2.4.2 Roof Leakage

Roof plays an important role in the building structure. This is because it acts as a weather shield for the building. Besides that, it also protects the occupants inside the building from heavy rain and excessive sunlight. According to Chong, W. and Low, S. (2005), he found out that by reducing the defects at the roof may also reduce the possibility of leakage at the roof and increase the duration of life span for the roof. The greatest threat for the roof is the penetration of water which means leakage. Normally, roof defects are due to unsealed penetration, roof tiles have missing or improper installation of the underlayment.

Moreover, leakage at the roof may cause staining occur to the ceiling and the drywall. Whenever there is a staining, moisture can be seen and it will started to rot the wood frame and this is weaken the integrity of the structural. Presence of moisture in a long duration can cause mold to grow on the walls as well. Roof defects can be classified into two types which is flat and pitch roof defects (Yahaya, 2007).

2.4.2.1 Flat Roof Leakage

This kind of roof is widely use in UK after the World War II. Flat roof is cheaper than pitched roof. Although the cost of it is lower but it can be prone to defects.

According to Peter Barry (2010), flat roofs have a minimum gradient of 1:40 and they are not technically flat. Where the appropriate fall has not built accordingly or been caused by the movement of structural, a 'ponding' will be formed. For example, the rainwater will settle on the surface of the roof (Peter Barry, 2010).

Other than that, ponding can be formed due to various reasons. Poor edge detailing of the parapet and the flat roof, differential movement of the slab and waterproofing membrane system, caused by ultraviolet radiation and moisture is trapped inside it.

2.4.2.2 Pitch Roof Leakage

Pitched roof is form by two pieces of angles which meet in the centre. It also provides more stability and structure compare to flat roof and as well as excellent drainage in places that receive high amount of rainfall. Besides that, pitched roof is cover by using clay tor concrete tiles, slate and synthetic slate. However, various types of defects may occur by using pitched roof. For example, deterioration of the surface finish with subsequent moisture penetration, insufficient pitch with backflow, the overlaps of the material joins are insufficient and flashing failure at juncture of roof and the wall.

Apart from that, the installation for pitched roof is expensive and due to the design of the roof is very complex, more labours and materials are needed to support the roof. The pitched roof also will cause the depths of the house footings because it places larger burden on the foundations of the buildings.

2.4.3 Dampness

Dampness is among one of the building defect issue in the building. High amount of moisture or dampness of a building will cause physical or chemical deterioration of the building according to (Haverinen, 2007). Moreover, dampness will cause serious risk and also will affect the performance of the building. A new building should not have the presence of dampness and there are few reasons that cause dampness to happen such as leakage of the downpipes or the gutters around the buildings and drains that malfunction (Ahmad, 2004).

According to Bornehag et al (2004), dampness is also a risk factor for the symptoms of asthma. In the country of Ghana, a research has shown that dampness in a building have cause many problems to arise (Agyekum et al., 2013). If there are any dampness occurring in the residential building, it must be treated immediately in order to avoid deterioration to occur and damage the health of the occupants.

2.4.4 Erosion of Mortar Joint

The factors that cause erosion in the mortar joints are due to the action of weathering, influence of thaw and freeze cycle and unaccommodated of the building movement. We can predict or avoid the weather condition and the influence of rain water and strong wind will erode the mortar. Especially acid rain will penetrate easily inside the mortars that are lack of Portland Cement. If the mortars are expose to excessive acid rain, the mortar joint can be reduced to several inches and normally the action of weathering will cause the masonry to be deteriorated.

An open mortar joint will cause the moisture to enter inside easily can it can freeze or expand a part of joint and will cause the masonry to pop out. This process is called spalling and it will keep repeat the same cycle until it causes a failure in the mortar joint.

The movement or uneven settlement of the foundation for the building will cause cracking in the masonry and moisture can penetrate inside the mortar joints. This will cause the masonry to be contract and expand. By doing so, it will breaks the bonding between the mortar and the units.

2.4.5 Corrosion of Reinforced Steel

According to Sheena, (2008), there are various concrete structure have been repaired because of the corrosion of the reinforcement steel. The corrosion in the reinforced steel will affect its structural components or performance. There are few factors that cause corrosion to be occur in the reinforced steel. For instance, quality of the concrete, the cover thickness, and crack lines that cause the water to penetrate into the steel bar and inadequate of concrete curing (Raupach, 2006) will cause the steel bar to corrode easily.

Normally, the reaction of the chemical that cause corrosion in the reinforcement steel bar is as following (Berkeley, 2001);

1. Concentration of the chloride and oxygen
2. Penetration of the carbonation
3. Action of the bacterial
4. Access of the moisture

Apart from that, the quality of the concrete will affect the rate of corrosion by limit the penetration of any harmful substances such as oxygen. Besides, the concrete quality can be enhance by lower the water-cement ratio and add in supplement for the cement materials. The thickness of the concrete cover also will affect the penetration of harmful substances into the steel bar. If not maintain it properly, it will cause the reinforcement steel bar to be exposed fully.

Furthermore, the amount of crack line that occur will provide a way for the harmful substances such as chemical, water and oxygen enter into it. The main cause for corrosion to be occurred is normally due to oxygen and water presence in the reinforced steel. The process for this both substances is called electrochemical. There will be no corrosion take place if one of the substance is absent in the process of electrochemical.

Corrosion of the reinforcement steel bar can be prevented by using a watertight concrete and cover works must be done properly as well. Concrete that are highly impermeable will prevent the rebar from corrosion. Besides, by using cathodic, it can prevent corrosion by reverse the process of electrochemical that can cause corrosion. Sufficient of sealers that apply on the reinforced steel bars like epoxy coating, acrylic sealers can stop the corrosion from happening.

2.4.6 Cracking

Cracking normally can occur in various elements in the buildings. For instance, walls ceiling, columns or beams. Moreover, cracking also is a sign of corroded reinforcement. Precaution steps can be used to reduce the cracking that appear in the buildings. The cracks can be classified as structural and non-structural cracks.

Structural cracks usually can be found in wall, columns or the beams and it is cause by dead loads or other forces that applied on it. Other than that, poor soil bearing, poor construction site and overloading may cause structural cracks to be formed as well (Admin, 2015) while non-structural cracks will occur because of the internally induced stresses in the building materials.

Normally, the structural cracks can be seen is tensile, compressive and shear cracks (Ling, 2006). If the elements of the structural fails to hold any of the imposed tensile load, then it will cause cracking occur in the tensile. The slab and beams occur such cracks usually. Besides that, the elements also subjected to shear cracks. When the

compressive strength of the material is lesser than the imposed loads, then the compressive cracks will happen. Columns usually have this kind of issue.

In addition, many types of cracks can be occur in the surface of the concrete such as: transverse and longitudinal cracks, surface and map crazing, shrinkage drying due to long term of duration, plastic cracks and thermal contraction in the early stage.

2.4.6.1 Transverse cracks

Excessive of loading from the structural, thermal contraction or the condition, shrinkage of the concrete will cause the transverse cracks to be occur after hardened of the concrete.

2.4.6.2 Longitudinal cracks

It occurs directly to the reinforcement bars. Rusting of the reinforcement bars will cause the cracks to be happened and it will eventually lead to spalling and the cover will loss completely.

2.4.6.3 Shear Cracks

Any loading or movement from the structural of the building will cause the crack to be occurred. Besides that, this type of cracking will happen when the capacity of the shear elements are lesser than the shear force that applied on it.

2.4.6.4 Plastic settlement cracks

A high amount of bleeding and restraint in the construction work will cause cracking in the plastic settlement to be occurred. Meanwhile, the concrete can be solid and water will bleeds only at the top if the mixing of concrete is workable. Normally, the cracks will forms longitudinally all over the reinforcement bar.

2.4.6.5 Crack in Plastic Shrinkage

Malaysia is a hot country and will cause moisture to evaporate quickly. This will cause the cracks to be occurred easily when construction works are on-going due to high amount of moisture being loss from the surface of the concrete. If the cracks contaminated by the salts or dust, then it will cause harm to the concrete.

2.4.6.6 Crazing Crack

This type of crack usually is a fine cracks only. It is common in the buildings and is cosmetic issue. We cannot see the cracks but when they surface of the concrete is wet and it is dry, we can see the pattern of the cracks. The causes of this type of cracking is due to insufficient of curing, the mixing is too wet, finishing take place when the bleeding still occur in the surface of it and reaction of chemical like carbonation where the reaction took place between the carbon dioxide and the cement.

2.4.6.7 Map Crack

This type of crack also known as pattern crack. It is common to be seen in any of the concrete structure. The main cause for this crack to be happen is because expansion due to the reason of alkali-silica reaction (ASR) and the drying of the concrete surface and cause shrinkage. It can be prevented by prevent adding of water or finishing take place while bleeding still occur (Hanley, 2001).

2.4.7 Foundation Failure

Every building has its own foundation. It is important because it supports the building structure and prevent it from collapsing. Besides, foundation also helps in distributing the loads from floors and roofs to the earth below. Settlement will also occur if there is a foundation failure. The causes of this problem is due to overloading of the foundation, movement of water under the ground, the condition of the soil is poor and the bearing capacity of the soil is uneven, material use for foundation will cause the foundation to perform its serviceability or function to the new building (Amobi, 2006).

2.4.7.1 Overloading of foundation

Overloading of foundation occur is because of additional load is added by building in extra floors to an existing building. This is cause the foundation cannot support the new load and cause the building to collapse of have cracks at the surface of the exterior wall.

2.4.7.2 Movement under the ground

Any movement under the ground will eventually affect the foundation of the building. The major cause that causes the movement under the ground is due to the presences of flow of water. For hill slope place, landside will occur more often when there is a heavy rain. Other than that, vibration, settlement that are not equal, and subsidence from the mining will cause movement under the ground and the foundation to become loosen or collapse.

2.4.7.3 Construction Material

To determine whether the stability of foundation is good, the use of material is also important. This is because it can affect the concrete strength and to make sure the foundation can have a higher life expectancy. Moreover, the materials use for foundation should also made from good materials so that it can perform its function well even though there is a presence of water.

2.4.8 Blemishes (Honeycomb)

Honeycomb meant by spaces that are hollow or cavities that are not filled by mortar (Charles, 2012). The pattern of honeycomb looks like a honey bee nests. Besides, the form of honeycomb may be seen obviously after the formwork is removed, reveal a hard and ‘stony concrete surface with air voids occur in the coarse aggregate.

Apart from that, honeycomb can occur more inside in the concrete and honeycomb normally is an aesthetic problem for the contractor and the depth and extend of honeycomb will reduce the performance and strength of the member. The presence of

air bubbles will cause the honeycomb to be formed at the surface of concrete and it will cause the separation of aggregate and mixture of cement. By doing so, it will cause damages to the concrete.

Honeycomb occurs are due to few reasons. For example, lack of vibration when concreting works are on-going, poor sampling, incorrect placement of the reinforcement bars, inaccurate of water cement ratio will cause honeycomb to occur (Schultz, 2014). Other than that, by using a good mix design, vibrate or compact the concrete evenly, use formwork that are good in watertight and avoid segregation to take place by pouring the concrete properly can prevent the honeycomb from occurring.

2.4.9 Defective Plaster Rendering

The coating of the mortar is like plaster or the render at the block work. The plaster is known as a coating at the inside of the wall while the coating at the outside of the wall is known as render. Both is a different thing and have different function. The function of the plaster is to make the wall feel smooth, can clean it more easily and have a good appearance. Furthermore, the plaster is a fire protection, resistant to the abrasion, breathable for the walks and can use for decorating. Other than that, the renders is used to protect the plaster from the weather.

Apart from that, plaster rendering that are defective occurs at the external surface of the building walls and ceiling. The defects in the rendering occur is because of the attacks from the biological like acid rain penetration, pollution of the air, hot temperature and dry out of the external walls. The growth of mold or invasion of insects will also cause the defect in plater rendering. Plaster rendering can be classify as few types which is plaster cracks, shrinkage cracks, and plaster fall off from the ceiling. These three types are the most common defect to occur for plaster rendering (Low & Wee, 2001).

2.4.10 Timber rot

Timber will start to deteriorate when it exposed to the penetration of water and excess moisture contain inside it. Generally, timber decay can be classified into four types which is biological deterioration, chemical deterioration, physical deterioration and mechanical deterioration.

2.4.10.1 Biological Deterioration

The deterioration of biological is caused by living organisms. For example, fungi, termites, insects. Fungi can be classified into brown rot, soft rot and white rot. The fungi will attack the timber that consist of high moisture condition. Other than that, the moisture content of timber that is below 20% will immune to the fungal attack; above this level, the temperature below 30'c, the timber will at high risk (Che-Ani et al., 2008). Fungi is an organisms that can cause discolouration and decay of cellulose material for example wood (Ridout, 2000).

For soft rot fungi, it will attacks the damp wood and penetrate slowly from the surface. The impact of the attack will eventually cause the wood turns into dark and brown colour which is similar to the brown rot attack (Brian Flannigan, 2001). Soft rot can be seen mostly in the wooden windowsills and drips of water from the roof and wets the wooden materials.

Meanwhile, for the white rot decay, it normally attacks the lignin and leave a white cellulose residue that has a black lines over it and feels like sponge. Other than that, the brown rot fungi is known as dry rot fungi (Ridout, 2000) can be classified into two types which is dry and wet rot. The brown rot fungi can live inside a dry wood although no air circulation and it can reproduce quickly in a wooden structure (Zakaria, 2005). This is because they can produce their own water through metabolic processes and transport the water to the wood. Lastly is the wet rot, it will attacks the wood with

average moisture content of 40-50%. The wood colour will become very dark and brown or a black colour appearance will form on it

Other than that, timber facing a large threat which is the termite attack. Termites can improve the pH value of the soil, water and organic carbon content and porosity by cycling dead organics. Although termites are important for the ecosystem of soil but termites also can cause damages to human as well (Ghaly & Edwards, 2011).

Termites can cause damages to any unprotected timber structures, cables that are in underground and earthen dams. This attack will happened in a damp and digestible timber. In addition, the annual cost for damages cause by termites and prevention of termites is estimated in billions (Ghaly & Edwards, 2011). Termites will attack whatever materials that are made from timber and it will cause the structures to become soft then it will collapse. Materials that may attacked by termites includes window and door frames, timber door and roof struts.

2.4.10.2 Chemical Deterioration

The timber will become softened and loses its strength through high amount of concentration of alkaline in it (Ridout, 2000). This is because the timber exposed to alkaline environment. The impact and rate for the timber to deteriorate will depends on how long the timber expose, the chemical concentration and also the stimulation of the temperature.

2.4.10.3 Physical Deterioration

It refers to the aesthetic defects and imperfections of the wood. Continuous expose to high ultraviolet rays will cause defects that can pale and bleach out the natural colour of the wood. Besides that, the thermal defects can cause the surface to be chequered as a result of high temperature condition such as fire and heat (Ridout, 2000).

2.4.10.4 Mechanical Deterioration

A friction in the mechanical during the process of handling such as cutting and drying the timber can cause defects to be occurred. In addition, the effect of the wind and movement of water, light will produce stress and will result the timber to form cracks and small surface of checks (Ridout, 2000). Moreover, erosion will take place because of the weathering process and will form greater cracks.

2.5 Solutions for Defects in New Buildings

Defects are major contributions to rework. Therefore, unnecessary efforts are needed to correct it. However, defects in new buildings can be prevented and minimized by implementing a strict supervision towards the workers and also the construction of new buildings, provide training and education to the workers, communicate well with the parties that are involving inside, proper design and construction management, lastly will be the allocation of the manpower.

2.5.1 Strict Supervision

According to Ghaffar et. al. (2010), the quality of the construction of new buildings can be enhanced by having a strict supervision towards the workers. Besides, the site supervisors also need to inspect their work regularly in order to prevent the defects from become worsen. Moreover, the subcontractors or main contractors also need to carry out daily supervision to supervise the workers so that any problems regarding the workmanship can be identified immediately and rectify it before it is too late. In addition, the site supervisor and the contractors must possess such knowledge, skills and the abilities to inspect the construction work and supervise the workers effectively (Maloney, 2002).

2.5.2 Provide training and education

In order to have a good quality of construction, it is essential to have a good training and experience from the related field (Chan et al., 2006). Osama and Khan (2010) also mentioned that the quality of construction can be enhanced by improve the capabilities of the labours. This is because they will have the knowledge from the related field if they go through the trainings and programmes that will benefit them.

2.5.3 Proper communication among parties involved

Communication is very important in construction site. Communication is to deliver a message or information from one person to another. According Tai et al. (2009), he mentioned that if there are no communications, there will be no management. However, the workers got barriers in communicating with the supervisors due to the reason that they are from foreign country. Therefore, it is important to let the workers

understand what the supervisors are trying to deliver the message or information to them.

Apart from that, the contractors and subcontractors also need to communicate with each other effectively to prevent any misunderstanding especially when casting or installing formwork and concreting. One wrong information will cause the whole formwork to be installed again due to wrong communication. Therefore, a proper communication is essential in order to improve the quality of workmanship and construction by deliver correct information and message.

2.5.4 Proper design and construction management

According to Chong & Low (2005), a proper design in construction can reduce the defects in workmanship. The proper design need to be start of from beginning until completion of the whole projects in order to avoid the defects. For example, the drawings and the designs must be well-prepared to prevent rework in the future due to defects. Ali & Wen (2011) also mentioned that the construction work will progress faster and easier if the defects have been identified and remedy it immediately before it become worst.

Other than that, the proper construction management also will minimize the defects in new buildings. According to Dai et. al. (2009), the ability of the project manager to arrange, lead and manage the work will affect the productivity of the construction labour. If the project manager cannot manage and lead the construction project efficiently, then the quality issues will arise which are defects. Therefore, the project manager must possess such skills and knowledge so that he can manage and control the project fully.

2.5.5 Allocation of Manpower

According to Ali & Wen (2011), the allocation of manpower in a construction site will affect the quality of the buildings. This is because insufficient of manpower will cause the work to be done is a rush manner and therefore, the quality will be affected. Likewise, a project will sufficient of manpower will eventually produce a good quality of project. Moreover, Abdulaziz (2010) mentioned that the availability of manpower will be the sole for the source of production. Hence, the productivity in a construction is depends on the workers performance as well. In a nutshell, the allocation and management of manpower in the projects need to be arranged skilfully so that defects can be minimized.

2.5.6 Six Process to Managing Defects in New Buildings.

To reduce the defects in construction effectively and efficiently, six steps of process were introduced which are as following (Frank, 2013),

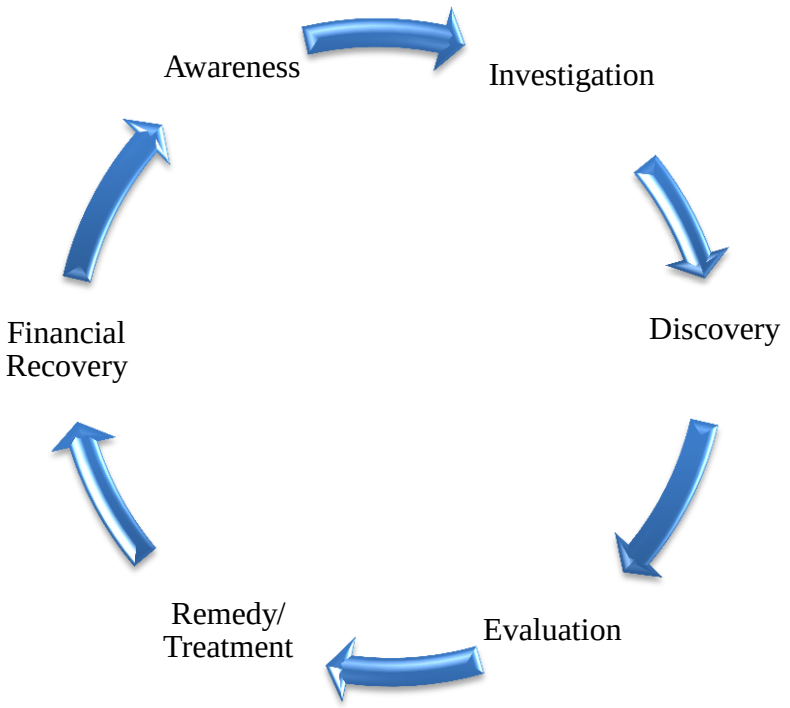

Figure 2.1 Six process to managing defects in new buildings (Frank, 2013).

2.5.6.1 Awareness

The first step in the process of the awareness is the identification of the defects in new buildings. Normally, the manifestation of the defects are usually the first clue where it shows something or part of the buildings are not quite right and a further investigation is required on it. A defect that occur in the new buildings are the results of default or deficiency of a specific part of the building systems. Deficiency or default can be broadly defined as malfunction, low quality of a system, materials or any components.

2.5.6.2 Investigation

Second step is the investigation process. After the defects have been aware, an investigation will be carried out. A detail investigation which include inspection of the buildings in order to observe the manifestation of the defects. This type of investigation is executed without any demolition work and is done to identify any conditions that may show the existence of defects.

There are two types of investigation in this process which is practical and academic value. Defects for practical value are where the defects that will cause serious harm or damages to the building structure. For example, vibration of settlement which cause the building's exterior walls started to have cracks. Meanwhile for defects of academic value, it is the small hairline cracks, minor cracks at the concrete pavement which would not cause major damages and is within acceptable structural tolerances.

The main function of this investigation is to get as much as information that is required to the owner of the buildings so that it would not incurred a great expense. In addition, an informed decision can be made about what further action is required or any recommendations that are needed.

2.5.6.3 Discovery

Third step would be the discovery process. After the investigation process has been completed, a further discovery is required in order to identify the parties that are responsible for the construction and design stages of the new buildings. For example, the determination need to be made to identify whether the materials or items that are malfunction are covered under the warranty issued by the main contractors or subcontractors. Other than that, parties that would be involved need to be notified. This is to allow them to take part for the evaluation and remedy process as well as financial recovery.

2.5.6.4 Evaluation

Fourth step is the evaluation process. The person or an individual who in-charge of the investigation need to determine and evaluate whether the defects are belongs to practical or academic value other than just to identify and observe the defects. It is advisable that all the parties for instance architect, consultants, site engineers and contractors take part in the evaluation process so that they can provide more solutions and ideas for it.

Besides that, the evaluation process need to test for the presence and hazards of the defects as identified in the first step which is investigation process. The objective of doing this is to collect sufficient information and data to detect any resultant damage. However, this investigation need to have a complete set of documents which is allied to the problems as mentioned in the questions.

Moreover, the owner or the client should be informed in order to make a decision whether to remedy the defects and look for compensation for damages from another party through the preparation of a claim. Any defect which might compromise health, safety and welfare of the public must be deal with immediately.

2.5.6.5 Remedy or treatment

After evaluating the defects the next step will be rectify it by using least amount of money. In this process, the main goal is to avoid further damages. If the defects will cause safety hazard to the buildings and also the occupants, then this step need to be follow up immediately. When rectifying the defects, the workers need to ensure that potential damages are kept to the lowest.

Furthermore, a direct and simple approach of remedy the defects will be a wise solution. However, they might deal with the replace and remove approach where some of the components and materials need to be removed because of major damages. Sometimes, this approach is not the most effective way to solve the problems. Therefore, it will be essential to the contractors and clients to think of a creative approach to rectify the defects. Moreover, not all of the defects in new buildings cab be repaired due to some circumstances like surrounding temperature and environmental issues.

2.5.6.6 Financial Recovery

Final step will be the financial recovery process. If the owner has the intention to claim for the damages, he/she should look at its insurance coverage. Normally the policies of the insurance just to cover the amount to repair the damages due to the defects but it does not cover the cost the rectify the defects itself.

However, if the insurance coverage is presence and the payment has made against it, the owner has to right to claim back the cost to repair the defects from the responsible party. Likewise, if there are no insurance coverage, the owner can make a decision whether they want to repair the defects against the responsible parties.

In a nutshell, it is to remember that no design documents are perfect and no construction can be completed perfectly as well due to some circumstances like workmanship, environmental issue and etc. A new building also has its limited useful

life and tear and wear is unavoidable. Therefore, it is important for the parties that involving in investigating the defects use an organized and systematic approach to effectively manage and determine any defects in construction.

2.6 Maintenance

In Malaysia, the buildings are built according to the standard that set by British and under strict supervision. However, in the aspects of maintenance for the buildings it is still very weak. The repair works will goes up to millions if no proper maintenance works are done for the buildings (Anthony, 2013). Therefore, it is important for a building to conduct regular maintenance to prevent unnecessary repair works. In general, the activities for building maintenance can be categorized into two types which is repair work and rehabilitation work.

Repair work is an action to be taken in order to refurbish the building into the original appearance while for rehabilitation work is to allow the building maintain to a condition which it is acceptable and normally it often needs perfection or improvements as well. Besides that, the main functions of maintenance for a building is as following (Ahmad Ramly, 2002):

I. To provide a comfortable, safe and healthy building to the occupants
II. To increase the profit to the maximum especially for owners of shaped building industry, business or private oriented
III. To get maximum performance by using lowest cost for public owned buildings, oriented security and non-profit

2.6.1 Types of Maintenance

Maintenance can be classified as planned an unplanned maintenance according to the standard of British BS3811.

2.6.1.1 Planned Maintenance

The approach of the planned maintenance is very proactive in which the work is planned to take place on a regular basis without waiting for the damage or problems occurs to act. The schedule of the maintenance scope is decided based on the previous performance and the experiences from the same facilities (Olanrewaju and Abdul-Aziz, 2015). In addition, there are two types of planned maintenance which is corrective and preventive maintenance.

2.6.1.2 Unplanned Maintenance

It is a type of maintenance where it carries out to no predetermined plan. Unplanned maintenance consist any types of maintenance activities that are no predetermined plan in all aspects. Moreover, unplanned maintenance helps to repair the faults that already occurred. It consists of all unscheduled actions performed as a result of product or system failure. Normally, this type of maintenance attempts to restore the product or system failure to a specified condition where it can function properly. Activities that are included in unplanned maintenance are such as: restore an electrical power, fixing a broken window and etc.

2.6.1.3 Preventive Maintenance

It is a type of maintenance that is carry out to a predetermined intervals or according to the prescribed criteria in order to reduce probability of failure and degradation of the functionality of an item. For instance, replace a door locks or the hinge after 5 years whether the hinge has failed to work properly or not. The requirements to do so are normally based on the manufacturer's instruction or experience. Moreover, preventive maintenance mainly focus in inspection and cleaning the building. This is to decrease the probability of any defects or breakdown work before it becomes an issue to the occupants (Olanrewaju and Abdul-Aziz, 2015).

Apart from that, by introduce the preventive maintenance to the owners of the building, it can minimize the problems of functional and structural deterioration, save more energy, health and safety of users can be improved and it can decrease the cost of maintenance by 15% if corrective actions are taken properly (Olanrewaju and Abdul-Aziz, 2015). Therefore, this type of maintenance procedures should be incorporated into a building's operational programme.

2.6.1.4 Corrective Maintenance

This type of maintenance is the simplest type of maintenance strategy, where an element in a building is used when it breaks down (Wong, 2010). Moreover, the maintenance is used in order to restore a system from a breakdown or failed state (e.g. replacement or repair of components that have broken).

The difference between the preventive and corrective maintenance is that the failure need to be occurred before any corrective action is taken against it. According to Olanrewaju and Abdul-Aziz (2015), corrective maintenance is to restore the building into its original condition and it requires regularly service or replace any components

that are broken or defective in the building. Besides, corrective maintenance require less staff because less work to be done.

However, the corrective maintenance also cause the structure of the building to degrade and the progress of the future maintenance activities will be more complicated and expensive (Olanrewaju and Abdul-Aziz, 2015).

2.6.1.5 Emergency Maintenance

This type of maintenance need to be carried out immediately in order to prevent serious consequences for the building. Examples of activities that requires the maintenance of emergency are; leakage of roof, failure occur in the lift, heavy flooding and etc.

2.6.2 Maintenance Requirement

In order to make sure the physical lifetime of a building can reach age for a longer time, the building needs a serious attention and care from all the parties that are involved. This can be done carefully and in detail in the early stage of construction work and design stage. In addition, the maintenance work still necessary in the accordance with a certain time.

Apart from that, the main concern of having maintenance for a building and its services is to ensure it can perform its designed function for a long period of time with a high degree of reliability. Other than that, the objective for having maintenance for a building is as following (Gahlot, 2006 in Olanrewaju & Abdul-Aziz, 2015).

I. To prevent the deterioration rate increases
II. To make sure the building appearance and the components are in acceptable condition.
III. To maintain the utility and also the value of a building
IV. To restore the building and its services to the original condition
V. To achieve the acceptable requirement for the purpose of safety and health

2.7 Defects Liability Period in Malaysia Construction Industry

The defect liability period is a common type of features that normally can be seen in the standard form of the contracts for construction in Malaysia. The duration of the DLP is within 12 or 24 months from the date or practical completion (Minter, 2016). In addition, the main contractor need to rectify and repair the defects that occur during the period where the Certificate of Practical Completion is being issued and the expiry of the DLP.

Apart from that, the employer normally will claim for the defective work and it is the most common claim that can be seen in every site. In addition, defects can be distinguish into two types which is latent and patent defects. Latent defects is where the error is visible only after the element is constructed and used over some time whereas patent defects are discovered through testing or inspection during the DLP.

Other than that, the provisions of the DLP can be found in the standard forms of the construction contracts as following:

1. PAM 2006: Clause 15 which is Practical Completion and Defects Liability Period
2. CIDB 2000: Clause 27 which is the Defects Liability after Completion

The DLP will begin when the works have been completed practically and have issue the Certificate of Practical Completion. However, any default, deficiencies or defects that occurs during the DLP due to the reason of poor workmanship and materials that are defective will be put right to the contractor at his own expense. Therefore, the contractor need to go back to the site to rectify and repair the defects during the DLP according to the contract where the contractor responsible for any defective work that occur in the new building.

Normally, the employer will give priority to the original contractor to remedy the defects before he employ other contractor to repair the defects. The original contractor is responsible to carry out the remedy work with a cheaper cost and it will be more efficient than the employer to employ other party to remedy the defects work.

In conclusion, new buildings are defined as buildings that are under defects liability period. In the DLP, the contractors need to rectify all the defects that have been listed under the list of schedule of defects. After they have rectify all the defects, then only the architect will issue the certificate of making good defects for the new buildings. This will eventually has the effect to release the remaining retention sum and the final certificate will be issued as well for the new buildings.

2.8 Chapter Summary

This chapter consists various type of literature review to support the objectives of this research which is to determine the causes of defects in new buildings, second is determine the types of defects in new buildings and third is to determine the solutions for the defects in new buildings. Moreover, it also explains about how maintenance can help to reduce defects in new buildings and also the defects liability period in Malaysia's new buildings.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This research is discuss about the methodology that is used in this study and it deals with many types of methods or sources of data in order to collect the results to use by the researcher for this chapter. By doing so, the researcher can collect accurate results so that he can carry out the research work successfully.

Research methodology is defined as a study that is systematic (Kumar, 2011). The way to collect the information is very vital in order to get the data. Besides, the procedure on how to get the results will be describe from one by one in this research. From data collection, interview survey and data analysis. In addition, the survey are carried out in new residential buildings in Penang, Malaysia.

In this chapter, the researcher will also identify the types of research method used and method to collect the data. There are two methods to collect the data which is primary and secondary data. Primary data can be obtained through varies method. For example, interview, observation and questionnaire. Meanwhile, for the secondary data is data that have existed which is articles, relevant books and other types of references that researcher may use for research work purposes.

Lastly, the purpose of this chapter is to allow the researcher to identify the causes and types of defects occur in the new buildings. By doing so, the researcher will understand more and will be useful when facing this kind of issue in the future.

3.2 Recapitulation of Problem Statement

Construction deficiencies such as poor workmanship and low quality of materials, design deficiencies like not according to the specification and faulty design, limited time and cost, external environment and etc. lead to various types of defects in new buildings. In Malaysia, defects in new building are too many unabated and the impacts of defects are high maintenance costs, poor user satisfactions, dangerous to the tenants and the buildings cannot function properly. While there is information on defects in buildings in general, such is not available for new buildings, though theoretically, new buildings should be free from defects. Therefore, this research project aim to evaluate the causes defects in the new buildings

3.3 Definition of Research

Research is a scientific method used to study the problem in a detailed and careful way. Besides that, it is a systematic and logical search for useful and new information on the particular topic. Research also is an investigation method to find solutions to social and scientific problems based on objectives analysis. In addition, research is done with the aid of literature, observation and analysis. The objectives of the research is to test, discover and verify the facts, seek solutions to non-scientific and scientific problems and to overcome the problems that occur in our daily life.

3.4 Types of Research Methods

Research method can be classified into two types which is quantitative research method and qualitative research method.

3.4.1 Quantitative Research

Quantitative data can used to analyse the problem by generate numerical data or data that can use for statistics (ACAPS, 2012). Apart from that, the importance of using quantitative method is it is more reliable and objective, can use as a statistics to generalize the finding, and test the theories Quantitative data methods are more structured than Qualitative data method. This is because it consist various types of surveys. For example, telephone survey, online survey, questionnaire survey, personal interview and etc. (Susan, 2011).

3.4.2 Qualitative Research

Qualitative research is known as an interactive approach (Maxwell, 2012). This is type of approach is only involving the interviewer and also the interviewee only. Qualitative means directly interact with the individual on one by one basis. Besides, it can give a better detail and able to interact with the individual about the research area by using the language they feel comfortable. Moreover, this type of research can use to uncover any trends in thought and opinions. Besides, it also can dig deeper about the issue. Lastly is the sample size is small but the respondents are chosen based on the criteria of the research.

In the study, the researcher will use qualitative method to collect the data. It will use the primary data which is interview to interview the people that are working in

construction site. By using interview method, it also got advantages and disadvantages. the advantages of using interview survey is as following:

1. The interviewee can be probed in the interview session
2. The information can be follow up and be traced as well
3. The emotions, feelings and sentiments of the interviewee can be examined
4. The questions mostly are standardise
5. Is a face to face interview
6. Interview survey also is a high response rate
7. Longer interview more likely to be tolerated as well
8. Keep focus. The interviewer has to control the whole interview and make sure the interviewee stay focus to you until survey complete.
9. Accurate screening. The interviewee cannot provide wrong information to you such as occupation and age during the one by one interview.
10. Can ensure questions are understand well by the interviewee because interviewer will explain to him.

However, interview method also got disadvantages as show below:

1. Time consuming because interviewer need to travel to the site.
2. The sample size is small due to limited time
3. Quality of the data that gather by the interviewer
4. Hard to find a suitable time and place to conduct the interview
5. Sometimes the interviewee can run off the topic when responding
6. Hard to compare the result because each answer from the interviewees are different
7. The interview session may take longer time to complete
8. Will have distraction. For example, need to go for meeting
9. Limited data because limited sample and it may not accurately reflect the views of large population.
10. High cost

The method to overcome the disadvantages which is time consuming is to shorten the question and make it straight to the point so that the interviewee can answer it generally. Moreover, more time should be given in order to do this data collection so that the researcher can reach more sample size. Sometimes the interviewer may misunderstand the meaning of the answer that provided by the interviewee and this will affect the quality of the data. Therefore, the interviewer need to let the interviewee to have a look of the answers to see whether it is correct or not.

Other than that, the interviewee might be busy due to need to attend important meetings with the clients or subcontractor. Therefore, it would be easier it the interviewer make a call to the interviewee or send an email to him within 3 working days to let him know that what time you will be coming to conduct the interview and at where.

The interviewee might run off from the topic when responding and the interviewer need to explain the question carefully so that the interviewee can understand it well. Besides that, each answer provided by the interviewee is different. Therefore, to prevent this from happening, the questions set by the interviewer need to be general and need to explain carefully to the interviewee.

In addition, the duration for the interview may take longer time and it can be overcome by limit the time for the interviewer so that it would not drag the interviewee time to do other matters. However, there might be some distraction when having interview session. It can be overcome by having the interview session in a private and quiet room so that no other people can disturb during the session. The interview survey also have limited data because of limited sample. This can be overcome by conduct the survey using telephone survey or online survey.

Lastly is the cost will be higher compare to questionnaire survey. This is because the interviewer needs to go to the place to conduct the interview. This problem can be overcome by going to the nearest site or interview lecturers who have such knowledge and experience.

3.5 Area and Population of Study

The geographical location for the research study is at Penang, Malaysia and the targeted of study consists of residential high-rise buildings within Penang.

3.6 Interview Survey

There are many ways to collect the data by using the primary data or secondary data. For example, primary data consists of observation, interview, case studies, questionnaire, experiment, role – playing, ethnographic research and studies of longitudinal. The secondary data is the data that already existed, such as previous research, online information, official statistics, government reports and diaries.

The researcher will use primary and secondary data to collect the result. For primary data, interview method will be used to interview the people that are working in construction site in Penang. The interview will be carried out with respondent who are familiar with the building defects and got experience in it. It is a conversation between the interviewers and the interviewee that is carry out in order to produce an unique information from the interviewee. The process of the interview is a two ways street with both of you and the interviewer plays an active role in the conversation. Moreover, interview is suitable for data collection at the later stage of research work.

Meanwhile, the researcher also will use secondary data like literature, books and articles in this study. After collecting the result, it will be analyse and include in this study. The major merits for using interview is that the interviewee can be probed, information can be follow up and the emotions and feelings of the interviewee are examinable. Apart from that, interview survey can be differentiated into two types which is structured and unstructured interview.

The questions are standardised for structured interview and it resembles a checklist type of observation research. Besides that, the interviewers can complete the

questionnaire not the interviewee. Probing often requires for the interviewee and the questions mostly ‘closed-ended’ but start with ‘open ended’. Questions that are ‘open-ended’ normally can provide a rich qualitative data while the ‘close-ended’ questions are more conclusive in nature. This is because the questions are designed in a way that the data are easy to quantifiable.

For the unstructured interview, the scope it covers is wide and mostly use ‘open-ended’ questions. Moreover, it is more suitable to be use in qualitative research and interviewees can have more freedom to say what they want to express. In this research work, the structured and unstructured interview methods will be used to get more relevant information regarding the research topic.

Furthermore, using the interview method can allow the interview session more friendly and can have more discussion about the research work so that the researcher can collect more useful information to be included inside it (Kumar, 2011). The aim and objective of this survey also will be explained to the interviewers before interview session begins in order to allow the interviewee have an idea about what is the purpose of this interview.

This interview session will be conducted at the construction site and the target from the interviewers are mainly from Construction Company and got 10 years experiences in construction work like site manager, project manager, site engineers and consultants in order to gather their opinion. This is because they have more experience and knowledge in construction site and encounter more problems. Besides, the interviewer need to let the interviewee know how long the interview will takes. This research work is essential so that the researcher can have a better clarification and better detail about new building defect.

3.7 Data collection sampling

This sampling will be based on the Construction Industry located at Penang construction site. The target is Quality Assurance and Quality Control Department (QAQC) staff, site engineers, project manager and consultants who involve in building defects issue from the company. 9 interviewees will be interviewed and they will have experience from 3 to 21 years in construction industry.

3.8 Chapter Summary

This chapter will explains about the researcher using the qualitative method in the research work. Primary data which is the interview method will be used to gather relevant information based on the objectives from the experience people. This interview session will be conducted at Batu Kawan, Pulau Penang construction site. Nine respondents will be interviewed to collect different types of results based on their working experience and knowledge in construction industry. The interview sessions will be based on the three objectives to gather different types of data from the interviewees. The results will be interpreted and generated in following chapter which is chapter 4.

CHAPTER 4

RESULT AND DISCUSSIONS

4.1 Introduction

In this chapter, it will analyse the respondent's opinion about the questions. The results of the interview will be shown in Table 4.1. The data was collected at Batu Kawan Site Office, Pulau Pinang. The main contractor of the site is Builtech Project Management Sdn.Bhd. In this chapter, the researcher will use qualitative method to collect the data. It will use the primary data which is interview to interview the people that are working in construction site. In addition, the researcher will use the secondary data is data that have existed which is articles, relevant books and other types of references that researcher may use for research work purposes.

4.2 Respondent's Profile

Based on Table below, there were a total of 9 respondents who accepting an interview session for sharing the information that is required in this research. These interview sessions were conducted at the construction site at PDCH, Batu Kawan, Pulau Penang. By referring to the information given below, the respondents consist of one

project manager, one senior and one junior construction manager, one resident engineer, two QAQC engineers, one site engineer and two consultants. These interview sessions was conducted at May 2016.

Table 4.1 shows the information about the respondents and their experience and duration of interview session.

NO.	**Interviewee's Name**	**Position in the Site**	**Company**	**Working Experience**	**Duration of Interview**
1.	Mr. Lee Pei Chow	Senior Project Manager	Builtech Project Management Sdn.Bhd.	21 Years	20 Minutes
2.	Mr. Loh Kean Giap	Senior Construction Manager	Builtech Project Management Sdn.Bhd.	10 Years	15 Minutes
3.	Mr. Beh Chin Sian	Construction Manager	Builtech Project Management Sdn.Bhd.	7Years	25 Minutes
4.	Mr. Ong Hock Ben	Resident Engineer	PDC Properties Sdn.Bhd.	8 Years	20 Minutes
5.	Nabilah Najihah Binti Khalidbiuwalid	QAQC Engineer	Builtech Project Management Sdn.Bhd.	4 years	25 Minutes

Table 4.1 shows the information about the interviewees and their experience and duration of interview session. (Continue)

6.	Maslinda Binti Saidin	QAQC Engineer	Builtech Project Management Sdn.Bhd.	4 years	15 Minutes
7.	Mohammad Farhan	Site Engineer	Builtech Project Management Sdn.Bhd.	3 years	30 Minutes
8.	Mohammad Abu Zar Bin Abu Hassan	Consultant	PDC Properties Sdn.Bhd.	10 years	20 Minutes
9.	Mohammad Hussairi Bin Abdul Manap	Consultant	PDC Properties Sdn.Bhd.	8 Years	25 Minutes

As may be seen, there are six interviewees are from Builtech Project Management Sdn.Bhd. while another three interviewees are from PDC Properties Sdn.Bhd. Builtech Project Management Sdn.Bhd. is a fast growing and experience project management company located in Penang. The company has an employee's size of about 250 workers. The company mandate is to provide an engineering expertise and quality construction to the private sector and government as well. Besides that, the company has extensive experience and knowledge with the developers, industry and governments.

The company is major in commercial buildings, high rise buildings, housing estates, industrial building and landscaping works and etc. Moreover, the company is well-prepared to face any challenges of rapidly changing economic and technology

conditions as well as competition from other competitors. This is because they have highly skilled engineers and managers with high experience to overcome various type of project natures.

Other than that, Penang Development Corporation (PDC) Properties Sdn.Bhd is a premier development agency for the State Government of Penang. The corporation has about 350 workers and their principal activities of the corporation include urban and township development, industrial development and affordable housing and investments. The corporation aimed to make Penang a better place for its people and also serve as a guide in all its development.

Following shows nine types of questions that were asked during the interview session with the respondents. These questions were asked in order to obtain more specific information and answers to produce a better research.

Interview Questions

1. Based on your experience, what is the cause of defects in new buildings?
2. Based on your experience, what is the type of defects in new buildings?
3. What are the precautions to reduce defects?
4. Based on your experience, the defects normally occur at which stage? why?
5. How does the limitation of time will cause defects to be occurred?
6. What are the consequences to the new building and also the tenants if no action taken seriously against the defects?
7. Based on your experience, can maintenance reduce defects for new buildings?
8. Is it possible for a new building to achieve zero defects?why?

These questions were asked to the respondents in order to obtain more specific information and answers from them and also to produce a better research.

4.3 Analysis of the Results

Objective 1: To Determine the Causes of Defects in New Buildings

Based on Table 4.2, the answers of the interviewees' opinions regarding the causes of defects in new buildings have been identified through the interview session. This question was asked in order to identify the causes of defects in new buildings. All together there are eight causes of defects in new buildings as mentioned by the interviewees. The eight defects include poor workmanship, work executed are not in proper manner, poor material usage and not according to specification, lack of supervision, surrounding temperature and environment, manpower allocation, and lastly is not follow the method statement given. Responses of the survey responded to the question on causes of defects in new buildings are shown in Table 4.2.

Question 1 : Based on your experience, what is the cause of defects in new buildings?

Table 4.2 : Answers for causes of defects in the new buildings

No.	Interviewees	Answers
1.	Mr.Lee Pei Chow	The causes are due to the workmanship issues, usage of the materials at the site and quality of concrete used.
2.	Mr.Loh Kean Giap	The causes are due to workmanship issues, surrounding temperature and environment.
3.	Mr.Beh Chin Sian	The causes are due to the workmanship issue, usage of the materials, allocation of manpower and also method of application that used to construct the building.
4.	Mr.Ong Hock Ben	The causes are due to the workmanship or poor skills when constructing the structure, poor management skills and poor use of materials for example, poor quality of concrete always has been an issue that leads to defects to be occurred.

Table 4.2 Answers for causes of defects in new buildings (Continue)

5.	Nabilah Najihah Binti Khalidbiuwalid	The causes mainly are due to the materials transport to site, worker skills or the workmanship and also the temperature of the surrounding.
6.	Maslinda Binti Saidin	The causes are due to the materials use, workmanship and also environmental factors that can cause defects in the building.
7.	Mohammad Farhan	The causes are due to the workmanship of the workers, vibration or piling that causes crack to be occurred and settlement occurred after piling due to no proper installation.
8.	Mohammad Abu Zar Bin Abu Hassan	The causes are due to not following the method statement given by the consultants or the client and also the workmanship issue.
9.	Mohammad Hussairi Bin Abdul Manap	The causes are mainly due to the poor workmanship for example, plastering, the work executed are not in a proper manner, usage of the materials are not according to the specification and also lack of supervision to the workers.

The result shows that all of the 9 interviewees agreed that the workmanship and usage of materials are the issues that frequently happen and is the causes of the defects in new buildings. This was supported by the Anthony's (2013) findings that many defects occur in the new high-rise buildings was due to poor workmanship of the labour, lack of skilled supervision and usage of the materials. In addition, the factors that causes poor workmanship includes lack of supervision, lack of experience and competency from the labours, barrier in language and lack of communication (Adbulrazak et al, 2010).

Besides that, two interviewees highlighted that defects in new buildings may cause defects due to not following the method statement given by the consultants or the client. However, there are three interviewees respond that surrounding temperature or

the environmental factors will also cause defects and settlement. For instance, hot temperature, UV rays and acid rains, and foundation failure which will cause settlement to occurred.

Question 2 : Based on your experience, what is the type of defects in new buildings?

Based on Table 4.3, the answers of the interviewees' opinions regarding the type of defects in new buildings have been identified through the interview session. This question was asked in order to identify the types of defects that normally happen in new building. All together there are six types of defects in new buildings as mentioned by the interviewees. The six defects include structural cracks like wall crack, hairline cracks at joint of beam and column, architectural cracks like plastering fall off and skim coat issue, honeycomb, pipe clogged and cause leakage at toilet, roof leakage, hollowness at columns and floors.

There are 7 interviewees responded that structural cracks are normally can be seen in new buildings. In addition, the interviewees highlighted that the types of structural cracks are honeycomb, joint crack between the beam and the column. This normally will happen in new building due to less vibration and pressure from the upper floor. Poor soil bearing, poor construction site and overloading may cause structural cracks to be formed as well (Admin, 2015).

Besides that, the interviewees also responded that structural crack will come together with the architectural cracks. The example of architectural cracks are plaster fall off, surface cracks and hairline cracks which normally will happen after plaster work has been done. However, got 2 interviewees mentioned that settlement occur at the foundation is common to be happened because the footing is not design properly and cause the building to have cracks. Moreover, we can see defects in newly completed buildings such as peeling of paint, roof defects, dampness and etc. (Sommerville, 2007).

Responses of the survey responded to the question on types of defects in new buildings are shown in Table 4.3.

Table 4.3 : Answers for type of defects to be occurred in new buildings

No.	Interviewees	Answers
1.	Mr. Lee Pei Chow	The types of defects are structural cracks, honeycomb, defects in architecture work like plastering work, skim coat issue and hollow found at columns. Besides, also consists crack in plastering, rendering cracks at the ceiling as well.
2.	Mr.Loh Kean Giap	The types of defects are pipe leakage, roof leakage, pipe clogged, structural cracks, honeycomb.
3.	Mr.Beh Chin Sian	The types of defects are wall surface crack, honeycomb, settlement occurred at the foundation due to footing not good and design got problem. Besides, structural settlement also can be seen when the cracks happen at the sides of the columns. Water leakage always can be seen as well.
4.	Mr.Ong Hock Ben	The types of defects are bulging of the walls, rebar corrosion, honeycomb, structural cracks.
5.	Nabilah Najihah Binti Khalidbiuwalid	The types of defects are honeycomb, plaster crack with hollow, window frame will become bulging if got gap, settlement at the foundation, tiling or screeding not properly installed, pipe stuck and lastly is the toilet will have water leakage and cause lower unit to be affected.

Table 4.3 : Answers for types of defects in new buildings (Continue)

6.	Maslinda Binti Saidin	The types of defects are structural cracks, honeycomb, paint peel off, roof leakage and toilet leakage as well.
7.	Mohammad Farhan	The types of defects are structural cracks, architectural cracks. Architectural cracks happen first then follow by the structural cracks. Example of architectural crack are wall/plaster crack, hollowness at the columns. Structural cracks are toilet or water leaking and honeycomb.
8.	Mohammad Abu Zar Bin Abu Hassan	The types of defects are architectural and structural cracks. For example, honeycomb, cracks at the wall and hairline cracks after plastering work.
9.	Mohammad Hussairi Bin Abdul Manap	The types of defects are paint peel off, architectural crack, structural cracks, pipe clogged, leakage at the toilet area or the roof, slab crack due to settlement and also the mosaic will break due to hollowness.

Question 3 : What are the precautions to reduce defects?

Based on Table 4.4, the answers of the interviewees' opinions regarding the precautions to reduce defects in new buildings have been identified through the interview session. This question was asked in order to identify the precautions to reduce defects in new buildings. All together there are six types of precautions to reduce defects in new buildings as mentioned by the interviewees. The six precautions are ensure good workmanship by supervise the workers, give proper training to workers, ensure good quality of materials before usage, have a rehearsal before doing anything, engage third party or specialist, lastly is using the method statement given by the developer or consultants to avoid defects.

All of the 9 interviewees agreed that they will engage third party to solve the issue if their own general workers cannot solve it. Besides, seven interviewees agreed that by giving full supervision and monitor the workmanship of the workers will reduce the number of defects. According to Ghaffar et. al. (2010), the quality of the workmanship can be guaranteed if the works are supervised strictly by the site supervisor.

Besides, got 2 interviewees responded that by using good quality of materials and make a material comparison before usage is important to prevent defects from occurring. The materials must also get approval from the consultants and the clients before purchasing it. However, one interviewee also highlighted that need to have a rehearsal before doing anything and the management must be acknowledged for every work done.

In addition, the interviewees agreed that by giving proper training to the workers can reduce the number of defects. This was supported by Chan et.al., (2006)'s findings that the workers will done the work in a better manner because they will have the knowledge about it. Moreover, this will ensure the quality of the construction project can be satisfied by enhancing the capability of the site workers.

Responses of the survey responded to the question on precaution to reduce defects in new buildings are shown in Table 4.4.

Table 4.4 : Answers for precautions to reduce defects

No.	Interviewees	Answers
1.	Mr. Lee Pei Chow	The precaution to reduce defects is to ensure workmanship is supervised and engage third party. Besides, control the material for concrete, temperature, slum and casting time. The curing steps for it is use wet gunny sacks. Sufficient concrete cover also needed to be used to avoid cracks from happening.

Table 4.4 : Answer for precautions to reduce defects (Continue)

2.	Mr.Loh Kean Giap	The precaution to reduce defects is to ensure full supervision and hire third party. Besides, check the quality of the materials before deliver to site.
3.	Mr.Beh Chin Sian	The precaution to reduce defects is has a full supervision during construction and engage the third party. Controlling the use of materials and material comparison before usage is important. Most defects will occur at design stage therefore need to pay more attention in it.
4.	Mr.Ong Hock Ben	The precaution to reduce defects is to have a rehearsal before do anything and also hire specialist or third party. Besides, give training to the workers and the management must be acknowledge for every work done. Main-contractor and sub-contractor are responsible for it. Moreover, construction method is important to avoid defects occurred in new buildings.
5.	Nabilah Najihah Binti Khalidbiuwalid	The precaution to reduce defects is to use the materials approved by the consultants or the clients. Besides, need to ensure material quality although is cheap. Give training to the workers and monitoring them also one of the ways to reduce defects and also hire third party if cannot solve it.
6.	Maslinda Binti Saidin	The precautions to reduce defects are to ensure good quality of the materials, contractors need to supervise the workers fully and the consultants need to monitor the defects to prevent further consequences. Besides that, need to hire third party if necessary.

Table 4.4 : Answers for precautions to reduce defects (Continue)

7.	Mohammad Farhan	The precautions to reduce defects are to monitor the workmanship. For example, water proofing for the toilet. Moreover, hire the expert to have an inspection to identify the main issue. Then get the advice and method from the party to solve the defects.
8.	Mohammad Abu Zar Bin Abu Hassan	The precautions to reduce defects are giving training programme to the workers consistently because new team that comes in may not have the relevant knowledge and also hire third party or the specialist in the relevant field.
9.	Mohammad Hussairi Bin Abdul Manap	The precautions to reduce defects are ensure good workmanship, give proper training to the workers and full supervision when constructing the buildings and hiring the third party or the specialist to solve the issue.

Question 4 : Based on your experience, the defects normally occur at which stage? why?

Based on Table 4.5, the interviewees' opinions regarding the defects that occur at which stages and reason for it have been identified through the interview session. This question was asked in order to identify the defects that occur at different stages. All together there are three stages where the defects will normally occur. The three stages are architectural stage, construction stage and structural stage.

Four interviewees responded that the defects normally occur at architectural stages. For example, plastering fall off, hairline crack and surface cracks. This was supported by Anthony's (2013) findings that hairline cracks and surface cracks will normally occur in new buildings after completion.

Another 3 interviewees mentioned that the defects normally occur at the construction stage. This was supported by Robin's (2013) findings where the building errors are due to the poor design stage which contributed to 50% and construction stage which contribute to 40% and another 10% is because of the product failure. Example of defects in construction stage are lack of supervision and low quality of workmanship (Robin, 2013).

Other than that, 1 interviewee responded defects occur at the structural stages and 1 interviewee responded it occur at all stages of the construction. The reason why defects occur at different stages is because of insufficient vibration to the concrete, weather condition and surrounding environment issues. Latent stage and patent stage of defects are normally can be seen in new buildings (Olanrewaju & Abdul-Aziz, 2015). Furthermore, the major contributors to the latent defects are the deficiencies in the design stage. However, it can be prevented by improving the design. Respondents of the survey responded to the question on which stages that the defects normally occur and reason for it is contain in Table 4.5.

Table 4.5 : Answers for defects that occur at which stages and reason for it

No.	Interviewees	Answers
1.	Mr. Lee Pei Chow	The defects normally occur at the architectural works. It can be seen after handling over. If no proper curing done, the defects will come out after 1 week.
2.	Mr.Loh Kean Giap	The defects normally occur during the construction stage. For example, concreting not done properly and no enough vibration will have honeycomb.
3.	Mr.Beh Chin Sian	The defects normally occur at architectural works. For example, wall plaster will start to crack after 2 weeks due to workmanship or weather condition.
4.	Mr.Ong Hock Ben	The defects normally occur at the construction stage because due to workmanship. For example, joint not properly and cause defects to occur.
5.	Nabilah Najihah Binti Khalidbiuwalid	The defects normally occur at the construction stage and also at the architectural stage after handling over.
6.	Maslinda Binti Saidin	The defects normally occur at the architecture stage where the stiffener wrong installed or plaster cracks will happen as well.
7.	Mohammad Farhan	The defects normally occur after the structural works have done like cracks and honeycomb. Besides, it will also occur at the architectural work like plaster cracks.
8.	Mohammad Abu Zar Bin Abu Hassan	The defects normally occur at the architectural work. The plastering will start to crack after 2 or 3 weeks and cause shrinkage cracks.
9.	Mohammad Hussairi Bin Abdul Manap	The defects normally occur at all stages but most is within 1 year after handling over. After handover will have failures, different movement of settlement and wall crack. Besides, it also happens in architectural work first.

Question 5 : How does the limitation of time will cause defects to be occurred?

Based on the Table 4.6, the answers of the interviewees' opinions regarding whether time limit given in a construction site to complete the work will cause defects in new buildings. There are seven interviewees responded that due to the limit of time, the work will be done in a rush manner where the quality of workmanship will not be supervised fully. This will eventually cause many defects to be occur in the new buildings after and before completion.

Besides that, due to limit of time, workers need to rush for the work and will cause them not enough rest and simply do the work for example, insufficient of vibration to the concrete. However, there are one interviewee responded that the contractor will not follow the method statement given if there are insufficient of time to complete the project. According to Atkinson (2016), insufficient of labours supplied will lead to insufficient time to complete the project and need extension of time (EOT).

Respondents of the survey responded to the question on the limitation of time will cause defects as shown in Table 4.7.

Table 4.6: Answers for does the limitation of time will cause defects to be occurred

No.	Interviewees	Answers
1.	Mr. Lee Pei Chow	The quality of the work will be affected if there are limitation of time. Besides, the workers will not focus in doing the job due to insufficient of rest and sleeping.
2.	Mr.Loh Kean Giap	Limitation of time will cause the work to be done in a rush manner and overlapping work will cause them to rework. Besides, it will have no time to handover due to rework and defects. Some of the inspection part may be overlook due to limitation of time especially at the architectural stage.

Table 4.6: Answers for does the limitation of time will cause defects to be occurred (Continue)

3.	Mr.Beh Chin Sian	Since the project have limitation of time and cause work to be done in rush manner, it will eventually cause more defects to be occurred and it will also delay the handover and causes contractor to pay liability damage as well. Besides, the contractor also need apply EOT from architect or owner and is a wastage of time.
4.	Mr.Ong Hock Ben	The project will have a tight schedule and the quality will be affected. All the inspection, cleanliness will be done in a rush manner and sometimes will missing out some of the rebar. This will eventually causes the concrete column not strong enough and started to crack or collapse.
5.	Nabilah Najihah Binti Khalidbiuwalid	If there are limit of time, the contractor will need to complete the project faster. By doing so, the work will no following the method statement give and cause defects to be happened.
6.	Maslinda Binti Saidin	The management need the work to proceed faster due to limitation of time. Therefore, it will cause the quality of work is poor and cost will be higher. Besides, the supervision work will not be done in a properly manner.
7.	Mohammad Farhan	As there are limitation of time, works are done in a rush manner and there are no quality assurance. Moreover, it also due to poor workmanship to achieve fast product.
8.	Mohammad Abu Zar Bin Abu Hassan	A tight schedule project will eventually cause more defects to be occurred cause all works are progress in a rush and poor workmanship manner. For example, concrete need time to cure if not it will easily crack.

Table 4.6: Answers for does the limitation of time will cause defects to be occurred (Continue)

9.	Mohammad Hussairi Bin Abdul Manap	Limitation of time will cause all works to be done in a rush manner. For example, the casting of concrete need at least one week curing time only can open the formwork. If early open will cause insufficient of curing and cause crack lines to be occur and the concrete will not strong enough.

Question 6 : What are the consequences to the new building and also the tenants if no action taken seriously against the defects?

Based on the Table 4.7, the answers of the interviewees' opinions regarding the consequences to the new building and also the tenants if no action taken seriously against the defects have been determined throughout the interview session. This question was asked to identify the consequences to the new building if no action taken seriously against it and also the tenants.

Three interviewees agreed that the defects will spread to other units or area if no maintenance or any action taken against it. Besides that, another 3 interviewees responded that leakage of the toilet will occur and plaster will fall off as well. However, there are 2 interviewees responded that the tenants cannot utilize the new building fully if there are defects occur and they might need to bear the cost themselves. Lastly, 1 interviewee responded that the contractors need to repair the defects within 2 years under the defects liability period if found any defects in the new buildings.

However, the consequences of the defects will cause dissatisfaction of the customer because they are not satisfied with the building and cannot fully utilize it (Neha & Shruti, 2015). In addition, the contractor company may need to bear the extra

cost due to the defects and cause delay in handover and this will also reduce the productivity of the company as well (Neha & Shruti, 2015).

Respondents of the survey responded to the question on the consequences to the new building and also the tenants if no action taken seriously against the defects as shown in Table 4.8.

Table 4.7: Consequences to the new building and also the tenants if no action taken seriously against the defects

No.	Interviewees	Answers
1.	Mr. Lee Pei Chow	If no action taken seriously against the defects, leakage might happen at the toilet, pipes and cause lower unit to be affected, settlement and etc. Besides, the cost for the management to repair the defects who will responsible for it. In addition, the tenants might need to bear the cost to repair the cracks, leakage at the toilet if the contractors are not responsible for it after the tenants moves in.
2.	Mr.Loh Kean Giap	The pipe will clogged and facilities cannot be utilize fully due to the defects and tenants will not utilize the building fully as well.
3.	Mr.Beh Chin Sian	If no action taken seriously, similar defects will occur again and it will continue to spread to other places. If the defect is due to the design problem then the defect will not end immediately and it will occur from time to time.
4.	Mr.Ong Hock Ben	If no action taken seriously against the defects, the new buildings will meet many problems. For example, leakage, plaster falling down, cracks at the joint of the beam and columns. The tenants cannot utilize the building fully also.

Table 4.7: Answers for consequences to the new building and also the tenants if no action taken seriously against the defects (Continue)

5.	Nabilah Najihah Binti Khalidbiuwalid	If no action taken seriously against the defects, the tenants might need to bear the cost to repair it themselves and the new building will start to have many defects issue after the tenants moving in. besides, settlement and architectural work will face many problems like cracks.
6.	Maslinda Binti Saidin	The defects will become more serious if no action taken immediately. Besides that, the tenants cannot focus to sleep because they will scare whether the building will collapse due to the cracks at slab and joints.
7.	Mohammad Farhan	The defects will spread to other places if no action taken seriously like the hollowness will become bigger. The remedy works for the defects will become expensive as well if no action taken immediately. Tenants cannot live happily in their unit also.
8.	Mohammad Abu Zar Bin Abu Hassan	If no action taken immediately, the leakage will spread to lower unit and similar defects will happen around the building units and the maintenance cost will be greater. In addition, the tenants daily routine will be affected by the defects as well.
9.	Mohammad Hussairi Bin Abdul Manap	Normally, the contractors will repair the defects within 2 years under the defects liability period. Besides, if no action taken seriously by the contractors, the tenants cannot utilize the building fully and will suffer loss as well.

Question 7 : Based on your experience, can maintenance reduce defects for new buildings?

As may be seen, the answers of the interviewees' opinions regarding whether maintenance can reduce defects in new buildings have been identified through the interview session. All together there are three different types of response whether maintenance can help in reducing building defects. The purpose of maintaining the building is to retain the value of investment, maintain the building in a good condition so that it can provides its function fully and have a good appearance (Al-Hammad, 2014).

Four interviewees agreed that maintenance can help in reduce the number of defects. This is because maintenance got few types which are preventive, corrective, schedule, and emergency maintenance (Olanrewaju and Abdul-Aziz, 2015). By follow these steps, it can help in reduce the number of defects.

Besides, 3 interviewees responded that some can while some cannot be reduced by using maintenance. For example, as the Project Manager Mr.Lee responded, paint that peeled off can be re-paint while concrete cannot be maintained. It needs to be hacked off after 100 years because the duration of concrete life has expired. In addition, structure work cannot be maintained while facilities only can be maintained through the interview session with one of the consultant which is Mr.Abu.

Lastly, 1 interviewee responded that maintenance cannot reduce defect at all because it will still occur due to the environmental issue like the building expose to heavy sunlight. However, 1 interviewee responded that is hard to reduce defect also by using maintenance due to surrounding issue like hot temperature as well.

Respondents of the survey responded to the question on whether maintenance reduce defects for new buildings are shown in Table 4.9.

Table 4.8: Answers for would maintenance can help in reduce defects for new buildings?

No.	Interviewees	Answers
1.	Mr. Lee Pei Chow	Some can while some cannot. For example, the paint can be repaint if it has peeled off while concrete cannot be maintained, it need to be hack off after every 100 years.
2.	Mr.Loh Kean Giap	Yes. It can prevent defects become more serious due to schedule maintenance and preventive maintenance.
3.	Mr.Beh Chin Sian	Yes. Need to have maintenance regularly. Especially for the design work. If no maintenance regularly on it, it will affect he structural work and causes more defects to be occurred.
4.	Mr.Ong Hock Ben	Some can some cannot. Facilities can be maintained but honeycomb, slab cracks will hard to be maintained due to environmental issue and need to hack off and rework.
5.	Nabilah Najihah Binti Khalidbiuwalid	Maintenance cannot reduce the defects in new buildings because although it has been completed it will still have defects occur due to the environmental issue.
6.	Maslinda Binti Saidin	Hard. It can reduce the defects but not in 100% condition because of the surrounding issue like hot temperature.
7.	Mohammad Farhan	Yes. It reduce the defects by having a checklist. For example, what items or equipments need to have maintenance and if any defects are found, it needs to be maintained immediately to prevent higher maintenance cost in future.
8.	Mohammad Abu Zar Bin Abu Hassan	Some can some cannot. For example, structure work cannot be maintained, only facilities got maintenances.

Table 4.8: Answers for would maintenance can help in reduce defects for new buildings? (Continue)

9.	Mohammad Hussairi Bin Abdul Manap	Yes. The new buildings can use few types of maintenance like schedule maintenance, emergency, preventive and corrective maintenance to prevent the defects become worsen.

Question 8 : Is it possible for a new building to achieve zero defects?why?

Based on Table 4.9, the answers of the interviewees' opinions regarding possibilities to achieve zero defects in new buildings have been identified throughout the interview session. According to Eaton, 1996; Al-Mahade et al., (2008), zero defects literally means 100% error free. The concept of zero defects was developed by Crosby which is a quality manager. He believes that the product must be defect free before delivered to the customer (Salahaldein et.al, 2010).

Based on the results, 3 interviewees responded that it is possible to achieve zero defects although it needs more time and cost to ensure good quality. Besides, it also depends on the method of installation and type of buildings according to the Project Manager, Mr.Lee responded. Furthermore, the building must be carefully constructed and design start from design stage, procurement, construction then handover. Each stage need to be fully compromised and done in a perfect manner. However, it stills depends on the budget.

Other than that, 5 interviewees responded that it is not possible to achieve zero defects due to the reason of environmental factors like hot temperature, quality of workmanship and moving of settlement. One of the interviewees also responded that it

depends to the budget of the construction. However, if precaution steps are taken, the quest towards the way to achieve zero defects can be obtained.

Lastly, 1 interviewee responded it is hard to achieve zero defects because need more time and environmental factors as well. For instance, hot temperature, high humidity and weather conditions.

Based on the survey responded by interviewees, the possibilities to achieve zero defects in new buildings are shown in Table 4.10.

Table 4.9 : Answers for is it possible to achieve zero defects and reason for it

No.	Interviewees	Answers
1.	Mr. Lee Pei Chow	Yes. This is because it depends on what type of buildings and needs and also method of installation.
2.	Mr.Loh Kean Giap	Is hard because need more time and cost and main factor is due to environmental issue.
3.	Mr.Beh Chin Sian	Yes but it is hard. To have a zero defects, the building must be carefully constructed and design start from design stage, procurement, construction then handover. Each stage need to be fully compromised and be done is a careful manner. Besides, it stills depends on the budget.
4.	Mr.Ong Hock Ben	No. This is because the buildings will still be affected by the quality of workmanship issue and it still depends on the budget. But in country of German is possible to have zero defects, very near to zero.
5.	Nabilah Najihah Binti Khalidbiuwalid	No. It can reduce the defects but it will still exist. This is because of the external environment factors.

Table 4.9 : Answers for is it possible to achieve zero defects and reason for it

(Continue)

6.	Maslinda Binti Saidin	No. This is because the new building is affected by the environmental factors like settlement, temperature.
7.	Mohammad Farhan	No. This is because although the new building is done by good quality by it still can cause defects due to environmental issue like paint peel off and hot temperature cause cracks at wall.
8.	Mohammad Abu Zar Bin Abu Hassan	Yes. But need more time and cost to ensure good quality and zero defects.
9.	Mohammad Hussairi Bin Abdul Manap	No. Although have done the prevention but it will still cause defects to exist because of weather and quality of materials. In addition, it might due to unexpected case like earthquake, settlement moving.

4.4 Chapter Summary

This chapter will use the interview method to collect data at the construction site where it located at Batu Kawan, Pulau Penang. Different types of data will be obtained based on the interview session with different interviewees. After finish collecting the data the next step will be analysing it. Follow by generating the results. The objectives of the study also will be identified in this chapter.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

A study was conducted to investigate the causes of defects in new buildings and a conclusion has been drawn based on the outcome of the analyses from the chapter 4. New buildings mean different thing to different people. In fact, there is not exact definition for what is meant by new building. However, the definition is centre around the age of the buildings. While some might considered building less than five years old as new building some might considered building less than ten years old as new. In this research project, new building is defined as building within the defects liability period. In Malaysia, the defects liability period is from 12 months to 24 months which is 1 to 2 years (Minter, 2016). After that, the buildings will be defined as new which is free from DLP.

Other than that, the results are obtained from the interview sessions that have been done at Batu Kawan, Pulau Penang. The objectives have been identified throughout the whole interview sessions. The three objectives are to determine the causes of defects in new buildings, to determine the types of defects in new buildings and to determine the solutions for defects in new buildings. Based on the research findings in chapter 4, there are several causes and types of defects that are normally encountered by the Project Manager, Construction Managers, Consultants and Engineers in construction site. The

motivation of doing this study is I will gain more knowledge about defects and can apply the same knowledge in the construction industry when I go for work next time.

5.2 Causes of Defects in New Buildings

In this research, the first objective which is to determine the causes of defects in new buildings have been achieved. There are eight causes of defects that have been identified through the research findings. The eight causes of defects in new buildings are shown as following:

a) Poor workmanship
b) Work executed are not in proper manner
c) Poor material usage and not according to specification
d) Lack of supervision
e) Surrounding temperature and environment
f) Limited time
g) Manpower allocation
h) Not follow the method statement given

However, the causes of defects that mostly will be found during the defects liability period are poor workmanship, low quality of construction materials and faulty design. Generally, the causes of defects can be further categorized into construction deficiencies and design deficiencies.

Construction deficiencies are building errors due to the poor design stage which contributed to 50% and construction stage which contribute to 40% and another 10% is because of the product failure (Robin, 2013). Meanwhile, design deficiencies can be known as design error or omission. It is the design failure that caused by the design professionals. This is because they have failed to produce an accurate and a complete set of drawing and also the construction documents.

In conclusion, the poor workmanship in new buildings can be overcome by strictly supervise their work. Besides, need to ensure the workers follow the method statement given and execute the work accordingly to prevent defects. Other than that, the contractors need to ensure the good quality of the materials and also need to follow the method statement according to the consultants and clients. Lastly is need to have a proper manpower management in the construction site so that the workers can complete the work without rushing it and the quality will not be affected as well.

5.3 Types of Defects in New Buildings

There are six types of defects that have been identified through the research findings. The six types of defects in the new buildings are shown as following:

a) Structural cracks like wall cracks, hairline cracks at joint of beams and columns
b) Architectural cracks like plastering fall off and peeling paint
c) Honeycomb
d) Pipe clogged and cause leakage at toilet
e) Roof leakage
f) Hollowness at columns and floor tiles.

These types of defects are mostly will be found in new buildings due to less vibration for the concrete and cause cracks at the wall and joints. Sometimes rework for the new buildings are needed if the defects are serious and need to be rectify immediately to prevent it from getting worse.

The structural cracks in the buildings can be prevented by have a proper inspection and good workmanship when constructing works are on-going. Moreover, the architectural cracks like plastering fall off and peeling paint can be prevented by using a good quality of materials and apply additional coats to it. Apart from that, honeycomb defects can be minimized by vibrating the concrete properly and give sufficient curing.

Roof plays an important role in the building structure. This is because it acts as a weather shield for the building. Besides that, it also protects the occupants inside the building from heavy rain and excessive sunlight. If defects are found at the roof, then the buildings and the occupants will be affected as well. Therefore, it is important to ensure good quality of workmanship and inspection when installing the roof for the new buildings.

Lastly will be the hollowness at the floor tiles and columns. This defect often can be seen in new buildings. Unnecessary efforts are need to correct the construction error. The workers need to ensure sufficient of concrete and vibrate it compactly to prevent hollowness. In conclusion, the types of defects can be prevented if the contractors have a strict supervision for the workers.

5.4 Solutions for Defects in New Buildings

In a nutshell, it is important for the parties like construction managers, consultants, project managers, engineers and etc. that are involved in the construction of new buildings have a strict supervision to all the workers and inspect the buildings carefully to minimize the defects. Besides that, they can engage the third party or an expert to solve the defects when their own general workers cannot solve it. This is because the third party and the experts will have more knowledge and experience. They can identify the problem and rectify it immediately without delaying the whole project.

Apart from that, the company need to provide trainings to the workers so that they can gain more knowledge about the field that they are involving into. This will give a lot of benefits to them. Other than that, the contractors need to ensure the materials are in good quality. This is because low quality of materials will cause many defects in new buildings. For example, poor quality of concrete will cause cracks to be happened and the buildings also might collapse. Therefore, the contractors need to compare the

materials before purchasing it and get agreement from the architects as well as the clients.

Next is to have a rehearsal before doing anything. For example, before concreting takes place, the site engineers need to cooperate with the project manager and the consultants to discuss about what concrete grade that is suitable and how long is the duration needed to cure it. By doing so, it will minimise the defects in new buildings.

5.5 Recommendations

Based on the investigation, there are few recommendations that can be made in order to improve the defects for new buildings in future studies. The recommendations that can be made for future studies are as following:

a) To study the potential ways to overcome the defects in new buildings in Malaysia
b) To study the relationship between the defects and costs in the new buildings
c) To study the repair techniques and selection of materials in the maintenance of new buildings.

5.6 Chapter Summary

This is the final chapter of the whole research. This chapter will explain about the conclusion based on the three objectives which is to determine the causes of defects in new buildings, to determine the types of defects in new buildings and to determine the solutions for defects in new buildings. In addition, the objectives of the research have been determined based on the findings from interview survey, analysis of the results, journals, articles and books as well. Lastly, the recommendations also have been made for further studies in this chapter.

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APPENDICES

Appendix: Interview Survey Form

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF ENGINEERING AND GREEN TECHNOLOGY

BACHELOR OF SCIENCE (HONS) CONSTRUCTION MANAGEMENT

UGBA3928 FINAL YEAR PROJECT

TITLE: INVESTIGATION ON CAUSES OF DEFECTS IN NEW BUILDINGS

Interview Questions

1. Based on your experience, what is the cause of defects in new buildings?
2. Based on your experience, what is the type of defects in new buildings?
3. What are the precautions to reduce defects?
4. Based on your experience, the defects normally occur at which stage? why?
5. How does the limitation of time will cause defects to be occurred?
6. What are the consequences to the new building and also the tenants if no action taken seriously against the defects?
7. Based on your experience, can maintenance reduce defects for new buildings?
8. Is it possible for a new building to achieve zero defects?why?