THE IMPLEMNTATION OF PRE-CAST CONCRETE PANEL SYSTEM FOR HIGH-RISE RESIDENTIAL BUILDING IN MALAYSIA

by

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8255

Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Engineering (Hons)
(Civil Engineering)

JULY 2008

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CERTIFICATION OF APPROVAL

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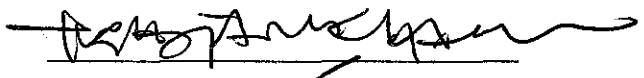
Approved by,



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TRONOH, PERAK

July 2008

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the originality work is my own except in the references and acknowledgement, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

MOHD FARHAN BIN ABDUL RAZAK

ABSTRACT

The purpose of this project is conducted to examine the level implementation of the pre-cast concrete panel system and its barrier in Malaysia. Besides that, it is also to study the usages of both panel and non-panel system in Malaysia. Pre-cast concrete panels is one of the components in IBS which made with concrete cast in reusable mould and cured in a controlled environment before transfer and erected at site to form a building. There were many advantages of using this system as compared to the conventional method especially regarding the problems of dependency on foreign workers by Malaysian construction industry. Even with all the advantages of this system, it still not fully utilized especially for high rise residential building. Therefore, identifying the barrier of using this system was necessary, thus it can be the main alternative method of construction for high-rise residential building in Malaysia by year 2020. The methodology that has been conducted is a Survey Research Methodology (SRM). The methodology are use to collect quantitative information about item in population based on questionnaire survey and opinion survey. Based on the result of the survey it shows that the cost is the main barrier or the least attraction of using the system in current construction industry in Malaysia. Majority of the respondents agreed that the system involves high start-up cost, which most of the construction firms do not have financial capability to do so. The data also shows that even though numbers of labour are reducing when implementing the system, the cost is still unchanged. This unchanged cost, probably due to high cost in fabrication and erection of the pre-cast concrete panel system. Contrary to that, the most attraction of using the system was the speed of construction as compared to the conventional method. Therefore, local authorities need to take note about this problem and develop a solution to attract small companies and to reduce the start-up cost to implement the system. If the system can be refined and the barrier of using this system can be overcome, thus it can be the main alternative to cater the demand of residential properties in Malaysia.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Industrialised Building System (IBS) is a construction process that utilizes components or building system that involve prefabricated components and on-site installation. From the structural classification, there are five main IBS groups identified as being used popularly in Malaysia which are Pre-cast Concrete, Panel and Box System; Formwork Systems; Steel Framing Systems; Prefabricated Timber Framing Systems; and Block Work Systems. The IBS system that generally implemented for high rise building especially apartment is pre-cast concrete panels system.

In Malaysia, prefabricated constructions have been implemented since forty years ago with the completion of the Tunku Abdul Rahman Public Housing Estate in Kuala Lumpur or commonly known as the Pekeliling Flats. The IBS system that they implemented for this project is the pre-cast concrete walls and planks slab. Since then the implementation of this system for high-rise residential building in Malaysia not fully utilized. In fact, most of the contractor for high-rise building construction more preferred labour-intensive method as compared to the IBS system. The studies will focus on finding the data regarding the barrier and the level of the implementation of pre-cast concrete panels system in Malaysian construction industry.

1.2 PROBLEM STATEMENT

Pre-cast concrete panel system is one of the components in IBS. The pre-cast concrete panel system has been introduced in Malaysia 4 decades ago; however, the usage of this technology was not fully utilized in Malaysian construction industry especially for high rise residential building. Although, many fact that shown the system have more advantages as compared to the conventional Cast-In-Situ method. In reality, most of the parties involved in the construction industry are not really exposed to and lacked knowledge in the system. If the system can be refined and any barrier of using this system can be overcome, thus it can be the main alternative method of construction to cater the demand on high rise residential building in Malaysia. Besides that, the objective of this survey is also to be a reference for the local authorities to take note and aware about the problem facing by the client, contractor or manufacturer during implementation of the system in Malaysia.

1.3 OBJECTIVES

The objectives of the project are as follows:

i. To examine the usage of pre-cast concrete panel systems in Malaysia for high-rise residential building.
ii. To determine the barriers of using pre-cast concrete panel system.

1.4 SCOPE OF STUDY

The project will provide a detail description on the level of implementation of this system in Malaysia. It will be achieved by performing a survey research method that incorporates tools such as questionnaire and interview in order to obtain the information.

Questionnaire surveys shall be submitted to all parties that involved in construction industry mainly in Peninsular Malaysia. Preliminary, a minimum of 30 construction firms shall be selected as the study sample. The reason with minimum of 30 data samples because its enable us to draw conclusion sufficiently. This will be explained in detail in the Survey Methodology topic.

The questionnaire will cover information related to pre-cast concrete panel system that implemented in Malaysia such as type of pre-cast concrete system; the barrier of using this system; the process of improvement for this system etc.

Furthermore, it can be achieved through the literature review based on journal papers, conference papers, reference books, surfing information through the websites and so on. The study will also implement the data collection method that incorporates interview and observation to the project site and pre-cast concrete panels factory.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION OF THE MALAYSIAN CONSTRUCTION INDUSTRY

Malaysian construction industry has been contributed around 3% to 5% of Malaysia KDNK since 1980 until 2000 (CIDB, 2003). Even though, it seems small as compared to other economic sector in Malaysia, but in the long term the construction industry has high potential to be developed and improved. This can only be archived if suitable method or technology been progressively introduced and implemented in Malaysia construction industry such as IBS.

The fact is that by 2020, it was estimated Malaysian citizen will be increased from 25 millions up to 34 millions and based on statistic, around 60% will inhabiting in urban areas (CIDB, 2003). Due to this, free land space in urban areas are become to constraint for residential properties especially landed properties, hence low cost high-rise residential such as flat or apartment is a best alternative to cater the demand.

Nevertheless, to archive that target is quite difficult in current Malaysian construction industry which still using the less productive method or process as compared to other economic sector such as manufacturing. This problem due to construction industry itself is a huge economic sector that involved many parties including developer, contractor, consultant, supplier, labour etc. Every party in the industry have there own role and agenda, thus it was difficult to archive significant improvement and collaboration between each party. Without this collaboration, Malaysia has difficulty to revolutionize their construction industry from current conventional method of construction to more advanced construction method such as IBS.

This also supported with the high availability of cheap labour in Malaysia. Besides that, other reason that been identified was the mentality and perception of many construction firm in Malaysia. Their perception that hindered them was that with the new technology required large investment such as new equipment needs to be introduced and required skilled worker to operate it. Therefore, they tend choose the safe method which is the labour-intensive method that already have well known procedures and with available resources.

2.2 INTRODUCTION OF THE INDUSTRIALISED BUILDING SYSTEM

In Malaysia, IBS has been an existence since the 1960s, with the completion of the Pekeliling Flats in Kuala Lumpur as a benchmark. Nevertheless, since then, the system not fully put into practical used as a method of construction for high rise residential building such as flat or apartment. Based on the survey conducted by CIDB until 2003, the usage level of IBS systems only stand 15% from the total local construction industry (CIDB, 2003). Most of the contractor or parties involves in this industry still depending on labour-intensive method (CIDB, 2007). As a result, severe influx of foreign workers in this country due to high demands in the Malaysian construction industry. **Figure 2.1** shows below is one example of high-rise residential building in Malaysia that implemented the pre-cast concrete panel system.

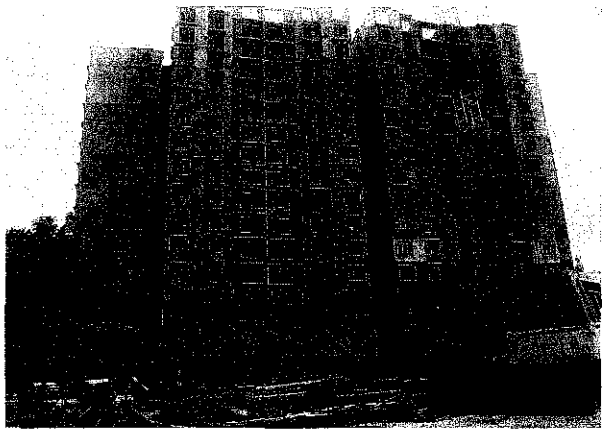

Figure 2.1 Implementation of Pre-cast Concrete Panel System at Precinct 15 Apartments Project, Putrajaya.

Despite the fact that the construction industry had been experimenting with various prefabricated construction and lead by various pre-cast solution providers but in most cases, it was for one-off and isolated project usage. There were no proper plan was formulated by the government for the industrialisation of construction until the orientation of the IBS Road Map 2003-2010. This road map is a master plan to facilitate the alteration of the Malaysian construction based on the formulation of inputs from industry and endorsed by the Cabinet back in October 2003.

There are many advantages of using pre-cast concrete wall systems especially in order to transform the construction sector into a modern and progressive industry. Firstly, the system will give an aesthetically pleasing especially within interior because there was no protruding beams and column compared with the conventional apartment building. Besides that, the quality and architectural features of the building are consistent because the panels were manufactured at the factory with high quality standard and proper monitoring. As compared with conventional method that only depend on the workers workmanship at the construction site. **Figure 2.2** shows how the pre-cast panel wall erected.

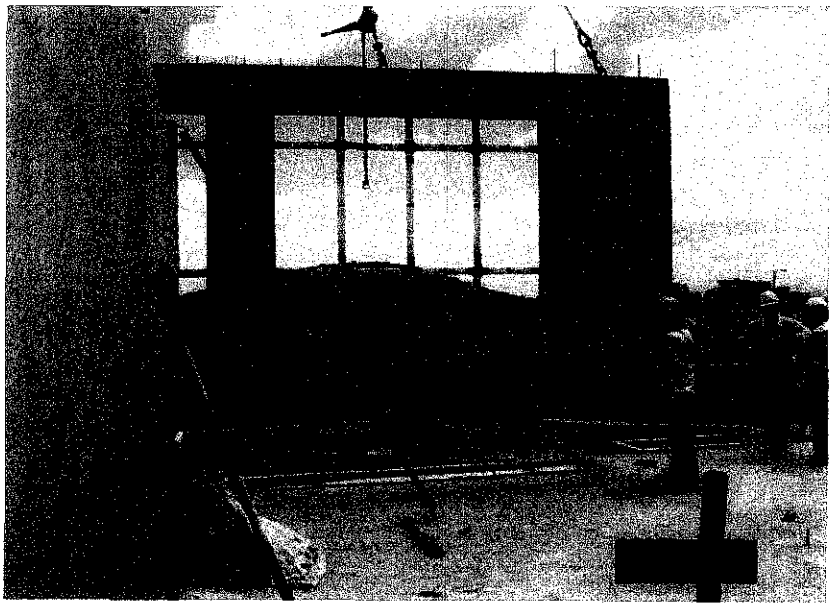

Figure 2.2 Pre-cast Concrete Panel Erections.

Furthermore, the speed of the construction and labour efficiency increase even though the workers are reduced up to 30%. This will also reduce the dependency on foreign workers because the prefabricated IBS components are mechanically installed using cranes at site using with only minimal number of man power.

Other factors that nowadays decisive for any construction were regarding Health, Safety, Security and Environmental or HSSE at the construction site. Therefore, the usage of this technology will reduce the hazard at the construction site. For instance, pre-cast wall panels itself will act as a permanent barrier and will reduces the risk of falling object and accident as compared to an overcrowded scaffolding when constructing high-rise building. The system also environmental friendly because most of the pre-cast concrete panel itself was fabricated at pre-cast factory before erected at site. Therefore, less construction debris produced because of less usage of formwork on site, no brickwork and plastering. **Figure 2.3** below shows worker levelling the panel.

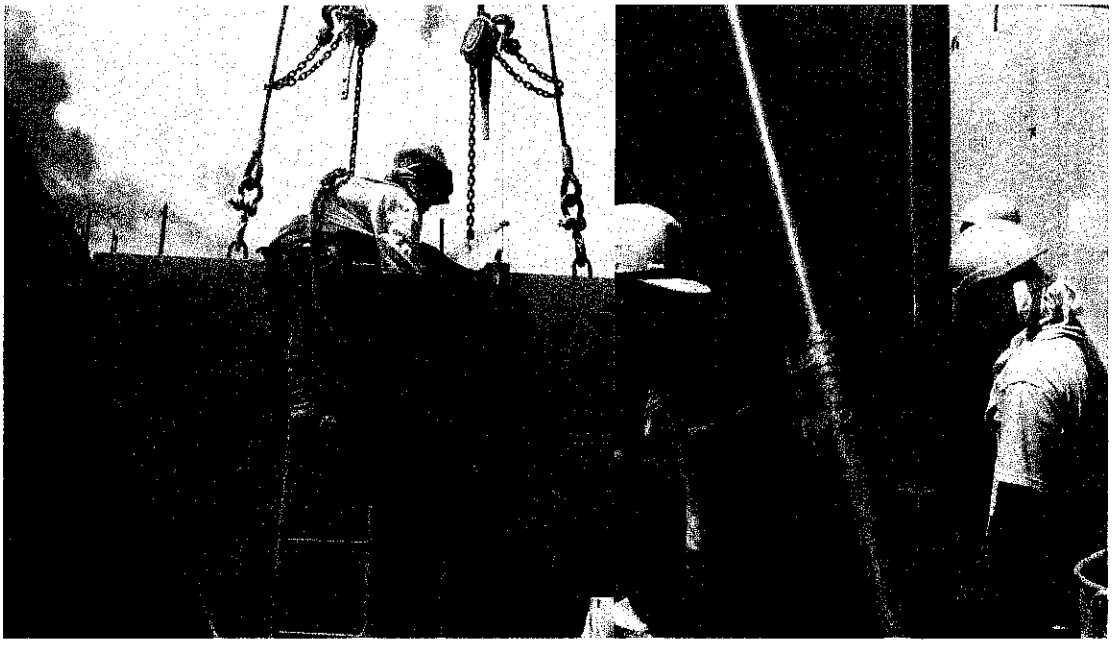

Figure 2.3 Workers Levelling the Pre-cast Concrete Panel.

In term of cost, the system will be costly during initial stage. But after considering other factors such as cost for labour; building quality; waste disposal cost and construction period, the whole cost of the system will eventually become less than the conventional method of construction.

Even though, there are many advantages of using the system but apparently it still have disadvantages during the construction and after the projects completed. Firstly, during the construction due to delivery and unloading of structural components it will lead to poor productivity in pre-cast construction method. This is because the workers or installers are given multi-tasking jobs, including unloading and installation. While, in conventional method projects, it only involves raw material deliveries and unloading were taken over by general workers. Besides that, at pre-cast construction project site to relocate the pre-cast wall panels' placement and storage will be a problem. **Figure 2.4** below shows how the panel are jointed to the floor slab.

Figure 2.4 Pre-cast Concrete Panel Jointing Welded and Pasted with Concrete.

After the project completed, for pre-cast concrete load-bearing wall any mechanical and electrical conduit cannot be altered or relocated because any hacking and rectification process at the pre-cast concrete wall will reduce the strength and the integrity of the wall that sustain the load transfer upon it. Any changes only can be done during the

preparation and fabrication at the off-site pre-cast yard at the early stage. Besides that, other problem such as poor fire resistant and maintainability need to be consider.

2.3 DETAILS OF PRE-CAST CONCRETE WALL PANELS

Pre-cast concrete wall panels is a type of material made with concrete cast in a reusable mould and cured in a controlled environment, then transported to the construction site and erected into specific place to form a building. It is different compare with standard in-situ concrete, which is poured-in-place in large forms and cured on site. It is one of the components of Industrialised Building Systems along with Formwork Systems; Steel Framing Systems; Prefabricated Timber Framing Systems; and Block Work Systems.

2.3.1 Description

2.3.1.1 Pre-cast Panel Types

In general, there are five types of pre-cast panels used as part of building envelopes:

- Cladding (curtain walls);
- Load-bearing wall units;
- Shear walls;
- Formwork for cast-in-place concrete; and
- O-Stable Panel System.

The pre-cast cladding or curtain walls are pre-cast concrete panels that do not transfer vertical loads but it simply encloses the space. It only designed to resist wind, seismic forces generated by it own weight, and forces required transferring the weight of the panel to the support. There are a few common cladding units include wall panels, window wall units, spandrels, mullions, and column covers. Moreover, these units can be removed individually if necessary.

The pre-cast load-bearing wall units are contrast with the pre-cast cladding because it can resist and transfer loads from the roof to the foundation. It has a similar characteristic like column, which bears the weight and forces of the structures resting on it. Hence, it cannot be removed without affecting the strength or stability of the building. Typical load-bearing wall units include solid wall panels, and window wall and spandrel panels.

The pre-cast concrete shear wall panels are used to provide lateral load resisting system when it combined with diaphragm action of the floor construction. It depends upon the panel-to-panels connection to deliver the effectiveness of the pre-cast shear walls system.

The pre-cast panel itself can be used as a formwork for a cast-in-situ concrete. This will provide a visible aesthetics of the system, while the cast-in-situ portion provides the structural component system.

New technology of the panel system that been introduced recently in Malaysia was the O-Stable Panel System. It is a prefabricated system created for versatility to suit any layout and design required by the architect. The system provides method of joining pre-cast concrete panel wall onto adjoining column or wall or another pre-cast concrete wall panel without water leakage and flushes surface joints (CIDB, 2007).

2.3.1.2 Support and Anchorage Systems

One of the important main components for the pre-cast concrete panels for the building envelope system is the connection. Therefore, pre-cast manufacturers or suppliers develop several various types of anchors with the gravity and lateral types of connection as the fundamental characteristic. In order to achieve its primary purpose to transfer the load to the supporting structure and provide stability, thus there are criteria need to be implemented to design the pre-cast connection, which are:

- Strength;

- Ductility;
- Volume change accommodation;
- Durability;
- Fire resistance; and
- Constructability.

2.3.1.3 Joint and Joint Treatments

To prevent leakage through the pre-cast wall system the joints between pre-cast units or with the other building components must maintain. It must integrate the structural, thermal and other factors that may affect the performance and movement of a joint. The joint seal itself also need to be adequately designed to withstand the movement of the joint.

2.3.1.4 Common Backup Wall Elements

In commercial construction, the most common back-up wall element for architectural pre-cast concrete wall metal is an insulated, metal wall assembly.

2.3.2 Structural Aspects

Pre-cast concrete wall systems naturally has high levels, safety and performance in the face of external forces and other implied and dead loads base on the special jointing systems deployed into the pre-cast component. Generally, the pre-cast concrete wall system must resist a lateral loads directly imparted on it, such as from wind and earthquake. These both loads must be transmitted through the wall system and the secondary element of the building's structure. Other additional load such as during erection, impact, construction related and transportation must also be taken into an account in the design. To avoid imposing of unwanted load onto the panel, thus it is important to evaluate the design, detailing and erection of pre-cast panels. Due to thermal expansion and differential movements between panels, the joint between panels

must be wide enough for it motion. The spaces between these panels are commonly sealed with sealant to prevent water penetration in the wall cavity. In order to provide secondary line protection against water penetration to this wall cavity it is also usually covered with a water resistant membrane.

2.3.3 Performance Aspects

2.3.3.1 Fire Safety

One of the main disadvantages of using the pre-cast concrete wall systems as compared o the cast-in-situ concrete is the fire resistance. In fact, for high-rise building pre-cast concrete panels can result a serious safety hazard when a fire occurs that may damages the panel connection and causes a panel to collapse from the building.

2.3.3.2 Thermal Performance

Thermal performance characteristic of the pre-cast panels' wall derived from the amount of insulation placed in the cavity or within the backup wall. This is a metal stud in commercial construction.

2.3.3.3 Acoustics Aspects

A pre-cast concrete wall system and cast-in-situ façade will provide a similar performance regarding sound transmission from the exterior to the interior. On the other hand, the distressed and open joint between panels capable to provide a condition in which sound transmission to the interior may be increased.

2.3.3.4 Maintainability Aspects

Even though the pre-cast concrete wall systems have high level of quality and durability compared with the cast-in-situ concrete or conventional method of construction, it also

required some maintenance. The crucial maintenance item for pre-cast panels is the sealant in joints and protection system. If a sealer or concrete coatings used as aesthetic or to minimize moisture from penetrate into the panel, thus it will require reapplication. Commonly the sealant and surface protection system can sustain between range of 7 to 20 years before it need the reapplication.

2.3.3.5 Moisture Protection

In order to protect pre-cast panels wall from the moisture. A barrier system is incorporated along with an adequate joint seal. Besides that, an additional protection can also be introduced such as sealer or a concrete coating. This sealer can be cleared or pigmented if used as an enhancement of the pre-cast appearance. Film-forming coating usually offers a higher level of performance but will have significant impact on the appearance of the pre-cast concrete unit. Besides that, the pre-cast concrete panels itself must be designed to provide a significant level of durability to environmental exposure. This durability achieved by specifying minimum compressive strengths; maximum water cement ratios and an appropriate range of entrained air.

2.4 IBS Road Map 2003-2010

IBS Road Map 2003-2010 has been discussed and agreed by IBS Steering Committee and Working Groups organised by CIDB Malaysia where the members are represented by government sector, professional bodies, higher learning institution and all the parties that involves in construction industry. The Road Map 2003-2010 was formulated due to the usage of the system still low based on IBS Survey 2003 which is only 15% from Malaysian construction industry.

These mean that construction industry in Malaysia still practising conventional construction methods that have proven time and again to be wasteful, dangerous and messy. This due to the fact that the labour cost in this country is the main root causing the industry failed to reform and being satisfied with the current level of productivity, quality and safety. Therefore, by produced this IBS Road Map 2003-2010, it will ensure that its programs are implemented to meet the total industrialisation of Malaysia's construction industry by year 2010 (CIDB, 2003).

The IBS Road Map 2003-2010, basically the improved and fine-tuning version of IBS Strategic Planning 1999. The outlined strategies encompass manpower, material /component/machine, management/process/method, monetary (economical/financial) and marketing/promotion. Therefore, the Cabinet of Minister has endorsed the roadmap to be a blueprint for total industrialisation of the construction sector and achieving Open Building by 2010 (CIDB, 2003).

Based on the IBS Roadmap 2003-2010, positive impacts from the fundamental proposal and new Government incentives are:

i. The industry will choose Industrialised Building System which guarantees better quality, productivity and safety;
ii. The enforcement of using Modular Coordination (MC) through Uniform Building By Laws (UBBL) will encourage standardisation and subsequently increase the usage of IBS components. It also encourages participation from

manufacturers and assemblers, especially Bumiputera, to enter the market, thus reducing the price of Industrialised Building System components. In essence, Modular Coordination will facilitate open industrialisation;

iii. A screening and selection programme based on Industrialised Building System standard components will ensure that low quality products are not marketed in the country and this prevents the dumping of foreign Industrialised Building System products in Malaysia. This aspect is important to avoid failures in Industrialised Building System projects; and

iv. By reducing wet-trades through IBS, the dependency on foreign workers will also diminish, thus gaining the billions of Ringgit currently being transferred out by foreign workers to their home countries, and reducing inherent socials problem involving these foreign workers.

2.4.1 Modular Coordination

Dimensional conversion for the building and construction industry from Imperial System to Matrix System required implementation of dimension using the correct building components and construction materials. Most of the dimension for building still depends on direct conversion to Matrix which has the same value as the Imperial. This situation will lead to many complications in term of dimensional coordination and increase waste disposal at site. It also time consuming during planning, designing, erection and components production from the factory. If there are no action taken to overcome this matter it will raise many negative impact to Malaysia's construction and building industry. Dimensional coordination for the building components were essential for:

- Reaching the maximum economical value in building components production;
- Reducing manufactured units that do not follow the specification of the standard dimensional required; and
- Avoiding cutting process and reduce construction debris or waste disposal at construction site.

Therefore, Government has proposed the introduction of Modular Coordination. This Modular Coordination was use to enforce the implementation of IBS in Malaysia. It was consider as practical method to coordinate component dimensions and spaces during designing the building. It also used as a tool in order to assist our building sector to achieve industrialised sector.

Basically, Modular Coordination was one of an international system which implemented dimensional standardisation for a building. Based on ISO Standard; Modular Coordination was produced to introduce certain geometric disciplines by using method that practical and related with each other. Its function was to standardise the position and components dimension, and spaces for designing a building.

CHAPTER 3

METHODOLOGY / PROJECT WORK

3.1 INTRODUCTION

Survey Research Methodology (SRM) or Statistical Survey are use to collect quantitative information about item in population. SRM may focus on the opinions or factual information depending on its purpose. It is also deals with people who can response verbally. Typically, respondents are asked question on their behaviour towards the issue, attitudes, awareness, motivation and lifestyles characteristic. The SRM can be conducted by interview (face-to-face/telephone) and postal questionnaire. Interview is usually qualititative, thus postal questionnaire is qualititative and sometimes more on quantitative. There are a few ways to administrating a survey, including:

a. Face to Face Interviews
   i. Interviewer administers structured questionnaire to respondents.
   ii. Flexible - interviewer able to explain, probe, check, and deal with unforeseen situations
   iii. Can have complex definitions, instructions and routing
   iv. Interviewer can motivate respondent
   v. Can use visual aids (e.g. show cards)
   vi. Can deal with complex sampling rules

b. Telephone
   i. Use of interviews encourages sample persons to respond, leading to higher response rates.
   ii. Interviewers encourage sample persons to respond, leading to higher response rate.
   iii. Fairly cost efficient, depending on local charge structure.

c. Mail

i. Response rate 5% - 30%

ii. The questionnaire may be handed to the respondents or mailed to them, but in all cases they are returned to the researcher via mail.

iii. Suitable three pages the most, starting with a paragraph describing the objective of the survey.

iv. Cost is very low, because bulk postage is cheap.

v. But disadvantages of using mail were that it took long time, often several, before the surveys are returned and statistical analysis can begin.

d. Online Survey

i. Can use web or email

ii. Web is preferred over e-mail because interactive HTML forms can be used but difficult to setup or prepared.

iii. Often inexpensive to administer and operate.

iv. Very fast result and easy to modified.

3.1.1 Advantages and Disadvantages of SRM

a. Advantages of Survey Research Methodology are:

i. Efficient to collect information in a large number of respondents.

ii. More flexible in the sense that a wide range of information can be gathered or collected.

iii. It is standardize therefore relatively free from several types of errors.

iv. Easy to administer compare with Experimental Research Methodology.

v. Economical in term of cost due less equipment or material expenses

vi. Less logistical problem compare with Experimental Research Methodology.

b. Disadvantages of Survey Research Methodology are:

i. Accuracy of data may depend on among other factor such as the question is posed of emotional condition of respondent or time of the day/week/month/year.

ii. Structured of the survey may have low validity when researching affective variables.

iii. Data collected may be susceptible to biases.

iv. Difficult to get cooperation from local company because data collected may relate to their company confidential matter.

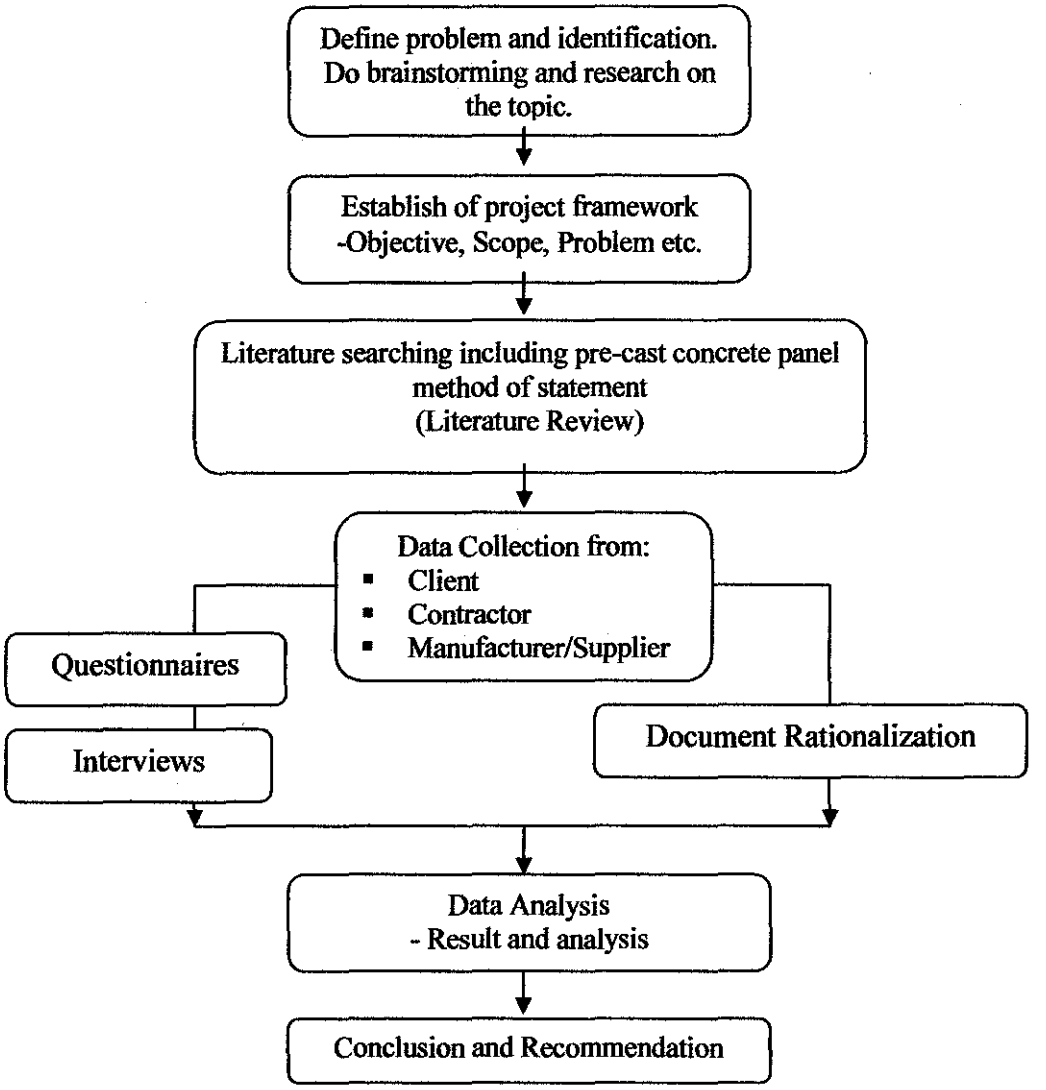

Figure 3.1 Methodology / Project work

Figure 3.1 shows the methodology or the project work involved in order to complete this Final Year Project. The research methodology performed to facilitate the progress of the project in order to achieve the objective of this case study. To accomplish this objective, major process have been formulate which are identify problems; establish target and objective; literature review; data collection and sampling; data analysis and lastly the conclusion of the project.

3.2 RESEARCH TOOL

The main tools that will be used in this study are consists of:

- Questionnaire for the data collection
- Statistical tools for the data analyzing

3.3 RESEARCH DESIGN

This research will be carried out with the inputs from the parties that involve in pre-cast concrete panel systems industry included the contractors, manufacturers and suppliers in peninsular of Malaysia. The numbers of these parties selected base on their involvement in the construction of high rise residential building. The reason of this is to examine the level of the implementation of pre-cast concrete panels in constructing a high-rise residential building such as flat or apartment in Malaysia. Since the study will be based on the pre-cast concrete panel systems, thus a study will also be conducted in order to understand the method of preparation and installation of this system.

3.4 DATA COLLECTION

The data collection is divided into two types. The first type is primary data collection while the second type is secondary data collection. Both of these stages are discussed by looking into the methods and purposes of collecting the data.

3.4.1 Primary Data Collection

The primary data collection use questionnaires and these methods are discussed as below:

a) Questionnaires Design

The questionnaires were designed to examine the usage and barrier of using the pre-cast concrete panel system within the construction industry in peninsular of Malaysia. The questionnaires then were sent through mailing along with return envelopes and directly distribute to the selected company. Before proceeding with the real ones, pilot survey was used as a trial to know the response / comments the response regarding the survey questionnaire for further improvement. The questionnaires were prepared based on the fully structured questions and close-ended questions so that it easy for the respondent to give their feedback.

The questionnaire is divided into four section, which are Section A, B, C, and D. It consists of general/background information, survey on completed project, opinion survey and feedback. The four Sections are:

Section A: General / Background information

- Consist of the company background and their respondent.

Section B: Survey on Completed Project

- Data from the company that had been implemented pre-cast concrete panel system in their previous and current project.
- Before proceed to Section C.

Section C: Opinion Survey

- More on the company opinions and comments regarding the problems, difficulties, reason and recommendation of using the system in Malaysia.

Section D: Feedback

- Indicate whether the respondents wish to receive a copy of the result of this study.
- A contact number and email, if the respondents need further information

Comments or opinion are flexible and suitable for all construction companies either they implemented or not the system.

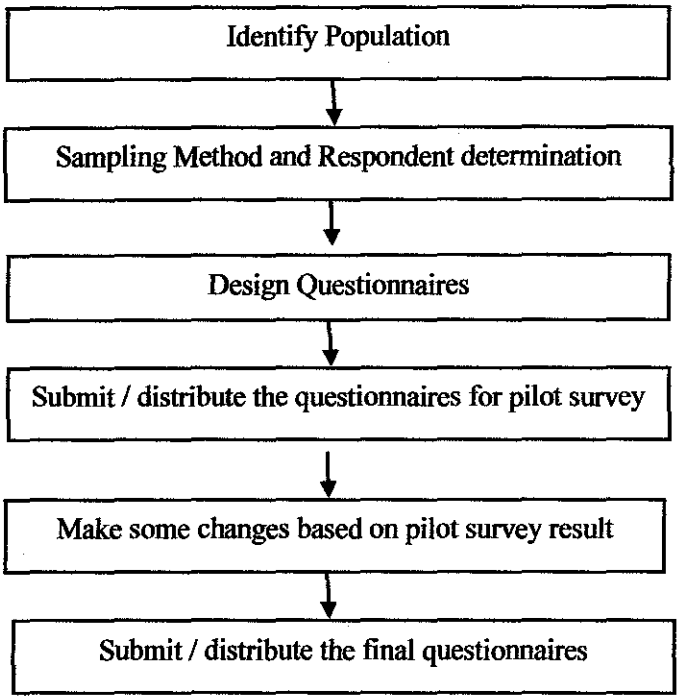

Figure 3.3.1 The Flow Chart Of Questionnaires Design

3.4.2 Secondary Data Collection

Secondary data collection was done by using the method of literature review. Journals, reference books, and other relevant materials are important sourced of secondary data. To gives information in designing better questionnaires, the secondary data will provides an overview of the related research which has been done before.

Documents obtained from the research sample with permission from UTP-IRC OPAC. As a result the study of literature gives an overall view of the past and current issues and information related to the pre-cast concrete panel system especially in Malaysian construction industry. Thus, the data provides can be used to provide a significant and suitable survey questionnaires.

3.5 DATA ANALYSIS

The collected data analyzed based on the objectives of the study. The statistical data also analyzed as well and eventually, findings and conclusion will be derived based on the analysis. There two types of data analysis. The data collected from Section A and B will be shown in pie chart, were use to show the comparison. In the other hand, data from Section C was use to state recommendation and suggestion based on the comments and opinion from the respondents.

3.6 HAZARD ANALYSIS

For this survey research methodology, the health, safety and environment (HSE) need to take under consideration. Even though, the survey research methodology not as risky as the experimental research methodology but as an act of precaution and to avoid any risk of hazard during conducting the research, thus Hazard Analysis is essential. Besides that, it can prevent any adverse effect such as on health causes by working condition and provide occupational environment adapted to physical and mental need.

There are some hazards that need to be considered during this survey research such as:

- Physical Hazard
- Ergonomic Hazard

3.6.2 Physical Hazard

In any workplaces it is the most common hazard that needs to take into consideration at one time or another. These include unsafe conditions that can cause injury and illness or even lead to death. Examples of physical hazards include:

- constant loud noise while conducting the survey at site project
- electrical hazards while using the computer
- high exposure to sunlight/ultraviolet rays, heat or cold

- working with mobile equipment such as fork lifts (operation of fork lifts and similar mobile equipment in the workplace requires significant additional training and experience)

3.6.2 Ergonomic Hazard

Ergonomic is a science that concerned with the "fit" between people and their work. It is a physical factor within the environment that harms the musculoskeletal system. Ergonomic hazards include uncomfortable workstation height and poor body position. Therefore, the suitable ergonomics is by makes sure that tasks, equipment, information and the environment suit every worker.

It commonly occurs when the type of work, body position and working conditions put strain on your body. They are the hardest to spot since you do not always immediately notice the strain on your body or the harm these hazards pose. The ergonomic fields could be divided into 2 categories which are:

- Physical aspects (body size and shape, fitness and strength, posture, senses e.g. vision, hearing, touch and stresses and strains on muscles, joints and nerves)
- Psychological aspects (mental abilities, personality, knowledge and experience)

Short-term exposure may result in "sore muscles" the next day or in the days following exposure, but long term exposure can result in serious long-term injuries.
Ergonomic hazards include:

- poor lighting;
- improperly adjusted workstations and chairs;
- frequent lifting;
- poor posture;
- awkward movements, especially if they are repetitive;
- repeating the same movements over and over; and
- having to use too much force, especially if you have to do it frequently.

As for summary, ergonomics solve physical problems (work surface high enough, adequate leg room), psychological as well as social problems (too much workload, unclear tasks, time pressures, inadequate training and poor social support) and by practicing the health, safety and environment rules and regulations, accident could be reduced during conducting the works.

CHAPTER 4

RESULTS AND DISCUSSION

4.0 CHAPTER OVERVIEW

This chapter concluded all the findings and research that has been done for this project. All the findings and research result were gathered through replied questionnaire from the respondents. It also included the current development for the project and the result from the portion that has been done.

4.1 SURVEY SAMPLE

This project has been conducted through the questionnaire survey method in order to get the information regarding the implementation of pre-concrete panel system in Peninsular Malaysia.

The final questionnaire forms were sent to the construction and other parties that involves in the industry in Peninsular Malaysia in Jun 2008 and October 2008 along with return envelopes. Besides that, about 30 e-mails with an attached questionnaire were sending to the selective company. The sample comprised 200 contractor firms based on CIDB Registration grade which listed in *CIDB Directory 2007.*

The questionnaire is divided into four section, which are Section A, B, C, and D. It consists of general/background information, survey on completed project, opinion survey and feedback. For Section A, it is basically regarding the general or background information of the research company. This includes the company background such as type of firm involvement, years of experienced and their respondent. For Section B, the survey is more concerned on the construction company or parties that involve in the industry that have been implemented the system in any of their project. These include

data from the company that had been implemented pre-cast concrete panel system in their previous and current project.

Next is Section C, which is more general and flexible to any construction company or parties that involves in the industry either implemented or not implemented the system. They can give their opinion and comments regarding the problems, difficulties, reason and recommendation of using the system in Malaysia. Lastly is Section D, which the respondents can choose whether they want the result of this survey or not.

The questionnaires are inclusive of open-ended, close-ended and likert-scale questions. On the most questions, the respondents were requested to express their views on a five-point scale. For example, in Section B, the respondents were required to rate their perception of the **most advantage/attraction** of using pre-cast concrete panel system as a construction method compared with the conventional method in differences categories. The respondents can rate from *"least"* to the *"most attractive"*.

Until end of October 2008, 6 respondents from the construction industry had returned and responded the questionnaires by mail. In order to increase the number of replies, phone conversations were made at the beginning of August, 2008 with personnel of the construction firms that had not returned the questionnaire. By mid of August 2008, about 50 fax and e-mail with attached survey questionnaire were send to the selective construction company. As a result, 19 companies reply for both email and fax. Therefore, up to now only 25 respondents have responded. Even though, proactive measures such as follow up through email and telephone were conducted to raise the number of respondents but it is still below the minimum target which are 30 respondents.

4.2 METHOD OF ANALYSIS

4.2.1 Severity Index

Severity index was calculated based on the response of the survey to reflect the level of severity effect of the level of **attraction/advantages** of using the pre-cast concrete panel system. This index was calculated as follow (Al-Hammad, 2000) :

$$\textbf{Severity Index (I)} = [\sum_{i=0}^{4} a_i . x_i] / [4 \sum x_i] \times 100\% \quad \text{.....(2)}$$

Where;

a_i = constant expressing the weight given to i

x_i = variable expressing the frequency of the response for i ;

I = 0,1,2,3,4 and illustrate as follow ;

x_0 = frequency of the 'less' response and corresponding to $a_0 = 4$

x_1 = frequency of the 'least' response and corresponding to $a_1 = 3$

x_2 = frequency of the 'average' response and corresponding to $a_2 = 2$

x_3 = frequency of the 'attractive' response and corresponding to $a_3 = 1$

x_4 = frequency of the 'most attractive' response and corresponding to $a_4 = 0$

The percentage of the severity index then categorized as below in order to reflect the scale of the answer of the respondents to the questionnaire.

- 0% - 20% ~ 'non-severe'
- 20% - 40% ~ 'somewhat non-severe'
- 40% - 60% ~ 'moderately severe'
- 60% - 80% ~ 'severe'
- 80% - 100% ~ 'most severe'

4.3 DATA ANALYSIS AND RESULT

4.3.1 Data Collection

Data retrieval was received in form of hardcopy (mail and fax) and softcopy (e-mail). A total of 25 respondents out of 200 returned the questionnaire. For this survey research, it not within the range of the minimum of 30 respondents required in order to conduct an accurate analysis. This had been expected from beginning of the research for a mailed and questionnaire-based survey research which low percentage of responded from the construction company or parties that involves in the industry with only 13% of the respondents replied. As shown in **Figure 4.1**

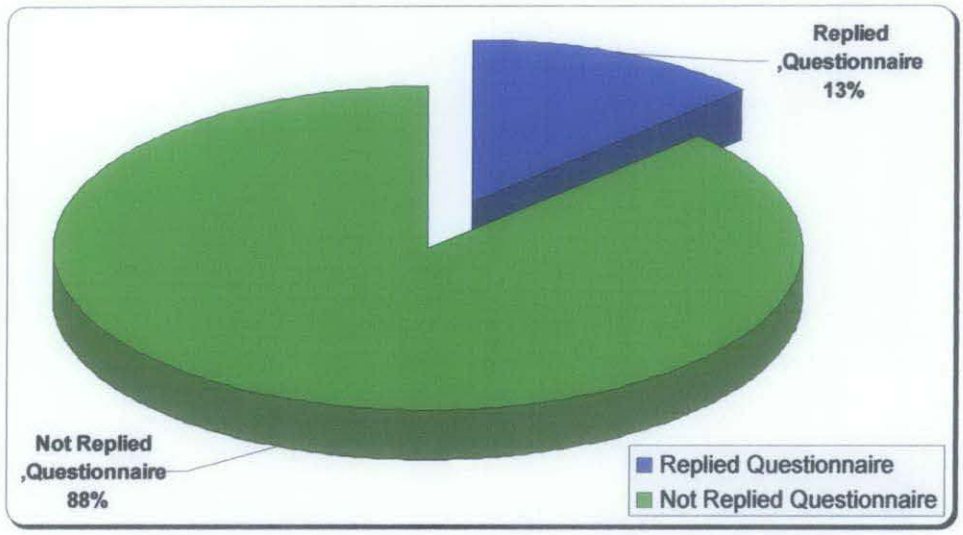

Figure 4.1 : The Questionnaire's Data Retrieval

4.3.1.1 Section A: General/ Background information

The Data retrieval shown in **Figure 4.2**, in total 64% or 16 respondents are from contractor firm and 20% or 5 respondents are from Developer firm; and other, which is mainly suppliers consist of 16% or 4 respondents. There no responded from other type of firm involved in the construction including Government Sector, Engineering Consultant, and Architect Consultant.

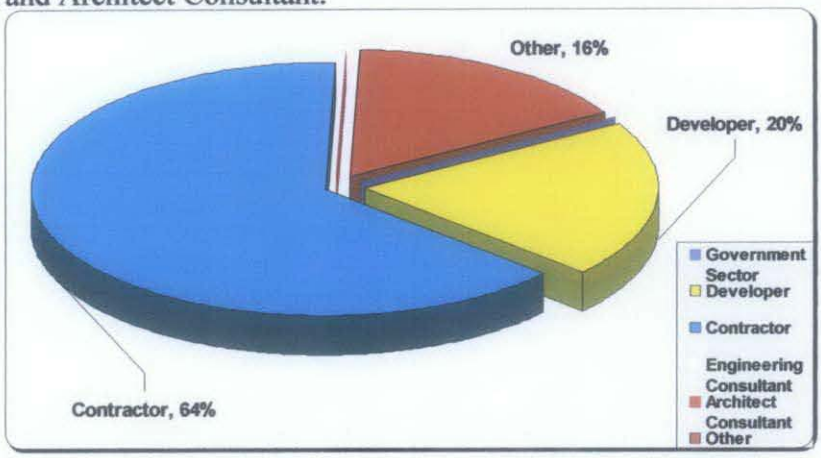

Figure 4.2 : The Percentage of Respondents According To Type of Firm Involved

Based on the total respondent, 20 out of 25 respondents or 80% have experienced in construction industry more that 20 years (>20). The remainder of the respondents, which 2 respondent or 8% have experiences between 5 to 10 years (5-10) and 3 respondents or 12% have experiences more10 to 20 years (10-20). **Figure 4.3** explained the percentage of the respondents according to their experienced.

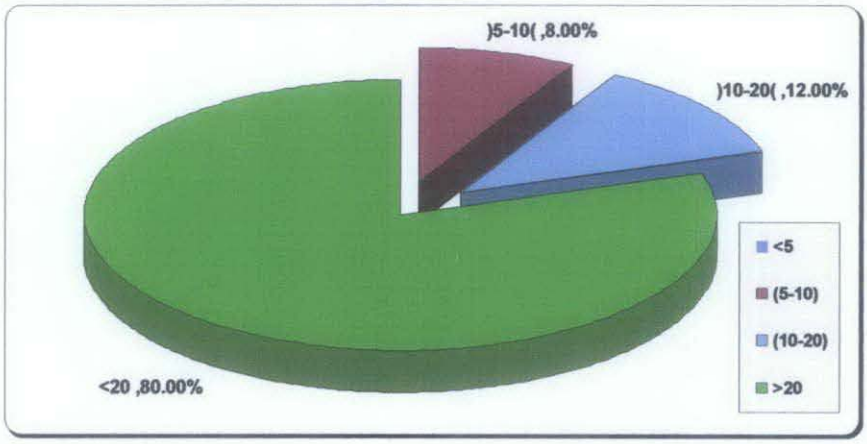

Figure 4.3 : The Percentage of Respondents According To Company's Experienced

As shown in **Figure 4.4**, from the total of respondents, 20 respondents or 80% are from firms with G7 status while 3 respondents or 12% are from G6 contractor firms and 2 respondents or 8% are from G5 contractor firms. There are no respondent from G4 to none graded construction company.

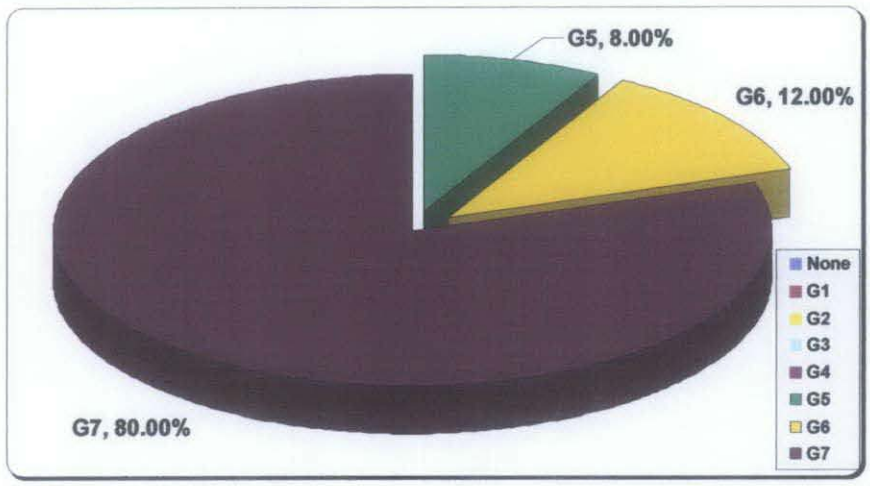

Figure 4.4 : The Percentage of Respondents According To CIDB Registration Grade of Contractor

The respondents were consists of Owner/Investor, Project Manager, Structural/Civil Engineer, Architect, Quantity Surveyor, Site Supervisor and Other. Out of 25 completed forms, the highest respondents are from Structural/Civil Engineer which consists of 88% or 22 respondents followed by Owner/Investor for 4% or 1 respondent, Quantity Surveyor level for 4% or 1 respondent and other which is Senior Technical Manager for 4% or 1 respondent. Most of the respondents have experience in construction more then two years. **Figure 4.5** explained the percentage of the respondents according to their designation.

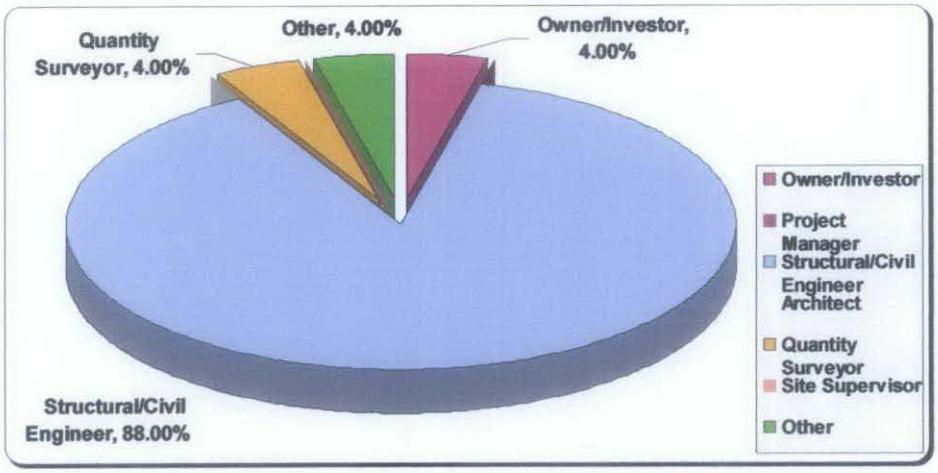

Figure 4.5 : Percentage of Respondents Designation

4.3.1.2 Section B: Survey on Completed Project

From all the data collected, 23 out of 25 respondents or 92% have implemented Pre-cast Concrete Panel System as their construction method with an experienced between one to three years. As shown in **Figure 4.6**.

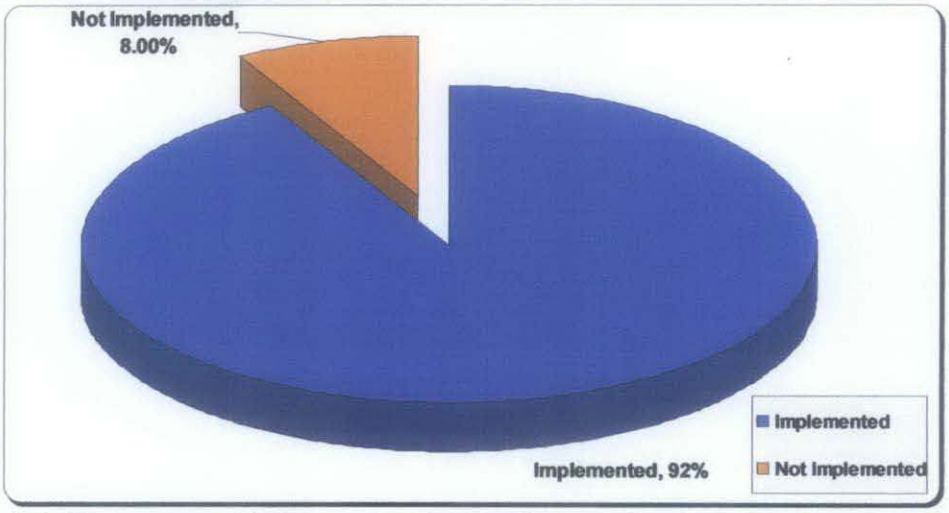

Figure 4.6 : Percentages Of Companies that Implemented and Not Implemented the Pre-cast Concrete Panel System.

Data also shown, that 95.66% or 22 respondent have used or implemented the system between one to five of their projects and 4.34% or one company have implemented the system more than 15 projects. Mostly, type of project they preferred is a low-cost

apartment, condominium and also medium cost apartment. Common types of pre-cast concrete panel system that they implemented are the shear wall and load bearing wall. For **Percentage of Cost Saving**, 4.34% of the respondent or 1 respondent stated that no cost saving using the system and another 4.34% or 1 respondent stated that the cost saving around 25% to 50%. The remainder 20 respondents or 84 % agreed with 0 to 25% saving for their project as compared to the conventional method. As shown in **Figure 4.7**

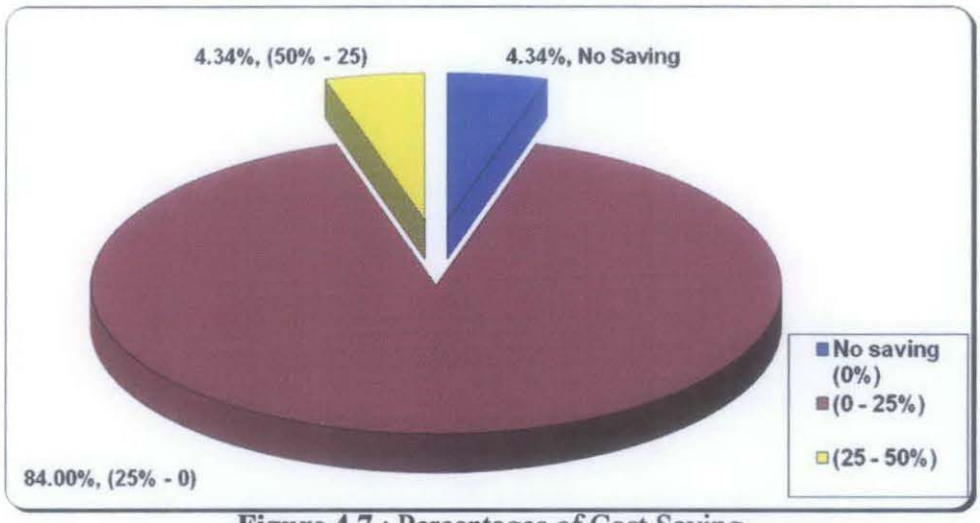

Figure 4.7 : Percentages of Cost Saving

For **Percentage of Workers Reduction**, 47.83% or 11 respondents agreed with the percentage reduction between 0 to 25% (0 - 25%) and 52.17% or 12 respondents agreed with percentage reduction estimated around 25% to 50% (25 – 50%). As shown in **Figure 4.8**

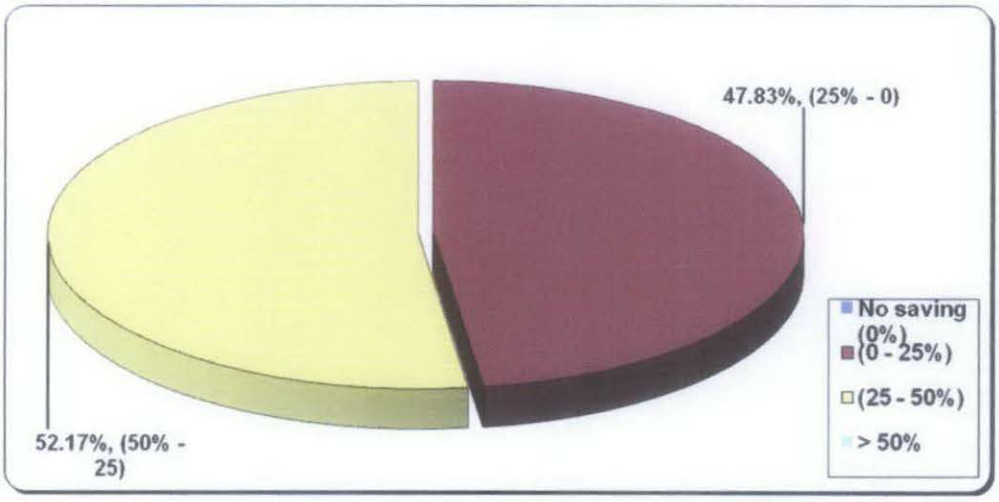

Figure 4.8 : Percentages of Workers Reduction

In this section, the respondents were also asked regarding the advantages or attraction of using the pre-cast concrete panel system. This attraction in term of cost, quality, aesthetically, labour efficiency, construction speed, safety and property market demand. The respondents were given choices of answers based on the likert-scale and the respondents need to choose the best answer for choices given either "Least", *"Less"*, *"Attractive", and "Most Attractive"*. Each rating score that varies from 1 represent the scale of "*Least*" attraction to 5 for "*Most Attractive"* respectively. Higher the total point for each category will show the most advantages and attraction of using the system.

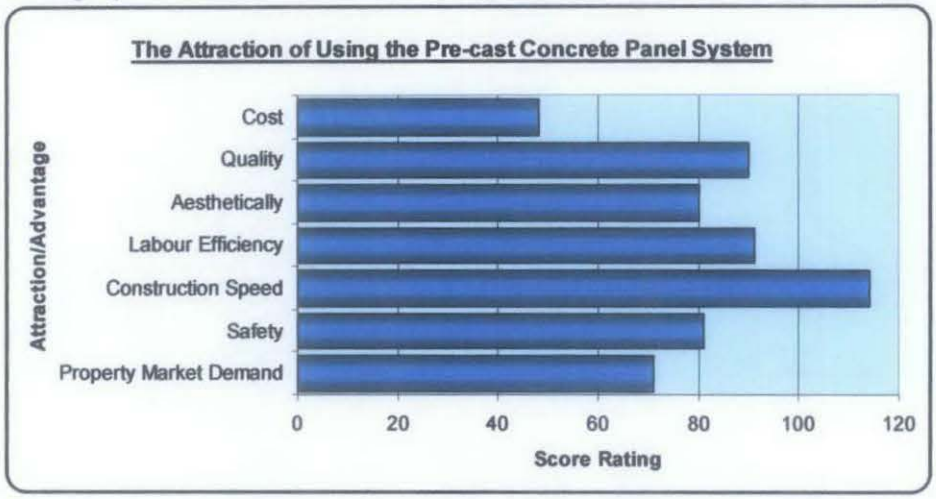

Figure 4.9 : The Attraction of Using the Pre-cast Concrete Panel System

Figure 4.9, it shown most of the respondent's most advantage/attraction of using the system were the Speed of Construction with the highest total point of 114 and the lowest attraction or least advantage/attraction of using the system is the Cost with only 48 point. For the Quality and Safety, both have a total of 90 point and 83. Lastly, in term of aesthetically, Labour Efficiency and the Property Market Demand all have total point of 47.

Based on the data obtained from **Figure 4.9**, by applying the severity index method to this analysis of, the severity of survey was calculated to reflect the level of severity effect of the level of attractions or advantages of pre-cast concrete panel wall in Malaysian construction industry. Based on the analysis, the rating of the level of severity and mean value effect then could be identified as shown in the **Table 4.2.8.1,**

Figure 4.10 and **Figure 4.11**. Based on the analysis, it shows the lowest percentage is the cost attraction with 27%, thus range within 20% - 40% of the severity index and as stated by Al-Hammed (2000), this range could be categorized as a 'somewhat severe'. The Highest is an attraction in term of construction speed with 99%, thus it is range within 80% - 100% of the severity index and categorized as the 'most severe'. Other attraction or advantages are within 60% - 80% of the severity index and categorized as the 'severe' accept the property market demand that are within 40% - 60% and categorized as the 'moderately severe'.

Table 4.8.1 : The Ranking And Level Of Practices Based On Severity Index

ATTRACTION/ ADVANTAGES	RESPONSE					MEAN	SEVERITY INDEX (%)	RANK
	1	2	3	4	5			
a) Cost	3	15	5	0	0	2.09	27	Somewhat Non-severe
b) Quality	0	0	3	19	1	3.91	73	Severe
c) Aesthetically	0	0	12	11	0	3.48	62	Severe
d) Labour Efficiency	0	0	4	16	3	3.96	74	Severe
e) Construction Speed	0	0	0	1	22	4.96	99	Most Severe
f) Safety	0	0	3	11	6	3.52	68	Severe
g) Property Market Demand	0	1	19	3	0	3.09	51	Moderately Severe

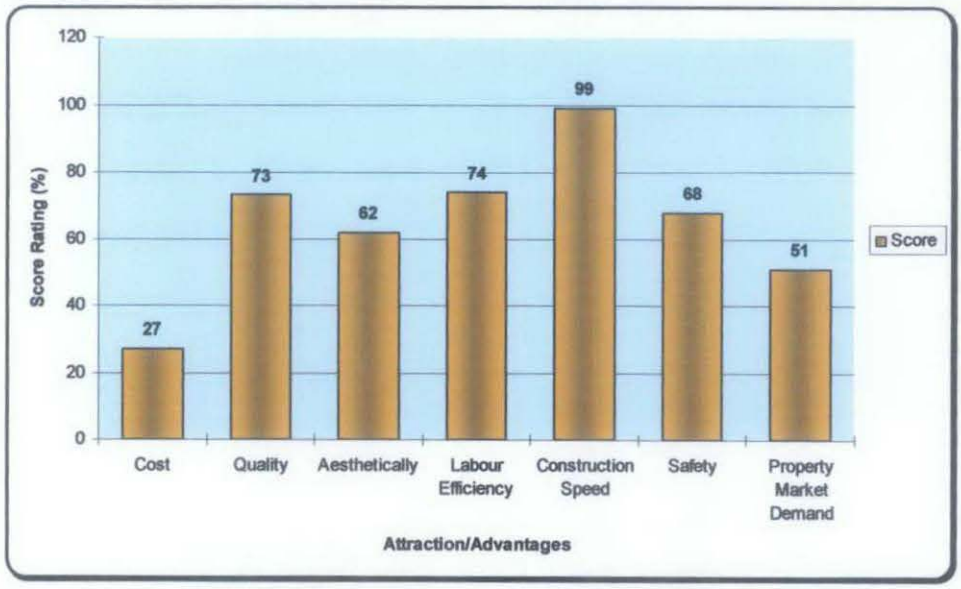

Figure 4.10 : Severity Index of Attraction/Advantages

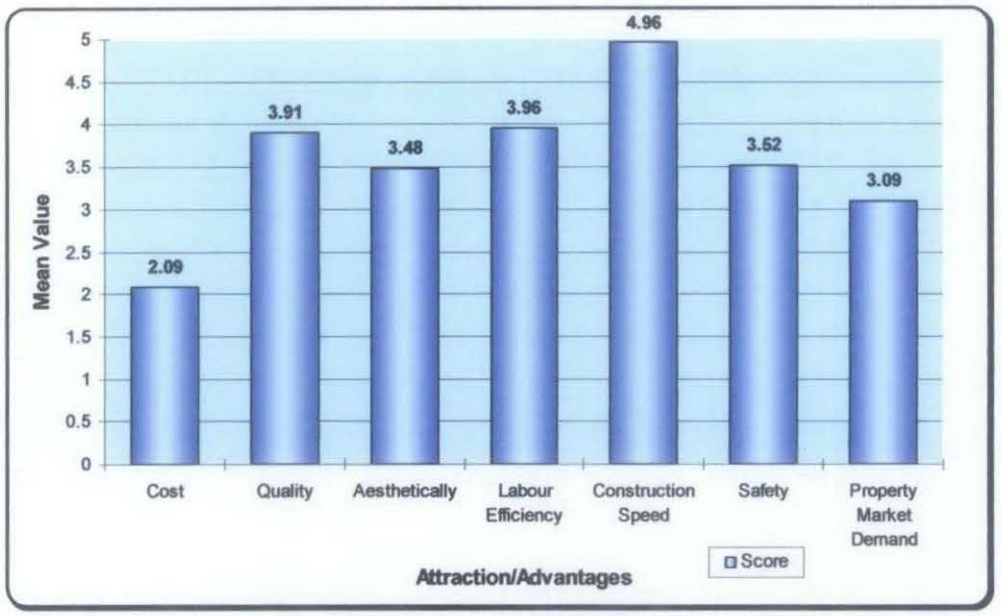

Figure 4.11 : Mean Value of Attraction/Advantages

4.3.1.3 Section C: Opinion Survey

This section will cover the opinion or comment from the construction company or any parties that involves in the industry. The first question, respondent's were ask about their comment toward the problems occurs in current construction industry especially for high-rise residential building. Majority of the respondents mention that the problem facing the current construction industry is the dependency on the labour intensive method which resulting to an influx of unskilled worker, thus lead to inconsistency of building quality. Other answers of from the respondents are that the pre-cast concrete panel system required extra storage space and highly skilled worker for the system. Besides that, most contractors in Malaysia do not know the methodology when using pre-cast concrete panel system.

The second question, the respondents were asked about their opinion regarding the reason why the system rarely applied in construction industry in Malaysia especially for high-rise residential building. Based on the result, majority of the respondents agreed that the system involves high start-up cost in which most of the construction firms do

not have financial capability to do so. In the same time due to the cost of labour is still low which provides competitive advantage for the labour intensive conventional contractors.

Other opinion is that the system required many different dimensions and better system is required to enhance the system. Therefore, due to this many dimensions went design the pre-cast concrete panels, thus most of the design engineers in Malaysia do not know and lack of experienced to design the system and they tend to fall back to conventional method.

Besides their opinion regarding the reason why the system rarely applied in Malaysia, many of the respondents have share their experiences with the difficulties went implementing the system. The difficulties that commonly occur during construction process were due to opening and work that involves electrical and mechanical installation and location.

Other than that, due building designed was not customized for pre-cast usage. Therefore, the contractor or consultant needs to study and propose certain modifications for suitability of using the system. However, in current construction industry in Malaysia, most of the contractor or engineer lack of know how to construct or design the system. They also do not inculcate a "Quality and Precision" mind set during constructing their building.

4.4 DISCUSSION

The survey has been conducted and the data have been collected regarding the implementation of pre-cast concrete panel system for high-rise residential building in Malaysia. Only 25 out of 200 respondents or 13% has replied the questionnaire.

Based on the result from Section A and B, the respondents are mainly from the developer and contractor firm in which carries about 40% and 60%. Also most of them are from grade G7 based on the CIDB Registration grade and have experienced more than 20 years. In addition, 23 out of this 25 respondents have been implemented the system. These results have a correlation with the respondents' opinion in Section C in which the majority of the respondents agreed that the system involves high start-up cost, which most of the construction firms do not have financial capability to do so. Besides that, they agreed that most contractors in Malaysia do not know the methodology to construct the pre-cast concrete panel system. Based on this correlation, it shows that common construction firm in Malaysia that implemented the system was a big company that have financial capability and high experienced in construction industry. Basically, the type of project that they commonly used when implementing the system is built and design project.

In term of implementation, types of high-rise residential building that commonly built using the system are low-cost apartment, medium cost apartment and also a condominium. The preferred types of pre-cast concrete panel system are the shear wall and load bearing wall. Besides that, the results in Section B indicate that the percentage of cost saving is less than the percentages of worker reduction when implementing the system. This shows that even though numbers of labour are reducing when implementing the system, the cost is still unchanged. This unchanged cost, probably due to high cost in fabrication and erection of the pre-cast concrete panel system. Contrary to this, the conventional method is required more labour than the pre-cast concrete panel system method but due to cheap labour in Malaysia the cost of the project is not effected. Besides that, based on the level of attraction of using the system the cost are

range within 20% - 40% of the severity index and as stated by Al-Hammed (2000), this range could be categorized as a 'somewhat severe'.

Based on the severity index it shows that the 'most severe' attraction of using the system is the speed of construction. In term of property market demand, it is 'moderately severe' which categorized within range of 40% - 60% severity and categorized as the 'moderately severe'. Other attractions indicate 'severe' attraction that categorized within 60% - 80% of the severity index. Based on this severity index, it shows that the system have many attraction and advantages such as the building quality, aesthetically, labour efficiency construction speed, safety and property market demand even though the cost is least attraction as compared to the conventional method of construction.

In this survey, most of the respondents have given a constructive opinion and comments regarding the problem occur in current construction industry. They also share some of their experience regarding the difficulties that facing them during implementing the system in their project. By understanding these difficulties a continual improvement is necessary in order to overcome it.

CHAPTER 5

CONCLUSION AND RECOMENDATION

5.1 CONCLUSION

Based on the data and the discussion, the usages of pre-cast concrete panel systems in Malaysia for high-rise residential building have been examined. It shows that around 90% from 25 respondents have been implemented IBS System, specifically pre-cast concrete panel system. The types of high-rise residential building that commonly built using the system are low-cost apartment, medium cost apartment and also a condominium. The preferred types of pre-cast concrete panel system are the shear wall and load bearing wall. About 84% respondents agreed that the cost saving only around 0% - 25% as compared to conventional method. All the respondents agreed that the worker reduction either between 0%-25% and 25%-50% reduction. These mean that the cost of the completed project using the system is unchanged even though the number of labours reduces. By using mean value and severity index for ranking, the level of Attraction/Advantages could be figure out as explained in the result of Section B which shows that the least attraction or 'somewhat non-severe' was the cost and most attraction or 'most severe' was the speed of construction.

The barriers of using pre-cast concrete panel system have been determined which was the cost of implemented the system was the key factor that hindered the usages of the system for high-rise residential building in Malaysia. This was based from the respondents' opinion, regarding the barrier of implementing the System according to the result in Section C. Besides that the correlation in Section A, B and C shows the significant of the cost as the main barrier of using the system.

5.2 RECOMMENDATION

Based on the survey we can conclude that the level of usage for pre-cast concrete panel system in Malaysia especially for high – rise residential building is still low. In addition, majority of company that implements the system are from a big company that have financial capability and experience in construction industry. The data from the survey also shows that the main barriers or the less attraction of using the system is the cost especially start-up cost. Therefore, local authorities need to take note about this problem and develop a solution to attract small companies and to reduce the start-up cost to implement the system. If the system can be refined and the barrier of using this system can be overcome, thus it can be the main alternative method of construction for high-rise residential building in Malaysia by year 2020.

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UNIVERSITI TEKNOLOGI PETRONAS

APPENDIX 1-1

Dear Sir/Madam,

Implementation of Pre-cast Concrete Panel System for High-rise Residential Building in Malaysia

We seek your help in a university research survey on the implementation of pre-cast concrete panel system for high-rise residential building in Malaysia specifically in peninsular Malaysia.

Pre-cast concrete panel system is one of the components in Industrialised Building System or IBS. The pre-cast concrete panel system had been introduced in Malaysia 4 decade ago; however the usage of this technology was not fully utilized in Malaysian construction industry especially for high rise residential building. Although, it is a fact that the system have more advantages compared to the conventional Cast-In-Situ method. In reality, most of the parties involved in the construction industry not really exposed to and lacked knowledge in the system. If the system can be refined and any barrier of using this system can be overcome, thus it can be the main alternative method of construction to cater the demand on high rise residential building in Malaysia. Besides that, the objective of this survey is also to be a reference for the local authorities to take note and aware about the problem facing by the client, contractor or manufacturer during implementation of the system in Malaysia.

We have devised a questionnaire which we would like you to participate. It will only take no more than 15 minutes of your time. With your cooperation, we should be able to collect as many data as possible regarding the implementation of pre-cast concrete panel system for high-rise residential building in Malaysia.

It would be very helpful us very much if you could complete and return the questionnaire before _____. As an enclosure to this letter, please find a self-addresses and stamp envelope to return the questionnaire.

If you need further information, please contact Mohd Farhan at **019-2985680** or email to **paan_smallville@yahoo.co.uk / mohd_farhan@utp.edu.my**

We thank you in advance for your support and co-operation.

Yours sincerely,

(Mohd Farhan Abdul Razak)
Civil Engineering Department
Universiti Teknologi PETRONAS

Cc: Dr. Mohd Faris Khamidi

IMPLEMENTATION OF PRE-CAST CONCRETE PANEL SYSTEM FOR HIGH-RISE RESIDENTIAL BUILDING IN MALAYSIA

Pre-cast concrete panel system is one of the components in Industrialised Building System or IBS. If the system can be refined and any barrier of using this system can be overcome, thus it can be an alternative method of construction for high-rise residential building in Malaysia. The main objective of this survey is also to be a reference for the local authorities to take note and aware about the problem facing by the client, contractor or manufacturer during implementation of the system in Malaysia.

This questionnaire is divided into **four** sections which are **section A, B, C and D**. Please answer the questionnaire by referring to the instructions given in each section

Section A: General / Background information

Please fill in the blanks or tick in the [ ] provided.

I. Company:

1. Name of Company: _____
2. State the type of firm involved

   [ ] Government Sector [ ] Developer [ ] Contractor

   [ ] Engineering Consultant [ ] Architect Consultant

   [ ] Other, please state _____
3. Company's experience in building construction? (Years)

   [ ] <5 [ ] 5-10 [ ] 10-20 [ ] >20
4. CIDB Registration grade of the company

   [ ] None [ ] G1 [ ] G2 [ ] G3 [ ] G4 [ ] G5 [ ] G6 [ ] G7

II. Respondents

1. What is your designation with the company?

   [ ] Owner/Investor [ ] Project Manager [ ] Structural/Civil Engineer

   [ ] Architect [ ] Quantity Surveyor [ ] Site Supervisor

   [ ] Other, please state _____
2. Respondent's experience in construction industry? _____ years

Section B: Survey on Completed Project

Please fill in the blank or tick in the [ ] provided

1. Does your company implement Pre-cast Concrete Panel System as a construction method?

   [ ] Yes [ ] No

   *(If your answer is **No**, please proceed to Section C)*

2. How many **years** have your company used/implemented Pre-cast Concrete Panel System as a method of construction?

   [ ] <1 years [ ] 1-3 years [ ] 4-5 years [ ] > 5 years

3. How many **projects** have your company implemented this system?

   [ ] 1-5 [ ] 5-10 [ ] 10-15 [ ] >15

4. What kinds of project **mostly use** Pre-cast Concrete Panel System?

   [ ] Infrastructure [ ] Landed Properties [ ] Office Building

   [ ] Low-Cost Apartment [ ] Condominium [ ] Shop

   [ ] Other, please state _____

   *(You can fill or tick **more than one** [ ] provided)*

5. What **type** of Pre-cast Concrete Panel System implemented?

   [ ] Cladding (Curtain Wall) [ ] Load Bearing Wall

   [ ] Shear Wall [ ] Formwork for cast-in-place concrete

   [ ] Other, please state _____

   *(You can fill or tick **more than one** [ ] provided)*

6. Please state the **percentage of cost savings** of the project after applying Pre-cast Concrete Panel System.

   [ ] No saving (0%) [ ] 0 – 25 % [ ] 25 – 50% [ ] > 50%

7. Please state the **percentage of workers reduction** of the project after applying Pre-cast Concrete Panel System.

   [ ] No reduction (0%) [ ] 0 – 25 % [ ] 25 – 50% [ ] > 50%

8. Which of the following is the **most advantage/attraction** of using pre-cast concrete panel system as a construction method compared with the conventional method?

   (Please rate the answer according to your understanding)

   1- Least, 2- Less, 3- Average, 4- Attractive, 5- Most Attractive

	(1)	(2)	(3)	(4)	(5)
Cost	[ ]	[ ]	[ ]	[ ]	[ ]
Quality	[ ]	[ ]	[ ]	[ ]	[ ]
Aesthetically	[ ]	[ ]	[ ]	[ ]	[ ]
Labour Efficiency	[ ]	[ ]	[ ]	[ ]	[ ]
Construction Speed	[ ]	[ ]	[ ]	[ ]	[ ]
Safety	[ ]	[ ]	[ ]	[ ]	[ ]
Property Market Demand	[ ]	[ ]	[ ]	[ ]	[ ]

Section C: Opinion Survey

Please give comment and opinion related to the question given

1. Please comment on the problems occurs in current construction industry especially for high-rise residential building. State your reason.

   _____
   _____
   _____
   _____

2. In your opinion, why Pre-cast Concrete Panel System is rarely applied in construction industry in Malaysia especially for high-rise residential building?

   _____
   _____
   _____
   _____

Section D: Feedback

1) Please indicate whether you wish to receive a copy of the result of this study

   [ ] Please send me a copy of the result

   [ ] Please do not send me the copy of the result.

2) If you need further information, please contact Mohd Farhan 019-2985680 or email to **paan_smallville@yahoo.co.uk/ mohd_farhan@utp.edu.my**

Thank you for your time and cooperation in completing the questionnaire.

APPENDIX 1-3

Severity Index For the most advantages/attraction of using pre-cast concrete panel system as constuction method compared with the conventional method

ADVANTAGE/ATTRACTION	PERCEPTION	RESPONDENTS,xi	CONSTANT, Xi	ai.xi/∑xi	TOTAL ai.xi/∑xi	SEVERITY INDEX [(total ai.xi/∑xi)/(4x23)]	CATEGORY OF SEVERITY
a) Cost	Least	3	0	0	25	27	Somewhat Non-Severe
	Less	15	1	15			
	Average	5	2	10			
	Attractive	0	3	0			
	Most Attractive	0	4	0			
b) Quality	Least	0	0	0	67	73	Severe
	Less	0	1	0			
	Average	3	2	6			
	Attractive	19	3	57			
	Most Attractive	1	4	4			
c) Aesthetically	Least	0	0	0	57	62	Severe
	Less	0	1	0			
	Average	12	2	24			
	Attractive	11	3	33			
	Most Attractive	0	4	0			
d) Labour Efficiency	Least	0	0	0	68	74	Severe
	Less	0	1	0			
	Average	4	2	8			
	Attractive	16	3	48			
	Most Attractive	3	4	12			
e) Construction Speed	Least	0	0	0	91	99	Most Severe
	Less	0	1	0			
	Average	0	2	0			
	Attractive	1	3	3			
	Most Attractive	22	4	88			
f) Safety	Least	0	0	0	63	68	Severe
	Less	0	1	0			
	Average	3	2	6			
	Attractive	11	3	33			
	Most Attractive	6	4	24			
g) Property Market Demand	Least	0	0	0	48	52	Moderately Severe
	Less	1	1	1			
	Average	19	2	38			
	Attractive	3	3	9			
	Most Attractive	0	4	0			

***The Total Respondent are 23 Respondents**

Legend	
0% - 20%	Non Severe
20% - 40%	Somewhat Non Severe
40% - 60%	Moderately Severe
60% - 80%	Severe
80% - 100%	Must Severe