UNIVERSITI PUTRA MALAYSIA

IDENTIFYING APPROPRIATE CONCURRENT ENGINEERING PRINCIPLES FOR MASS HOUSING INDUSTRY IN MALAYSIA

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By:

MOHD ZAIRUL BIN MOHD NOOR

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Masters in Science of Architectural Studies

December 2011

DEDICATION

TO

My Dearest Mum

My Dearest Wife

My Lovely Daughters

Amra & Azra

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

IDENTIFYING APPROPRIATE CONCURRENT ENGINEERING PRINCIPLES FOR MASS HOUSING INDUSTRY IN MALAYSIA

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MOHD ZAIRUL BIN MOHD NOOR

DECEMBER 2011

Chair: Professor Rahinah Ibrahim, PhD

Faculty: Faculty of Design and Architecture

The aim of the study was to identify the appropriate Concurrent Engineering principles in the mass housing industry to address the issue of quality and competitiveness. The study conducted a qualitative approach inquiring how concurrent engineering (CE) principles can help to address the issue of quality and competitiveness in mass housing industry. The research posits that selected Concurrent Engineering (CE) principles can be adopted in the mass housing industry due to its similarity in nature with its counterpart in the manufacturing sector in solving the same issue. Three cases representing different level of company structures: multi-million capital companies, medium-sized and small-scaled housing developers; were chosen as the units of analysis for purposive sampling. One respondent represented each company was interviewed with open-ended questions using the snowballing technique. These respondents were the key personnel and were considered

the gatekeeper of the respective company's information. Information such as the company's mission, decision-makings or the stakeholders was elucidated to explain the issues and problems of quality and competitiveness in the mass housing industry. Primary data was obtained from literature and validated through interviews. Observations were made during visits to the case's sites, and documents, which include company profiles, records and minutes of meetings, were reviewed to supplement the data collection. The cross-case analysis using the constant comparative method was used to generate the categories. Triangulation, peer examination and member checking were used to ascertain trustworthiness of the study.

The findings suggested that although some of the principles in Concurrent Engineering might appropriate in the current mass housing industry, it could not be considered as a total adoption of CE in the mass housing industry. There are several CE fundamentals that are contradicted with the current practice of mass housing industry. However, the research posits that some principles might applicable for current mass housing industry for a good practice exercise and CE might works for manufactured construction or IBS housing construction. In summary, the research contributes to the identification of Concurrent Engineering (CE) principles for mass housing industry and addressed the issue of quality and competitiveness in the mass housing industry.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Ijazah Master Sains

MENGENALPASTI PRINSIP KEJURUTERAAN SELARI YANG SESUAI UNTUK DIGUNAPAKAI DIDALAM INDUSTRI PERUMAHAN AWAM DI MALAYSIA

By

MOHD ZAIRUL BIN MOHD NOOR

DISEMBER 2011

Pengerusi : Professor Rahinah Ibrahim, PhD

Faculty : Fakulti Rekabentuk dan Senibina

Kajian ini bertujuan mengenalpasti prinsip kejuruteraan selari yang sesuai untuk digunapakai didalam industri perumahan awam tempatan. Bagi mencari jawapan kepada persoalan "Bagaimanakah kejuruteraan selari dapat membantu mengatasi masalah kualiti dan kompetitif di dalam industri perumahan awam?" Selepas menjalankan analisa teratur, kajian ini telah membangunkan satu cadangan teori iaitu sebahagian prinsip didalam kejuruteraan selari boleh digunapakai di dalam industri perumahan awam di atas dasar persamaan di antara industri ini dan industri pembuatan dalam menangani isu yang sama. Tiga lokasi kes yang merangkumi syarikat berkapital besar, sederhana dan kecil telah dipilih sebagai unit analisis dan sampel bertujuan. Tiga responden mewakili setiap syarikat masing-masing telah dipilih menggunakan teknik 'snowballing'. Mereka juga telah dipilih berdasarkan kepada kelayakan dan merupakan orang yang utama atau kunci kepada maklumat di dalam syarikat dan terlibat di dalam menentukan hala-

tuju syarikat ataupun merupakan pemegang saham utama. Maklumat seperti misi syarikat, pembuat keputusan, atau pemegang saham telah diperincikan bagi menerangkan tentang isu dan masalah yang berkaitan kualiti dan kompetitif di dalam industri perumahan. Data utama yang diperoleh dari analisa teratur akan digunakan dan disahkan dari sesi temubual. Teknik pengutipan utama data dalam kajian kes ini adalah melalui analisa teratur yang hasilnya akan disahkan oleh temubual. Pemerhatian juga telah dibuat ketika melawat lokasi kes, serta semakan dokumen yang merangkumi profil syarikat, rekod dan minit mesyuarat sebagai menyokong pengutipan data. Kajian silang kes menggunakan perbandingan sekata telah berjaya menghasilkan kategori berkaitan. Untuk tujuan kesahihan, teknik pemeriksaan rakan, triangulasi dan semakan ahli telah digunakan.

Penemuan dari kajian telah mencadangkan walaupun sebahagian prinsip kejuruteraan selari amat sesuai digunapakai pada industri perumahan kini, ia masih tidak dapat memenuhi konsep sebenar prinsip ini secara keseluruhan. Kajian juga mendapati sebahagian prinsip amat berlawanan dengan sistem perumahan konvensional yang digunakan pada masa kini. Walaubagaimanapun, kajian berpendapat sebahagian prinsip boleh digunapakai sebagai proses penambahbaik dan mencadangkan bahawa kejuruteraan selari lebih sesuai untuk diamalkan di dalam pembinaan yang berunsurkan pembuatan seperti pembinaan perumahan berkonsep IBS. Secara rumusan, kajian ini akan menyumbang dalam mengenalpasti apakah prinsip yang sesuai digunapakai didalam industri perumahan tanahair bagi menyelesaikan permasalahan kualiti dan kompetitif.

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CHAPTER 1

INTRODUCTION

This chapter presents the background of the study. Then it summarizes problem statement, research questions, significant of the study, definitions used in the study, research objectives, and research framework.

1.1 Background of the Study

The mass housing industry in Malaysia is regarded as one of the main industries contributing to the economic and social development of the nation. The industry nevertheless is regulated by several sets of rules and the imposition of regulations, guidelines and standards to ensure that all categories of houses, inclusive of houses for lower income group will be constructed according to the acceptable standard. However, despite the existence of these regulatory measures and its subsistence for more than 50 years after independence, the research notes that the problems of quality and issue of sub-standard still appear in the mass housing industry due the to the method of current conventional construction which is fragmented and time consuming (Chohan et al 2011). According to a recent survey done by Chohan et al (2011), it was reported that house buyers' complaints on building façade deterioration dampness were the highest statistic in Kuala Lumpur housing problems and those are some of the issues relating to quality in mass housing industry. The research are concerned about house buyers' rights in

securing a better place to live after put hefty sums of investment on their dream house. On the other part, the issue of quality will affect on the competitive issues among the shareholders and housing developers. This research notes that currently the practice of conventional mass housing does not promote a close link with the end-users or the house buyers and the need for change in construction is brought about by the uncompetitive nature of the industry, and the inability to fully satisfy the clients with respects to costs, time and value. The issue of integration is also seen as one of most important strategy to improve the notoriously fragmented mass housing industry. The research proposed that with the success of CE principles in the manufacturing industry have become a role model for mass housing industry to eradicate the current problems and issues in the mass housing industry. The identification of Concurrent Engineering in the mass housing industry would boost the confidence in the market segment and eradicate the uncertainties towards the project and thus giving a competitive business towards the housing developers and stakeholders.

Currently, the normal construction of mass housing development took almost 24 months to complete and the industry lifecycle involves fragmented stages, sequential and adversarial issues among parties involved. Responses from experts and decision makers strikingly agree that the issue of quality and competitive is prevalent. However, due to the fact the conventional construction is still the cheapest way to construct. The cheap materials, cheap labours and accustomed with the system are some of the reasons why the industry are not willing to change. This research concerned about the trend of escalating price of housing units especially in the Klang valley and the rising

trend has put housing ownership out of the reach of many. This was supported by the National House Buyers Association (HBA) which has play a vocal role to dismiss a host of reasons given by the industry to justify the escalation of house prices (House Buyers Association, 2011).

In Malaysia, the practice of selling the house is using the 'sell then build' concept which the house are offered for sale even prior to the clearing of land. The payment of the purchase price of house is made progressively according to the stages of completion as regulated by the Housing development (Control and Licensing) Regulations 1989. This has made it even difficult for the house buyers to monitor the quality of the house and was forced to accept the delivery of the house irrespective of the quality. Despite the common practice of 'sell then build' the Malaysian government is giving incentives towards developers who are willing to implement 'build then sell' concept in their housing development. However, the offers turned lukewarm among the developers due to not understand the concept and the preparedness of the financial institutions (House Buyers Association, 2011).

By looking at both systems that have been adopted in the mass housing industry now, it is still debatable whether the practice of the 'built then sell' will solve the quality and competitive issues in the mass housing industry. Our goal is to look for an alternative solution in the construction management strategy for mass housing industry by employing the manufacturing industry strategy through identifying appropriate Concurrent Engineering principles in the mass housing industry. The Concurrent Engineering (CE) as supported by Kamara (2006) is to achieve customer's satisfaction through shorter delivery times at the lower cost with high quality products. In order to achieve this,

rigorous requirements analysis coupled with early consideration of all life cycle issues and the use of multi-disciplinary teams are necessary.

In term of competitive, the research proposed that the industry can move further in the future by applying some of the Concurrent Engineering principles through optimising the process of project design and construction in order to achieve shorter time completion, to improve quality and cost (Khalfan et al. 2007). Currently, the traditional construction is seen leads to misperceptions and misunderstandings due to the disintegration of the different parties involved. These problems will later leads to clashes, omissions and errors (Khalfan et al. 2007). Khalfan et al (2007) later added that, the shortage of early life-cycle analysis considerations would lead to inability to maintain a competitive edge in a challenging industry. Therefore, the research argues that there is an urgent need for a paradigm shift within the mass housing industry and need to improve the performance of the construction supply chain. Further, Love and Gunasekaran, (1997) highlighted the fundamental constituents in the Concurrent Engineering: 1) the identification of related downstream aspects of design and construction process; 2) the elimination of non-profit activities and 3) the adoption of multi-disciplinary teams.

This research proposes that the identification of appropriate CE principles would give the same benefits towards mass housing industry as its counterpart in the manufacturing industry. Three housing developers were chosen as the unit of analysis; the respondents' backgrounds are presented in the data collection chapter. The case study was selected based on the size of the company; small, medium and large respectively. The small sample is

purposely chosen to evaluate the validity of the propositions of the study. The study hopes that the findings could be the impetus in adopting the Concurrent Engineering and opening the options for CE in the mass housing industry in the future.

1.1.1 Housing Development in Malaysia

Housing provision has played an important part of the government's social policy in Malaysia since independence. It is very crucial in order to ensure social economic stability and to promote national development (Khalid, 2005). It also plays major concern for all people around the world as the welfare of a country is reflected and to let the people enjoy a standard of living. It is undeniable that residential and neighbourhood satisfaction is an important indicator of housing quality and condition, which affects individual's quality of life. (Salleh, 2008)

According to Zainal (2010), issues pertaining to home ownership have been a major concern among political leaders, town planners and the government over the years. Owning a house is considered an impetus towards integration among family members. In support of this, in the announced Budget 2010, various incentives and measures were announced to promote home ownership among Malaysian, which caters priority to be given towards the low and middle-income group to own or rent houses provided by the government(Ministry of Housing and Local Government, 2010). Through Five Year Plans (Malaysia Economic Plan), the government has focused on various housing programmes in both rural and urban areas. To most

individual, house ownership represents the largest investment in a lifetime and always viewed as a basic consumption and key to a comfortable life. However, the myopic of below quality housing and competitive issues have marred the awaited anticipation of home ownership by the middle-income group in Malaysia. This is due to the old conventional method of construction, which is fragmented, sequential and involves adversarial problems. As a result, a significant portion of this country's population currently has been denied of their rights to obtain a quality affordable housing. In relation to housing price and affordability, like any goods and services in a market economy, are determined by interactions of supply and demand. As such, a precise measure of housing affordability is essential to ensure future homeowners can fulfil this biggest investment and also the need for shelter. The notation of affordability however cannot be justified on the same frequencies especially with different economic demographic not only in Malaysia but also to other developed countries. Over the years, affordability indicators have evolved, Zainal (2010) in his study on the housing affordability between Kelantan and Selangor has identified the glaring differences in defining the affordability and looking at the contemporary developments of affordability measures to be relook on the aspect of three sources namely interest rate, income risk and price votality.

Over the last three decades, the scope of development prospects undertaken by developers has increased from encompassing traditional housing projects to condominiums, townships, towering commercial complexes, shopping malls, state-of-the art golf courses, hospitals, theme parks and industrial estates. As the population-increased programs in urban areas were further

accelerated with emphasis given to low-cost housing in subsequent Malaysia plans (Construction Industry Development Board, 2007). The task to built housing for the masses was passed towards the private housing developers. From the table below, it was reported that the units of houses completed by the private housing developers has shown a tremendous increased except for the Fourth and Fifth Malaysian Plan term, which show the units plummeting demand due to dawdling income growth, difficulty in term loan, high interest rates from the financial institutions and expensive housing price.

Malaysia Plan	Units completed	% from total achievement of private sector	% of fulfilment to the target
2nd (1971-1975)	64 862	37.3	-
3rd (1976 – 1980)	199 490	55.0	199.5
4th (1981-1985)	104 800	51.3	30.0
5th (1986- 1990)	196 319	96.3	36.4
6th (1991 -1995)	551 613	98.0	142.8
7th (1996 – 2000)	724 153	98.1	130.5
8th (2001 – 2005)	632 223	96.5	218.8
9th (2006 – 2010)	655 374	77.6	216.3

Table 1: Malaysia Plan on Housing Development
Sources: Malaysia (1976; 1981; 1986; 1991; 1996; 2001; 2006)
Note: Private sector includes private developers and cooperative societies

During the 4th and 5th Malaysian Plan, the slow performance was also caused by the project delays and abandoned projects. Some of the factors recorded include poor location, financial and management problems among the housing developers, mismanagement and incompetent members in the team. Even so, the housing industry slowly tapping the needs for housing in the country in 8th and 9th Malaysian Plan to fulfil the demands of house buyers. Although still grappling with the number of units completed, the performance of housing development was seen encouraging with the number of houses constructed exceeding the targeted plan.

Despite the encouraging performance, the housing industry, which had grown rapidly in the 1980's, also faced several issues and problems recently. Even after 50 years of its establishment since independence, the mass housing industry still facing problems of unsold, overhangs and abandoned projects. Most of the housing units remain unsold beyond the price factor ranging from poor location and unattractive design (Tan, 2008). To rub salt to the wound, this house is not only expensive in term of pricing but sometimes delayed and being abandoned by unscrupulous developers. Malaysia of course are neither unique nor exception in having such problems.

No:	State in Malaysia	Nos of Delayed Project (s)		Nos of Sick Project (s)	
		2010	2011	2010	2011
1	Perlis	-	-	-	-
2	Kedah	2	1	11	17
3	Pulau Pinang	1	1	18	13
4	Perak	2	-	16	7
5	Selangor	18	17	89	88
6	Wilayah Persekutuan	12	8	11	14
7	Negeri Sembilan	-	4	11	9
8	Melaka	2	1	14	7
9	Johor	2	4	27	39
10	Pahang	-	8	14	15
11	Terengganu	-	-	8	14
12	Kelantan	-	3	6	23
	Total	**39**	**47**	**226**	**246**

Table 2: Statistics on problematic housing projects in Malaysia
Sources: Ministry of Housing and Local Authority

Based on the table above, the numbers of delayed projects and sick projects has shown an increment and make it a nerve-racking numbers to most of us as the house buyers. Despite efforts given by the government such as incentives for sell then built, this has turned into lukewarm among the private developers. The record found that the number of delayed projects has

increased from 39 to 47, which shows additional numbers and also recorded an increment in sick projects mainly in Kedah, Wilayah Persekutuan, Johor, Pahang, Terengganu and Kelantan. Despite the set of legal procedures and controls, the country still facing with customer's complaints and demand for quality of housing (Azlinor & Rozanah, 2008). The construction industry is always being labelled as fragmented, adversarial and involved lot of professional disciplines in typical construction projects. In the case of mass housing development, the quality, time factors and the cost incurred are at stake and causing problems and dilemma towards house buyers especially between medium and low-income group. The recent fuel hike coupled with higher cost of living and inflation has also required a sober assessment in the local property and construction sectors. According to the Master Builders Association of Malaysia (MBAM), building material cost for local contractors have risen by 25% on average since early January 2008. Due to this gesture, more contractors are asking for a revision in their contract prices in order to cope with the situation (San D. , 2008). The normal conventional construction period for a mass housing development usually takes up to 24 months. However, this is not including the design stage or pre-construction stage which normally took three to six months with taking into consideration the design process, authority submission and other administration and management procedures.

In essence, this research is to focus on the issues of quality and competitiveness in the mass housing limited to affordable housing under the definition of Property Market Report, Valuation and Property Services Department, Ministry of Finance Malaysia for 2011 record, namely, terrace

house, semi-detached house and high-rise residential unit. Therefore, with the similarity of its nature in the production with its counterpart in manufacturing, the mass housing industry has the potential to achieve the same success by it manufacturing sectors through the adoption of CE principles in the construction management process.

1.2 Problem statement

The literature shows how Concurrent Engineering contributed to mass housing industry. The encouraging performance of Concurrent Engineering in the manufacturing is one of the motivations for adopting CE in the mass housing industry (Anumba et al. 2007). It is also based on assumptions that the next future construction can be considered as a manufacturing process, and similar concepts, which have been successful in the manufacturing industry, can bring the same improvement towards mass housing industry. Furthermore, the goals and objectives of CE are to achieve customer's satisfaction through improvement of quality and to provide competitive business towards shareholders.

The interest in modelling mass housing development as a manufacturing process is primarily based on the similarities between the two industries and the assumption that arranging the business processes of the housing industry to those of the manufacturing industry will significantly improve its quality and address the housing competitiveness. However, in the case of mass housing

industry this might not necessarily true. Kamara (2007) added that, both the manufacturing and mass housing industry share the following:

Character	Manufacturing Industry	Mass Housing Industry
Producing Engineering products	√	√
Processing raw materials and assembly of several components in the final products,	√	√
Utilising repetition processes in the design and production of the products	√	√
High cost in correcting design due to late changes, poor resource utilisation and inadequate information management.	√	√

Table 3: The similarity between manufacturing and mass housing industry
Source: Adopted from Kamara (2007)

It is a crucial term for any housing projects to complete their project on time and satisfy the quality requirements and specifications spelled in the contract. These requirements become excruciate in case of mass housing projects, simply because the demand from the client and partly selling the housing products in the competitive market. The houses built by the housing developer should demonstrate reasonable quality and available in time. In term of business edge, since the houses are being built on the expense of investors and the developers, the return of spent money is important to maintain the cash flow. The research agrees that this could be achieved by proper planning at the initial stage with the incorporation of requirements from the early stage of design. The research connotes the term mass housing as to provide the identical link between manufacturing sectors and the mass housing industry. Due to the similarities as being described by Kamara (2007), the research proposed that there is a possibility of looking on how

manufacturing sectors solve on the issues of quality and competitiveness in the production could be applied in the mass housing industry. This research has denoted the meaning of 'mass housing' as an identical house, mass-produced and housing products that have similar characters. Therefore, the question lies to be addressed is what could be the appropriate Concurrent Engineering principles for quality and competitiveness issues in the mass housing industry?

1.3 Purpose and Research Questions

The aim of this research is to identify appropriate CE's principles for mass housing construction management in Malaysia. This research does not attempt to expose the totality of the construction problems in Malaysia but rather focusing towards issues of quality and competitiveness in mass housing industry in Malaysia.

Three research questions were used as a guide to the study:

Main Research Question (RQ)

How can we use Concurrent Engineering (CE) principles to improve quality and competitiveness in mass housing industry in Malaysia?

Sub RQ 1

What are the common issues of quality and competitiveness in the mass housing industry?

Sub RQ 2

What are the principles of CE that supports the issues of quality and competitiveness?

Sub RQ 3

What are the appropriate CE principles to address quality and competitive issues in the mass housing industry?

1.4 Objective of the Study

1) To define the meaning of quality and competitiveness in mass housing industry

2) To identify the principles of CE that supports the issues of quality and competitiveness

3) To identify the appropriateness of CE in the mass housing industry

1.5 Significance of the Study

Currently, housing supply chains in Malaysia are fragmented and underpinned by poor communication, adversarial relationship and lack of trust and commitment. This was proven based on data of abandoned and housing surplus from chapter 1 earlier. Although the industry has known for many years, this system still needs dire changes in order to provide alternatives towards new directive in housing industry and new direction in national

housing segment. This research suggests the roles currently available in the Concurrent Engineering to suit to mass housing industry. It sets out to explore the wider range of generic roles, which are deemed necessary to operate a more efficient Concurrent Engineering for mass housing construction management. The result will highlight principles of CE as a tool to help mass housing industry in Malaysia and to find out whether CE is applicable towards current mass housing industry. This research adds to the body of knowledge by identifying similarities between manufacturing industry and mass housing industry. It will extend the knowledge of CE in the construction industry and identify the definition of quality and competitiveness in mass housing industry. The study will open-up new directive for CE in the industry and perhaps the adoption of the principles in the mass housing industry in the future.

1.6 Limitations of the Study

Like any other research, this particular research has its own limitations. The study was only confined to three developers selected from REHDA (Real Estate Housing Developers Association) Malaysia due to the fact that the industry is very selective and timid to disclose their project information towards outsider. The interviewee also suffers refusals and plagued by the problem of the respondents who does not refuse but repeatedly postpones the interview, break appointments, or cannot decide whether or not to cooperate. Initially, the respondents were selected based on the list of problematic developers under the Ministry of Housing and Local Authority; in fact, the research had also experiencing rejection and refusals from the

selected private developers from the beginning thus demoralising the researcher who often interprets the refusing or staling behaviour as his personal failure. Nonetheless, the budget of time and money the researcher allocated to complete his sampling list, has inevitably still has a nucleus of obstinate refuses at the end of the data collection. However, towards the end despite having four rejections and refusals, the research managed to obtain the final three companies. The research also noted that the information disclosed here would be make strictly confidential only for academic purposes. It is a qualitative research that seeks to understand and explore the problems and experiences facing by the personnel who have the authority as the decision maker and fully answerable on the success and the failures of the project. As such the findings from this research cannot be generalized for the whole mass housing industry but to be developed further for future study. In the process of data collection and interpretation, the research was also limited to the researcher's experience as a project architect for housing projects in Johor Bahru for 4 years from 2005 to 2008. The researcher tried as much as possible relate to his experience back then. Therefore, the interpretation part of the research was confined to the personal perspective of the researcher. The researcher believes there are better-experienced respondents in the case sites. However, due to the snowballing techniques, the experiences captured were from the perspectives of a certain group of project manager of project personnel participating in the research.

1.7 Research framework

The initial Interview Guide

1) What is your background (position, years of experience job scope, qualifications, training attended? (**RESPONDENT'S BACKGROUND**)
2) What do you think of the concept of Concurrent vs Sequential in housing development and what do you understand on the term 'Concurrent Engineering'? (**DEFINITION**)
3) What are the main caused of conventional construction problems in relation to the actors involved, anticipated life-cycle problems and management? (**ISSUES IN MASS HOUSING**)
4) How can you improve the current building procurement in order to address quality and competitiveness issues? (**QUALITY AND COMPETITIVENESS ISSUES**)

Stake (1995) reminds that issues in qualitative research is evolving, issues emerge, grow and die. Creswell (1998) adds the research questions in qualitative research are evolving as the research progresses. He suggested that research questions to be open-ended and non-directional to restate the purpose of the study. In relation to this, **probing** is necessary whenever the researcher need to clarify on certain matters.

1.8 Data Collection

The goal of data gathering is to collect the richest possible data, ideally wide and diverse range of information. Lofland et al. (2005) proposes that

achieving "intimate familiarity" with the setting and participation in the minds of the settings participants to arrive to richness of the data. Lofland et al. (2005), Stake (1995), Yin, (2009) identify at least six sources of evidence in case studies: i) documents, ii) archival records, iii) interviews, iv) direct observation v) participant observation IV) physical artefacts. Hancock & Algozzine (2006) added due to its intrinsic in nature, qualitative usually involves individual interviews, focus groups, observations, a review of existing documents, or a number of these. Based on this, triangulation was used by using multiple methods of data collection in order to view for deeper understanding of the subject. Therefore, the research applies triangulation in term of qualitative data sources of this case study research by utilizing;-

1) Interviews with experts;
2) Direct Observation of the three cases study and document review on the project information and records.
3) Archival / Documents review

Interview with experts: Interview is one of the common and important techniques in data collection of qualitative inquiry. Hence, we applied in-depth interview with open-ended questions to allow the interviewees feel unobstructed. We applied open-ended questions which formulated based on the literature review with probing strategy to reaffirms the issue of quality and competitiveness in the mass housing industry. The interview results confirm the proposition we had identified from the literature.

Direct Observation and Documents review: Direct Observation and documents review is necessary especially if the study includes performance

based and competitive strategy. Therefore, we have employed this technique to browse through some of the files in the each company's construction management record. However, due to the confidential issue we are only able to record our observation on this matter by showing some descriptions. (Chapter 3).

1.9 Data Analysis

The nature of qualitative enquiry produces volume of rich and deep data that need to be analysed, coordinated and organized into a form, which conclusions can be drawn and recommendation can be made. Yin (2009) supports this and presents four principles in producing quality analysis which are i) show that the analysis relied on all relevant evidence ii) include all major rival interpretations in the analysis iii) address the most significant aspect of the case study iv) use the researcher's prior, expert knowledge to further the analysis. Therefore, we have manually transcribe the interviews done with the experts and secondly, we come out with a coding and match it with the constructs we have established earlier.

1.10 Trustworthiness

Yin (2009) listed four tests of validation includes construct validity, internal validity, external validity and reliability in ensuring the quality of the research. The construct validity requires the researcher to establish the correct operational measures in measuring the concepts studied. Multiple sources of

evidence and establishing the relevant chain of evidence were employed in the data collection. The internal validity is to validate the fundamental relationship of the concepts explored. Yin (2009) added the case study enable the researcher to make correct presumptions through pattern matching and explanation building. Pattern matching predicts a series of results that form a pattern and determining the degree to which the actual results fit the predicted pattern (Stake, 1995).

On the other hand, peer examination and member checking were used to internally validate the findings from the transcript analysis. The supervisory committee and colleagues in the faculty, professional architects and Engineers were requested to give comments on the findings. The member's checking requires the researcher to seek confirmation from the respondents of the research from the information gathered during the interview session. The transcribed and coded interviews were bought back to the respondents.

External Validity in a case study enables the generalization of findings to theory. A single case study offers a poor basis for generalizing (Yin, 2009). In order to enhance the possibility of the results of a qualitative study generalizing in a single case study, Merriam (1998) suggested the case to be thick and rich description, the use of typically or modal category and multi-site designs using several sites, cases, situations especially those that maximize diversity in the phenomenon of interest. Four case studies that were explored in this research provided the thickness in description and comply with the multi-site designs requirement. Each case site was examined in the discovery of the concept of integration in the housing project development, the role of clients and stakeholders; the contractual matters pertaining to CE and

technology enablers' readiness among the personnel involved. The examination on the three case sites will provide the readers with the experiences of the three different personnel with their experiences in handling the mass housing projects within their respective organizations. The constant comparative analysis within the individual respondents had provided insight information as to how the concept of CE may be apply into the mass housing development.

In term of the reliability test, it is designed to demonstrate the replication of the study and how to minimize error and biases in the study. In ensuring this, Merriam (2009) recommended several techniques, which among others are; declaring the investigator's position, triangulation and audit trail. In the social research, the human instrument can become more reliable through training and practice. The author had enrolled himself into Qualitative Methodology class in semester 2 to develop himself as a reliable instrument. An audit trail (see Appendix) describing the whole process of the research was documented beginning from the researcher's starting point of determining the area of interest for research and ended with the compilation of the final five chapters of this thesis.

1.11 Shaping the theoretical propositions

We briefly discuss some criteria that became the basis for shaping the theoretical propositions of this study as follows:

1) 100% of the constructs must be supported by the experts or the gatekeeper. In this regard 100% of the respondents must support the propositions.

2) The respondents agreed that the quality and competitiveness issue is prevailing and tainting the image of mass housing industry in Malaysia.

3) The respondents agreed that some appropriate principles of CE might be applicable for mass housing industry.

1.12 Organization of Thesis

The study organized in six chapters. Each chapter is briefly explained below:

Chapter One: This chapter introduces the background and problem statement. Then it summarizes its research questions, objectives, significant of the research and research framework.

Chapter Two: This chapter lays out the literature review where the study draw the theoretical framework based on reviews of existing adoption of Concurrent Engineering both in manufacturing and construction industry. Before that, the overview of current scenarios of construction industry and mass housing industry were elaborated with data from authority and current scenarios. The constructs development for the propositions were established and finally to be used as the theoretical framework

Chapter Three: This chapter explains the research method used for the study. The research is using Qualitative approach with framework developed

from Merriam (2009). It applies pure qualitative approach with triangulation of data collection and how the data shaping the theoretical propositions established earlier.

Chapter Four: This chapter explains the interview protocol, the coding and transcribing of the data and the observation study conducted during the data collection process. This chapter will answer the sub RQ no: 3.

Chapter Five: This chapter integrates all the findings and answering the objective of the research. It also includes the knowledge contributions of the study.

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