

CHAPTER 4

RESEARCH DESIGN AND METHOD

4.1 INTRODUCTION

This chapter presents and discusses the research methodology adopted. It also describes the research design, research process, method of data collection, method of data analysis, and the application of the data analysis. This chapter also addresses the objectives of the study that were achieved through a pilot study followed by the main study, which comprises four (4) phases.

4.2 RESEARCH DESIGN

Research can be described as a systematic and organized effort to investigate a specific problem to provide a solution (Sekaran; 2000; Burn, 1994). Consequently, its output is to add new knowledge, develop theories as well as gathering evidence to prove generalizations (Sekaran, 2000). Furthermore, Bulmer (1997) defined sociological research as a primary commitment to establish systematic, reliable and valid knowledge about the social world. However, Kerlinger (1986) states that a scientific research is a systematic, controlled, empirical, and critical investigation of propositions about the presumed relationships between various phenomena.

Research can be classified into three basic categories: quantitative, qualitative and mixed methods research (Creswell, 2008; Cohen *et al.*, 2007; Gliner *et al.*, 2009; Kothari, 2010). According to Smith *et al.*, (1979), quantitative research employs the traditional, the positivist, the experimental, or the empiricist method to enquire into an identified problem. Quantitative is based on testing a theory, measured with numbers,

and analysed using statistical techniques and it particularly emphasizes objectivity and reproducibility (Smith *et al.*, 1979). Meanwhile, Fraenkel & Wallen (2003) argued that the goal of quantitative methods is to determine whether the predictive generalizations of a theory hold true. Thus, quantitative research is more concerned with issues of how much, how well, or to whom that particular issue applies. Kerlinger & Lee (2000) explained that quantitative research is deductive in nature, and that researchers make inferences based on direct observations with the primary goal to describe cause and effect.

According to Fraenkel & Wallen (2003), quantitative research can be classified as either descriptive or experimental research. The purpose of descriptive research is to become more familiar with phenomena, to gain new insight, and to formulate a more specific research problem or hypothesis. In contrast, experimental research is to test cause and affect relationships among variables. In descriptive research, researchers do not have direct control over independent variables because their manifestations have already occurred or because they are inherently not manipulable (Kerlinger & Lee, 2000).

In contrast, a study based upon a qualitative process of enquiry has the goal of understanding a social or human problem from multiple perspectives (Denzin & Lincoln, 2000). Thus, qualitative researchers deploy a wide range of inter connected interpretive practices, hoping always to get a better understanding of the subject matter at hand. Additionally, they also explained that qualitative research is conducted in a natural setting and involves a process of building a complex and holistic picture of the phenomenon of interest as well as being inductive in nature. A researcher also delves into the issues of interest in depth and detail. Mixed methods combine quantitative and qualitative research.

The research methodology primarily comprises the research design and research process, sampling design, data collection and method of analysis (Gill & Johnson, 1997; Sekaran, 2000; Ayob, 2005). The subsequent sub-sections present a brief outline of the research design and research process.

4.2.1 Research Design and Research Process

Kumar (1999) stated that a research design is a procedural plan that is adopted by researchers to answer questions objectively, accurately, economically and with validity. A traditional research design is a blueprint or detailed plan of how a research study is to be completed; operating variables for measurement, selecting a sample, collecting data and analysing the results of interest to the study, and testing the hypotheses (Thyer, 1993). In the most elementary sense, the design is the logical sequence that connects the empirical data, research questions and conclusions (Yin, 2002). Bryman & Bell (2007) stressed that research design should provide the overall structure and orientation of an investigation as well as a framework within which data can be collected and analysed. Miller & Lessard (2001), and Yin (2002) also provided detailed descriptions of the essential considerations in designing the research project. Based on their recommendations, the components of this research design should encompass the followings:

- i. The research problem and question,
- ii. Sampling design,
- iii. Methods of data collection

Furthermore, Yin (2002) stressed that the main purpose of the research design is to help avoid a situation in which the evidence does not address the initial research questions. In this sense, a research design deals with a logical problem and not a logistical

problem. In conclusion, Rani (2004) described a research design as a blueprint or a plan for action, specifying the methods and procedures for collecting and analysing the needed information, fulfilling the research objectives, and finding the solutions.

Identifying and formulating a problem is one of the most important aspects of doing research in any field. Research cannot proceed until a problem is recognized (Rani, 2004). The research problem serves as the foundation of a research study if it is well-formulated.

A research problem may take a number of forms, from the very simple to the extremely complex. The formulation of a problem is akin to the 'input' and the 'output' of a study, thus, reflecting the quality of the contents of the research report and the validity of the causation established (Chaudhary, 1991; Kumar, 1999). A problem does not necessarily mean that something is seriously wrong with the current situation or needs to be rectified immediately. A problem could simply indicate an interest in an issue where finding the right answers might help to improve an existing situation, or to minimize a gap between the actual and the desired ideal state (Sekaran, 2000). In the final stage of formulating the research problem, the general question can be transformed into a series of specific questions to indicate the strategic observations to answer those questions (Chaudhary, 1991).

Zikmund (2000) argued that the research design is a master plan specifying the methods and procedures for collecting and analysing the needed information and suggested four basic design techniques for research, namely, surveys, experiments, secondary data and observation.

According to Malhotra (2004), research design is a framework or blueprint for conducting the research project and it will specify the details of the procedures necessary for obtaining the confirmation needed to structure and solve the research problems. Furthermore, Malhotra (2005) classified the research design into two broad categories – exploratory and conclusive research, where the objective of exploratory is to provide insights into, and an understanding of the problem confronting the researcher, and conclusive research is designed to assist the decision maker in determining, evaluating and selecting the best course of action to take in a given situation. The research designs for this study were based on exploratory and conclusive research.

The research process of this study was adapted and modified from the research process used by Cavana *et al.* (2001), as indicated in Figure 4.1. It was formulated principally based on looking at four (4) different phases, which address the research questions at every phase of this study. The first phase comprises two (2) parts. In Part 1 (Phase 1) the factors for customer satisfaction for IBS houses were determined through a literature review and pilot study. In Part 2 (Phase 1) the factors for success and barriers to IBS adoption in the construction industry were also determined through a literature review and pilot study. Then, both factors were collected through quantitative study using a self-administered questionnaire survey.

In the second phase, both customer satisfaction factors in Part 1 and the IBS adoption factors in Part 2 were separately set as the requirements or “What’s” in the QFD application. Through qualitative study or focus group discussion, as the data collection method, both requirements were analysed and examined using QFD application in order to determine the strategies to fulfil both requirements.

The third phase of the research process combined the customer satisfaction strategies and the IBS adoption strategies determined from the second phase, and, further set as the new requirement or “What’s” for another stage of QFD application. The objective for combining both strategies was to determine which organizations are supposed to act in order to implement full IBS adoption in the Malaysian construction industry.

The fourth phase of the research process validated the entire research process, research findings and the research contributions for content validity, as defined by Cavana *et al.* (2001). Content validity ensures that the measures include an adequate and representative set of items that tap the concept. There are at least three ways to achieve content validity, namely, from the literature, from qualitative research and from the judgement of a panel of experts. The validation process for this study was conducted through semi-structured interviews among professional experts – academicians and construction stakeholders. The research process of this study is illustrated as in Figure 4.1. This figure provides the overall research process flow chart for the methodology of this study.

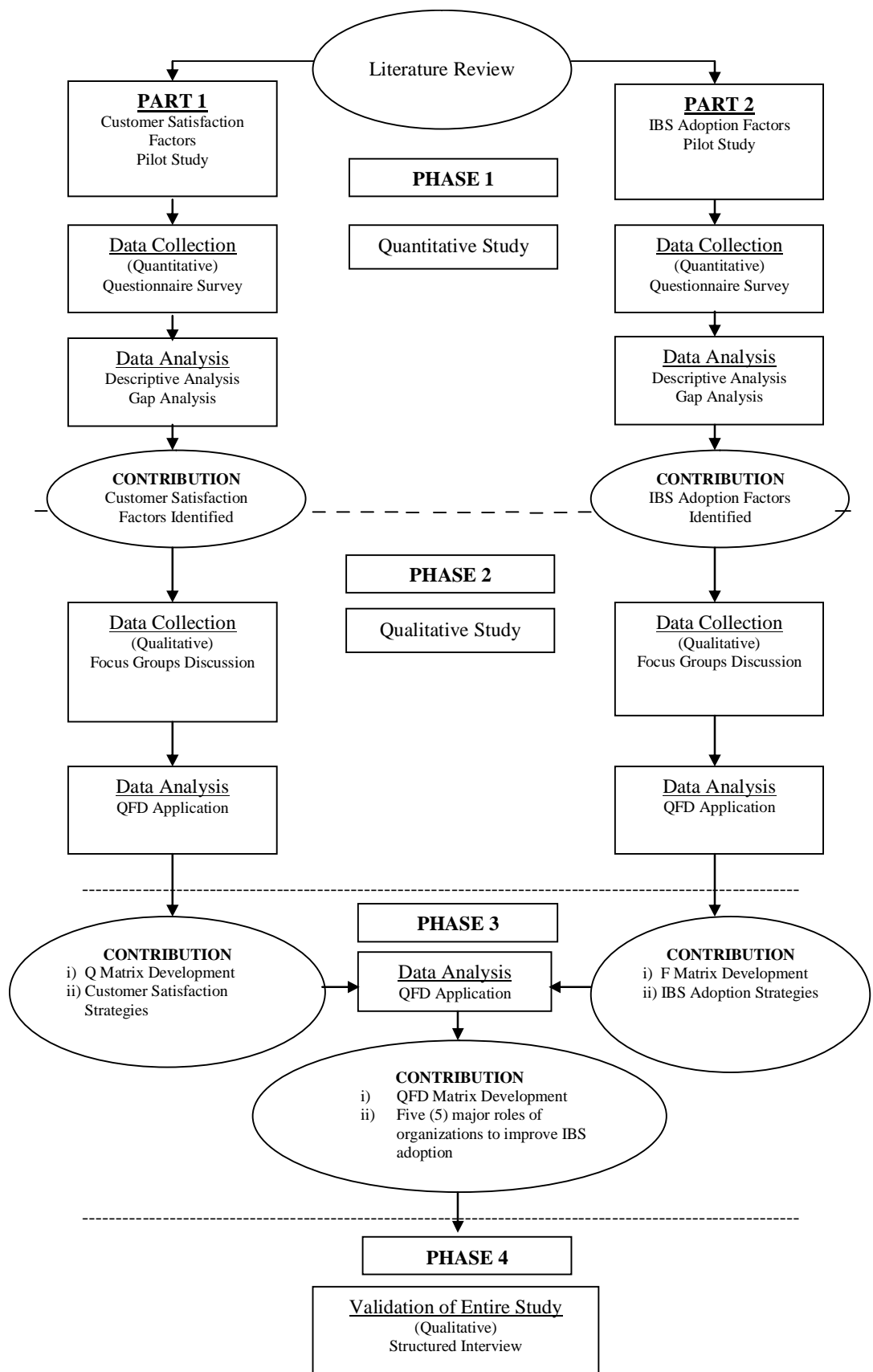


Figure 4.1: Research Process (adapted and modified from Cavana *et al.*, 2001)

4.2.2 Sampling Design

The sampling design for each study will depend on the population, sampling size and method of analysis used. Non-probability sampling was selected in this study. Non-probability sampling plans are more dependable than others and could offer an important lead to potentially useful information with regard to the population (Cavana *et al.*, 2001). The category of non-probability sampling used in this study was purposive sampling to obtain information from specific target groups. The sampling is confined to specific types of people who can provide the desired information, and who conform to some criteria set by the researcher. Each study had different sample sizes, all of which meet the basic requirement based on the purpose of study. In the first part of the first phase, the samples were selected from the IBS house occupiers. In the second part of the first phase, the samples were selected from construction stakeholders inclusive of both the public and private sectors within the construction industry. In the second and third phase, the samples were selected among the IBS house occupiers and the construction stakeholders as the representative sample.

4.2.3 Data Collection

According to Ayob (2005); Rani (2004) and Sekaran (2000), the researcher must specifically set up respondents for the research – individuals, groups, and a panel of respondents whose opinion may be sought on specific issues. Interviewing, questionnaires, and observing people and phenomena are the three main data collection methods in survey research.

According to Cavana *et al.* (2001), after the development of the research questions, data needs to be collected. Data can be collected by using either quantitative (example – questionnaires) or qualitative (example – focus groups) methods.

The methods of data collection in this study, were carried out through quantitative, a self-administered questionnaire survey in the first phase of the research process; through qualitative, a focus group discussion in the second and third phase; and, finally, through qualitative, structured interviews in the fourth phase.

Two sets of structured questionnaires were designed; the first set for IBS house occupiers and the second set for construction stakeholders, namely, clients of construction projects, developers, manufacturers, consultants, contractors and others. Both questionnaires were developed based on literature surveys and further enhanced by employing the outcomes, suggestions and comments from the pilot study.

The literature reviews from previous studies from sources, namely, journals, books, conference papers, proceeding papers were conducted. The objective is to determine and examine the factors of customer satisfaction and IBS adoption. The data collected from the questionnaire survey were analysed using descriptive, and gap analysis. The data collected from the focus group discussion were analysed using QFD application. Finally, the data collected from the structured interviews were analysed using descriptive analysis (percentage).

Upon identifying the research methodology, research design and sampling design, as proposed by Leedy & Ormrod (2005), and Cavana *et al.* (2001), data collection was then planned for the quantitative and qualitative study. The entire data collection of this study survey was conducted between June 2009 and February 2010. The data collection process covers the pilot study, and the two main studies – quantitative study and qualitative study.

4.2.4 Method of Analysis

This section discusses the method of analysis for the phases of study. An appropriate method of analysis was selected to ascertain the output of the analysis that addressed the research questions through the four respective (4) phases of the study. Very specific methods of analysis were used to analyse the data. The method analysis employed at each phase of the study is described including the methods and justification as to why these methods were selected. In the following sections, different methods of analysis are discussed as well as the specific method of analysis selected for each phase of the study.

In this study, the approach of using a combination of methods of analyses was applied in all the phases. In the first phase, frequency distribution, arithmetic measure, gap analysis and Pareto analysis were employed to identify both the customers' satisfaction factors and the IBS adoption factors. However, in the second phase, which was the most crucial among all the phases, Pareto analysis and QFD application were used to identify the customer satisfaction strategies and IBS adoption strategies. The use of QFD application was repeated in the third phase to extract the major roles of organizations in order to implement IBS adoption in construction. In the fourth phase, the data collected to validate the entire study were analysed according to the percentage, as proposed by Creswell (2008) and Cohen *et al.* (2007). Table 4.1 indicates the appropriate method of analysis employed for each phase of the study. The rationale behind selecting the respective method of analysis reflects the purpose for conducting each of the analyses. The software used to analyse the data collections was Microsoft Excel.

Table 4.1: Summary of Method Analysis

Phase	Method of Analysis	Purpose
1	Frequency Distribution	To classify and display the data of respondents, companies' background (Creswell, 2008; Cohen <i>et al.</i> , 2007)
1	Arithmetic Measurements	To present the factors evaluation (mean)(Creswell, 2008; Cohen <i>et al.</i> , 2007)
1	Gap analysis	To compare between satisfaction level and importance level (Parasuraman <i>et al.</i> ,1985; Zeithaml <i>et al.</i> , (1991)
2 and 3	Pareto Analysis	A method of classifying items, events or activities according to their relative importance. The so-called Pareto Principle (also known as the 80-20 Rule) suggests that for many phenomena 80 per cent of consequences stem from 20 per cent of the causes (Juran & Godfrey, 2003;Le Blanc & Rucks, 2009; Bass & Lawton, 2009)
2 and 3	Quality Function Deployment	QFD is a tool that is able to ensure that the voice of the customer is deployed throughout the product planning and design stages. It provides a list of activities and a graphic representation of the design deployment that allows one to see the relationships between goals (What's) as well as the means to realize them (How's), (Balthazard & Gargeye,1995)
4	Percentage Analysis	Validation of results from the entire study (percentage) (Creswell, 2008; Cohen <i>et al.</i> , 2007)

4.3 RESEARCH METHOD

This current study is carried out to address the research issues and answer the research questions. Thus, the research method is hereby established from the research process formulated from the review of previous literature. It was performed in different phases – literature review, quantitative, qualitative and validation of the entire study. The phases are described in the following section:

4.3.1 PHASE 1: QUANTITATIVE STUDY

To establish the research aims and objectives, a thorough literature study was conducted, including both primary and secondary sources. Initially a pilot study was conducted before specific attention was given to identify the customer satisfaction

factors for IBS houses and the success factors and barriers to IBS adoption as the main study.

4.3.1.1 Pilot Study

According to Naoum (1998), good research practice starts with a pilot study before the actual study is carried out. This is the way to trace any discrepancies in the design of the questionnaire. Liaw & Goh (2002) stated that a pilot study is not mandatory in research design, but it is a normal practice before an actual study. A pilot study is used to test the consistency of internal data, the reliability of the measurement scales for the variables used in the questionnaire and to test the goodness of data (Sekaran, 2000). In addition, a pilot study ensures that the respondents understand the questions, makes required data available, and avoids misinterpretations (Naoum, 1998). In addition, several matters need to be ensured in the pilot study (Naoum, 1998). In short, a pilot study allows a time period to complete/answer the questionnaire; ensures clarity of the questions and instructions; identifies sensitive questions that respondents are reluctant to answer; ensures the questionnaire has covered all important topics; ensures the layout is clear and attractive; and facilitates consideration of the comments and suggestions by the respondents (Bryman & Bell, 2007).

In this research, the pilot study was conducted by the quantitative method, and data collection was based on a questionnaire survey. The purposive sampling method was employed as the sampling method. This type of sampling method has less reliability but is preferred when the time is short, and where the information is needed quickly (Cavana *et al.*, 2001; Sekaran, 2000). The effectiveness of each question designed was achieved by providing the necessary information and data required through the questionnaire. The questionnaire was designed and drafted based on the literature

review and was distributed among 30 respondents of IBS house occupiers in the first part of the first phase and another 30 respondents who were construction stakeholders in the first part of the first phase. These respondents contributed immensely by giving ideas on how the questions should be restructured to achieve the maximum impact on the respondents, and, ultimately, on the entire research study.

Following the pilot survey, an important observation was made in that there was an ambiguity in three of the questions. Following this observation, the questions were modified to reflect the correct questions as intended by the researcher.

(i) Testing for Instrument Reliability and Validity

The testing for the questionnaire reliability and validity can be observed mathematically. In view of this, the questions were studied in discussion with the learning supervisor and the responses were deliberated upon concerning their ability to answer the investigations proposed in the research. Since no major incongruence was found, it was decided that the questionnaire was suitable for the intended purpose of this research.

An experiment is valid if it does what it is intended to do. To some extent, the two terms are indistinguishable and do have some overlaps. To establish if a questionnaire is reliable and valid we need to calculate the alpha coefficient, which is defined as follows:

$$\alpha = \frac{n}{n-1} \left(1 - \frac{\sum s_j^2}{s_j^2} \right)$$

Where;

N is the number of measurement items,

$\sum s_j^2$ is the sum of the variance of all the measurement items,

s_j^2 is the variance of the total value measurements

$$\text{Reliability } \alpha = \frac{N}{N-1} \left(\frac{\sigma_X^2 - \sum_{i=1}^N \sigma_{Y_i}^2}{\sigma_X^2} \right)$$
$$\text{Validity } \gamma = \sqrt{\alpha}$$

A questionnaire can be reliable and valid, if both α and β are greater than 0.7. The reliability test was conducted on the questionnaire used in the pilot study. Table 4.2 shows the results of the reliability for the IBS house occupier questionnaire (First Part of First Phase), whilst Table 4.3 shows the results of the reliability of the IBS adoption in the construction industry questionnaire (Second Part of the First Phase). From these tables, the overall co-efficient values of Cronbach's Alpha for both questionnaires were 0.762 (Q1) and 0.712 (Q2). Since both the IBS house occupiers and IBS adoption stakeholders achieved above 0.7 co-efficient values of Cronbach's Alpha, the results showed that all variables indicated internal consistency and achieved reliability values based on the scales developed by Sekaran (2000) and Nunally (1978). Thus, the co-efficient values of Cronbach's Alpha showed that the respective respondents were able to understand all questionnaires and they admitted the necessity for asking the questions (Bonett, 2002; Feldt *et al.*, 1987).

Table 4.2: Reliability Test on IBS House Occupiers Questionnaire

Item	Coefficient Value -Cronbach's Alpha	No. of items
House Owners Questionnaire	0.762	132

Table 4.3: Reliability Test on Construction Stakeholders Questionnaire

Item	Coefficient Value -Cronbach's Alpha	No. of items
Construction Stakeholders	0.712	34

4.3.1.2 Customer Satisfaction Factors of IBS Houses- Part 1 in Phase 1

The first part of the first phase of the research process is to determine and examine the customers' satisfaction factors of IBS houses. It is part of the research process in order to achieve the first research objectives.

(i) Sampling Design

Copper & Schindler (2008) suggested that in designing the sample, the following should be performed: the target population, parameters of interest, sampling frame, the appropriate sampling method and the required sample size of the sample. For the quantitative study in the first part of the first phase, the sampling was purposive (Cavana *et al.*, 2001; Creswell, 2008), as this research intended to select respondents among the IBS house occupiers. The parameter of sampling interest was from the population of the IBS house project. The sampling frame of this study comprised the

house occupiers from three IBS housing projects. The unit of analysis required was the individual.

The samples were taken from the population of three (3) IBS house projects that were chosen. The sample frame involved projects of three (3) blocks of medium cost apartments in Putrajaya, two-storey terrace house in Putrajaya and one (1) block of low cost flats in Puchong, Selangor. The total population of the three IBS house projects studied was 1,364. The researcher used purposive sampling with a total of 391 respondents responding to this research study. The total population of the three (3) blocks of medium cost apartments at Precinct 9, Putrajaya was 684 units. The researcher managed to collect (188) data from the total population equivalent to 27 percent. The total population of the two-storey terrace house in precinct 11, Putrajaya was 340. The researcher managed to collect (102) data from the total population equivalent to 30 percent. Finally, the total population of low cost flats in Puchong, Selangor was 340. The researcher managed to collect (101) data from the total population equivalent to 30 percent.

(ii) Data Collection

Survey research is widely used to determine specific characteristics of groups (Fraenkel & Wallen, 2003) and measure attitudes and opinions of groups towards certain issues (Ary *et al.*, 2002). Surveys are conducted through various methods including mail, telephone, and personal interviews based on the contents of the questionnaire, number of subjects, budget, time available and target response rates. This research adopted a self-administered questionnaire survey method as the strategy for data collection. To achieve the first objective, a questionnaire was designed for the IBS house occupiers.

(iii) Design of Questionnaire

This section will explain the issues involved in designing the questionnaire. The issues include the content, format and structure. A structured questionnaire design was used in this study. The questionnaire takes approximately 20 minutes to complete. The use of a self-administered questionnaire instead of a postal or e-mail questionnaire may encourage people to participate in this study.

According to Malhotra (2004), the advantages of a questionnaire to collect data are:

i) it is simple to administer; ii) the data obtained is reliable; and iii) the coding, analysis and interpretation of data are relatively simple and straight forward. In this questionnaire, most of the questions are fixed alternative questions that require the respondents to select from a predetermined set of responses. A copy of the research instrument used in this study is shown in Appendix A and B.

Itemized scale ratings, namely, the Likert-type scale was applied to most of the questions in this questionnaire. The advantages of Likert scaling are that it is easy to construct and understand as well as flexible and economic in terms of space (Alreck & Settle, 1995).

The main objective of this survey is to get first-hand information from the consumer's of IBS housing occupiers regarding the current standard and conditions of the IBS houses. This is the essence of QFD application. The feedback obtained directly from the users was based on their experiences and described in their own words.

The questionnaire for the House Occupiers was designed in three different sections. First is the occupiers background, second is house background. The third section concerns importance and satisfaction. These sections are identified as follows:

a) Occupiers background

- i. Name
- ii. Address
- iii. Telephone Number
- iv. Location
- v. Age
- vi. Sex
- vii. Race
- viii. Nationality
- ix. Education
- x. Marital status
- xi. Children
- xii. Income
- xiii. House type
- xiv. House Built-up area
- xv. Ownership status
- xvi. House price
- xvii. Reason for purchasing house

b) House background

- i. Developer
- ii. Number of floors
- iii. Number of rooms
- iv. Renovation done to the house
- v. Main issues or problems
- vi. Types of issue and cost of renovation
- vii. House owner's question

c) Customer satisfaction factors

There are numerous questions in nine major areas with both importance and satisfaction answers in the form of a 5-point Likert scale. There is a final question with an overall satisfaction question with five answers, as follows:

- i. Extremely dissatisfied;
- ii. Dissatisfied;
- iii. Satisfied;
- iv. Very satisfied; and
- v. Extremely Dissatisfied

Table 4.4: The construct of the customer satisfaction factors for the IBS house (Cont'd)

Customer Satisfaction Factors	Source
<p>Quality of building materials</p> <ul style="list-style-type: none"> a. Substructure b. Superstructure c. External Wall d. Internal Wall e. Window f. Door g. Finishes h. Building Services i. Built in Fittings j. Layout of house k. External Work 	<p>Abdul-Rahman <i>et al.</i> (1999) Stehn & Bergstrom, (2002) Kam & Tang, (1997) Mustafa & Ghazali (2011) Gargione (1999) Ashworth (1994), Hock (2007) Dikmen <i>et al.</i>(2005) Quantitative Study</p>
<p>Design quality</p> <ul style="list-style-type: none"> a. Substructure b. Superstructure c. External Wall d. Internal Wall e. Window f. Door g. Finishes h. Building Services i. Built in Fittings j. Layout of house k. External Work 	<p>Abdul-Rahman <i>et al.</i> (1999) Stehn & Bergstrom, (2002) Dikmen <i>et al.</i>(2005) Kam & Tang, (1997) Mustafa & Ghazali (2011) Gargione (1999) Ashworth (1994), Hock (2007) Quantitative Study</p>
<p>Building strength</p> <ul style="list-style-type: none"> i. Structure Strength ii. Stability of Building iii. Weather Resistance iv. Fire Resistance v. Security 	<p>Abdul-Rahman <i>et al.</i> (1999) Dikmen <i>et al.</i>(2005) Kam & Tang, (1997) Gargione (1999) NorAini (2007) Jose & Simoes (2003) Quantitative Study</p>
<p>Comfort</p> <ul style="list-style-type: none"> i. Privacy ii. Health iii. Internal Fittings iv. Good Functional Materials and Accessories v. Security 	<p>Kam & Tang, (1997) Abdul-Rahman <i>et al.</i> (1999) Jose & Simoes (2003) Dikmen <i>et al.</i>(2005) NorAini (2007) Quantitative Study</p>
<p>Environmental Conditions</p> <ul style="list-style-type: none"> i. Ventilation ii. Pollution Condition iii. Traffic Congestion 	<p>Abdul-Rahman <i>et al.</i> (1999) Stehn & Bergstrom, (2002) Dikmen <i>et al.</i>(2005) NorAini (2007) Quantitative Study</p>
<p>Maintenance work</p> <ul style="list-style-type: none"> i. Repair Works ii. Cleanliness iii. Garbage Collection System 	<p>Abdul-Rahman <i>et al.</i> (1999) Stehn & Bergstrom, (2002) NorAini (2007) Mustafa & Ghazali (2011) Dikmen <i>et al.</i>(2005) Quantitative Study</p>

(iv) Method of Data Analysis

The methods of data analysis used in this section include frequency distribution, arithmetic measurements and the gap analysis. These types of data analysis were chosen in order to determine the most critical customer satisfaction factors for IBS housing.

a) Frequency Distribution

The data collected answered some of the issues raised in the study. The analysis of the data can be performed through descriptive statistics. One of the initial steps is to perform frequency distribution, which summarizes the data and displays the number of the observations into distinct classes or categories for each distribution. For the purpose of this research, graphical and data analysis techniques were used (Creswell, 2008; Cavana *et al.*, 2001).

b) Arithmetic Measurements

Arithmetic measurements include the everyday measures used to describe the distribution of daily personal and business activities, for example, the arithmetic mean, which is the most useful measure in business statistics (Bryman, 2004:537). In this study, the mean was used in the evaluation of the measurement for answering the issues raised in the research questions.

c) Gap Analysis

The other method of analysis that was used in this study is gap analysis. The main reason why gap analysis is important to firms is the fact that gaps between customer expectations and customer experiences lead to customer dissatisfaction. Consequently, measuring gaps is the first step in enhancing customer satisfaction. As a result, understanding customer perception is important to a firm's performance. As such, gap

analysis is used as a tool to narrow the gap between the perceptions and reality, thus, enhancing customer satisfaction. Parasuraman *et al.* (1985) proposed that service quality is a function of the differences between expectation and performance along the quality dimensions. They developed a service quality model based on gap analysis. The rationale of adopting the gap analysis is due to the flexibility and applicability of the analysis over any aspect of industry (Parasuraman *et al.*,1985; Zeithaml, 1991; Brown & Plenert, 2006).

4.3.1.3 IBS Adoption in the Malaysian Construction Industry- Part 2 in Phase 1

The second part of the first phase of the research process was to determine and examine the factors for IBS adoption. It is part of the research process in order to achieve the second research objective.

(i) Sampling Design

The names and addresses of the housing developers, primarily the IBS developers or manufacturers, were obtained from the Construction Industry Development Board (CIDB). The total number of IBS registered contractors was 1,993 and registered IBS developers or manufactures in Malaysia was 138. The total population is 2,131. The researcher used purposive sampling with a total of 105 valid respondents who responded to this study. This sample was collected from the IBS construction stakeholders, namely, developers, manufacturers and contractors.

(ii) Data Collection

This research adopts a self-administered questionnaire survey method as the strategy for data collection. To achieve the second objective, a questionnaire was designed for the construction stakeholders.

(iii) Design of Questionnaire

The questionnaire was designed in a manner such that it addresses issues relating to IBS adoption in the Malaysian construction industry. The subsequent sub-sections address the demographics of the respondent, project and building information, IBS factors and the understanding of IBS.

The objective of this questionnaire survey was to measure the level of awareness among construction stakeholders, especially those adopting the IBS technology regarding quality in their products, how much consideration is given towards consumer requirements, the problems faced in meeting the quality demands, the success factors and barriers to IBS adoption in the construction industry and their acceptance of QFD in improving the situation. The questionnaire was designed in four (4) sections, namely, the demographics of the respondents, project and building information, IBS factors and the understanding of QFD among construction stakeholders. The breakdown of these sections is as follows:

a) Demographics of the respondents

- i. Demographic Profile of the Respondent
- ii. Demographic Information
- iii. Job Affiliation
 - i. Position
 - ii. Working Experience

b) Project and building information

- vi. Project Information and Building Information
- vii. Project Information
- viii. Project Type
- ix. Building Cost Type
 - x. Height of Building
 - xi. Building Type
- xii. Structural Construction Method

c) IBS adoption factors

There were 34 questions with both Importance and Satisfaction answers in the form of a 5-point Likert scale. There is a final question, 35, with an overall satisfaction question with 5 answers – extremely satisfied, very satisfied, satisfied, dissatisfied and very dissatisfied.

The scale for the degree of Importance used in the questionnaire survey is as shown in Table 4.5 below.

Table 4.5: Degree of Importance

Scale	Degree of Importance
1.	Extremely unimportant
2.	Unimportant
3.	Important
4.	Very important
5.	Extremely important

The scale for degree of Satisfaction used in the questionnaire survey is as shown in Table 4.6:

Table 4.6: Degree of Satisfaction

Scale	Degree of Importance
1.	Extremely dissatisfied
2.	Dissatisfied
3.	Satisfied
4.	Very satisfied
5.	Extremely satisfied

Table 4.7: The constructs of the IBS adoption factors

IBS Adoption Factors	Source
<p style="text-align: center;"><u>Quality</u></p> <ol style="list-style-type: none"> 1. IBS provides higher quality than conventional system. 2. IBS provides higher productivity than conventional method. 3. IBS does not consider the consumer preferences. 	<p>Thanoon <i>et al.</i> (2003) Din (1984) CIDB (2004) CIDB (2005) Omar (2003) Elias (2006) CREAM (2007) Kamar <i>et al.</i> (2009) Quantitative study</p>
<p style="text-align: center;"><u>Cost</u></p> <ol style="list-style-type: none"> 4. IBS reduces overall construction cost due to reduction of site works. 5. IBS reduces overall construction cost due to reduction in construction wastage. 6. IBS reduces overall construction cost due to faster completion of construction projects. 7. IBS increases construction cost compared to conventional system due to lower competition in tendering process. 8. IBS increases cost due to imported technology or product. 9. IBS increases cost due to higher interest rate because of higher capital investment. 10. IBS needs higher capital investment to start production. 	<p>Bing <i>et al.</i> (2001) CIDB (2004) CIDB (2003) Elias (2006) CREAM (2007) Kamar <i>et al.</i> (2009) Haron <i>et al.</i> (2004) Haron <i>et al.</i> (2005) Thannon <i>et al.</i> (2003) Rahman & Omar (2006) Quantitative study</p>
<p style="text-align: center;"><u>Time</u></p> <ol style="list-style-type: none"> 11. IBS reduces completion time of construction projects due to the usage of standardized pre-fabricated components and simplified installation process. 	<p>Friedman & Cammalleri, (1993) Peng (1986) CIDB (2004) Elias (2006) CREAM (2007) Kamar <i>et al.</i> (2009) Quantitative study</p>
<p style="text-align: center;"><u>Design</u></p> <ol style="list-style-type: none"> 12. IBS provides flexible design. 13. IBS provides highly aesthetic end product through the process of controlled pre-fabrication and simplified installation. 14. Uncertainties of IBS to meet aesthetic design. 15. IBS designs are monotonous and stifle creativity. 16. IBS has problems with connections and jointing methods. 	<p>Din (1984) Warszawski (1999) Zaini (2000) Elias (2006) CREAM (2007) Kamar <i>et al.</i> (2009) Hamid <i>et al.</i> (2008) Kampempool & Suntornpong (1986) Tan (1997) Quantitative study</p>

Table 4.7: The constructs of the IBS adoption factors (Cont'd)

IBS Adoption Factors	Source
<p style="text-align: center;"><u>Policy</u></p> <p>17. IBS reduces dependency on foreign workers. 18. IBS execution must be given levy exemptions. 19. IBS encourages policy on the investment in technologies, techniques and process of construction 20. IBS encourages action plans to ensure a successful upgrading of the construction industry 21. IBS adoption does not attract enough incentives from the government. 22. IBS policies are not strict enough. 23. IBS education and training is not sufficient in universities and institutes of higher education. 24. Inadequate R&D undertaken to substantiate the benefits of IBS. 25. Lack of R&D in the area of novel building systems (IBS) that use local materials. 26. Abundance of cheap foreign workers to use conventional construction system compared to IBS.</p>	<p>Thannon <i>et al.</i> (2003) CREAM (2007) Kamar <i>et al.</i> (2009) Haron <i>et al.</i> (2004) Haron <i>et al.</i> (2005) Elias (2006) CREAM (2007) Kamar <i>et al.</i> (2009) Badir <i>et al.</i> (2002) Quantitative study</p>
<p style="text-align: center;"><u>Management</u></p> <p>27. IBS contributes to cleaner site conditions due to less construction wastage. 28. IBS provides safer construction sites due to the reduction of site workers, materials and construction wastage. 29. Limited number of local IBS manufacturers. 30. Lack of skilled workers to adopt IBS methodology. 31. Do not know where and how to start using IBS methodology. 32. The industry is not ready for IBS adoption. 33. Bumiputera participation is left out in the IBS adoption. 34. Construction players still lack scientific information about the economic benefits of IBS.</p>	<p>Thannon <i>et al.</i> (2003) Elias, (2006) CREAM (2007) Kamar <i>et al.</i> (2009) Haron <i>et al.</i> (2004) Haron <i>et al.</i> (2005) Quantitative study</p>

d) Understanding of QFD among construction stakeholders

There are ten (10) questions concerning the understanding of QFD including the open-ended comments questionnaire. The completed questionnaire survey was attached as in Appendix B.

(iv) Method of Data Analysis

The methods of data analysis used in this section are frequency distribution, arithmetic measurements and the gap analysis. These types of data analysis were chosen in order

to determine the most critical IBS adoption factors. The types of data analysis were the same as in part 1 in the first phase.

4.3.2 PHASE 2 AND 3: QUALITATIVE STUDY

Phase 2 and phase 3 of the study adopted a qualitative study through focus group discussion. This is part of the research process in order to achieve the third and fourth research objectives.

(i) Sampling Design

The author used purposive sampling as this research intentionally selected the respondents from among the IBS house occupiers and the construction stakeholders (Cavana et al., 2001; Creswell, 2008) in order to obtain valid data from the valid respondents or representative sample and to avoid from a biased sample. A biased sample consists of respondents who don't represent the group of interest. Twelve (12) respondents from both the IBS house occupiers and construction stakeholders attended the focus group discussion session. The focus group respondents were considered from the external customers (IBS house occupiers) and the internal customers (construction stakeholders). The unit of analysis required was a group or collectively.

(ii) Data Collection

According to Cavana *et al.* (2001) and Creswell (2008), the methods of data collection of qualitative study are interviews, observation and focus groups. For the qualitative study in the second and third phase, focus group discussion was chosen as the method of data collection. According to Boddy (2005) a focus group discussion is defined as a group of people brought together to participate in the discussion of an area of interest. In other literature, focus group discussions are also defined as organised discussions

(Kitzinger, 1994), collective activity (Powell *et al.*, 1996) social events (Goss & Leinbach, 1996) and interaction (Kitzinger, 1995).

According to Morgan & Kreuger (1993), the main purpose of focus group research is to draw upon respondents' attitudes, feelings, beliefs, experiences and reactions in a way that would not be feasible using other methods, for example observation, one-to-one interviewing, or questionnaire surveys. These attitudes, feelings and beliefs may be partially independent of a group or its social setting, but are more likely to be revealed via the social gathering and the interaction that being in a focus group entails (Morgan & Kreuger, 1993). The focus group discussion aims to provide an environment in which all members of the group can discuss the area of investigation with each other (Boddy, 2005). A successful focus group discussion has the group members involved as participants in discussing the area of interest. They may argue with each other, try to persuade each other of their point of view, agree or disagree, ask each other questions and generally discuss the topic in an open, and, usually, friendly manner (Boddy, 2005). The moderator, acting as first among equals, intervenes, i.e., moderates, only to keep the topic of discussion on the area of interest. The moderator introduces new elements of the area of interest, probes for a deeper understanding of statements made by group members and gains explanation for the differences of opinion held. Participatory discussion is maximised (Boddy, 2005). The moderator in a focus group discussion mediates between group participants and settles disputes in terms of trying to explore and understand different points of view or to explain differences in opinions (Boddy, 2005).

The benefit to participants of focus group research should not be under estimated. The opportunity to be involved in decision making processes (Race *et al.*, 1994), to be

valued as experts, and to be given the chance to work collaboratively with researchers (Goss & Leinbach, 1996) can be empowering for many participants. If a group works well, trust develops and the group may explore solutions to a particular problem as a unit (Kitzinger, 1995), rather than as individuals. Another advantage of focus groups to clients, users, participants or consumers is that they can become a forum for change (Race *et al.*, 1994), both during the focus group meeting itself and afterwards. For example, in research conducted by Smith *et al.* (1995), patients in a hospital were invited to give their views about services and provide ideas about improvements. In this instance change occurred at the management level as a direct result of patients' input. A structured focus group discussion was conducted to identify the strategies on subject matters and develop the Quality Function Deployment matrix's. The focus group was facilitated by the researcher as the moderator. This group had active participation from the members who attended the focus group discussion. The collection of data from the focus group discussion was performed according to the following schedule:

Venue : Putri Room, Palm Garden Hotel in IOI Resort Putrajaya
Date : 16th August 2009
Time : 2 pm – 7 pm.

In order to facilitate the implementation of this discussion, the format was structured according to the following sub-sections:

(a) Agenda

The agenda of the focus group is to confirm the customer satisfaction requirements or factors, and the IBS adoption factors, which were determined from the quantitative study in the earlier phase. The factors are regarded as the “What’s” in the QFD terms. The focus group was called for discussion among the delegates to identify and agree on the new strategies or “How’s” to fulfil all the requirements. Through group discussion,

the delegates can obtain not only agreement on the “How’s” but also a consensus on the correlation between the “What’s” and the “How’s”. The correlation is crucial for the proper conducting of the QFD for the purpose of this study.

(b) Participation Composition

There were a total of 12 people participating in the focus group discussion comprising representatives from the Public Works Department, consultant engineers, IBS developers, house occupiers, architect, academician and researcher. The attendance list is as shown in Table 4.8:

Table 4.8: Attendance list for Focus Group

No.	Sector	No. of persons
1	Public Works Department representatives	2 persons
2	Engineers	2 persons
3	IBS Developers	2 persons
4	House Owners	3 persons
5	Architect	1 person
6	Academician and researcher	2 persons
	Total	12 persons

(c) Focus Group Discussion

The researcher was able to manage the entire focus group discussion in a very focused direction. The objectives, aim and output were clearly explained to the participants. All the participants who attended the focus group discussion were initially passive, however, along the way the researcher was able to encourage the participants to be more active and to make sure all the participants get equal talk time. All the participants offered their ideas and suggestions generously with no one holding back with none being considered less creative or innovative.

As the discussion progressed, most of the aims to extract the feedback from the industry players were achieved. The feedback for the Quality (Q) matrix, Function (F) matrix

and Quality Function (QF) matrix were completed with active participation from the focus group participants.

(d) Contribution from the Focus Groups

The participants of the focus group were not trained in QFD. However, the researcher took the effort to explain what QFD is all about and the objectives for the day. With this in mind, the researcher conducted the session in an informal manner. The participants were able to contribute to the focus group with their ideas and specific knowledge in the ensuing discussion.

(e) Focus Group Activities

The activities for the focus group discussion can be summarized as follows:

- i. Introducing the agenda for the day
- ii. Explaining the QFD concept to the participants
- iii. Actual focus group session
- iv. Discussing issues arising
- v. Capturing the points raised by participants
- vi. Clearing doubts of the participants
- vii. Cross-referencing with points raised in the focus group
- viii. Concluding remarks
- ix. Thanking the participants

The detailed information of the Structured Focus Group Discussion produced the Q matrix, F matrix and the QF matrix development. The details of the focus groups discussion activity are shown in Appendix D.

(iii) Method of Data Analysis

The methods of data analysis used in this section include Pareto rules and QFD analysis. These types of data analysis were chosen in order to develop strategies to improve customer satisfaction of IBS housing, strategies to improve IBS adoption, and recommendations to the related organizations to implement IBS adoption.

a) Pareto Analysis

Pareto analysis is a simple method of analysis and yet powerful in determining the most important factors. Pareto analysis is a method for classifying items, events or activities according to their relative importance. It was named after the Italian economist Vilfredo Pareto, who observed in 1906 that 80 per cent of property in Italy was owned by 20 percent of the Italian population. The principle was suggested by management advisor and quality pioneer Joseph M. Juran (Juran & Godfrey, 2003). The so-called Pareto Principle (also known as the 80-20 Rule) suggests that for many phenomena 80 percent of consequences stem from 20 percent of the causes. Organizations can concentrate on the highest value and most important items (Le Blanc & Rucks, 2009). Later empirical evidence showed that the 20/80 ratio was determined to have a universal application (Bass & Lawton, 2009) that explains:

- i. 80% of customer dissatisfaction stems from 20% of defects
- ii. 80% of the wealth is in the hands of 20% of the people
- iii. 20% of customers account for 80% of the business.

b) QFD Analysis

In this study, the QFD technique is the most crucial method of analysis among all the methods of analysis. Hence, the author used the QFD technique for data analysis. The rationale of employing QFD is because it is a tool that enables and ensures that the voice

of the customer is heard and considered throughout the product planning, design and construction planning stages. This method also provides a list of activities and a graphic representation of the design deployment that allows one to see the relationships between the goals (What's) and means to realize them (How's) (Balthazard & Gargeye, 1995).

4.3.3 PHASE 4: VALIDATION OF THE ENTIRE STUDY

The last part of the research method is the validation of the entire finding of the study performed through purposive sampling. The researcher used structured interviews with ten (10) respondents from construction stakeholder experts and academicians. The data collected were analysed to confirm and verify the findings from the quantitative study (Phase1), and qualitative study (Phase 2 & 3).

The findings of the study were validated to ensure the quality of research and that the interpretation of the data collected was precise and accurate (Fraenkel & Walllen, 2006; Cresswell, 1998, 2006). Since this study used both quantitative and qualitative, or mixed method, the findings can be validated or checked by content validity, as proposed by Cavana *et al.* (2001), Crestwell (1998, 2006), Lincoln & Guba (1985), Miles & Huberman (1994), Malterud (2001), Mays & Pope (2000) and Fraenkel & Wallen (2006). During the validation process, the researcher collected the data from both the quantitative and qualitative methods and then the findings were validated from the professional or expert judgement (Cavana *et al.*, 2001; Fraenkel & Wallen, 2006; Creswell, 2006; Lincoln & Guba 1985; Miles & Huberman, 1994; Malterud, 2001; Mays & Pope 2000) Through the validation process, the reliability and validity of a research can be improved and strengthened.

The validation of this study is performed in three (3) stages. The first stage is the validity of the quantitative study for both the customer satisfaction factors and IBS adoption factors identified. Although the quantitative study is performed through the Gap analysis method, the additional validation of the findings is also performed as recommended by Cavana *et al.*, (2001); Creswell (2006); Fraenkel & Wallen (2006). The second stage is the validity of the qualitative study for both the customer satisfaction strategies and IBS adoption strategies. The third stage or the final validation process is confirming the major roles of organizations to improve the IBS adoption process as recommended by Creswell (1998; 2006), Lincoln & Guba (1985), Miles & Huberman (1994), Malterud (2001), Mays & Pope (2000).

Structured interviews constitute one of the data collection processes in a qualitative study in which individual in-depth or detailed interviews act as guidance to a specific way of answering the questions (Cooper & Schindler, 2006). In this study, the researcher adopted a structured interview since the purpose is to validate the entire study. Structured interviews were selected to ascertain the exact findings for each stage of the study, which were performed and verified by the selected respondents. The findings at each stage of the study, as mentioned by Cooper & Schindler (2008), were transformed into direct questions so that the variability of questions was eliminated and remained real. Each structured question was confirmed by the respondent to determine whether the finding from each stage of the study fell into the category of strongly important/strongly agree, important/agree, or not important/disagree. The results calculated as a percentage should reflect the accuracy of the interpretation of the findings at each stage of the study. The structured interview questions used in the validation process are shown in Appendix E.

Finally, the researcher also conducted the validation process for the research models as recommended by Cavana *et al.* (2001), Crestwell (1998, 2006), Lincoln & Guba (1985), Miles & Huberman (1994), Malterud (2001), Mays & Pope (2000), and Fraenkel & Wallen (2006). There were a total of four (4) respondents who participated in the validation process. The validation process of the research models was conducted with the facility manager of IBS house as a representative of the maintenance and management company, a project manager as a representative of the IBS manufacturer, a certified professional civil engineer as a representative of the Public Works Department, Malaysia, and a certified professional architect as a representative of a consultant architect. Each semi-structured question was verified by the respondent to determine which category the research models fell into: strongly important/strongly agree, important/agree, or not important/disagree. The semi-structured interview questions used in the validation process of research models are shown in Appendix F.

4.4 APPLICATION OF ANALYSIS IN THE PHASES OF THE RESEARCH PROCESS

This section discusses the application of analysis in the phases of the study. Appropriate application of analysis was conducted to ascertain that output of the analysis addressed the research questions and the research objective through the four (4) respective phases of the study. A very specific application of analysis was used to analyse the data. The following is a description of the application of analysis employed in the phases of the study.

4.4.1 Application of Analysis in the First Part of the First Phase

To achieve the results for the first research question (RQ1) and the first research objective (RO1), the researcher analysed data from the IBS house occupiers through

data collection from a self-administered questionnaire survey. The questionnaire form is included in Appendix A. The first part of the questionnaire survey section analyses the background information of IBS house occupiers, background information of IBS house, overall analysis of customer importance and satisfaction level.

(i) Background Information of IBS House Occupier

In this section, the researcher investigated all the finer details of the house occupiers. In total, there are 391 respondents accounting for 100% in this study. Some details, such as name, address and telephone number, were captured in the researcher's database but were not analysed here. The researcher started with the relevant demographics.

(ii) Background Information of IBS House

The following section describes the analysis of the house background information. In this section, the researcher analysed the house background details in relation to the house.

(iii) Overall Analysis of Customer Importance and Satisfaction Level

The researcher attempts to identify the level of importance and satisfaction of customer satisfaction factors concerning IBS housing. A total of 132 questions were asked. Descriptive statistics were used to describe the level of importance and satisfaction. Graphs are employed to highlight the overall mean value for each question or factor.

The purpose of this arrangement is to compare the level of importance with the level of satisfaction. Upon identifying the importance and satisfaction level the researcher proceeds to identify the gap between what the house occupier perceives as important

and the corresponding satisfaction level. By doing this, the researcher is able to ascertain the gap.

Subsequently, at this stage, all the items are sorted in the order of priority. The items are sorted from the highest to the lowest. Should there be a negative value, then the indication is shown by the difference in the gap between the satisfaction and level of importance. The items with a higher negative value are those items that have greater difference between satisfaction and importance.

The researcher ranked the factors of customer satisfaction on IBS housing according to gap analysis. The gap analysis is the difference between the importance level and satisfaction level. The overall satisfaction level is analysed using descriptive statistics. The nine factors of customer satisfaction concerning IBS house occupiers from the literature that were investigated by the researcher are as follows:

- i) Size of house
- ii) House Price
- iii) Quality of workmanship
- iv) Specification/Quality of Building Materials
- v) Design Quality/Aesthetic Value
- vi) Building Strength
- vii) Comfort
- viii) Environmental Conditions
- ix) Maintenance Work

4.4.2 Application of Analysis in the Second Part of First Phase

To achieve the results for the second research question (RQ2), the researcher analysed data from the construction stakeholders through data collection from a self-administered questionnaire survey. The questionnaire form is included in Appendix B. The first part of the questionnaire survey section describes the background information of construction stakeholders, demographic profile, background information of IBS house, and the overall analysis of customer importance and satisfaction level

(i) Background Information of Construction Stakeholders Demographic Profile

In the analysis of the respondent's demographic profile, the researcher attempts to collect some demographic data of the stakeholders in the construction industry. This mainly covers areas like the respondents' jobs, positions and their experience in the construction industry. Overall, there are 105 respondents from the construction stakeholders who responded to the questionnaire survey. The construction stakeholders comprise government ministry officials, developers, consultants, contractors and manufacturers. Descriptive statistics are used to analyse the respondents' particulars.

(ii) Background of Project Information

The project information is yet another aspect of demographic profiling. The researcher investigates the project information within the scope of this research. This includes the project type, building cost type, height of building, building type and structural type. The overall outcome is presented in terms of project information. The construction methods of IBS houses are classified according to building structure. The construction methods are "conventional construction method" (type A), "formwork system" (type B) "composite construction method" (type C) "fully prefabricated construction" (type D),

and other types of construction. Thus, the type of building is investigated in respect of the houses of the occupiers. The definition for each classification of the building structure is indicated in Table 4.9, as follows:

Table 4.9: Classification of the Building Structure

Type	Classification	Definition
A.	Conventional construction method	The traditional construction method using timber formwork and brickwork
B.	Formwork System	"Uses material made of steel/fibreglass/aluminium as a prefabricated formwork
C.	Composite Construction Method	Combination of prefabricated and conventional construction method
D.	Fully Prefabricated Construction Method	(Breaking a whole housing unit into different components –floors, walls, columns, beams, roofs, etc., – and having these components separately manufactured in standard dimensions in the factory or site and assembled /erected outside
E.	Others	Please Specify

(ii) Identifying Construction Stakeholders Importance and Satisfaction Level

The researcher attempts to identify the importance and satisfaction level given to all the selected factors by the construction industry stakeholders. A summary of the questions (a total of 34) is provided. Descriptive statistics are used to describe the level of importance of the questions and the factors of the construction stakeholders. Graphs are employed to highlight the overall mean value for each question or factor.

The next step is for the researcher to look at the levels of both the importance and satisfaction in conjunction with the stakeholders. The purpose of this arrangement is to compare the level of importance to the level of satisfaction. Upon identifying the importance and satisfaction level of the construction industry stakeholders, the researcher proceeds to identify the gap between what the construction industry perceives as important and the corresponding satisfaction level. By doing this, the researcher is able to ascertain the gap.

Subsequently, at this stage, all the items are sorted into the order of priority– from the highest to the lowest. Should there be a negative value, then the indication is shown by the difference in the gap between the level of satisfaction and level of importance. Items with a higher negative value are those items that have a higher difference between satisfaction and importance.

The researcher ranked the factors for the IBS adoption by the construction industry according to gap analysis. The gap analysis is the difference between the level of importance and the level of satisfaction. The researcher selected nine (9) factor items as the final product in terms of the critical success factors. These nine (9) items consisted of both barriers and opportunities. The selection of factors can be described in a tabulated form in the form of short and long descriptions. The overall satisfaction level was analysed using descriptive statistics.

(iii) Analysing the Understanding on QFD

It is crucial to gauge the extent of the IBS adopters on QFD in the construction industry. In order to achieve this, the researcher measured the understanding and appreciation of QFD among the construction industry stakeholders. The results were analysed by answering the specific open-ended question. Each question was measured according to the selected scales. The question to evaluate whether or not the respondents understand the “design quality in the context of construction”, with the choice of answers ranging from A to E, as described further in Table 4.10.

Table 4.10: Description of “Design quality in the context of construction”

Item	Description
A	An effective design to serve its intended purpose
B	A constructible design with the best possible economy and safety
C	Designed to meet customer needs and expectations
D	Something you put into design of product through customer feedback
E	Others (please specify)

Question 5 asked, “if the respondents agreed, what are the possible reasons”. There were 6 possible choices for the possible reasons. These are identified as indicated in Table 4.11.

Table 4.11: Definition of answers for question 5

Items	Definition
A	Quality of products is created by people, for people
B	Designer translates the customer’s needs and desires into product
C	Designer emphasizes technological features rather than actual needs
D	If customer is unhappy over design, competitors might win over him/her
E	Doing it right the first time to avoid delays, rework or changes in design
F	Others (please specify)

Question 6 asked, if respondent disagrees, “demand should be based on the feedback from the customer”. The choice of answers (range from items A to F) for this question is as indicated in Table 4.12.

Table 4.12: Definition of answers for Question 6 and Question 7

Items	Definition of answers
A	It is not economical to conduct a market survey
B	Demands of customers are endless and impossible to satisfy them all
C	Too time-consuming
D	Traditional method based on knowledge & experience is good enough
E	Concept not suitable for construction industry
F	Others (please specify)

Question 7 asked, “suggestions towards IBS adoption in Malaysian building construction industry using QFD”. The choice of answers (range from item A to F) for this question is as indicated same as in Table 4.12.

Question 8 asked, “in the manufacturing industry, producers are striving for continuous quality improvement by incorporating the customers’ demands into the product through design. Do you foresee this trend being adopted by the IBS construction sector in Malaysia?”

Table 4.13 shows the definition of answers for question 9. The question asked if the respondent agrees that “In the manufacturing industry, producers are striving for continuous quality improvement by incorporating the customers needs”, then “what are the possible reasons?”

Table 4.13: Definition of answers for question 9

Items	Definition of answers
A	The need to strive for excellence in the construction industry
B	To uphold the positive reputation of the industry. i.e., quality conscious
C	To compete with foreign companies who emphasize quality
D	More affluent consumers who choose products designed to their needs
E	To improve the current cost, delivery and reliability aspects in this sector
F	Others (please specify)

Question 10 asked, if you disagree that “in the manufacturing industry, producers are striving for continuous quality improvement by incorporating the customers’ needs” and “what are the possible reasons?”

Table 4.14 shows the definitions for the answers for question 10. The question asked if you disagree that “in the manufacturing industry, producers are striving for continuous quality improvement by incorporating the customers needs” “what are the possible reasons?”

Table 4.14: Definition of answers for question 10

Items	Definition of answers
A	Every project is unique with varying customer demands and needs
B	There are two parties of customer, i.e., developer and purchaser whose requirements may contradict each other
C	The industry involves many parties with different organizations, priorities and quality policies
D	Quality in construction is difficult to define or measure
E	Deploying customer needs into design and construction procedures is too costly and time consuming
F	Others (please specify)

Question 11 asked, “Do you agree that if IBS products development with considering customer satisfaction factor through QFD technique can improve the level of IBS adoption in the Malaysian building construction industry?”

(v) Understanding of QFD Application via Open-Ended Questions

The understanding of the QFD application was formulated via open-ended questions. Hence, in this part, the researcher prompted the respondents to provide comments, views and suggestions through “Please kindly give your comments/views/suggestions” of QFD application in the construction industry. The respondents were expected to answer this question in a subjective manner unlike all the other questions.

However, for the purpose of analysis the researcher identified relevant answers to address the issue of IBS house occupiers and IBS adoption in the construction industry, as described in this section. These responses are treated as different and relevant responses related to the QFD issues and are numbered accordingly.

The researcher used the affinity diagram (Juran & Godfrey, 2003; Le Blanc & Rucks, 2009; Bass & Lawton, 2009) to analyse the comments made. The outcome of the analysis is shown in a tabulated form. The verbatim comments are grouped into common clusters (affinity). The analysis of these different clusters is then formed into an affinity group of understanding of QFD in the construction industry. These different groups are listed in a tabulated form.

Upon identifying the affinity group the researcher proceeded to list the comments one by one in each of the relevant affinity groups. The comments are then presented through the Pareto analysis formula, which shows both the frequency percentage together with

the cumulative frequency percentage. The presentation of the comments and suggestions from the relevant affinity group are shown in Pareto form analysis outcome. It then incorporates in terms of frequency and cumulative percentage to describe the understanding of QFD. The outcome from the affinity group drawn from the comments and suggestions from the construction industry are then illustrated into descriptive statistics.

4.4.3 Application of Analysis in the Second Phase and Third Phase

The key analysis of this study is the application of QFD in the analysis of the data. The QFD is performed in the second phase and third phase of the study, primarily to identify the strategies and the roles of organizations in construction industry. The first part of the second phase is where the application of the QFD is used to determine the customer satisfaction strategies. In the second part of second phase, the application of QFD is used to determine the IBS adoption strategies. In the third phase, the application of QFD is used to determine the roles of organizations to implement the customer satisfaction on IBS adoption in Malaysian construction industry.

The approach on the application of QFD is through the development of the QFD matrix. The QFD matrix was developed using focus group discussion based on the factors identified in the quantitative study in phase one. The researcher attempts to develop the relevant QFD matrix.

There are two applications to the development of the QFD matrix. One application is the “quality” matrix and the other application being the “function” matrix, which is also called Q matrix and F matrix, respectively. The quality matrix is derived from the IBS house occupiers, as the external customer response. While, the function matrix is

derived from the construction stakeholders, who act as the internal customer response. The reason behind this is that IBS house occupiers are interested in the quality perspective of their houses whereas the construction industry stakeholders are more concerned with the functional perspective, which is part of the interest and daily activities.

Upon completing the Q and F matrix individually, the researcher combined these two strategies into another QFD application, thus, developing the third matrix which is called as QF matrix.

4.4.3.1 Description on Application of QFD Analysis – Second Phase

The application of QFD data analysis of the second phase is the development of the strategies for IBS. Both the strategies for customer satisfaction and IBS adoption are developed in this second phase of the application stage.

(i) Application of QFD analysis for Q Factor – First Part (Second Phase)

The data analysis of this section produces the strategies to improve the customer satisfaction of IBS houses and IBS adoption in the construction industry. The initial analysis is the development of the QFD Q factor. The overall factor chosen and investigated is indicated by the gap for each of the “Quality” or Q factors.

The researcher then studied all the factors extracted from the literature and the quantitative study. The factors selected for investigation form the quality or Q factors. After identifying these relevant factors, they are then used for the second level of QFD investigation.

(a) Development of the Q Matrix

After the identification of the QFD Q factor, the QFD matrix is further developed to form the second level of investigation. The Quality characteristics are identified. These are the “Whats” in the Q matrix. At this stage the researcher needs to identify a suitable “How’s” for all the “What’s” raised at this point. The activity here involves problem solving to identify a relevant and suitable solution to address the “What’s” identified so far. These are the “How’s”, to each and every one of the “What’s”. The relationship between the “How’s” and “What’s” should ideally be a strong correlation. The relationships can be one of not considered, weak, moderate or strong. The relationship is assigned a value corresponding to the strength of the correlation. If not considered the assigned value is zero (0). A weak correlation between the “How’s” and a “What’s” is assigned with one (1). A moderate relationship between the “How’s” and “What’s” is assigned with three (3). A strong correlation between the “How’s” and ‘What’s” is assigned with nine (9) (Guinta, 1993; Shen *et al.*, 2001; Franceschini & Rupil, 1999). The code values, assigned values and the classification of the “How’s” relationship is as shown in Table 4.15 below:

Table 4.15: The classification of relationship (adapted and modified from Guinta, 1993; Shen *et al.*, 2001; Franceschini & Rupil, 1999)

No.	Code Values	Description
1	0	Not considered
2	1	Weak correlation
3	3	Moderate correlation
4	9	Strong correlation

All the selected critical factors are entered into the chart under “What’s”. This is done row wise. Then the researcher identifies all the possible ways of establishing a suitable way to meet the “What’s”. These “How’s” are entered column wise. Then, a corresponding value of correlation is established for each of the “What’s” against the

“How’s” according to the strength of the correlation. This is done through brainstorming session from the focus group discussion. The “What’s” may have more than one “How’s”. The list of “How’s” is then ranked. It can be seen that twenty-three (23) “How’s” are identified in the Q matrix.

(b) Identification in the Development QFD Q Matrix

The identification of the “How’s” at this stage was developed with the IBS industry stakeholders through a focus group conducted by the researcher. The activities of the focus group have been discussed in the data collection of the qualitative study in the second phase. The list of “How’s” as a product of the Q matrix is then developed. Subsequently, the next level of the QF matrix is then developed.

The “How’s” identified here is the list of strategies of how to improve customer satisfaction in IBS housing, which the researcher has systematically researched. With the already established list the ranking helps to prioritize the key strategies on how to improve customer satisfaction in IBS housing in the Malaysian construction industry.

(ii) Application of QFD analysis for F Factor - Second Part (Second Phase)

Based on the gap analysis conducted from the IBS adoption factors in the second part of the first phase, the researcher selected the most critical gap between the level of importance and level of satisfaction, to be imported into the QFD chart from the entire list of thirty four (34) items selected from the quantitative study. The “function” factors were selected. The order is shown in order of priority based on decreasing negative gap.

(a) Development of the F Matrix

Upon completing the Q matrix with the support of the focus group, the researcher proceeded to conduct the F matrix. In an effort towards establishing the “How’s”, nine (9) critical factors are identified from the construction stakeholders’ questionnaire in the second part of the first phase. The same procedure in the Q matrix is repeated. By doing this, the researcher is able to identify the corresponding “How’s” for each and every one of the “What’s” or requirements selected. Twenty four (24) “How’s” are identified. The “How’s” are then similarly ranked from the highest to the lowest.

Upon completing the F matrix the researcher is able to compile the list of “How’s” for this set of “What’s”. The first eight (8) items marked in italics and bold are taken to the next level of QFD matrix in the third phase of the research process. The first eight (8) items are selected according to the Pareto rules (Juran & Godfrey, 2003; Le Blanc & Rucks, 2009; Bass & Lawton, 2009).

The “How’s” identified here is the list of strategies on how to improve IBS adoption, which the researcher has been systematically researching in order to achieve the last research objective. With the list established, the ranking helps to prioritize the key strategies to improve IBS adoption in the Malaysian construction industry.

4.4.3.2 Description on Application of QFD Analysis –Third Phase

Upon completing the Q matrix and then the F matrix in the second phase, the researcher has to combine both results from the Q and F matrixes into another final QFD application, which is also known as the QF matrix. In order to do that, the “How’s” or strategies from both the Q and F matrix are imported into this new QF matrix. All twenty-three (23) “How’s” or strategies from the Q matrix and another twenty-four (24)

“How’s” or strategies from the F matrix are imported into this QF matrix as the new “What’s”. However, the combination of the actual numbers of “How’s” or strategies in the Q and F matrix is far too many, a total of forty-seven (47). Looking at a more practical and viable option the researcher selected the first eight (8) items from both the Q and F matrix based on their relative importance. The reason for selecting the first eight (8) items is because the researcher adopted the Pareto principle also known as the 80-20 Rule. The so-called Pareto principle suggests that for many phenomena 80 per cent of consequences stem from 20 per cent of the causes (Juran & Godfrey, 2003; Le Blanc & Rucks, 2009; Bass & Lawton, 2009).

Thus, the third QF matrix has sixteen (16) “What’s”. The new “What’s” is then put through the same procedure as done in the Q and F matrix to identify the corresponding “How’s”. In the chart below the “What’s” from the Q and F matrix are placed row wise. The “How’s” are systematically entered column wise. Through the focus group discussion, the researcher identified some thirteen (13) “How’s” that have a highly correlated relationship between the “What’s” and the “How’s”. The “How’s” identified here is the list of the major roles by construction organizations in implementing IBS in Malaysia.

4.5 THE VALIDATION OF THE FINDINGS OF THE ENTIRE STUDY AND THE RESEARCH MODELS

The analysis of the validation of the findings is categorized into three (3) phases. The first phase was the validation of quantitative findings followed by the second and third phases the validation of the qualitative findings. Finally, the researcher conducted the analysis of the validation for the research models.

4.6 SUMMARY

This current chapter presents the research methodology that was adopted in the study. A self-administered questionnaire survey was chosen as the appropriate approach for the quantitative study to determine the factors of customer satisfaction and IBS adoption. In this chapter the researcher has compiled all the details of the housing projects used as a sample in this investigation. The three IBS housing projects selected for this study provide an extensive opportunity for the researcher to execute the questionnaire survey. Through the active participation of the members who attended the focus group the researcher was able to get more input from the stakeholders in relation to the issues raised in this study. The new strategies or “How’s” for Q matrix, F matrix and the requirements or “What’s” for QF Matrix from the input of the focus group participants.