PRIORITIZING CRITERIA FOR ASSESSMENT OF QUALITY IN COMPLETED RESIDENTIAL BUILDING PROJECTS

MOHD LABIB BIN MOHD ARIFFIN

CIVIL ENGINEERING
UNIVERSITI TEKNOLOGI PETRONAS
JUNE 2010

PRIORITIZING CRITERIA FOR ASSESSMENT OF QUALITY IN COMPLETED RESIDENTIAL BUILDING PROJECTS

By

Mohd Labib bin Mohd Ariffin

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

JUNE 2010

Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

Prioritizing Criteria for Assessment of Quality in Completed Residential Building Projects

By

Mohd Labib Bin Mohd Ariffin

A project dissertation submitted to the

Civil Engineering Programme

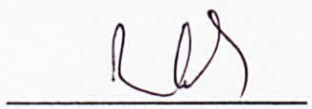
Universiti Teknologi PETRONAS

In partial fulfillment of the requirement for the

BACHELOR OF ENGINEERING (Hons)

(CIVIL ENGINEERING)

Approved by,



(Ap. Ir. Dr. Arazi Idrus)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

JUNE 2010

CERTIFICATION OF ORIGINALITY

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

MOHD LABIB BIN MOHD ARIFFIN

ABSTRACT

Nowadays, there are still no standard ranking of criteria established for assessing quality of completed residential buildings projects and the increasing demand to promote quality standards for completed building project. Thus, the research entitled "Prioritizing Criteria for Assessment of Quality in Completed Residential Building Projects" was chosen. The objective of this project is to identify and prioritize the important criteria for assessing quality in completed residential building projects. This research is done based on the quality assessment system that already being used in construction industries such as CONQUAS and QLASSIC. The data collection method used in this research is questionnaires survey which is distributed manually to the respondents at targeted housing areas. Once the questionnaires have been replied, it will be analyzed using descriptive statistical analysis to prioritize the criteria for assessing quality of completed residential building projects. At the end of this research, it is hopefully can be employed in assisting property developers or contractors in assessing the quality of their completed residential building projects. This finding would also help the developers in meeting and satisfying the need of their clients.

ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious, the Most Merciful. Praise to Him the Almighty that in His will and given strength, had I managed to complete this research in my Final Year Project.

My deepest gratitude goes to my supervisor for this final year project, Associate Professor Ir. Dr. Arazi Idrus whose has proposed, supervised and supported this project continuously in making this project a success.

I would also like to thank Mr. Mahmoud Sodangi, postgraduate student supervised under Dr. Arazi, for providing me the necessary information and cooperation in order to make this research a success. Without his guidance and valuable information, this thesis would not be completed in time.

Thank you to all respondents that willing to spend their time to fill-up the questionnaire and replied back because without their feedbacks, there would be no data to be analyzed in this project.

Lastly I would like to raise thanks to Universiti Teknologi PETRONAS (UTP) and all lecturers and staffs from Civil Engineering Department of Universiti Teknologi PETRONAS.

Thank you

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Quality assurance in the construction of building projects is an important factor in meeting clients' satisfaction especially during the completion of the buildings. One of the main reasons for clients' dissatisfaction on building projects is poor quality. In order to satisfy client, there has always been concern in what constitutes quality standards in the industry and how these can be maintained, improved and assured. Judging from the large volume of literature devoted to this issue, it would, however, appear that quality is indeed a difficult term to define [1]. Numerous studies have highlighted the difficulties faced in understanding and interpreting quality in the construction industry. Each study has its own contributions to make within its respective terms of reference, but the meaning of quality in the construction industry appears to encompass far wider implications.

Despite the difficulty in defining quality [2, 3], the need to promote quality standards for design and construction through to commissioning and maintenance has given rise to the need for quality assurance (QA) in the industry. Since there are still no standard criteria established for assessing quality especially for completed residential buildings, the author has chosen the "Prioritizing Criteria for Assessment of Quality in Completed Residential Building Projects" as the title for Final Year Project (FYP). In this research, the author will prioritize and rank the criteria in assessing quality of completed residential building projects in order of importance. Upon the completion of this research, it perhaps can be used as a guideline for property developer or contractor in achieving good quality for their projects as required by the clients.

1.2 Problem Statement

1.2.1 Problem Identification

Property developers often find it difficult to assess quality of their projects. There is no standard criteria established for assessing quality as this varies from person to person, product is qualified good by one may probably be qualified bad by others. Developers also unsure which criteria is given more priority than others.

1.2.2 Significant of the Study

Upon completion of this research, it perhaps can assist the property developers in assessing the quality of their projects especially for completed projects since there are no standard criteria have been established for assessment of quality in completed residential building projects. This study can be used as an additional reference for the existing references that have been already used in construction industries for developer or contractor in prioritizing criteria for assessment of quality in completed residential building projects.

1.3 Objectives of Study

i. To identify from published literature the quality assessment system used for assessing quality of building projects in the construction industry.

ii. To conduct questionnaire survey to prioritize the criteria in order of importance as perceived by the general public

iii. To test the hypothesis that there is no significant different between Architectural, Mechanical & Electrical and Structural Components in prioritizing the criteria for assessment of quality of completed residential building projects.

iv. To analyze the data collected from the survey

1.4 Scope of Study

This research was done in three parts, namely:

i. Literature study on quality assurance or quality assessment used in construction industries
ii. Survey on the perception of general public or end user about specific quality aspects of building
iii. Analysis of the returned forms and conclusions

In the first part of the study, the researcher made references to quality assurance or quality assessment systems that have been used for constructions in developed countries such as CONQUAS [Construction Quality Assessment System] (Singapore) and QLASSIC [Quality Assessment System in Construction] (Malaysia). From the quality assessment systems, the researcher identifies the criteria used for assessing quality of building projects to be used in the questionnaire design.

For the second part, a research survey using the Questionnaire Survey Method is executed. The target respondents identified for the survey are residents or end users. A total of 300 sets of questionnaires were distributed to the residents. The final part of this research was the writing of findings and conclusions; based on the analysis of the questionnaire forms returned by the respondents.

CHAPTER 2
LITERATURE REVIEW

The construction industry plays an important role in developing countries' development process [4]. The industry establishes buildings and infrastructure works required for social economic development which contribute to the overall economic growth. The industry also provides works for many ranging from professionals such as architects, engineers and surveyors to main contractors, subcontractors, suppliers and ultimately manual laborers who are employed by these contractors. However, a strong quality culture has been recognized to be an important prerequisite to the achievement of sustained competitive advantage through the continuous delivery of high quality products and services as well as clients' or end-users' satisfaction.

The construction industry as one with poor quality emphasis compared to other sectors like the manufacturing and service sectors [5]. Many criticisms have been directed to the industry for generally poor workmanship. It is not only the final product that is subject to criticisms but the processes and parties involved are under high pressure for better quality in construction. This is mainly the result of the industry's failure to achieve the expected performance level in delivering its finished product and services rendered to its teeming customers.

The construction industry has numerous problems because of its complicated nature of operation [6]. This industry is comprised of a multitude of occupations, professions and organizations [6, 7, 8]. They are involved in the different phases of a construction project, which, include: feasibility, development, finance, concept development and review, estimate, detailed engineering, procurement, construction and start-up [9].

The client, consultants, contractor and sub-contractors of a construction project all have a role to play in delivering a quality project. Failure of any of the parties will seriously affect the quality of the final project [6].

The construction industry is also characterized by its non-standardization [10]. Production processes are some different from one another. So, there are no universal standard or specification can be used to the product which will resulting to the difficulties in quality assurance. The extreme changes to the details of the design of a project during the construction process are usual which will risk the quality of the product.

The industry has also become increasingly dependent on troublesome specifications, which seldom says exactly what the owner intends them to say. This has led the owners to move the risks more to the contractors. As a result, the construction industry has been burdened with paperwork, defensive posturing and commonly to have a hostile attitude toward the other participants. So, the Construction Industry Board advocate that, it is imperative to convert the current vicious circle of poor image, poor performance, poor delivery to a virtuous circle of improved delivery and better image, attracting the right people to continue the right process [11]. This situation can be reversed by implementing Total Quality Management (TQM) in proper way. The outcome is TQM will improve the construction companies and help all the parties come closer.

There is the need for a proposed radical change in industry practice that will improve the quality of the completed project and level of clients' satisfaction. The image of most local contractors has been dented as a result of their inability to meet up with their clients' requirements which led to a decrease in the level of their clients' satisfaction. There have been reported cases of abandoned projects, total collapse of buildings at foundation stages, decrease in profit margins, lower productivity at higher cost, low quality of construction works, poor performance by contractors, increase in over head charges and formal litigation.

Above all, there is greater difficulty in measuring and managing quality and selecting a high quality oriented contractor. Therefore, in order for construction clients and end-users of completed facilities to realize best value, the concept of quality culture must be stressed in the industry to improve the quality of services (design and construction processes) and products (facilities constructed) offered by various organizations.

There is a consensus among professionals and researchers that the solution to the problem lies in formal quality management at all levels of design, procurement and construction. Providing superior quality is rapidly becoming the way for companies to differentiate themselves from competitors and win more projects. To meet this quality challenge, many companies should adopt management practices that focus on the continuous improvement of product and service quality [5].

Quality can be defined in terms of conformance to the agreed requirements of the customer and in terms of a product or service; it should be free of deficiencies [12, 13, 14]. In a research work on assessing the effect of project quality management on construction performance by Gilberto (2007), he affirmed that there is the need to differentiate between product quality and process quality. He added that Product Quality is the quality of elements directly related to the physical product itself while process quality deals with the quality of the process that causes the product to be either acceptable or not. For instance, a product quality in the construction industry may refer to achieving a level of quality in the materials, equipment and technology which will endure in the constructed facility; whereas process quality refers to achieving quality in the way the project is organized and managed during the three phases of planning and design, construction, and operation and maintenance.

The construction industry tends to define quality as the ability of products and processes to conform to the established requirements. These requirements are established characteristics of a product, process or service as specified in the contractual agreement. Quality is a persuasive concern throughout the entire project process, as the performance of each phase in the process will affect the performance of subsequent phases [15].

The quality of construction project is primarily determined during the design and construction phases of the project [16]. In fact, the major sources of quality deviation are usually identified during the undertaking of these tow project phases. This means corrective actions made in these stages of the project will have a significant influence on the quality of the project's product.

2.1 CONQUAS

The Construction Quality Assessment System (CONQUAS), was developed in Singapore since 1989 with inputs from the major public sector agencies, i.e. House and Development Board (HDB), Construction Industry Development Board (CIDB), Public Works Department (PWD), Port of Singapore Authority (PSA), etc., to provide a standardized, quantifiable and systematical assessment system for grading the construction quality of a building [17]. A de facto national yardstick for the industry, CONQUAS has been periodically fine-tuned to keep pace with changes in technology and quality demands of a more sophisticated population. In 1998, BCA introduced a number of new features to CONQUAS resulting in the launch of CONQUAS 21. Such refinements make CONQUAS scoring more comprehensive and customer oriented.

By using CONQUAS as a standardized method of quality assessment, developers are able to use the CONQUAS score to set targets for contractors to achieve and also assess the quality of the finished building. Today, CONQUAS is widely recognized and also accepted internationally as a benchmarking tool for quality. Indeed, countries like UK and Hong Kong have successfully adapted CONQUAS to their construction industries. CONQUAS is now a registered trademark in Singapore, Malaysia, China, Hong Kong SAR, United Kingdom, Australia, South Africa and India [18].

2.1.1 Objectives of CONQUAS

i. To have a standard quality assessment system for construction projects

ii. To make quality assessment objective by:

- measuring constructed works against workmanship standards and specifications
- using a sampling approach to suitably represent the whole projects

iii. to enable quality assessment to be carried out systematically within reasonable cost and time

2.1.2 Scope of CONQUAS

The assessment consists of 3 main components:

i. Structural Works

ii. Architectural Works

iii. M&E (Mechanical and Electrical) Works

Each component is further divided into different items for assessment. Points are awarded for works that meet the standards. Upon completion of all the assessments for a project, scores attained for structural works, architectural works and M & E works are summed up to give a total quality score called the CONQUAS Score. The building is assessed based primarily on workmanship standards through site inspection. The assessment is done throughout the construction process for Structural and M&E Works and on the completed building for Architectural Works. The assessment also includes tests on the materials and the functional performance of selected services and installation. These tests helps to safeguard the interest of building occupants in relation to safety, comfort and aesthetic defects, which surface only after sometime [18].

2.1.3 CONQUAS Assessors

The CONQUAS assessors consist of independent BCA assessors who had undergo vital training programme. The assessors are required to attend BCA's CONQUAS training and the calibration programme to ensure capability and consistency in assessment.

2.1.4 CONQUAS: Component & Building Category Weightage Distribution

Table 2.1: Weightages System by CONQUAS

Component	**CAT A** Commercial, Industrial, Institution & Others	**CAT B** Commercial, Industrial, Institution & Others	**CAT B** Private Housing	**CAT C** Public Housing	**CAT D** Landed Housing
Structural Works	25%	30%	25%	35%	30%
Architectural Works	55%	60%	65%	60%	65%
M&E Works	20%	10%	10%	5%	5%
CONQUAS Score	**100%**	**100%**	**100%**	**100%**	**100%**

The weightages system, which is aimed at making the CONQUAS score objective in representing the quality of a building, is a compromise between the cost proportions of the three components in the various buildings and their aesthetic consideration. The CONQUAS score of a building is the sum of points awarded to the three components in each category of buildings [18].

2.2 QLASSIC

Quality Assessment System in Construction (QLASSIC) is an independent method to measure and evaluate the quality of workmanship and finishes of construction works based on approved standards. It is an alternative tool to CONQUAS. This quality assessment system is quite similar to CONQUAS. QLASSIC enables the quality of workmanship between construction projects to be objectively compared through a sampling and statistical approach.

2.2.1 Objectives of QLASSIC

i. To elevate the level of quality in the construction industry.
ii. To have a standard quality assessment system as a benchmark for quality of construction works.
iii. To assist contractors to achieve defect-free when carrying out construction work.
iv. To be used as a criterion to evaluate the performance of contractors based on quality of workmanship.
v. To be used for data compilation for statistical analysis in estimating the level of quality and productivity of the construction industry.

2.2.2 Scope of QLASSIC

QLASSIC sets out the standards of workmanship for various construction elements in building work and other infrastructure work. The assessments of QLASSIC consist of 4 main components which are Structural Works, Architectural Works, M&E (Mechanical & Electrical) Works and External Works. This assessment does not take into account of material quality, design and aesthetic. The quality assessment on the workmanship and finishes of the construction work is assessed according to the requirement of the relevant standard, and marks are awarded if they comply with the standards.

2.2.3 QLASSIC Assessors

The QLASSIC assessors are independent CIDB assessors or CIDB accredited assessors who had attended the CIDB's QLASSIC training course before being qualified to implement the actual assessment at the construction sites. The QLASSIC assessors are also continuously updated to guarantee consistency and effective implementation of the assessment. These assessors are certified and registered by CIDB.

2.2.4 QLASSIC: Component & Building Category Weightage Distribution

Table 2.2: Categories of Building by QLASSIC

Component	**CAT A** Landed Housing	**CAT B** Stratified Housing	**CAT B** Public Building	**CAT D** Special Public Building
Structural Works	25%	30%	30%	30%
Architectural Works	60%	50%	45%	35%
M&E Works	5%	10%	15%	25%
External Works	10%	10%	10%	10%
QLASSIC Score	**100%**	**100%**	**100%**	**100%**

The assessment system used for QLASSIC Score is quite similar to the system used by CONQUAS Score. The QLASSIC score of a building is the sum of points awarded to the four components in each category of a building.

2.3 Assessment Approach and Sampling Process for CONQUAS and QLASSIC

Both of these quality assessments use sampling system for assessment which is mainly based on elements and locations of the building that will ensure that assessment adequately represent the entire building. The assessment performed by doing Site inspection, Laboratory tests and Field tests. For assessment, the assessors select the actual locations. Samples are selected based on the drawings and location plans. The samples shall be distributed as uniformly as possible throughout the construction stages. The scoring will be done on the works that are inspected for the first time. Rectification and correction carried out after assessment will not be re-scored. The objective of this practice is to encourage contractors "doing things right the first time" [19]. There are 2 methods of sampling which are based on GFA (Gross Floor Area) of building and based on 10m length section or per location for external works. Below are several examples of assessments on architectural components.

Figure 2.1: Assessment on Evenness of Surface (Left) and Hollowness for Internal Walls (Right)

Figure 2.2: Assessment on Straightness of Edge or Angle (Internal Wall) (Left) and Angle (Door Frame) (Right)

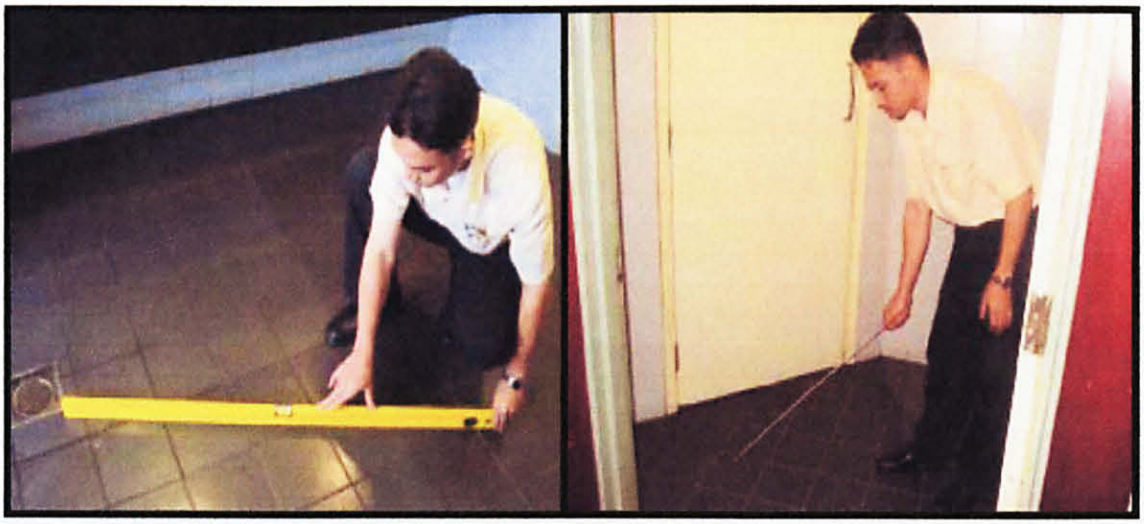


Figure 2.3: Assessment on Straightness of Edge or Angle (Internal Wall) (Left) and Angle (Door Frame) (Right)

2.4 Criteria for quality assessment from CONQUAS and QLASSIC

Based on the quality assessment systems that have been used by developer and contractor in measuring quality of building projects in construction industry as stated in literature review which are QONCUAS and QLASSIC, the researcher has found out and chosen several criteria that are suitable to be used in this research project in assessing quality for completed building projects. Below is the list of criteria which set by the researches based on QONCUAS and QLASSIC to measure the quality for completed residential building projects.

Table 2.3: List of criteria to measure quality for completed residential building projects

No.	Criteria to measure quality of completed residential building projects
ARCHITECTURAL COMPONENTS	
1) Floor & Internal Wall	
1	No cracks & damages on the finishing
2	No Sign of Hollowness & Delamination
3	Tile Joints Aligned & with Consistent Size
4	Consistent, smooth & neat painting of finishing
5	Edges of the wall finishing is aligned
2) Door & Window	
6	No visible gap between frame and leaf or wall
7	Leaf and frame corners maintained at right angles
8	Easy in opening & closing without squeaky sound
9	No sign of rain water leakage & corrosion on Leaf/frame
10	No visible damages on the frame or leaf

No.	Criteria to measure quality of completed residential building projects
	ARCHITECTURAL COMPONENT
	3) Roof
11	No leakages, rust, stains, cracks, chip & etc. on roof
12	All openings are sealed to avoid pest invasion
13	Good falls in right direction
14	No sign of chockage & ponding
15	Proper dressing for any protrusion
	MECHANICAL AND ELECTRICAL COMPONENTS
	1) Plumbing & Sanitary Fittings
1	No visible damages to plumbing & sanitary fittings
2	Fittings firmly secured & joints properly sealed
3	No leakages at joints
4	Fittings in working condition
5	Accessible for maintenance
	2) Mechanical &Electrical Works (power point, lighting, conduit, etc.)
6	Fittings is aligned & in correct positions
7	No exposed wiring within reach
8	No visible damages
9	Conduits properly secured
	3) Air Conditioning
10	Ensuring drainage is provided for air conditioner
11	Air conditioner unit is slightly tilted for condensation
12	Air conditioner drain pipe connected to drain pipe
	4) Fire Alarm
13	Location of fire alarm panel, breakglass & bell is correct

No.	Criteria to measure quality of completed residential building projects
	STRUCTURAL COMPONENTS
	1) Structural Works
1	No visual exposure of groups of coarse aggregates resulting from grout leakage
2	Cold joint & formwork joint must be smooth
3	No bulging, cracking and damages of structural element
4	No roughness on column & beam finishing
5	Rebar cannot be seen from soffit of the slab and properly secured/no exposed rebar
6	Sufficient cover and according to specification
7	No deviation of beams from their specified positions
8	No deviation of columns from their specified positions
9	Columns are constructed within acceptable verticality

CHAPTER 3

METHODOLOGY

The proposed method for this study which is Prioritizing Criteria for Assessment of Quality in Completed Residential Building Projects takes concern on perceptions of general public or end user rather than opinions of professionals. Every quality factor developed in this research was included in the survey. The reason of choosing a survey method for this study is because the data that will be collected in this study is related and involved with the opinion of people about the criteria in measuring quality of completed residential building projects.

3.1 Data Collection Method

This is an important choice related to costs, question formulation and quality of data. In the 1960s and 1970s there were only three procedures for data collection which are: paper-and-pencil interviewing (PAPI) by an interviewer (face to face interviews) in the home of the respondent; traditional telephone interviewing, where the interview was done by telephone; and, finally, mail questionnaires, which were done without the presence of an interviewer and where respondents had to fill in the forms themselves.

The data collection methods used for this research is questionnaire survey method distributed to the respondents. The questionnaire distribution was done through household drop-off since the targeted area for this research is near to the UTP. The questionnaire was distributed personally and manually to the targeted population. The choice of the mode of data collection is of significant importance not only for the resulting data quality but also for the formulation of the questions. The author has chosen these methods as survey methods because the questionnaire survey method is the cheapest and easiest method when compared to other methods.

3.2 The Questionnaire Design

The questionnaire consisted of two parts which are the general background or information of the respondents and opinion survey on prioritizing criteria for assessing quality in completed residential building projects. Minimal numbers of simplified questions were set in order to reduce the fill-in time of the forms; with the target of having a good rate of returned and fully-completed questionnaire forms. The questionnaire is constructed to be simple and direct so that the respondents will have no difficulties to response the questionnaires. The formulation of requests for an answers or questionnaire was based on the information gathered from the quality assessment systems in literature review of this study.

3.2.1 Pilot survey

Pilot survey is one of the major processes in the project and it could be included as one of the steps in the designing process. It serves as a tool to support in the questionnaire modifications. The purpose to have a pilot survey is to observe weather the understanding of respondent towards the question is same with what the author aim for. It is important to prepare a good questionnaire so that respondent will feel easy and comfortable to fill the questionnaire. From the pilot survey, the respondent will answer and comment on the structure of the questionnaire whether the question that includes is relevant and applicable upon the research topic. Please refer to appendix A for pilot survey questionnaire. For this study, pilot survey is conducted after the completion of draft questionnaire. The pilot survey will be sent to both internally and externally which include lecturers and general publics or end users. Two internal respondents (UTP's lecturers) and one external respondent (end users) will be chosen randomly for the survey. The respondents are given some period of time to complete and comment on the questionnaire. The commented pilot survey then will be resend to the researcher to analyze and modify it. After modifying the commented pilot survey, the researcher will come out with the final draft of the questionnaire which will be used in real survey of the study.

3.3 Population and sample

The population of study would be in the centre of state of Perak Darul Ridzuan, Malaysia. The sample or questionnaire is conducted by distributing the questionnaires using a survey method by household drop-off. The questionnaire to be distributed will at least be 300 and more because some survey might get a good feedback and some may not. Simple random sampling will be conducted. The sample will represent the whole population for the study. Minimum of 30 samples are required so as to be in accordance with the Central Limit Theorem, which states that "when sample size approaches 30, the sampling distribution approaches normality. Then, this normal distribution will have the same mean as the parent distribution and variance equal to the variance of the parent divided by the sample size" (David and Sutton, 2004).

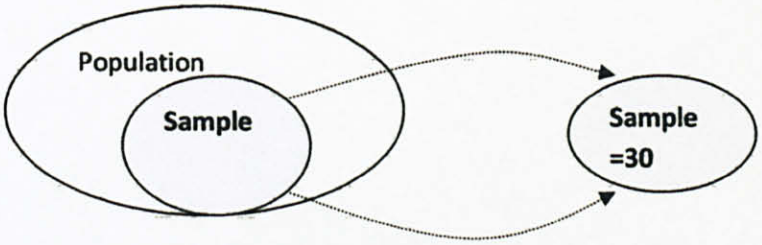


Figure 3.1: Population and sample

3.3.1 Respondents of Study

For the respondent party, it is focused on general public which mainly the end users in residential area at Taman Tasik Putra (Tronoh), Bandar Universiti (Taman Maju), and Bandar Seri Iskandar (Sri Iskandar) in Perak Darul Ridzuan, Malaysia. For this research, the list of addresses of the targeted residential areas is not necessary since the targeted area is near the UTP and the distribution is done by passing the questionnaire survey to the end users of those areas.

3.3.2 Housing Types Involved in This Study

In this study, there are three housing areas considered which are Bandar Seri Iskandar, Bandar Universiti, and Taman Tasik Putra that are located near to Universiti Teknologi PETRONAS in Perak. All these three housing areas are typical in term of types of houses that have been constructed or developed. There are only two types of houses constructed by the developer for these housing areas and have been considered in this study which are terrace house and semi house.

3.4 Method of analysis

Analysis of data is conducted using a descriptive analysis to rank and prioritize criteria for assessing quality in completed residential building. Below is the methodology of the research which has been used to get the respective results.

Table 3.1: Methodology method

Task	Method and Tools	Result
Identifying quality assessment systems used for assessing quality of building projects from literature review	Literature review	Criteria
Identifying criteria for assessing quality of completed residential building projects from quality assessment system in literature review	Survey using questionnaire	Criteria
Prioritizing criteria for assessing quality of completed residential building projects	Analysis by descriptive analysis using severity index	Prioritizing criteria

3.5 Tools

Table 3.2: Tools of research

Equipment	Description
A4 Paper	To be used for survey purpose where questionnaire is printed and to be distributed to respondent
Microsoft word and Microsoft Excel	Software to present the results (feedback) e.g. Pie chart and results calculation

3.6 Flow chart of research process methodology

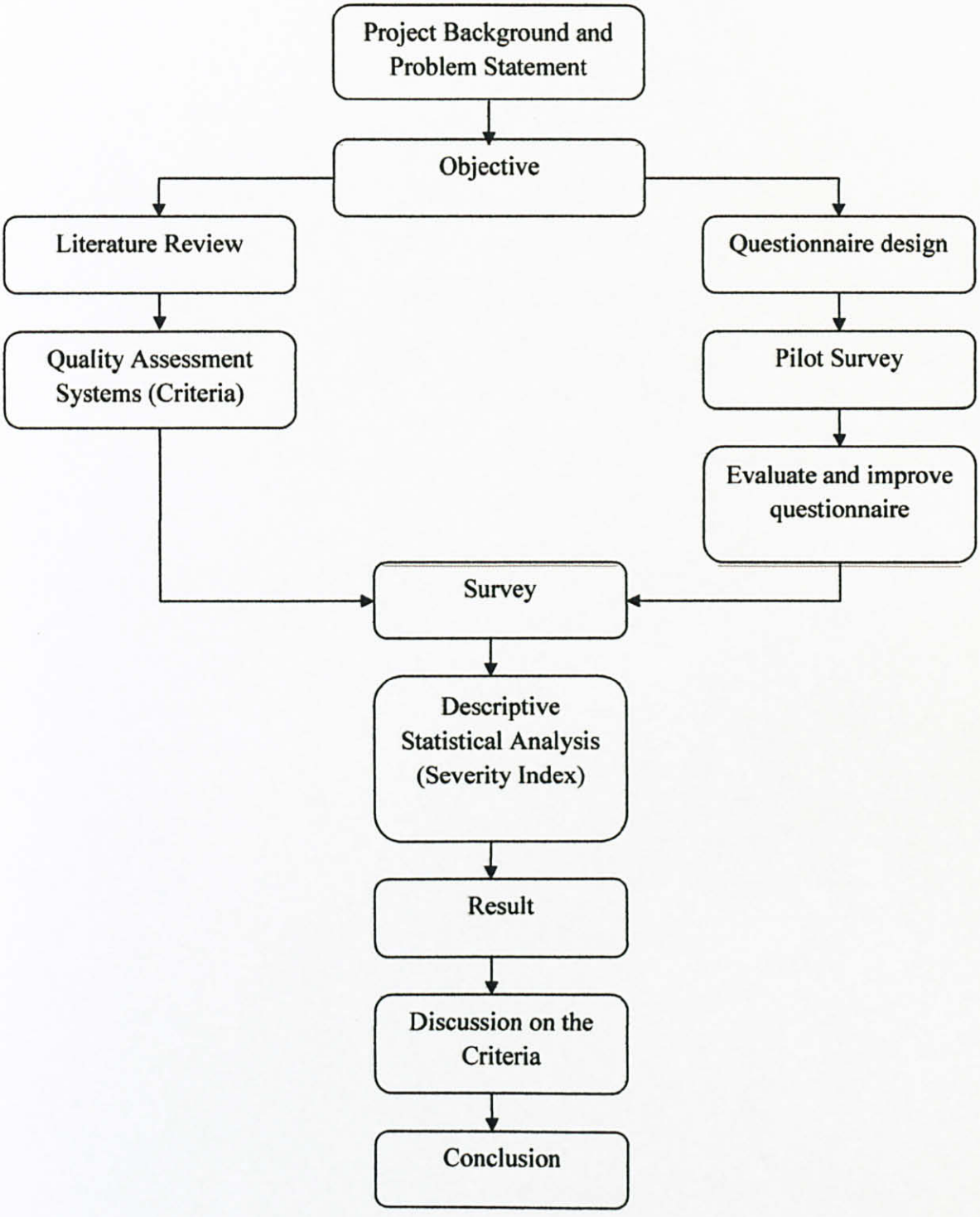


Figure 3.2: Flow chart of research process

3.7 Gantt Chart for FYP II

No.	Detail/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	15	19
1	Designing the questionnaire continue	■	■													
	- Conducting pilot survey															
	- Finalize the Questionnaire															
2	Distribution of questionnaires		■	■	■	■										
3	Submission of Progress Report							●								
4	Result analysis						■	■	■	■						
	- table and pie chart															
5	Poster Exhibition												●			
6	Continuing on result analysis								■	■	■	■	■	■	■	
	- Test of hypothesis															
	- Descriptive Statistical Analysis															
7	Submission of dissertation (Softbound)														●	
8	Oral presentation															●
9	Submission of dissertation report (Hardbound)											1 week after oral presentation				

Milestone
Process

Figure 3.3: Gantt Chart for FYP II

CHAPTER 4
RESULTS AND DISCUSSIONS

4.1 Pilot Survey

For the pilot survey, the researcher has managed to send the questionnaires survey to two internal respondents (UTP lecturers) who are Assoc. Prof. Ir. Dr. Arazi Idrus and Dr. Mohd faris khamidi, and one external respondent (general public or end user). The researcher has received all of the feedbacks from the respondents. Below are the comments given by all respondents which have been summarized into tabular form the questionnaire have been revised to come out with final draft of questionnaire survey.

Table 4.1: Summary of pilot survey comment from the respective respondents

Name	Respondent	Comment section	Explanation
Ap. Ir. Dr. Arazi Idrus	Internal	B	To make the questions simple and straight forward
Dr Mohd Faris Khamidi	Internal	B	• Suggestion to 'rank' and arrange the criteria in the questionnaire according to importance where the upper one is the most respondent will thick and the lowest one is the least respondent thick • Narrow down the scope of the questionnaire to suit with this research
Public/ End user/ Resident	External	All	To provide the questionnaires in 2 languages ; Bahasa Malaysia and English

4.2 Data Compilation and Presentation

For the questionnaire distribution, the author has managed to distribute questionnaire to 3 housing areas in Perak which are Bandar Seri Iskandar at Seri Iskandar, Bandar Universiti at Taman Maju and Taman Tasik Putra at Tronoh. The author has received 32 feedbacks from respondents for all targeted housing areas. Below is the number of feedbacks from respondents with respect to housing areas in Perak.

Table 4.2: Number of respondents' feedbacks from respective housing areas.

No.	Housing Area	No of Respondents	Percentage (%)
1	Bandar Seri Iskandar	15	47
2	Bandar Universiti	9	28
3	Taman Tasik Putra	8	25
Total		32	100

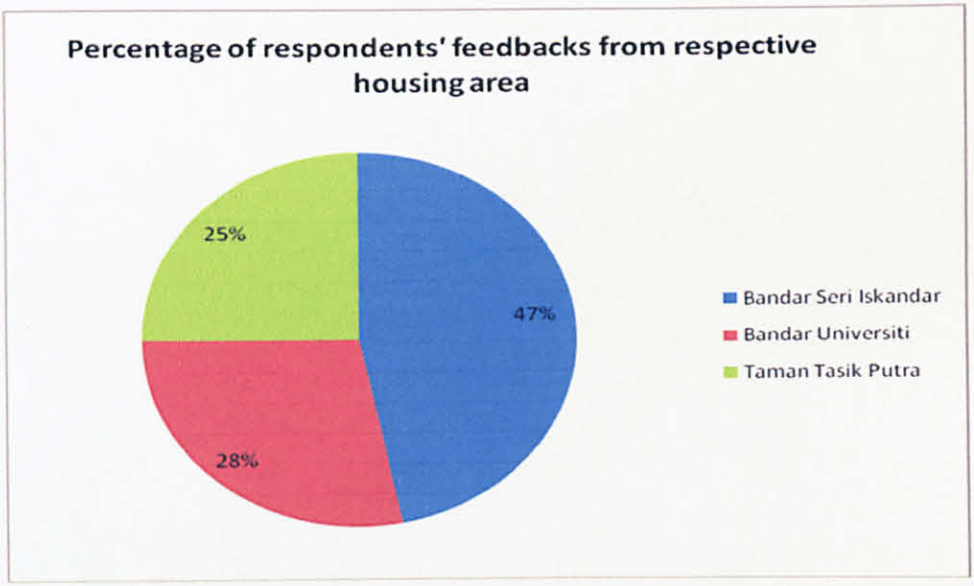


Figure 4.1: Percentage of respondents' feedbacks from respective area

Figure 4.1 shows the number of feedbacks from respondents of 3 housing areas. It shows that the number of respondents from Bandar Seri Iskandar is the highest with 15 feedbacks while respondents from Bandar Universiti have the second highest feedbacks which are 9. It is clearly show that Taman Tasik Putra has the lowest number of respondents with 8 feedbacks. The difference of number of feedbacks between these 3 housing areas is maybe caused by the size of the housing areas which is Bandar Seri Iskandar has the largest size of housing area, followed by Bandar Universiti. Taman Tasik Putra has the smallest size of the housing area among these 3 study areas.

4.2.1 Section A: General/ Background Information

I. Respondent's Information

1. Gender:

Table 4.3: Type of gender of the respondents

Gender	Number of Respondent	Percent (%)
Male	19	59.375
Female	13	40.625
Total	**32**	**100%**

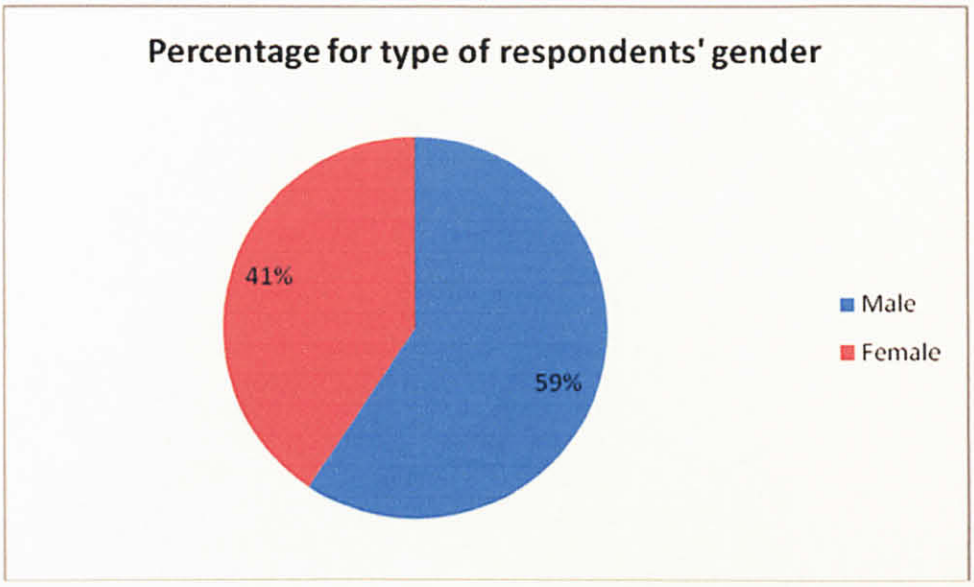


Figure 4.2: Percentage for type of respondents' gender

Figure 4.2 shows the percentage for type of respondents' gender. 59% of the respondents are male respondents while 41% are female respondents. This indicates that number of male respondents higher than female respondents. The gender of the respondents may affect the result since male respondent maybe tend to choose the criteria based on comfort and safety while female respondents may choose the criteria based on artistic or unique aspects.

2. Age:

Table 4.4: Range of age of the respondents

Age (years)	Number of Respondent	Percent (%)
< 25	4	13
25 – 50	26	81
> 50	2	6
Total	**32**	**100%**

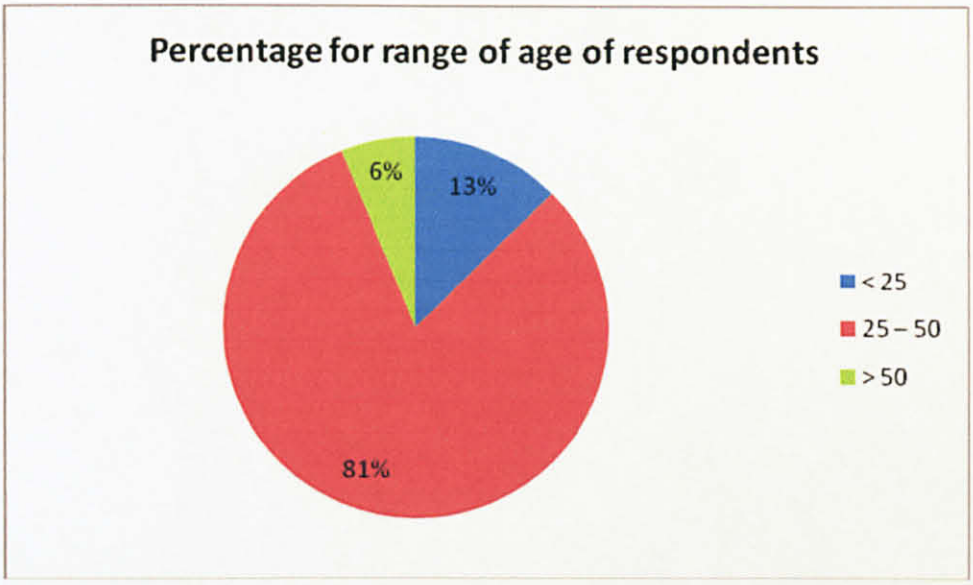


Figure 4.3: Percentage for range of age of respondents

Figure 4.3 shows the range of age of the respondents. It shows that numbers of respondents aged in the range of 25 – 50 years old are the highest which is 81% followed by the number of respondents aged below 25 years old which is 13%. The numbers of the respondents aged in range of 25 – 50 years old are the highest because at this range of age, people afford to own a house. The numbers of respondents aged below 25 years old maybe caused by the locations of study areas which are near the universities where there are possibilities of students rent the house there.

3. Education Background:

Table 4.5: Type of education background of the respondents

Education Background	Number of Respondent	Percent (%)
Doctor of Philosophy (PHD)	2	6
Master	6	19
Degree	9	28
Diploma	11	34
Sijil Pelajaran Malaysia (SPM)	4	13
Total	**32**	**100%**

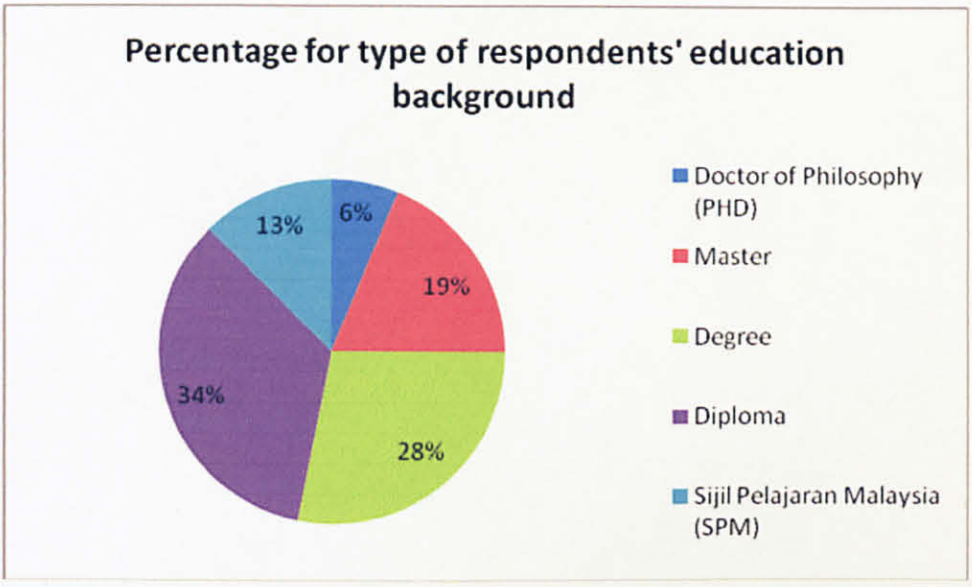


Figure 4.4: Percentage for type of education background of respondents

Figure 4.4 shows percentage for type of education background of respondents. It shows that the percentage of respondents have a diploma is the highest with 34% followed by respondents that have a degree with 28%. 19% of the respondents have a master in education while only 6% of the respondents have a doctor of philosphy (PHD). There are 13% of respondents who finish their studies only until SPM level and most of them are housewives. This clearly indicate that all of the respondents have education and most of their education are at least or higher than diploma. Thus reflect the responses or feedbacks given are reliable and trustworthy.

4. Occupation:

Table 4.6: Type of occupation of the respondents

Occupation	Number of Respondent	Percent (%)
Lecturer	5	16
Banking Staff	2	6
Teacher	5	16
Military	2	6
Business Person	4	12
Technician	2	6
Clerk	2	6
Nurse	1	3
Housewife	5	16
Student	4	13
Total	**32**	**100%**

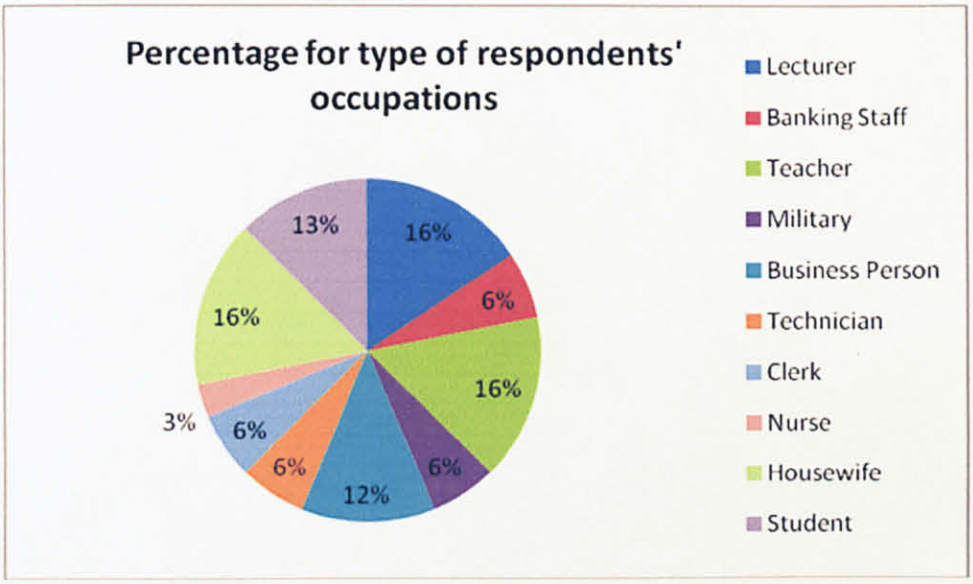


Figure 4.5: Percentage for type of respondents' occupation

Figure 4.5 shows the percentage for type of occupations of respondents. There are 10 types of respondents' occupation which are lecturers (16%), banking staffs (6%), teachers (16%), military (6%), business persons (12%), technicians (6%), clerks (6%), nurse (3%), housewives (16%) and students (13%). The number of lecturers, teachers and students higher compared to other occupation is because the locations of study areas are near the school and universities.

II. Residential Information

1. Type of house that have been bought or rented:

Table 4.7: Type of houses of the respondents

Type of House	Number of Respondent	Percent (%)
Terrace	25	78.125
Semi	7	21.875
Total	**32**	**100%**

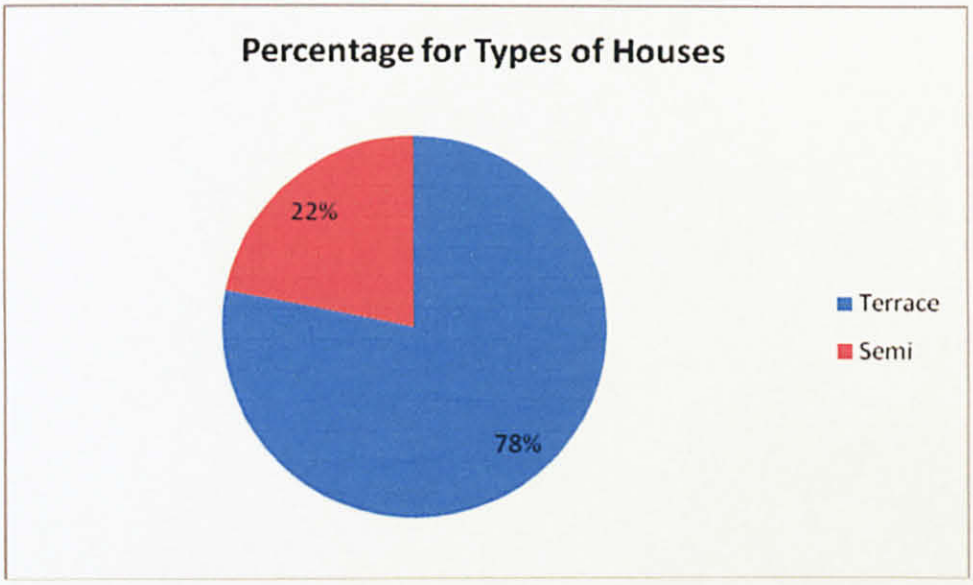


Figure 4.6: Percentage for type of respondents' houses

Figure 4.6 shows percentage for the type of respondents' houses. There are only two types of houses in the study areas which are terrace house and semi house. From Figure 4.6, it shows that 78% of respondents are occupying terrace houses while 22 % of respondents are occupying semi houses.

2. Residential Status of the house:

Table 4.8: Type of residential status

Residential Status	Number of Respondent	Percent (%)
Owned	22	69
Rented	10	31
Total	**32**	**100%**

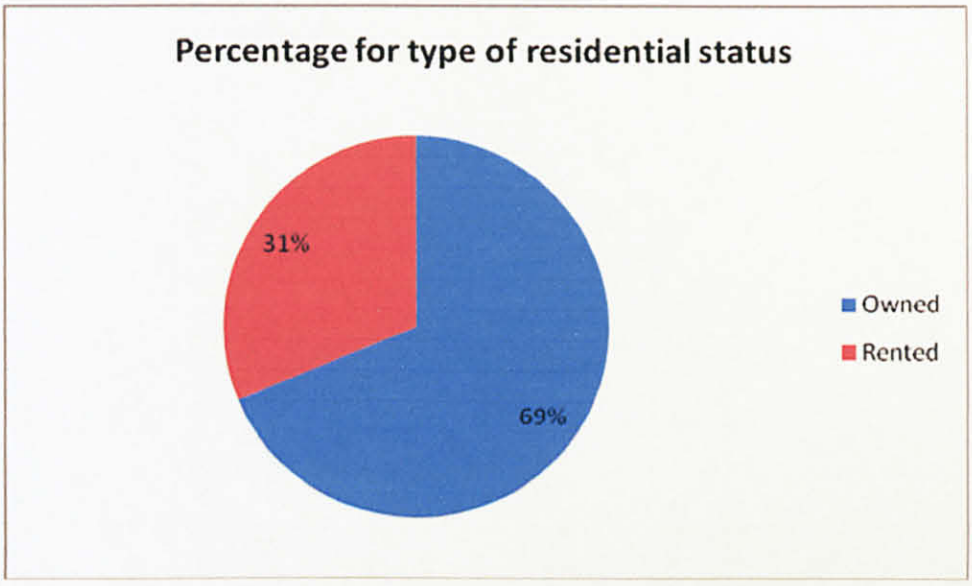


Figure 4.7: Percentage for type of respondents' residential status

Figure 4.7 shows the percentage for type of house users' residential status. From this figure, it shows that 69% of the houses users own or buy the house while the remaining 31 % just rent the houses. The number of respondents that buy their house higher compared to the one who just rent the house is perhaps because most of the respondents or houses users are the local people or originated from that place and vice versa. This statement is supported by the location of the targeted housing areas which are near the universities where there are lecturers or students who just rent the house for a period of time and they are not staying at the place forever.

4.3 Data Analysis

4.3.1 Test of Hypothesis

For this research project, two hypotheses have been postulated which are:

a) Null Hypothesis ($\mathbf{H_o}$): There is no significant different between Architectural, Mechanical & Electrical and Structural Components in prioritizing the criteria for assessment of quality of completed residential building projects.

b) Alternative Hypothesis ($\mathbf{H_1}$): There is significant different between Architectural, Mechanical & Electrical and Structural Components in prioritizing the criteria for assessment of quality of completed residential building projects.

The results of a contingency table X^2 statistical test performed at 23:22 on 10-APRIL-2010:

Table 4.9: Data contingency table of chi-square statistical test of feedbacks

Building Components	Level of Importance					Total
	Very Low	Low	Moderate	High	Very High	
Architectural	2	8	29	176	265	480
Mechanical & Electrical	3	13	67	150	183	416
Structural	2	8	50	103	125	288
Total	7	29	146	429	573	1184

Table 4.10: Expected contingency table of chi-square statistical test of feedbacks

Building Components	Level of Importance				
	Very Low	Low	Moderate	High	Very High
Architectural	2.84	11.8	59.2	174.0	232.0
Mechanical & Electrical	2.46	10.2	51.3	151.0	201.0
Structural	1.70	7.05	32.5	104.0	139.0

Calculated chi-square ($X^2_{cal.}$) = 36.4

Degrees of freedom = 8

Tabulated chi-square ($X^2_{tab.}$) = 2.733

Decision Rule:

Reject H_o if $X^2_{cal.} > X^2_{tab.}$ Otherwise accept at a given significance level (α).

From the result, calculated chi-square value ($X^2_{cal.}$) **36.4** is greater than the tabulated value ($X^2_{tab.}$) **2.733**, as such the null hypothesis, H_o is rejected and the alternative hypothesis, H_1 is accepted. This justifies that there is significant different between Architectural, Mechanical & Electrical and Structural Components in prioritizing the criteria for assessment of quality of completed residential building projects.

4.3.2 Summary of Tables of Feedbacks

After getting the feedbacks from respondents which is 32 feedbacks, the data of the feedbacks is summarized into tabular form as to make the process of analysis easier. Below is the data from feedbacks that have been summarized into tabular form.

4.3.2.1 Architectural Components

Table 4.11: Summary of feedbacks for Floor and Internal Wall

Floor & Internal Wall	Level of Importance				
	Very Low	Low	Moderate	High	Very High
No Cracks & Damage on the Finishing	0	0	0	8	24
No Sign of Hollowness & Delamination	0	0	0	13	19
Tile Joints Aligned & with Consistent Size	0	1	2	15	14
Consistent, smooth & neat painting of finishing	0	0	3	12	17
Edges of the wall finishing is aligned	0	1	3	10	18
Total	0	2	8	58	92

Table 4.12: Summary of feedbacks for Door and Window

Door & Window	Level of Importance				
	Very Low	Low	Moderate	High	Very High
No visible gap between frame and leaf or wall	0	1	3	15	13
Leaf and frame corners maintained at right angles	0	2	8	10	12
Easy in opening & closing without squeaky sound	0	1	1	12	18
No sign of rain water leakage & corrosion on Leaf/frame	0	0	0	11	21
No visible damages on the frame or leaf	0	0	0	8	24
Total	0	4	12	56	88

Table 4.13: Summary of feedbacks for Roof

Roof	Level of Importance				
	Very Low	Low	Moderate	High	Very High
No leakages, rust, stains, cracks, chip & etc. on roof	0	0	0	7	25
All openings are sealed to avoid pest invasion	0	0	1	8	23
Good falls in right direction	1	1	2	16	12
No sign of chockage & ponding	0	0	2	12	18
Proper dressing for any protrusion	1	1	4	19	7
Total	2	2	9	62	85

Table 4.14: Summary of feedbacks for all Architectural Components

Architectural Component	Level of Importance					**Total**
	Very Low	Low	Moderate	High	Very High	
Floor/Internal Wall	0	2	8	58	92	160
Door & Window	0	4	12	56	88	160
Roof	2	2	9	62	85	160
Total	2	8	29	176	265	480

4.3.2.2 Mechanical and Electrical Components (M&E)

Table 4.15: Summary of feedbacks for Plumbing and Sanitary Fittings

Plumbing & Sanitary Fittings	Level of Importance				
	Very Low	Low	Moderate	High	Very High
No visible damages to plumbing & sanitary fittings	0	0	2	8	22
Fittings firmly secured & joints properly sealed	0	1	3	16	12
No leakages at joints	0	0	0	12	20
Fittings in working condition	0	0	0	12	20
Accessible for maintenance	0	2	5	18	7
Total	0	3	10	66	81

Table 4.16: Summary of feedbacks for Mechanical and Electrical Works

M&E Works (power point, lighting, conduit, etc.)	Level of Importance				
	Very Low	Low	Moderate	High	Very High
Fittings is aligned & in correct positions	0	0	6	16	10
No exposed wiring within reach	0	0	3	10	19
No visible damages	0	0	1	9	22
Conduits properly secured	0	0	4	15	13
Total	0	0	14	50	64

Table 4.17: Summary of feedbacks for Air Conditioning

Air Conditioning	Level of Importance				
	Very Low	Low	Moderate	High	Very High
Ensuring drainage is provided for air conditioner	0	1	9	12	10
Air conditioner unit is slightly tilted for condensation	2	5	15	6	4
Air conditioner drain pipe connected to drain pipe	1	2	10	10	9
Total	3	8	34	28	23

Table 4.18: Summary of feedbacks for Fire Alarm

Fire Alarm	Level of Importance				
	Very Low	Low	Moderate	High	Very High
Location of fire alarm panel, breakglass & bell is correct	0	2	9	6	15
Total	0	2	9	6	15

Table 4.19: Summary of feedbacks for all Mechanical and Electrical Components

Mechanical Component	Level of Importance					Total
	Very Low	Low	Moderate	High	Very High	
Plumbing & Sanitary Fittings	0	3	10	66	81	160
M&E Works	0	0	14	50	64	128
Air Conditioning	3	8	34	28	23	96
Fire Alarm	0	2	9	6	15	32
Total	3	13	67	150	183	416

4.3.2.3 Structural Components

Table 4.20: Summary of feedbacks for Structural Works

Structural Works	Level of Importance					Total
	Very Low	Low	Moderate	High	Very High	
No visual exposure of groups of coarse aggregates resulting from grout leakage	1	1	6	14	10	32
Cold joint & formwork joint must be smooth	0	1	12	9	10	32
No bulging, cracking and damages of structural element	0	0	5	10	17	32
No roughness on column & beam finishing	0	1	7	13	11	32
Rebar cannot be seen from soffit of the slab and properly secured/no exposed rebar	0	2	3	10	17	32
Sufficient cover and according to specification	1	1	7	12	11	32
No deviation of beams from their specified positions	0	1	4	12	15	32
No deviation of columns from their specified positions	0	1	4	13	14	32
Columns are constructed within acceptable verticality	0	0	2	10	20	32
Total	2	8	50	103	125	288

4.3.2.4 Building Components (Architectural, Mechanical and Electrical, Structural)

Table 4.21: Summary of feedbacks for Architectural, Mechanical & Electrical and Structural Component

Building Component	Level of Importance					Total
	Very Low	Low	Moderate	High	Very High	
Architectural	2	8	29	176	265	480
M&E	3	13	67	150	183	416
Structural	2	8	50	103	125	288
Total	**7**	**29**	**146**	**429**	**573**	**1184**

4.3.3 Analysis Using Mean and Variance

There are a lot of methods in analyzing the level of importance of criteria. One of the methods is analysis using mean and variance. The higher the mean value, the higher level of importance the criteria will be. Opposing to the concept of mean, the concept of variance is the higher the variance value, the lower level of importance the criteria will be. From the results, the author has compared both mean and variance analysis where the comparison shows that the ranking of criteria produced by both analyses are not equal as represented in Table 4.22.

Table 4.22: Ranking based on mean and variance analysis.

No.	Building Components	Analysis			
		Mean	Ranking	Variance	Ranking
1	Floor & Internal Wall	4.5000	1	0.42767	1
2	Door & Window	4.42500	2	0.54780	4
3	Roof	4.41250	3	0.58350	5
4	Plumbing & Sanitary Fittings	4.40625	4	0.48172	3
5	Mechanical & Electrical Works	4.39063	5	0.46038	2
6	Air Conditioning	3.62500	8	1.07895	8
7	Fire Alarm	4.06250	7	1.02823	7
8	Structural Works	4.18403	6	0.74999	6

From the result, it is shown that the mean and variance analyses method cannot be applied as the ranking of criteria is not equal and consistent to both analyses. Further analysis should be applied in order to come out with more accurate results based ordinal type of data. Thus, the author has implemented Severity Index Analysis for data analysis.

4.3.4 Analysis Using Severity Index

From the test of hypothesis, it was found out that there is significant different between Architectural, Mechanical & Electrical and Structural Components in prioritizing the criteria for assessment of quality in completed residential building projects. Therefore, it became pertinent to rank the criteria which are building components consist of Floor & Internal Wall, Door & Window, Roof, Plumbing & Sanitary Fittings, Mechanical & Electrical Works, Air Conditioning, Fire Alarm and Structural Works so as to find out the level of importance of each criteria in assessing quality of completed residential building projects. In order to rank the criteria, Severity Index Analysis is applied.

Severity index analysis is calculated based on the response of the survey to reflect the level of severity effect. The severity index and the ranking for level of importance of the criteria for assessing quality in completed residential building projects are calculated providing the basis for the statistical measures. Below is the formula to calculate the index:

$$\textbf{Severity Index (I)} = [\sum a_i . x_i] / [4 \sum x_i] \times 100\%$$

Constant expressing the weight given to i,

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

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

x_0 = frequency of the 'very high important' response and corresponding to $a_0 = 4$

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

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

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

x_4 = frequency of the 'very low important' response and corresponding to $a_4 = 0$

The severity index calculated will give the results in term of percentage. The higher the percentage, the more important the criteria will be. By comparing to mean and variance method, severity index method is more accurate as it is more consistent and accurate in term of response frequency of the respondents. Table 4.23 shows the analysis using severity index method and the level of importance for criteria in assessing quality of complete residential building projects. Figure 4.8 shows severity index of criteria for assessing quality in completed residential building projects in percentage (%).

Table 4.23: Analysis of criteria of Building Component using Severity Index

Variable (frequencies of response)		0	1	2	3	4			
No.	**Building Components**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Total**	**Severity Index for ranking (%)**	**Ranking**
1	Floor & Internal Wall	0	2	8	58	92	160	87.50	1
2	Door & Window	0	4	12	56	88	160	85.63	2
3	Roof	2	2	9	62	85	160	85.31	3
4	Plumbing & Sanitary Fittings	0	3	10	66	81	160	85.16	4
5	Mechanical & Electrical Works	0	0	14	50	64	128	84.77	5
6	Air Conditioning	3	8	34	28	23	96	65.63	8
7	Fire Alarm	0	2	9	6	15	32	76.56	7
8	Structural Works	2	8	50	103	125	288	79.60	6
	Total	**7**	**29**	**146**	**429**	**573**			

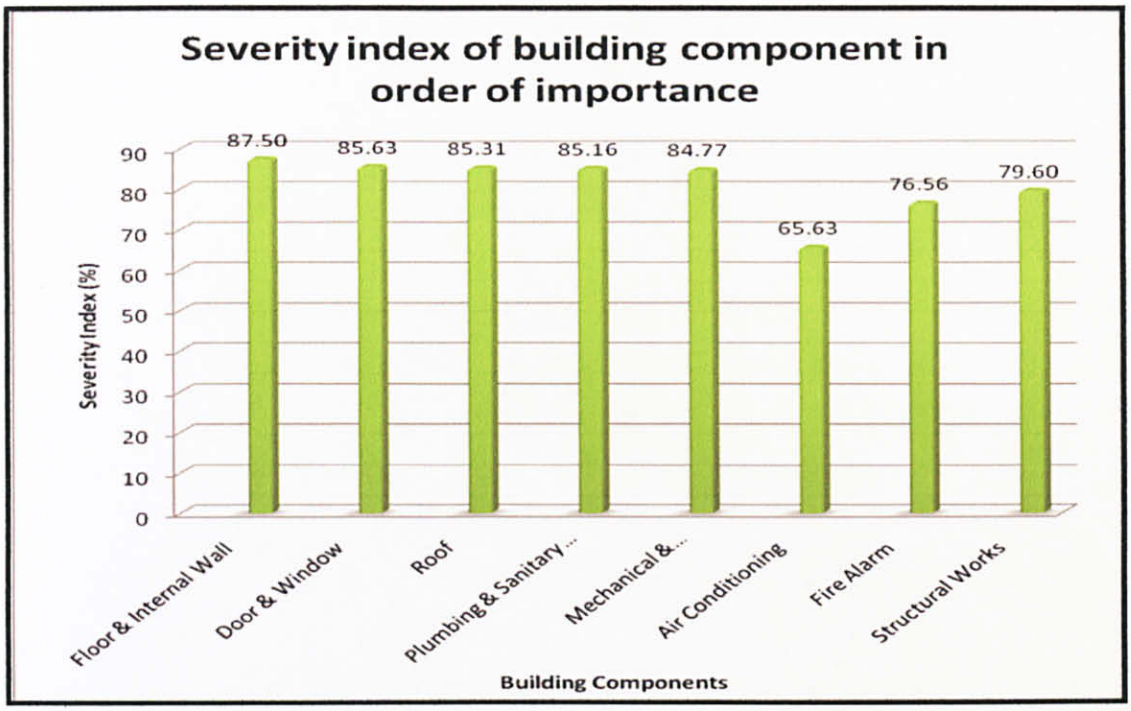


Figure 4.8: Severity index of criteria for assessing quality in completed residential building projects in percentage (%).

Table 4.24: Summary level of importance for criteria in assessing quality of completed residential building projects

No	Building Components	Severity Index (%)	Ranking
1	Floor & Internal Wall	87.50	1
2	Door & Window	85.63	2
3	Roof	85.31	3
4	Plumbing & Sanitary Fittings	85.16	4
5	Mechanical & Electrical Work	84.77	5
6	Structural Works	79.60	6
7	Fire Alarm	76.56	7
8	Air Conditioning	65.63	8

Figure 4.8 shows the Severity Index for the prioritization of the criteria for assessing quality in completed residential building projects. It is clear that Floor and Internal Wall which is an architectural component has the highest ranking of 87.50%. This clearly indicates the importance building users attached to this criterion. This could be justified by the fact that the building users prefer to have buildings with excellent floor and internal wall quality. This quality could be related to lack of cracks and damages on the finishing, and no sign of hollowness and delamination.

Interestingly, another architectural component; Door and Window are the next criteria with very high value of Severity Index which is 85.63%. This really justifies that Architectural Components are being regarded as most important when it comes to prioritizing the criteria for assessing quality in completed residential building projects. The reason for Door and Window having such a high severity index could be attributed to the fact that users would want to have the door and window that could be opened and closed easily without squeaky sound with no visible damages on the frame or leaf, and no sign of rain water leakage and corrosion on the leaf or frame.

The next most important criteria happen to be Roof. This proved beyond reasonable doubt that Architectural Components are the most important to users when it comes to prioritizing the criteria for assessing quality in completed residential building projects. This criteria has a severity index value of 85.31% as shown in the Figure 4.8. This high severity index value could be linked to the emphasis users put on having building roof that do not leak, no rust, stain, cracks and chips with no sign of chockage and ponding, and having good falls in right direction. Above all users would always ensure that all openings are sealed to avoid pest invasion, and ensure that all protrusions are properly dressed.

As shown in Figure 4.8, Plumbing and Sanitary Fittings has severity index value of 85.16% which is very close to Door and Window, and Roof. This show that Plumbing and Sanitary Fittings are of vital importance to users in prioritizing the criteria for assessing quality in completed residential building projects. This high importance that the users attached to plumbing and sanitary fittings maybe connected to the fact that users would want to have plumbing and sanitary fittings in their houses with no visible damages, fittings in working condition with no leakages at the joint, and most importantly is accessibility for maintenance.

As indicated in the Figure 4.8, Plumbing and Sanitary Fittings have the highest value of severity index among other criteria in Mechanical and Electrical Components followed by Mechanical and Electrical Works with severity index value of 84.77%. This also show that this component regarded as very important to users in prioritizing the criteria for assessing quality in completed residential building projects. The users would always ensure that the fittings are aligned and in correct positions with no visible damages, conduit properly secured, and no exposed wiring within reach.

Structural Works leapfrogs Air Conditioning and Fire Alarm in the severity index value as shown in the Figure 4.8. This absolutely confirms the importance users attached to Structural Works over the Air Conditioning and Fire Alarm. This importance could be related to the fact that users would want to have residential buildings that do not have visual exposure of group of coarse aggregates resulting from grout leakage. The users also want to have buildings with no bulging, cracking and damages of structural element, and its beam and column do not deviate from their specified positions. In addition to this, the users would not want to have a rough finishing on the column and beam, and rebar should not be seen from the soffit of the slab and should be properly secured.

Another important criterion used by building users in prioritizing the criteria for assessing quality in completed residential building projects is Fire Alarm which has value of severity index 76.56% as shown in Figure 4.8. This indicates the safety awareness of the building users. Ideally, the users would want to ensure that the location of fire alarm panel, breakglass and bell is correct.

Air Conditioning which provides comfort and luxury has the least severity index value which indicates that it is the least most important factor or criteria of all the criteria mention above in prioritizing the criteria for assessing quality in completed residential building projects. It has a low value of severity index of 65.63% far below fire alarm with severity index of 76.56% indicate that the users overrate the safety over the comfort. This low severity index value maybe connected to the fact that having air conditioning in the house is based on individuals need and affordability. This shows that the respondents either do not need air conditioning or they are low income earners which could be very difficult to afford running costs of having air conditioner. Some of the respondents may resort to use natural ventilation or ceiling fans to reduce the effect of scorching heat of Tronoh, Taman Maju and Seri Iskandar area which are the study area.

By the way of summarizing the result of this analysis, it was found out that Architectural Components are the most important components end users considered in prioritizing the criteria for assessing quality in completed residential building projects. This could be justified by the fact that the three Architectural Components which are; Floor and Internal Wall, Door and Window, and Roof rank first, second and third respectively. The reason Architectural Components are regarded as the most important by the end users might be because Architectural works deal mainly with the finishes and components. This is the part where the quality and the standard of workmanship are most visible compared to Mechanical and Electrical, and Structural works. Besides that, it also was found that Air Conditioning is the least most important criteria used in prioritizing the criteria for assessing quality in completed residential building projects.

CHAPTER 5
ECONOMIC BENEFITS

5.1 Cost of Research

This research has been done to prioritize the criteria in measuring quality of completed residential building projects. For this research project, the data collection methods used is questionnaire survey method distributed to the respondents. The respondents targeted in this research are the residents from 3 housing areas which are from Bandar Seri Iskandar at Seri Iskandar, Bandar Universiti at Taman Maju and Taman Tasik Putra at Tronoh. Since the targeted areas for this research survey are near to Universiti Teknologi PETRONAS or author hostel, the questionnaire distribution was done through household drop-off. The questionnaire was distributed personally and manually to the targeted population which mean there are no postages or stamps needed. So, most of the cost spent by the author are in preparing the questionnaire survey forms that will be distributed to the respondents which are 300 copies for Malay version and 300 copies for English version. The author has chosen these methods as survey methods because the questionnaire survey method is the cheapest method when compared to other methods. Thus, in order to ensure this project is done successfully, the author has spent cost as shown in the table below:

Table 5.1: Cost spent subject to each area for questionnaire distribution.

Items	**Bandar Seri Iskandar**	**Bandar Universiti**	**Taman Tasik Putra**	**Total Cost**
Questionnaire survey forms (300 copies for each Malay and English version)	RM 42 (300 copies for both version)	RM 28 (200 copies for both version)	RM 14 (100 copies for both version)	**RM 84**
Transportation	RM 20	RM 15	RM 15	**RM 50**
Total Cost	**RM 62**	**RM 43**	**RM 29**	**RM 134**

5.2 Business Element

Upon completion of this research, it perhaps can assist the property developers in assessing their completed residential building projects as it provide better understanding on the most important criteria which should be applied during assessing their completed residential projects. This finding would also help the developer in meeting and satisfying the need of their clients. So, for this research, the economic value is considered as a part of business element because the output from this research will be used by developer or contractor in the construction industry especially in residential building projects. The developer will know and understand which criteria are the most important compare to another which they can emphasize more on that important criteria. So, this can help them in saving the cost spent as they would spend optimum cost according to the order of importance of the criteria involved in order to achieve the best quality and meet the clients' need.

CHAPTER 6
CONCLUSION AND RECOMMENDATION

6.1 Conclusion

For the first part of study, based on quality assessment systems in the literature review which are CONQUAS and QLASSIC, the researcher has managed to identify the criteria to be used in assessing quality in completed residential building projects. After finishing and completing the questionnaire design including the pilot survey process, the researcher has distributed the complete questionnaires to the targeted housing areas and the feedbacks have been analyzed using Severity Index method.

From the analysis, the researcher has managed to prioritize and know the ranking of the criteria for assessing quality in completed residential building projects. Generally, it is found out that Architectural Components is regarded by end users as most important criteria compared to Mechanical and Electrical Components and Structural Component. The results hopefully will assist the property developers in assessing the quality of their completed residential building projects as it provide better understanding on the most important criteria which should be applied during assessing their completed projects. This finding would also help the developer in meeting and satisfying the need of their clients.

It can be concluded from the above, that all of the objectives of the research have been achieved.

6.2 Recommendation

Based on the research that has been completed, there are recommendations to be done in order to improve and expand this research more in the future. It is recommended for the researcher to collaborate with government or private firm specialized in construction industry such as Construction Industry Development Board Malaysia (CIDB) as they have specialization in quality assessment system.

For the future research, each criterion also must be provided with more detail explanation on it significant and correct way to assess it. Besides that, the researcher also must implement interview method in addition to questionnaire survey as to check the validity and the reliability of the responses given by the respondents.

REFERENCES

1. Low, S.P., *"An Evaluation of Quality and Workmanship in Construction", unpublished MSc (Eng) dissertation, Graduate School of Construction Management, University of Birmingham, 1987.*
2. Low, S.P., *"An Evaluation of Quality in Construction", The Professional Builder,* Vol. 4, No. 1, September 1989, pp. 28-36.
3. Seymour, D.E. and Low, S.P., *"The Quality Debate", Construction Management and Economics*, Vol. 8 No. 1, 1990, pp. 13-29.
4. Abdullah, F. (2008). *Construction Industry and Economic Development: The Malaysian Scene.* Johor: Universiti Teknologi Malaysia.
5. Wan Y., Mohammed A., Abdullah M. N., and Misnan M.S. (2008). *Towards a Quality Culture in the Malaysian Construction Industry*. International conference on Project Management (ICoPM), 18-20 November, 2008. Kuala Lumpur, Malaysia.
6. Kanji, G.K. and Wong, A. (1998). *Total quality in the construction industry, Total quality Management*. Vol. 9, Issue 4/5, PP 133-140.
7. Wong, A. and Fung, P. (1999). *Total quality Management in Hong Kong: a supply chain management perspective, Total Quality Management*, vol. 10, issue 2, PP. 199-208.
8. Sommerville, J. (1994). *Multivariate barriers to Total quality Management within the construction industry, Total Quality Management*, vol. 5, issue 5, PP 289-298.
9. Schultzel, H.J. & Unruh, V.P. (1996) *Successful Partnering—Fundamentals for Project Owners and Contractors* (New York, John Wiley and Sons).
10. Rowlinson, S.M and Walker, A. (1995). *The Construction Industry in Hong Kong*. Hong Kong: Longman

Appendix

Questionnaire Form

SURVEY QUESTIONNAIRE

Prioritizing Criteria for Assessment of Quality in Completed Residential Building Projects

In order to satisfy client, there has always been concern in what constitutes quality standards in the industry and how these can be maintained, improved and assured. Judging from the large volume of literature devoted to this issue, it would, however, appear that quality is indeed a difficult term to define.

Property developers often find it difficult to assess quality of their newly completed residential building projects. Currently there is no standard criteria established for assessing quality as this varies from person to person, qualified good by one probably may be qualified bad by others. Therefore this research seeks to prioritize the criteria that the end user or general public used in measuring the quality of their completed houses. The questionnaire below is divided into 4 sections which are section A, B, C and D. Please answer the questionnaire by referring to every section's instructions.

Section A: General / Background Information

Respondent can tick more than one for each [ ] provided or fill in the blanks.

I. Respondent's Information:

1. Gender :
   [ ] Male [ ] Female

2. Your age (years): _____

3. Education Background :
   [ ] Doctor of Philosophy (PHD) [ ] Master
   [ ] Degree [ ] Diploma
   [ ] Sijil Pelajaran Malaysia (SPM) [ ] Other: _____

4. Please specify your occupation: _____

II. Residential Information

1. Type of house you have bought or rented:
   [ ] Flat [ ] Terrace
   [ ] Semi [ ] Bungalow
   [ ] Other: _____

2. Is the house owned or rented by you:
   [ ] Owned [ ] Rented

Section B: Criteria to measure quality in completed building projects.
Please give your opinion of the importance of the following criteria in measuring quality of completed residential building project by circling a number to the lickert scale below. You may base your rating on the house you bought/rented here or elsewhere.

Note: Level of Important*				
1	2	3	4	5
Very disagree	Disagree	Moderate	Agree	Very agree

I. ARCHITECTURAL COMPONENTS

	Floor & Internal Wall	Level of importance*				
1	No cracks & damages on the finishing	1	2	3	4	5
2	No sign of hollowness & delamination	1	2	3	4	5
3	Tile joints aligned and with consistent size	1	2	3	4	5
4	Consistent, smooth & neat painting of finishing	1	2	3	4	5
5	Edges of the wall finishing is aligned	1	2	3	4	5
	Door & Window					
1	No visible gap between frame and leaf or wall	1	2	3	4	5
2	Leaf and frame corners maintained at right angles	1	2	3	4	5
3	Easy in opening & closing without squeaky sound	1	2	3	4	5
4	No sign of rain water leakage & corrosion on leaf/frame	1	2	3	4	5
5	No visible damages on the frame or leaf	1	2	3	4	5
	Roof					
1	No leakages, rust, stains, cracks, chip & etc. on roof	1	2	3	4	5
2	All openings are sealed to avoid pest invasion	1	2	3	4	5
3	Good falls in right direction	1	2	3	4	5
4	No sign of chockage & ponding	1	2	3	4	5
5	Proper dressing for any protrusion	1	2	3	4	5

II. MECHANICAL AND ELECTRICAL COMPONENTS (M&E)

	Plumbing & Sanitary Fittings	Level of importance*				
1	No visible damages to plumbing & sanitary fittings	1	2	3	4	5
2	Fittings firmly secured & joints properly sealed	1	2	3	4	5
3	No leakages at joints	1	2	3	4	5
4	Fittings in working condition	1	2	3	4	5
5	Accessible for maintenance	1	2	3	4	5
	M&E Works and Electrical Works (power point, lighting, conduit, etc.)					
1	Fittings is aligned & in correct positions	1	2	3	4	5
2	No exposed wiring within reach	1	2	3	4	5
3	No visible damages	1	2	3	4	5
4	Conduits properly secured	1	2	3	4	5
	Air Conditioning					
1	Ensuring drainage is provided for air-conditioner	1	2	3	4	5
2	Air-conditioner unit slightly tilted for condensation	1	2	3	4	5
3	Air-conditioner drain pipe connected to drain pipe	1	2	3	4	5
	Fire Alarm					
1	Location of fire alarm panel, breakglass & bell is correct	1	2	3	4	5

III. STRUCTURAL COMPONENTS

	Structural Works	Level of importance*				
1	No visual exposure of groups of coarse aggregates resulting from grout leakage	1	2	3	4	5
2	Cold joint & formwork joint must be smooth	1	2	3	4	5
3	No bulging, cracking and damages of structural element	1	2	3	4	5
4	No roughness on column & beam finishing	1	2	3	4	5
5	Rebar cannot be seen from soffit of the slab and properly secured/no exposed rebar	1	2	3	4	5
6	Sufficient cover and according to specification	1	2	3	4	5
7	No deviation of beams from their specified positions	1	2	3	4	5
8	No deviation of columns from their specified positions	1	2	3	4	5
9	Columns are constructed within acceptable verticality	1	2	3	4	5

Section C: Other information

For respondents who have added additional criteria regarding criteria to measure quality of completed building in **section B**, please state the criteria below:

_____

_____

_____

_____

_____

_____

Section D: Feedback

1. How do you prefer to know the result of research?
   [ ] via email [ ] via phone [ ] no, thank you

2. Please provide information below to send the result of survey:
   [ ] My contact telephone number is _____ ext: _____

   [ ] My email address is _____

Thank you for your time and cooperation in completing this questionnaire. Your response will be used for research purpose only. It would be appreciated if you could finish this questionnaire as soon as possible in a week time period. The answered questionnaire will be collected from you by a week or alternatively, you may send by fax to 05-3656716 with attention to Assoc. Prof. Ir. Dr. Arazi Idrus or Mohd Labib Mohd Ariffin (017-9551225).