CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter provides introduction of this research that highlights the main issues in selecting procurement method, rationale of study, the problem statement that become the factors in conducting this research, aim and objectives as well as briefly explain the research design and methodologies, the significance of the research and limitation to carry out this research. At the end of this chapter, the thesis structure is outlined.

This research presents a study of the selection of procurement method for building maintenance management for public universities in Malaysia through the use of Multiple Criteria Decision Making (MCDM) particularly Analytic Hierarchy Process (AHP). Building is an essential element which provides people of the nation with shelter and facilities to carry out daily task. However, buildings deteriorate and dilapidate during their service lives. It is indeed very critical that buildings require maintenance to be functional and perform efficiently. Yik and Lai (2005) stated that buildings need maintenance to retain its water-tightness, structural integrity and aesthetic appearance in order to ensure that the occupants of the building are comfortable, well facilitated to work and the services and amenities can be used optimally.

Lateef *et al.* (2011) claimed that the scope and size of building maintenance of university in Malaysia is huge and the potential is increasing. He further highlighted that the annual allocation by the government for the maintenance of university buildings is only 1 per cent of the total allocation for the education sector. This amount of allocation is inadequate to provide a quality maintenance services. However, an increase the allocation without an improvement the management systems is also not a strategic solution in optimising the given allocation because it could only possibly lessen the amount of maintenance backlogs but it definitely would not improve in term of productivity, user satisfaction and service delivery. Thus, he claimed that it is essential to select an appropriate procurement method in building maintenance management to provide better service to the occupants of the building and increase on productivity.

Improving the universities' building maintenance management systems by selecting the most appropriate procurement method is significant if universities wish to provide condusive learning environment and research centre for university organization, students, faculty members, parents and other users. More than 70 per cent of the universities in Malaysia spent more than RM5 million each on building maintenance annually and half of the universities spent more than RM10 million each on maintenance. The amount is too much for the available workforce to manage prudently under an in-house procurement system. University organizations prefer to outsource the larger part of maintenance services and it seems that outsource is the most common used procurement method for university in Malaysia (Lateef et al., 2011). The selection

of procurement method by university organization is proven not in a strategic way as there is no guidance available for the decision maker to select the most appropriate procurement strategy.

Alhazmi and McCaffer (2000) mentioned that the nature in selecting procurement method requires a suitable decision-making technique to evaluate the procurement methods against certain criteria systematically. Thus, this study aims to develop a decision making framework by identifying the available procurement method for building maintenance and the criteria to be considered when selecting the procurement method. The finding of this study will act as a tool to guide the university organization to select the most suitable and appropriate procurement method which will improve the maintenance management of university in Malaysia.

1.2 PROBLEM STATEMENT

Building need maintenance because value of building decreases throughout their entire life. Lateef *et al.* (2011) stated that if an organization wish to provide better service to the occupants of the university's building and increase the productivity of the management of building maintenance, it is essential to select appropriate maintenance procurement method. They also carried out a survey and claimed that most of the universities in Malaysia prefer to outsource the larger part of the maintenance services. This is mainly because the maintenance personnel opined that outsourcing the maintenance task reduces maintenance to corrective maintenance and the in-house

maintenance personnels are less competent and inactive because of redundancy. It is proven that the selection of procurement method by university organization is not systematic.

In international context, Hui and Tsang (2004) claimed that the two main success factors in building maintenance management are selecting the most appropriate procurement strategy and implement it in a proper way. An American study reported that it was possible to reduce project capital cost by an average of 5% through selection of the most appropriate procurement methodology (Morledge *et al.*, 2006 and Gordon, 1994). However, Love *et al.* (1998) claimed that there is insufficient empirical research in this field of study. Selecting a suitable procurement method is very important but there is still lack of empirical data in this area.

In addition, Wordsworth (2001) noted that the interaction between the form of procurement and the quality of delivery is complex in maintenance work compared to new-build. It is mainly because the process of maintenance work involves liaising with walking around building users where the works cannot be specified with certainty. In addition, maintenance manager facing a lot of challenges in order to ensure the procurement approach is effective. This indicated that the selection of procurement strategy for building maintenance is more challenging and complex.

The failure to select a suitable procurement strategy is now recognized as a main cause of project failure (Morledge *et al.*, 2006 and Masterman, 1996). Ng *et al.* (2002) agreed

that project success is depends on the selection and use of a suitable procurement strategy. Indeed, selecting the most suitable procurement approach which will give optimum result is very vital.

Hibberd and Djebarni (1996) carried out a research in UK which noted that 89% of the clients and consultants were dissatisfied with the procurement method they had employed previously. Moreover, Ng *et al.* (2002) highlighted that some inexperienced clients tend to seek for advice from the consultants or experts in order to select the best procurement method but inappropriate adoption of procurement method may result unforeseeable consequences. It is indeed very critical to have a procurement selection framework which can guide the clients and consultants to employ the most appropriate procurement method.

It is definitely impractical to replace all older buildings with new constructed building. In order to increase the productivity of maintenance management, selecting an appropriate maintenance procurement method is very essential. The growing importance of maintenance sector not only in Malaysia but also increasingly globalized, the difficulty in selecting an appropriate procurement method and lack of research in this area provide an impetus for this research. Hence, this study attempts to develop a framework that could assist the maintenance manager in decision making of selecting the most appropriate procurement strategy in building maintenance works.

1.3 RATIONALE FOR IMPROVING BUILDING MAINTENANCE MANAGEMENT BY ADOPTING THE MOST APPROPRIATE PROCUREMENT STRATEGY FOR UNIVERSITIES' BUILDINGS IN MALAYSIA

Selecting an appropriate procurement strategy for building maintenance is a very critical decision in building maintenance management. Ali et al. (2008) stated that any decision made in maintenance work will affect the cost, quality, duration and resource allocation of the building. Hashim *et al.* (2006) claimed that it is a complex and intimidate task for the client and the client's advisers to select the most appropriate procurement method.

In addition, Pesamaa *et al.* (2009) stated that procurement is vital since it sets the basis for cooperation between clients and contractors. This statement is true for local, regional or global project in scope. It is claimed that procurement method selection becomes a very significant task for clients because employing an inappropriate procurement method may lead to project failure (Ng *et al*., 2002 and Chua *et al.*, 1999). Ibbs and Chih (2011) mentioned that the use of a suitable procurement method can affect project efficiency and success. Indeed, selecting an appropriate procurement strategy is very critical to reduce cost as well as to ensure the quality and productivity of maintenance work.

Sheng (2012) emphasized that the adoption of appropriate sourcing strategy in building maintenance will not only help the good functionality of the building, the mechanical and electrical elements but also in achieving cost savings, higher comfort levels, better economic rent of the building space, elevated corporate image a sustainability of the building. Procurement system of a project is a significant element which contributes to the overall project success and client satisfaction. Therefore, selecting the most appropriate procurement strategy is very crutial for the clients and also the project participants (Love *et a*l., 1998).

Morledge *et al.* (2006) pointed out that their research led them to believe that relatively few professionals fully understood the differences between the various procurement systems and would be unable to make sensible recommendations as to which system would be most appropriate for a specific project. In fact, the amplification of demand on quality services for building or space, changes in business environment and the ever evolving market trend resulting in emergence of various procurement strategy. Thus, the tasks of decision makers to select the most appropriate procurement method becoming more challenging.

Masterman (1992) claimed that many clients have been selecting procurement systems in a cursory manner simply based upon subjective past experience and the conservative decisions and some client even employ a specific procurement strategy by default without making a deliberated choice. Moreover, Ng *et al.* (2002) also noted that clients that have experience may also suffer if their selection only depends on biased past

experience and the conservative decisions of their in-house experts. Although past experiences may be an essential factor that influences the selection of procurement strategy but experiences and solutions to problems retrieved from past projects may not be applicable to the current projects because each building has its own distinct characteristic. In addition, Love *et al.* (1998) highlighted that owners that have similar nature do not certainly have similar needs. In fact, the needs rely on many factors and are usually specific to the particular project.

Some researches highlighted that it is essential to establish a list of procurement selection criteria before various procurement methods were evaluated. The procurement selection criteria should reflect the requirements and characteristics of the client, project and external environment (Luu *et al.*, 2003a; Kumaraswamy and Dissanayak, 2001 and Ambrose and Tucker, 1999). Therefore, the first objective in this research is to identify and establish a list of criteria for procurement methods selection in building maintenance project.

Luu *et al.* (2003a) stated that the procurement selection process involves the analysis of complex and dynamic criteria such as cost certainty, time certainty, speed, flexibility responsibility, complexity, price competition, risk allocation and quality. It was also noted that decisions in procurement selection are usually derived from intuition and past experience in reality. However, Cheung *et al.* (2001) pointed out that the selection criteria are closely related with the objectives of project both tangible for instance cost and time and intangible such as relationships and buildability.

On the other hand, Cheung *et al.* (2001) consider eight selection criteria for selecting the most appropriate procurement method which include speed, cost certainty, flexibility, complexity, risk avoidance, price competition and point of responsibility. It can be seen that there is similarity for the selection criteria for Luu *et al.* (2003a) and Cheung *et al.* (2001) studies. Ng *et al.* (2002) also identified several criteria for selection of the most appropriate procurement method in his research which include time certainty, speed, complexity, price certainty, responsibility, flexibility, risk allocation, price competition, quality level, political issues, client requirement and public accountability. Hibberd and Djebarni (1996) agreed some of the criteria proposed by Ng *et al*. (2002) but he further suggested that knowledge of process for certain procurement method and dissatisfaction with previous procurement approach also being considered while selecting procurement method. Furthermore, Love et al. (1998) outlined the criteria employed to evaluate client requirements and experts preferences for the performance of each procurement method that include certainty, speed, quality, flexibility, responsibility, complexity, disputes and arbitration, price competition and risk allocation or avoidance.

Through literature search, there is very limited study found for maintenance procurement in Malaysia. There is only one research found which are carried out by Lateef et al. (2011) on university building. Indeed, the study is more focusing on which type of procurement methods that are adopted for maintenance work in universities in Malaysia. Most researches for procurement methods selection are focusing more on construction and project management field. Globally, limited empirical research found

with regards to procurement for maintenance. Love et al. (1998) claimed that there is insufficient empirical research in this field of study. Thus, the second and the third objectives of this research is to investigate the current procurement method option adopted by public universities in Malaysia and to review the current practices adapted by public universities organization in selecting procurement method to narrow the gap in the existing literature.

Through extensive literature review set out above, it can be seen that the selection of the most appropriate procurement method is very essential and the selection of procurement strategy is largely depends on the procurement selection criteria. Thus, the rationale for conducting this study is to create a framework for procurement selection that integrate the procurement selection criteria and procurement option in building maintenance management in order to improve the value of universities' buildings in Malaysia.

1.4 THE ASPECTS OF PROCUREMENT METHOD SELECTION PROCESS THAT NEED IMPROVEMENT

Ratnasabapathy and Rameezdeen (2007) stated that there were several procurement selection systems have been developed to help the client to select the most appropriate procurement strategy but all model failed to include some important factors based on main criteria and some of the models only include limited number of criteria. Thus this study attempts to identify all the criteria that need to be considered when selecting procurement method and establish a list of procurement selection criteria for

procurement methods selection in building maintenance project through extensive literature review and postal questionnaire survey. This will be achieved through the first objective of this study.

In addition, it was argued that the available procurement methods included in the existing models are limited and certain important options were ignored. In fact, a number of existing models adopted a primitive approach to the selection process and limit the number of option to be considered (Alhazmi and McCaffer, 2000). Therefore, the second objective of this study is to investigate the current procurement method option for building maintenance management in public universities in Malaysia and the third objective is to review the current practices adapted by public universities organization in selecting procurement method through extensive literature review and postal questionnaire survey so that the certain important options will not be overlooked in the proposed framework and the current practices of selection can be improved.

Masterman (1992) claimed that the practice of procurement selection is rather unstructured and unplanned. Many clients select procurement methods in a cursory way simply based upon biased the conservative decisions and past experience. In fact, some clients even employ certain procurement method by default without making a deliberated choice. Ratnasabapathy and Rameezdeen (2007) also highlighted that it is strategically essential to make sure the selection of procurement method is done systematically and in a closely controlled manner. Thus, Cheung et al. (2001) suggested that the use of the AHP technique in decision making process enables the decision

maker to structure a complex problem in the form of a simple hierarchy and to evaluate a large number of qualitative and quantitative factors in a systematic manner under multiple criteria. It is a logical way for people to make decisions.

Love et al. (1998) also suggested that owners that have similar nature do not certainly have similar needs. In fact, the needs rely on many other factors and usually are project specific. This study adopted Multiple Criteria Decision Making (MCDM) particularly the Analytic Hierarchy Process (AHP) in which decision is made based on multiple criteria that enables the decision maker to derive his own set of importance weightings for the selection criteria according to the building or project characteristics. The application of AHP and Expert choice which able to calculate the judgment consistency assure that the decision maker judgments are consistent and the final decision is made well. The decision makers are able to re-examine and revise the judgments for all level of the hierarchy and it shows where the inconsistency exists and how to minimize it in order to improve the decision.

Through the summary review of literature set out above, AHP has shown many advantages in a lot of aspects. The application of AHP and Expert choice software which able to calculate the judgment consistency assure that the decision maker judgments are consistent and the final decision is made well. Therefore, the fourth objective of this study is to establish a decision making framework using AHP as a basis of development for selection of procurement method in building maintenance project for public universities in Malaysia.

1.5 RESEARCH AIM AND OBJECTIVES

The main aim of this research is **to develop a decision making framework for selection of procurement method in building maintenance management for public universities in Malaysia**.

To accomplish the aim, the following objectives are established:-

- to identify criteria for procurement methods selection in building maintenance project
- to investigate the current procurement method option for public universities in Malaysia
- to review the current practices adapted by public universities organization in selecting procurement method
- to establish a decision making framework using AHP as a basis of development

1.6 RESEARCH METHODOLOGY

The present study is carried out step by step where the flow can be seen in Figure 1.1 while the research design can be referred to Figure 1.2. In order to achieve the objectives formulated, the research was mainly divided into four main phases:-

Phase 1: Literature Review

The literature review is to get an overview of the study and most importantly to identify two important components that were the possible assessment criteria and the procurement method available for selection. There were 26 procurement selection criteria identified from literature review that were divided into three main categories that were clients' requirements, project characteristics and external environment or factors. In addition, there were 13 types of procurement methods identified in literature review. In addition, decision making tools are reviewed as well in order to select the most appropriate tool to be adapted to select the most appropriate procurement method. As selecting procurement method is a Multiple criteria decision making (MCDM), reviews were did starting with decision analysis which is the main branch of MCDM and followed up with the tools and method available in MCDM.

Phase 2: Main data collection (Postal questionnaires survey)

The Postal Questionnaires Survey is developed on the basis of extensive literature reviews. The main purposes of this survey is to shortlist the most popular and important procurement selection criteria, obtain the current and available building maintenance procurement method and understand the process and tools used in selecting procurement method. Twenty set of questionnaires was sent to all public universities in Malaysia.

Phase 3: Developing decision making framework

The framework was developed based on AHP technique and principles. Expert Choice software was employed as development tool and the shortlisted criteria and alternatives from phase 2 (Postal Questionnaires Survey) was adapted into the framework.

Phase 4: Validation of the framework (Structured interview)

Structured interview was conducted to validate the framework developed. The validation process was carried out with 9 public universities selected. The framework produced was demonstrated to the interviewees and they were asked to run the framework and evaluate the framework in term of capability, applicability and validity.

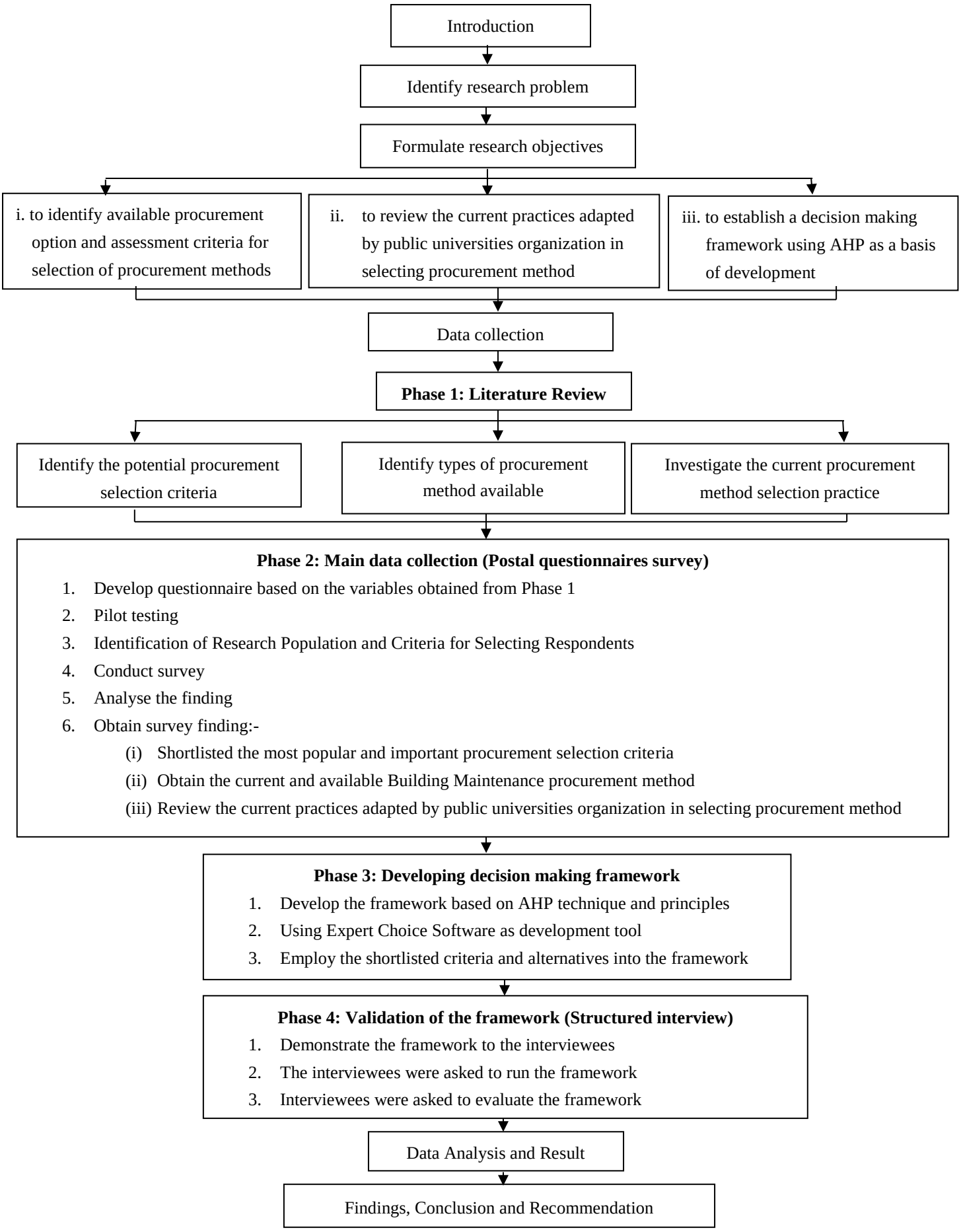

Figure 1.1: Flow of research methodology

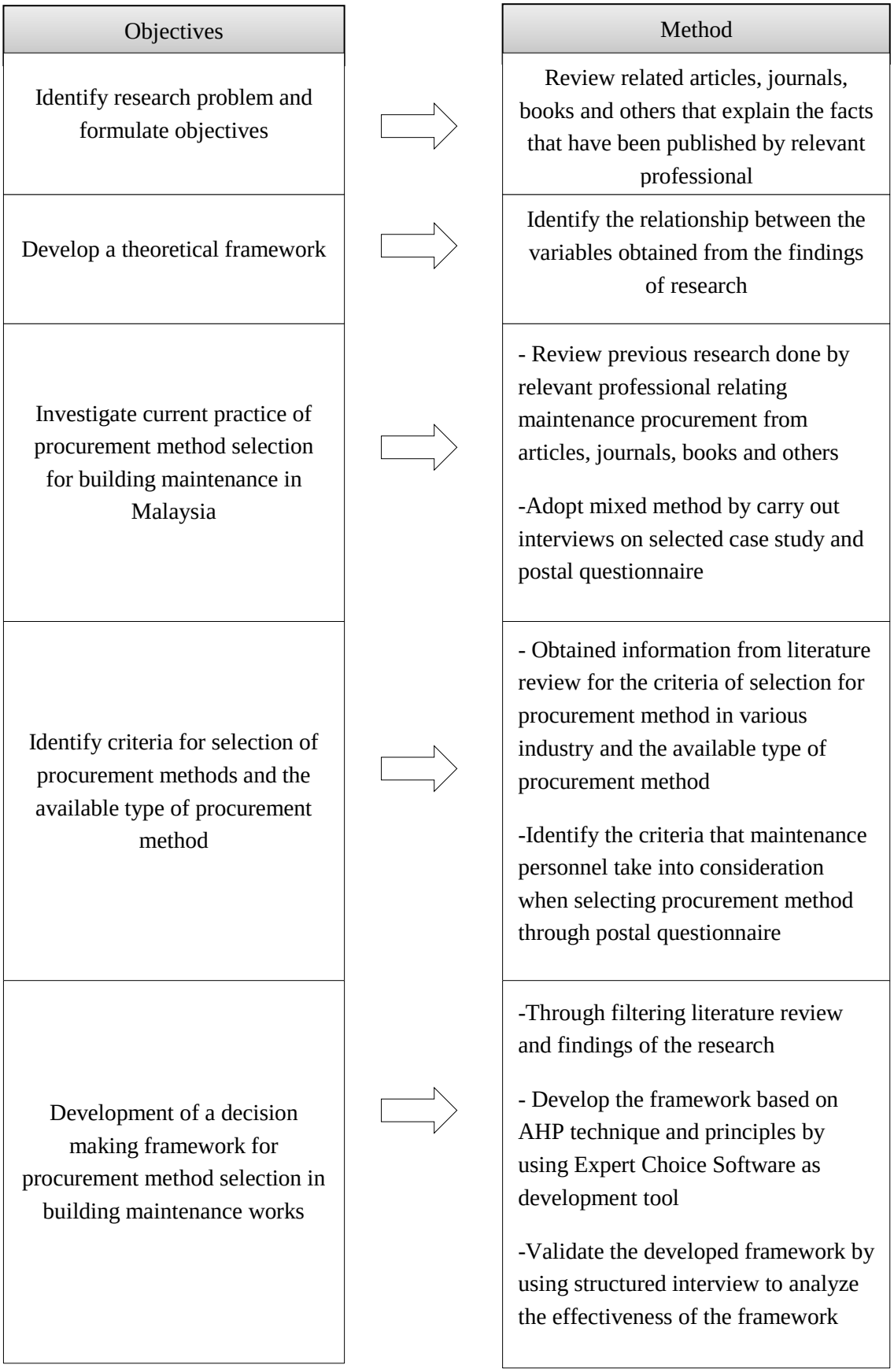

Figure 1.2: Research design

1.7 SCOPE AND LIMITATION OF STUDY

This research is mainly focusing on the selection of procurement method in building maintenance management for public universities in Malaysia. The study set out to identify two important components in procurement decision making that are the possible assessment criteria and the procurement method option available for selection.

This study has been limited to public universities in Malaysia after considering the uniformity of policy, time frame and financial aspect. To date, there are 20 public universities in Malaysia. No questionnaires and interviews will be conducted to private universities.

The decision to choose which procurement method to be adopted is usually made by the maintenance department of public universities that are in charge to plan the maintenance work for the buildings in the university. Therefore, this study will only approach the public universities' maintenance department to obtain relevant information.

The data about the process of procurement strategy selection obtained from the maintenance personnel that are involved in decision making of procurement strategy selection of building maintenance work. Therefore the respondents of the questionnaires and interviews are limited to only those involve in decision making for selection of procurement method for building maintenance work of public universities.

1.8 BENEFITS OF THE STUDY

The study expected to be beneficial to maintenance personnel involves in procurement method selection. The expected research ouput benefits are as follow:

(i) The study expected to produce an Analytic Hierarchy Process (AHP) decision making framework for the selection of procurement strategy in building maintenance management for public universities which can bring a lot of benefits to the maintenance personnel, clients or owner of the buildings, building users and the academicians that are related to maintenance industry. The study can contribute to academic organizations, professional bodies and building maintenance organizations by incorporating the finding into the body of knowledge.

(ii) This study provides the available building maintenance procurement options and the criteria to be considered before deciding which procurement strategy to be adapted to the maintenance personnels.

(iii) This research can assist the public universities' maintenance personnel in choosing the best procurement method.

(iv) The proposed decision making framework is expected to improve the maintenance management of public universities in Malaysia by selecting the most appropriate procurement method.

1.9 STRUCTURE OF THESIS

This thesis comprises eight chapters. The summary of the remainding chapters are presented below.

Chapter 2 begins with an introduction and background of asset management, facility management and building maintenance management whereby the definition of the asset management, facility management and building maintenance management, importance of building maintenance management and type of building maintenance were discussed. Literature related to procurement method selection, potential procurement selection criteria, types of procurement method available and the current procurement method selection practice were reviewed as well. There were 26 procurement selection criteria identified from literature review that were divided into three main categories that were clients' requirements, project characteristics and external environment or factors. In addition, there were 13 types of procurements methods identified in literature review.

Chapter 3 reviews the literature on decision making tools in order to select the most appropriate tool to be adapted to select the most appropriate procurement method. As selecting procurement method is a Multiple criteria decision making (MCDM), reviews are done starting with decision analysis which is the main branch of MCDM and followed up with the tools and method available in MCDM. It is followed up by the justification for using the selected decision making tool. As mentioned, this research

adopted AHP which is one type of MCDM as decision making tools. The proposed decision making framework is developed based on AHP technique and principles.

Chapter 4 presents the research design and the methodology adopted in the present study. The methodologies for this research aim to achieve the objectives formulated and lead to valid conclusions. The methodology approach implemented for this research is mixed method. This chapter discussed in three main sections which include research design, identification of research population and criteria for selecting respondents as well as data transformation.

Chapter 5 provides the results from the postal questionnaires survey that was conducted to investigate the current information in regards to building maintenance management in Malaysian's Public Universities. This include to get general overview of the characteristics of building maintenance procurement strategy implemented in this country and short-list the type of procurement and criteria that maintenance personnel take into consideration when selecting procurement method. In addition, this questionnaire also aims to understand the current processes and tools used in selecting procurement method in public universities in Malaysia. The results discussed were based on descriptive statistics using Statistical Package for Social Science (SPSS).

Chapter 6 discusses the development of decision making framework for selecting the most appropriate procurement method in building maintenance management of public university in Malaysia. The framework is developed based on MCDM particularly AHP.

The framework employed AHP techniques and principles using Expert Choice 11 Software as development tool. This chapter also provides the results obtained from structured interview which aim to validate the framework developed. The validation process was carried out through structured interview with 9 public universities selected.

Chapter 7 provides the overall summary of the research objectives and discusses the overall results of the study. This chapter also presents the conclusions and recommendations for the study.

1.10 SUMMARY

This chapter has highlighted the issue of the study and discusses the rationale to create a framework for procurement selection in building maintenance management in order to improve the value of universities' buildings in Malaysia. There are four objectives formulated to achieve throughtout this study. The benefits of the present study and structure of thesis were presented as well. The literature reviews for this study are discussed in the following chapters.

CHAPTER 2

LITERATURE REVIEW: PROCUREMENT METHOD FOR MAINTENANCE PROJECT

2.1 INTRODUCTION

This chapter begins with an introduction and background of asset management, facility management and building maintenance management whereby the definition of the asset, facility and building maintenance management, importance of building maintenance management and type of building maintenance were discussed. In addition, the development of building maintenance management in Malaysia was presented as well. As this research will be focusing on universities' building, the background of universities in Malaysia and their management system were presented as well. Then, the definition, type of procurement methods available in building maintenance industry and the procurement selection criteria in selecting procurement method were discussed. Finally, the current practices adapted by public universities organizations in selecting procurement method were provided.

2.2 ASSET, FACILITY AND BUILDING MAINTENANCE MANAGEMENT

2.2.1 Asset Management

RICS (2012) mentioned that the Institute of Asset Management describes asset management as "the management of physical assets which include selection,

maintenance, inspection and renewal that play a key role in determining the operational performance and profitability of industries that operate assets as part of their core businesses". The Institute also emphasized that asset management is the art and science of making the right decisions and optimizing these processes that aimed to minimize the whole life cost of assets and other critical factors such as business continuity or risk to be considered objectively in decision making (RICS, 2012). Hussain (2011) illustrated total asset management manual towards best practice as shown in Figure 2.1. It can be seen in the Figure 2.1 that total asset management covers facility management, maintenance management and maintenance repair, therefore all the components must be managed well in order to achieve best practice in asset management. RICS (2012) highlighted the benefits of property asset management which include the delivery of quality services to customers, improvement of the economic well-being of an area and maintenance of all property assets to good standards.

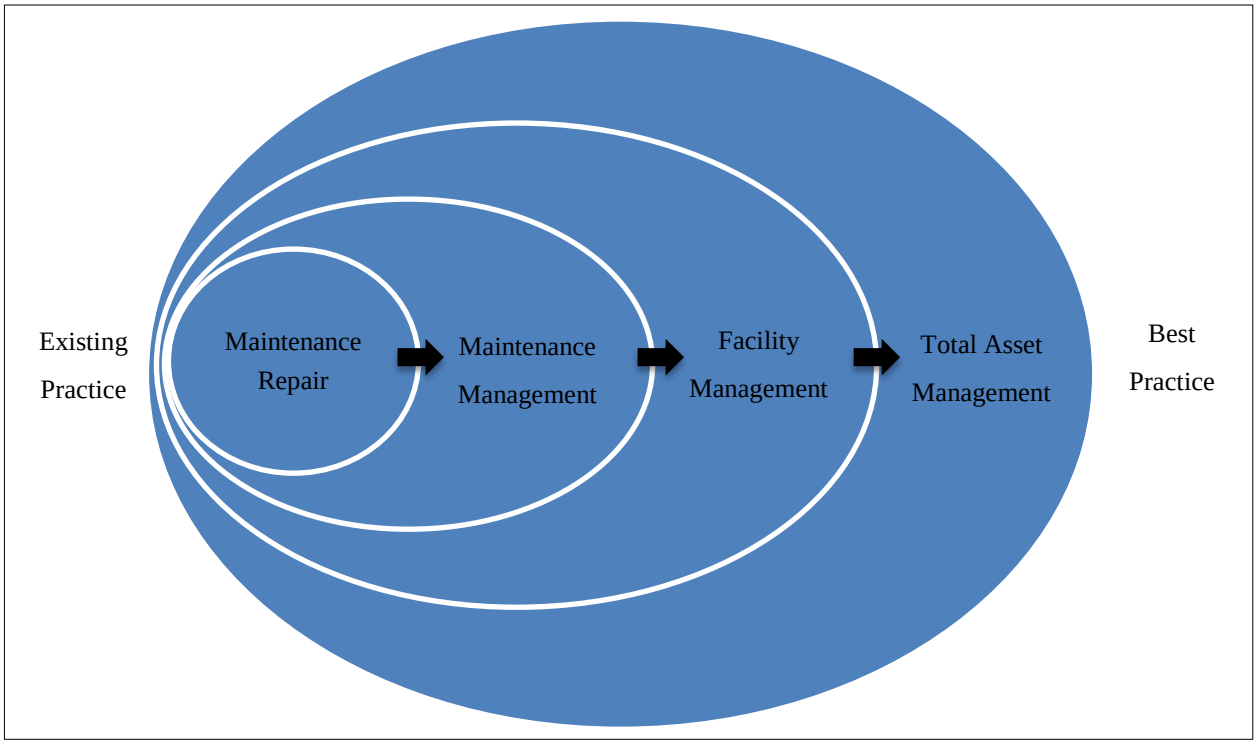

Figure 2.1: Total asset management manual towards best practice
Source: Hussain (2011)

2.2.2 Facility Management

Mustapa *et al.* (2008) highlighted that International Facility Management Association (IFMA) defined Facility Management (FM) as "the practice of coordinating the people and the work of an organization into the physical workplace". FM is a resource management that combines property, process management expertise and people to provide essential services in order to support the organization (Nik-Mat *et al*., 2011). FM is "an integrated approach to operating, maintaining, improving and adapting the buildings and infrastructure of an organization in order to create an environment that supports the primary objectives of the organization" (Mustapa *et al*., 2008). This is supported by RICS (2010) that FM is the total management of all services that support the core business of an organization. RICS (2010) also emphasized that good FM makes a huge difference to the efficiency and productivity of a company, its staff and even its clients.

Kamaruzzaman and Zawawi (2010) claimed that FM is an umbrella term which covers a wide range of properties and user related functions including change management, real estate management, financial management, health and safety, human resources management, building and engineering services maintenance, contract management, utilities supplies and domestic services. FM has been developed successfully and well established in many western countries such as Australia, Japan, Hong Kong, New Zealand and Singapore (Kamaruzzaman and Zawawi, 2010). However, Moore and Finch (2004) emphasized that the definition of FM is not well understood and not being practiced appropriately in Malaysia. Mustapa *et al*. (2008) supported that the definition

of facilities management is poorly understood in Malaysia which caused it not being practiced in an appropriate way. Mustapa *et al.* (2008) further stated that FM is quite new in Malaysia and the wider concept of FM of building management is still progressing and improving its maintenance management structure. Nik-Mat *et al.* (2011) noted that Public Works Department (PWD) which is known as Jabatan Kerja Raya (JKR) is the responsible government body that has started the introduction of FM to Malaysian industry in 1974. FM has not been readily encouraged or adopted by the Government in Malaysia in any structured way.

Mustapa *et al.* (2008) outlined that the failures found in the implementation and adoption of FM in Malaysia which can be categorized into four main factors as shown in Table 2.1.

Table 2.1: Facilities management failures on managing building features

	Failing Factors	**Description**
1.	Tactical Failings	Inadequate performance standards
		Low maintenance of cleaning standards
2.	Strategic Environmental Failings	Lack of building performance monitoring data
		Failure to anticipate the consequences of change
		Failure to understand the non-linear nature of building complexity
		Slow response of systems used
3.	Tactical Cultural Failings	Responding slowly to complaints
		Ignorance job stress
		Failure to provide appropriate advise on design and planning based on overall performance
4.	Strategic Cultural Failings	Facilities management issues not prioritized
		Over reliance on automated systems used
		Flagging improvement due to lack in technical knowledge and background

Source: Mustapa *et al*. (2008)

2.2.3 Building Maintenance Management

Ali *et al*. (2010) quoted from Francis *et al*. (2001) stated that building maintenance management is a process which involve the interaction or combination of technical, social, legal and fiscal determinants that govern and manage the use of buildings. Lateef *et al*. (2010a) explained maintenance management seeks to plan, coordinate, organize and control maintenance activities focusing on efficient allocation and utilization of resources to improve the building's value. In other words, it is procedure and process that is employed to achieve effectiveness in term of increase user satisfactions and efficiency means achieving optimum resource in service. Proper maintenance management has effect on the quality, reliability, availability and safety of the building. Lateef (2009) claimed that maintenance management comprises of achieving maximum benefit from the investment made in the maintenance activities. The best way to achieve excellent maintenance is to have a maintenance management that matches as closely as possible the expected requirements of the user (Zawawi *et al*., 2010 and Pintelon, 1999). Lateef *et al*. (2010a) further explained that building maintenance management involves the establishment of a framework for the maintenance of buildings and its associated services and the upkeep of the building performance.

Lateef (2009) stated that a fundamental aim of building maintenance management is to enhance the satisfaction, productivity and efficiency of activities scheduled in and around the building. In other words, it is a proactive procedure that is used to achieve efficient maintenance activities in a building by minimising the expenditure and optimising the value derived. Building maintenance management ties an organisation's

productivity and objectives to maintenance needs (Lateef, 2009). According to Yam *et al*. (2000) quoted from Priel (1974), the principles of maintenance management as an effective tool target to achieve the objectives as follow:-

- Ensure the availability of tools and equipment
- Ensure the equipment performance can meet output targets
- Balance the levels of preventive and corrective maintenance work in order to achieve the best conceivable trade-off of maintenance costs

In addition, Lateef *et al.* (2010a) explained that maintenance management system is directly related to poor service delivery, poor user satisfaction and maintenance backlogs which is illustrated in Figure 2.2.

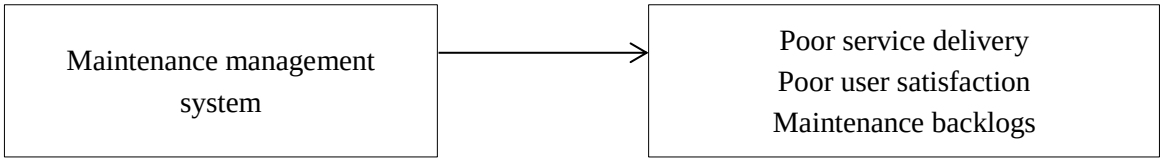

Figure 2.2: A schematic diagram showing the relationship between maintenance management systems and poor service delivery, poor user satisfaction and maintenance backlogs
Source: Lateef *et al.* (2010a)

2.2.3.1 Definition of Building Maintenance

The traditional perception on the role of maintenance is to fix and repair break down or failure items (Tsang *et al.*, 1999). Maintenance is defined in a broader view by BS 3811:1993 as "the combination of all technical and associated administrative actions intended to retain an asset in or bring it to a state in which it can perform its required function" (Royal Institution of Chartered Surveyors (RICS), 2009). Lateef (2010) defined maintenance conclusively from various definition as "the required processes

and services undertaken to care for a building's structure or/and service form after completion or after any repair, refurbishment or replacement to current standards to enable it to serve its intended functions throughout its entire lifespan without drastically upsetting its basic features and function". Lateef (2010a) defined maintenance as "the required processes and services undertaken to preserve, protect, enhance and care for the university buildings' fabrics and services after completion, in accordance with the prevailing standards to enable the building and services to serve their intended functions throughout their entire life span without drastically upsetting their basic features and uses".

Chanter and Swallow (2007) highlighted from British Standard 3811:1984 define maintenance as "the combination of all technical and associated administrative actions intended to retain an item in, or restore it to, a state in which it can perform its required function". The term "retain" suggests an action taken to prevent the flaws to become worst while the term "restore" suggests that minor defects are negligible before the fault are fixed (Pan and Gibb, 2009 and Son and Yuen, 1993). This explanation highlighted the two main types of maintenance which is unplanned maintenance is to restore while planned maintenance is to retain. In addition, Chanter and Swallow (2007) emphasized that the definition constituted two key components which are:-

i. Maintenance work should not only focus on the physical execution, several essential aspects such as initiation, financing and organisation need to be concerned as well.

ii. The concept of an acceptable condition indicates an understanding of the requirements for the effective usage of the building and its parts. As the result, it requires broader consideration of building performance.

Ali *et al.* (2010) defined building maintenance as "the combination of technical and administrative work executed to retain or repair the items and components of a building in a satisfactory standard so that it is in a state of functional". Arditi and Nawakorawit (1999) explained maintenance as the preservation of a building so that it can serve its intended purpose. Arditi and Nawakorawit (1999) further quoted from White (1969) claimed that a more functional definition proposed is that ''maintenance is synonymous with controlling the condition of a building so that its pattern lies within specified regions.'' The term ''control'' means a positive action which is planned in order to accomplish a defined end result. The term ''specified regions'' is synonyms to ''acceptable standards''.

Tsang *et al.* (1999) highlighted from the Maintenance Engineering Society of Australia (MESA) explained that maintenance shall be view in a broader perspective and define maintenance as "the necessary decision and actions taken so that a system has the ability to perform within a wide range of performance levels that are related to variety of aspects which include quality, rate and responsive".

2.2.3.2 Importance of Building Maintenance

Maintenance work started on the day the builder leaves the site. However, the importance of maintenance has been largely underestimated because it is considered as not productive (Pan and Gibb, 2009 and Seeley, 2003). The role of building maintenance is neglected which has accumulatively results with rapidly increasing deterioration of building (Seeley, 2003). Shen (1997) highlighted that the deterioration began to bring dangers to structures of building and indirectly will affect the health of the users. Moreover, it also degraded the function of the building and lowered the living standards which caused inconsistency with the booming the economy. Yik and Lai (2005) claimed that a building will only continue to be valuable asset if it is properly operated and maintained. In addition, Lateef (2010) stated that building maintenance maximize the service life of the building by delaying the failure, deterioration and decay.

A major aim of building maintenance is to preserve a building in its initial effective state, as far as practicable, so that it serves its purpose effectively (Zawawi *et al.*, 2010; Al-Zubaidi, 1997 and Chanter and Swallow, 2007). There are several objectives in building maintenance work which include (Ali *et al*., 2010):-

- the investment value of the building is retained
- the buildings are maintained to a state of required and acceptable condition
- the buildings has good physical appearances
- produce income to the owners of the buildings as well as the surrounding activities

- preserve the historical and architectural values of buildings

Magee (1988) noted that the main aim of maintenance is to maintain the value of an asset to ensure a long-term investment is able to provide continuous and satisfactory return. In order to achieve this aim, several objectives are generated (Arditi and Nawakorawit, 1999 and Magee, 1988):-

- Perform housekeeping work in daily basis so that all the facilities are in presentable condition.
- Scheduled inspection to repair failure of facilities.
- Actions are taken to prevent premature failure of the facilities and its elements and systems.
- Carry out repair work on lowest life-cycle cost.
- Ensure the facility operated efficiently.
- All works are scheduled and planned in advance.

2.2.3.3 Type of Building Maintenance

Generally, Seeley (2003) divided maintenance into two main type based on British Standard 3811: 1984 which are planned maintenance and unplanned maintenance. Planned maintenance is subdivided into preventive maintenance and corrective maintenance. Preventive maintenance consists of scheduled maintenance and condition-based maintenance. On the other hand, unplanned maintenance mainly focused on corrective maintenance. This is illustrated in Figure 2.3. It is definitely

impractical to replace all older buildings with new constructed building, thus the understanding of building maintenance is very essential.

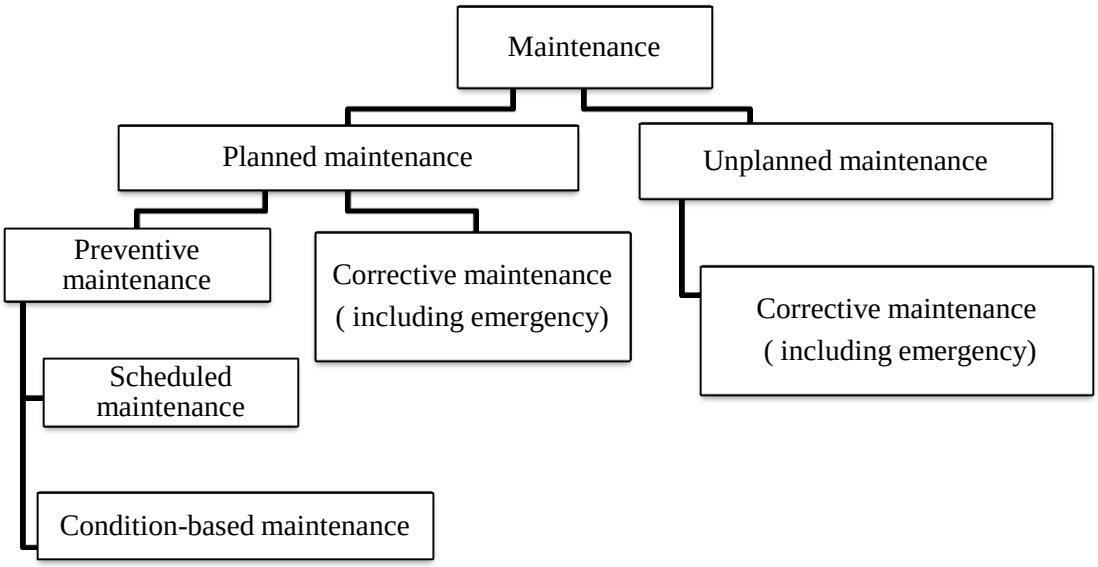

Figure 2.3: Types of maintenance
Source: Seeley (2003) based on BS3811:1984

2.2.3.4 Development of Building Maintenance Management in Malaysia

Maintenance management in the private and the public sector has been rapidly changing throughout the years due to several factors which include the enhancement of sophisticated technology, globalisation and change of economy (Zawawi *et al.*, 2010 and Horner *et al.*, 1997). The economy of Malaysia has been planned on the basis of five years strategic plan since independence. Construction industry plays an important role in the economy of Malaysia in generating wealth and improving the quality of life for Malaysians through the translation of government's socio-economic policies into social and economic infrastructure and buildings (CIDB, 2007). In 2010, the construction sector registered a growth of 5.2% and contributed 3.3% to our Gross domestic product (GDP) (CIDB, 2010). The Ministry of Finance, Malaysia (2006) highlighted that the construction sector accelerated with a double-digit growth of 15.5%

in the first quarter of 2012 (Q4 2011: 7.5%) on account of robust activity in the residential and civil engineering sub-sectors. This was supported by the special trade sub-sector grew 6.5% (Q4 2011: 4.8%) which is strengthened by increasing repair and maintenance activities, particularly in public residential and non-residential buildings (The Ministry of Finance Malaysia, 2012).

Lateef (2009) stated that the increase in supply of building will lead the increase in the amount invested in building maintenance. According to the latest Construction Quarterly Statistical Bulletin 2013 by CIDB (2013), 188 maintenance projects are awarded in 2011 and increased to 245 in 2012. The number of maintenance projects awarded until March 2013 (1st quarter of 2013) are 26 (CIDB, 2013). In addition, the number of maintenance projects awarded in 2010 and 2009 were 245 and 174 respectively (CIDB, 2012 and CIDB, 2011). The numbers of maintenance projects awarded for this recent 5 years were illustrated in Figure 2.4.

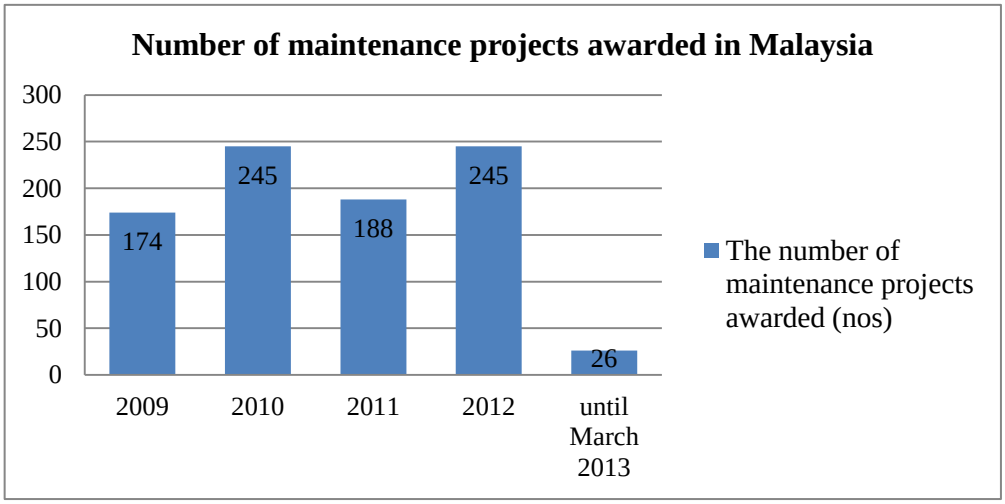

Figure 2.4: The numbers of maintenance projects awarded in Malaysia
Source of data: Construction Quarterfly Statistical Bulletin 2010, 2011 and 2012

Lateef (2009) claimed that the allocation for repair and maintenance works in Malaysia is grossly inadequate to meet the ever-growing demand for the maintenance backlog even the government consistently increase allocation to the maintenance sector. It is indeed worsen the situation that the allocation for repair and maintenance works decreased to RM500 million in the Tenth Malaysian Plan (2011-2015) compared to RM1,079 million during the Ninth Malaysian Plan (2000- 2010) and RM 296 million during Eighth Malaysian Plan (2001-2005) (Ali, 2009 and Government of Malaysia, 2010). Thus, the management of building maintenance in Malaysia should be improved to increase the functionality of building and at the same time reduce the cost of maintenance. Figure 2.5 illustrated the allocation for repair and maintenance works in the Tenth Malaysian Plan (2011-2015), Ninth Malaysian Plan (2000- 2010) and Eighth Malaysian Plan (2001-2005).

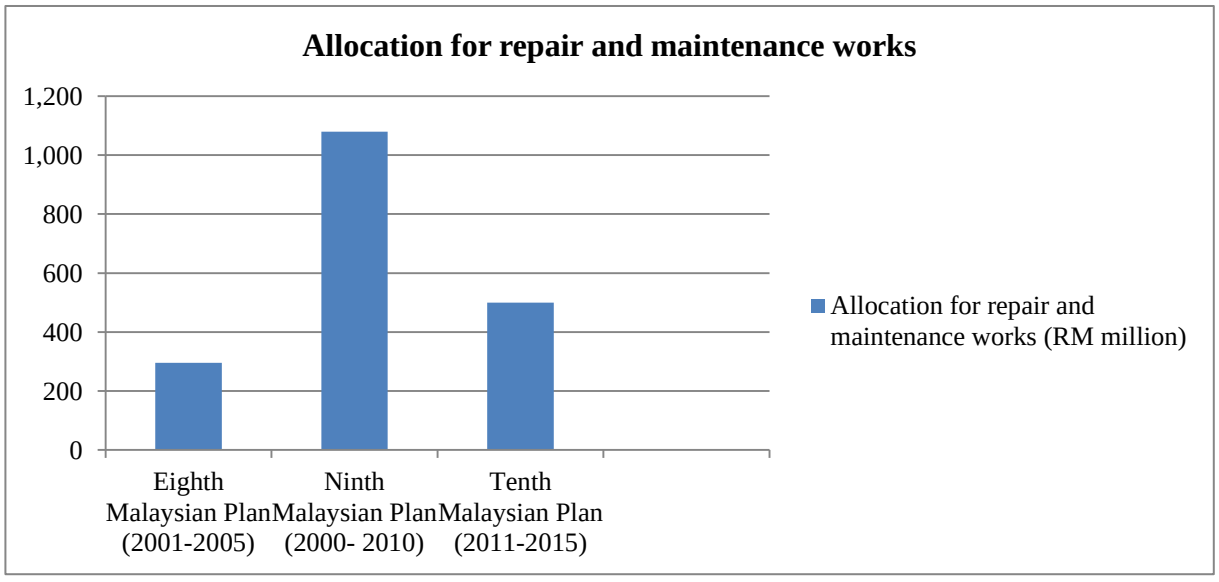

Figure 2.5: Allocation for repair and maintenance works in the Tenth Malaysian Plan (2011-2015), Ninth Malaysian Plan (2000- 2010) and Eighth Malaysian Plan (2001-2005)
Source of data: Ali (2009) and Government of Malaysia (2010)

It can be seen that the government invested huge amount of money in building maintenance sector and this sector is developing in Malaysia. However, the management of building maintenance in Malaysia is claimed to be ineffective and the backlogs of building that require maintenance seems to be endless (Wong, The Star, 20th February 2006; Syamilah, 2005 and Lateef, 2009). The former Prime Minister of Malaysia, Dato' Seri Abdullah Ahmad Badawi stated that Malaysia is losing billions of ringgit due to the poor maintenance of buildings and amenities. He further highlighted that there were weaknesses in the management and maintenance of public facilities (Wong, The Star, 20th February 2006).

In addition, Syamilah (2005) claimed that more than 90 per cent of the respondents of her research agreed that the practice of the maintenance management procedure of buildings in Malaysia should be improved. Hussain (2011) highlighted that General Auditor of Malaysia claimed that Malaysian government assets are on the high risk due to poor maintenances. This shows that buildings in Malaysia are not effectively maintained. In fact, there are many buildings in Malaysia that require maintenance and care as the backlogs of building maintenance seems to be endless. Therefore, it is very critical to improve the maintenance management of buildings in Malaysia. It was emphasized by Lateef (2009) that there is an urgent need to improve the ways building maintenance management executed in Malaysia to minimise building maintenance and ensure that building maintenance is effectively carried out. Therefore, this study aims to improve the building maintenance management in Malaysia by creating a framework which can guide the decision maker to select the most suitable procurement strategy.

2.3 BACKGROUND OF UNIVERSITIES IN MALAYSIA AND THEIR MANAGEMENT SYSTEM

Lateef *et al.* (2010) noted that building maintenance is a strategic issue for academic institution. It is essential for education building to plan effective building maintenance management because facility condition of education building directly impact teaching and learning (Lavy and Bilbo, 2009). University buildings are factor of production where future leaders, captains of industry, entrepreneurs, scientists, engineers and managers are produced. The objective of the university might not be met without proper infrastucture. It is critical for universities to take care of their interrelated assets namely buildings, technology and human resources for better performance as a failing part of one will affect the others (Lateef *et al*., 2010a). University buildings are procured to create a conducive, adequate and suitable environment to stimulate, encourage and support teaching, innovation, learning and research activities (Lateef *et al.*, 2011). Therefore, universities' buildings and the associated engineering services require maintenance to be in business.

Lateef *et al.* (2011) highlighted that there have been many complaints voiced out in the media. There are also research literatures that point out the fact that many of the university buildings in Malaysia are not in an optimal operable condition. The current maintenance management systems of universities in Malaysia are mainly corrective and cyclical which have not been scrutinized for inefficiencies which has led to backlogged maintenance works which in return results in poor user satisfaction (Lateef *et al.*, 2011).

Lateef *et al.* (2010a) pointed out that a major reason why the universities focus more on corrective maintenance was due to budget constraints and the lack of a competent workforce. In fact, the maintenance of the buildings in universities which is supposed to be a core activity is considered by the university management as non-core activity. It is a serious failure of the university management that prides itself as vehicle for scientific and technological advancement considered the management of their buildings as non-core activities (Lateef *et al*., 2010a and Lateef, 2010b). In addition, Lateef *et al.* (2011) highlighted that the maintenance management system of universities in Malaysia are not IT based which requires the work to be are computed manually which wastes time, energy and resources.

Universities contain complex, sophisticated and unique buildings to perform a number of types of functions and activities. A failure in supplying the require services is a loss in value to the university institution, other stakeholders and most importantly the users (Lateef *et al.*, 2010). The performance of educational buildings has a significant impact on both faculty members' productivity and student performance. Lateef *et al.* (2011) noted that university buildings are long-lived resources, with duration of 100 years or more being common. Therefore, an improvement in maintenance management processes is very critical for universities in Malaysia.

2.3.1 Introduction to Universities in Malaysia

Ministry of Higher Education (MOHE) is the government ministry that is in authority to determine the policies and direction of higher education in Malaysia. MOHE was

established on 27th of March 2004 intended to develop and create a higher education environment in order to encourage the establishment of centres of knowledge and the development of competent, innovative and ethical individuals consequently fulfilling national and international aspirations (MOHE, 2013). MOHE is in authority to develop an advantageous higher education ecosystem for Public and Private Institutions of Higher Education, Polytechnics and Community Colleges. These institutions are the main components in the ecosystem of higher education and national training to produce thinkers, scholars, scientists and a skilled or semi-skilled workforce. There are three departments established under MOHE to manage the higher education institution which include Department of Higher Education (DHE) to manage the Public and Private Institutions of Higher Education, Department of Polytechnic Education (DPE) to manages Polytechnics and Department of Community College Education (DCCE) to administer the Community Colleges. Meanwhile, there are key related agencies that provide support for higher education namely the Malaysian Qualification Agency (MQA) and National Higher Education Fund Corporation (NHEFC). MQA is a sole body that coordinates and supervises the quality assurance and accreditation of higher education in the country while NHEFC is a corporation that manages funding for higher education purposes.

The establishment of higher education in Malaysia started with the establishment of University of Malaya. University of Malaya was established on 8th October 1949 in Singapore with the merger of the King Edward VII College of Medicine (founded in 1905) and Raffles College (founded in 1928). The growth of the University was very

rapid during the first decade of its establishment which resulted the setting up of two autonomous division in 1959 located in Singapore and Kuala Lumpur. In 1960, the government of the two territories indicated their desire to change the status of the devisions into national university. Legislation was passed in 1961 and University of Malaya was established on 1st January 1962 and is known as Malaysia's oldest university. Then, two universities namely University of Science Malaysia and Tunku Abdul Rahman College were established in 1969 (Department of Higher Education, 2011). Presently, both public and private higher education institutions have rapidly expanded with the increase of various programmes of study and courses as well as the number of students.

According to MOHE, the higher education system is aimed to ensure that Public Institutions of Higher Education (PIHE) have the ability and capability in building a reputation with dynamic capabilities, competitive as well as able to anticipate the future challenges and be prepared to respond effectively in line with global trends. Efforts to enhance the capacity of PIHE will be continuous to ensure that the PIHE perform their functions and responsibilities in a more efficient, transparent and effective way to create an excellent higher education system.

In accordance with this, the public universities in Malaysia are categorized into three groups; Research Universities, Focused Universities and Comprehensive Universities. So far, there are 20 public universities in Malaysia, which comprise 5 research universities, 4 comprehensive universities and 11 focused universities. Research

Universities are public universities recognised by the cabinet on 11th of October 2006 to become a leading research and educational hub while Comprehensive Universities act as educational centres for pre-undergraduate, undergraduate and post-graduate programmes in various fields without focusing on any one area and finally Focused Universities are public universities which emphasize on specific fields such as technical, education, management and defence (Department of Higher Education, 2011). Table 2.2 showed the categorization of public universities in Malaysia.

Table 2.2: Categorization of public universities in Malaysia

No	**University**	**Characteristics**
	Research Universities	
1	University of Malaya (UM)	• Fields of Study: Focus is on research
2	University of Science, Malaysia (USM)	• Competitive entries
3	National University of Malaysia (UKM)	• Quality lecturers
4	Putra University, Malaysia (UPM)	• Ratio of undergraduates to
5	University of Technology, Malaysia (UTM)	postgraduates is 50:50
	Comprehensive Universities	
1	MARA University of Technology (UiTM)	• Various fields of study
2	International Islamic University of Malaysia (UIA)	• Competitive entries
3	University of Malaysia, Sabah (UMS)	• Quality lecturers
4	University of Malaysia, Sarawak (UNIMAS)	• Ratio of undergraduates to postgraduates is 70:30
	Focused Universities	
1	Northern University of Malaysia (UUM)	• Fields of Study : Focus is on
2	Sultan Idris University of Education (UPSI)	research
3	Tun Hussein Onn University of Malaysia (UTHM)	• Competitive entries
4	Technical University of Malaysia, Melaka (UTeM)	• Quality lecturers
5	University of Malaysia, Perlis (UniMAP)	• Ratio of undergraduates to
6	University of Malaysia, Terengganu (UMT)	postgraduates is 50:50
7	University of Malaysia, Pahang (UMP)	
8	Islamic Science University of Malaysia (USIM)	
9	Sultan Zainal Abidin University (UniSZA)	
10	University of Malaysia, Kelantan (UMK)	
11	National Defense University of Malaysia (UPNM)	

Source: Ministry of Higher Education (MOHE), 2013

In conjunction with the growth of PIHE, Private of Higher Education Institutions (PvIHE) also played an essential role in offering opportunities for higher education. The existence of PvIHE managed to reduce the Government's financial burden and savings on foreign exchange. The role of PvIHE began since 1950s with the establishment of several institutes such as Goon Institute, Stamford College and Maktab Kadir Adabi. PvIHE in Malaysia is categorized into two main categories that are PvIHE of University status and PvIHE of Non-University status. PvIHE of University status is divided into three main categories namely PvIHE of University status, University College and Foreign University Branch campus while PvIHE of non-university status is given College status. Up until 31st of March 2012, there are 29 PvIHE were given university status, 22 University College, 6 Foreign University Branch campuses and 412 colleges. Traditionally, the roles that PvIHE accepts students that did not obtain a place in PIHE but PvIHE substantially changed to become provider of quality tertiary education.

2.3.2 Building Maintenance Management for Public Universities in Malaysia

This research is mainly focusing on the selection of procurement method in building maintenance management for public universities in Malaysia after considering the uniformity of policy in public universities compared to private universities. Management is very significant for universities. The provision of building maintenance for public universities in Malaysia was appertained in the allocation for management of public universities. Table 2.3 showed the allocation for management of all public universities in Malaysia from year 2008 to 2012. It can be seen that the amount allocated increased from year to year. The increase in the allocations showed part of

government's commitment to improve the management of public universities in Malaysia. This will indirectly improve the management of building maintenance of public universities which will preserve the importance and comfort of the campus society and users of the university's facilities.

University buildings constitute a significant part of universities' assets. Thus it is essential to maintain the existing universities' buildings to an acceptable condition so that it is capable to facilitate in transferring knowledge and carry out other academic activities (Lateef *et al.*, 2010a). Lateef *et al.* (2010a) highlighted that in line with the intensive effort by the government of Malaysia in increasing the allocation for maintenance of public infrastructure assets and facilities, allocation for maintenance of universities' building has increased as well. The maintenance expenditure of public university buildings has expanded by nearly 85% from 2004 to 2008 based on inconclusive data obtained from the Ministry of Higher Education. They further claimed that even there is no comparable numerical data on the exact allocations to the maintenance of university buildings, a breakdown of maintenance expenditure of public university based on inconclusive data obtained from the Ministry of Higher Education was presented in Table 2.4.

Table 2.3: Allocation for Malaysian's public universities management

No.	Public University	Year				
		2008	2009	2010	2011	2012
1	UM	465,411,500.00	582,131,800.00	554,100,400.00	640,000,000.00	660,000,000.00
2	UKM	462,332,900.00	598,566,400.00	513,407,900.00	620,000,000.00	595,300,000.00
3	USM	695,212,400.00	611,974,500.00	874,305,600.00	746,500,000.00	753,500,000.00
4	UPM	542,054,900.00	621,481,000.00	558,628,600.00	603,500,000.00	605,500,000.00
5	UTM	369,176,000.00	450,431,400.00	412,549,300.00	546,400,000.00	543,700,000.00
6	UUM	160,195,000.00	202,167,200.00	196,413,700.00	231,600,000.00	236,600,000.00
7	UIAM	314,394,700.00	351,923,000.00	337,425,900.00	416,468,000.00	414,460,000.00
8	UNIMAS	166,686,000.00	185,574,300.00	170,226,700.00	191,000,000.00	190,410,000.00
9	UMS	254,549,140.00	253,663,400.00	237,876,100.00	261,550,000.00	266,550,000.00
10	UPSI	102,201,000.00	128,017,500.00	111,239,200.00	140,504,000.00	149,010,000.00
11	UiTM	1,549,988,200.00	1,725,623,000.00	1,514,577,700.00	1,642,000,000.00	1,642,000,000.00
12	UniSZA	81,700,000.00	102,988,100.00	80,523,100.00	108,975,000.00	108,975,000.00
13	USIM	80,456,900.00	92,856,000.00	80,636,000.00	109,500,000.00	107,500,000.00
14	UTHM	235,925,400.00	265,070,100.00	217,936,800.00	227,700,000.00	223,700,000.00
15	UMT	70,577,500.00	122,600,000.00	96,760,000.00	131,660,000.00	131,660,000.00
16	UTeM	158,965,000.00	182,678,200.00	163,887,900.00	180,434,000.00	180,434,000.00
17	UniMAP	118,113,200.00	173,157,000.00	143,454,500.00	176,000,000.00	178,000,000.00
18	UMP	150,985,000.00	202,708,200.00	140,143,600.00	185,900,000.00	183,900,000.00
19	UMK	21,163,357.00	74,911,400.00	57,913,500.00	63,000,000.00	63,000,000.00
20	UPNM	26,000,000.00	65,376,800.00	42,810,100.00	69,868,000.00	69,368,000.00
Total		6,026,088,097.00	6,993,899,300.00	6,504,816,600.00	7,292,559,000.00	7,303,567,000.00

Source: Ministry of Higher Education, Malaysia

Table 2.4: Expenditure on Maintenance of Public University Buildings

Year	Expenditure (RM)
2004	338,529,567
2005	470,480,191
2006	508,921,700
2007	580,491,662
2008	619,229,160
Total	**2,517,652,280**

Source: Lateef *et al.* (2010a)-adapted from data obtained from the Ministry of Higher Education Malaysia

The maintenance of public universities' is managed and carried out by Department of Development and Maintenance. Most of the Department of Development and Maintenance of the universities are divided into administrative division, maintenance and upgrading division, development division, contract division and services division. Maintenance works are responsible by maintenance and upgrading division which is usually consists of 5 units that responsible for management of facility maintenance and building campus, landscaping and infrastructure for the entire campus, upgrading and renovation. The 5 units are civil unit, electrical unit, mechanical unit, landscape unit and renovation unit. Electrical unit is responsible for maintenance of Closed-circuit television (CCTV), telecommunication and automation systems, Low Tension (LT) Switchboard, replacement of light fittings, light tubes and bulbs, rewiring, servicing of Building Automation System (BAS) and many other electrical and electronic systems. On the other hand, mechanical unit is responsible for installation and maintenance of air-condition system, fire-fighting system, lift system, transport system and water-cooler system while civil unit in-charge for maintenance, repair and replacement of building components and finishes, external works such as roads, pavements, rivers and walkways, civil infrastructure works such as water tank, reservoir and sewerage system,

cleaning of buildings and toilets, pest control and painting work. Furthermore, landscape unit is responsible for road sweeping and roadside drains cleaning, grass cutting, landscaped area weeding and trimming as well as pressure jet cleaning to footpaths, covered walkways and bus stops while renovation unit is responsible to plan and carry out renovation work in the university.

On the other hand, administrative division in charge for administration tasks, human resources management and financial training and quality while development division is responsible to plan and implement the overall physical development and infrastructure to meet the needs of universities. Contract Division is required to provide project planning advice, prepare and administer contract, responsible for procurement management, managing payments and act as contract administration solutions to the Development Division, Maintenance and Upgrading Division as well as Service Division. Finally service division manage services available in the universities such as vehicles, space rental and other services provided by the university.

2.4 PROCUREMENT METHOD

According to Love *et al.* (2002) and Adekunle (2009), procurement is defined as "an organisational system that assigns specific responsibilities and authorities to people and organisations". Procurement system of a project is a key factor which contributes to the overall client satisfaction and project success. This is supported by Cheung *et al.* (2001) which stated that procurement determine the overall framework embracing the structure

of authorities and responsibilities for the project participants which becoming the key factor contributing to project success. Therefore, the selection of the most appropriate procurement strategy is very critical for the clients and also the project participants.

Procurement method also outlines the relationships of the numerous elements involved in the project (Love *et al.*, 1998). Ibbs and Chih (2011) agreed that procurement method defines the process by which the design, finance, maintenance and operation activities of a project are implemented. Besides, procurement method also outlines the responsibilities and roles of the parties involved in a particular project (Ibbs and Chih, 2011; Love *et al.*, 1998; Miller *et al.*, 2000).

In addition, Masterman (1996) explained that project procurement act as the organizational structure where a group of people are brought together and organized systematically in term of their responsibilities, duties, roles and interrelationship between them. According to Walker and Hampson (2003), the procurement available for client can be viewed through a relationship risk or cost risk perspective. The initial tender cost can be fixed with all risk being absorbed by the contractor. Alternatively, the client can absorb a cost risk by letting variables sum contract and adopting an open book philosophy in which incurred costs are verified or a formulated schedule of agreed rates for various aspects of work is agreed upon.

On organization point of view, a sourcing strategy is to be considered for the achievement of cost reduction, improved quality, satisfy client and building tenant's needs, flexible on controlling manpower and quicker responses against technical problem (Usher, 2003 and Sheng 2012). Sheng (2012) pointed out that within this organization perspective, the organization can either be a building owner or property management consultant where both group of businesses will be involved in making any sourcing or procurement decisions. Sheng (2012) further highlighted that several factors in valuation on the appropriateness of different sourcing strategies towards the property maintenance and management services for certain buildings which include:-

- ✓ Total operation cost or fees of specialist services
- ✓ Promptness of reaction upon occurrences of major or critical issue
- ✓ Extent of supporting various specific needs of organization
- ✓ Extent of responsibility attached with organization
- ✓ Extend of transferring risk and liability from organization
- ✓ Extent of flexibility in controlling and altering the operation process

Luu *et al.* (2003a) highlighted several critical principles in selecting appropriate procurement method which include:-

- ✓ Adequately and accurately accounting for various characteristics, requirements and conditions unique to a client, project and external environment so that the success of the project is not the result of a mere chance but direct and guaranteed contribution of the derived procurement system.

- ✓ Clearly addressing the implicit interrelationships of procurement selection criteria that describe the distinctive characteristics of the client, project and external environment.
- ✓ Providing a procurement method solution that truly reflects industry practice.
- ✓ Providing users with confidence in adopting the derived solution through the provision of likely outcomes.

Different procurement method will have different effect on the time, quality and cost of the project therefore it is very crucial to consider all factors in the selection of the most appropriate procurement strategy. This is because each type of procurement system has its own feature and peculiarity that will have effect on the quality, cost and time of the project which is more likely to be known as project performance. Thus, selecting an appropriate procurement method is very essential to obtain optimum project performance.

2.5 PROCUREMENT METHOD IN BUILDING MAINTENANCE

Wordsworth (2001) defined maintenance procurement as "the process by which required maintenance works are carried out". The procurement process is concerned with the form of procurement whether by contract or direct labour and the quality of delivery of both the work carried out as well as the level of service provided. RICS (2009) highlighted that under a comprehensive maintenance procurement plan, all of the elements of building maintenance need to be addressed through some form of contract

strategy.

Lateef *et al.* (2011a) claimed that the procurement system for building maintenance in universities in Malaysia can be categorized into four categories; in-house, outsource, combination of in-house and outsource and others. The findings from his study revealed that a most of the universities prefer to outsource the larger part of the maintenance services. It was claimed that outsourcing the maintenance function reduces maintenance to corrective maintenance.

Sheng (2012) stated that procurement strategy for a particular building is always subjective and would depend on the nature of building, culture and objective of organization. He further suggested that organization should evaluate all factors and any other aspects that can aid in making wise sourcing strategy in order to minimize the risk associated with adoption of inappropriate sourcing decision. Thus, the present study aims to identify all the procurement selection criteria to evaluate the available procurement method in order to select the most appropriate procurement method.

Maintenance work range from very large maintenance projects to very small maintenance task. Subsequently, many different types of procurement methods have been developed to overcome the weaknesses of the existing procurement method and meet the range of services requirement. The main differences between the various types of procurement strategies lie in the methods of evaluating the work and the degree of financial risk borne by the contractor and the client respectively (Wordsworth, 2001).

There were 14 types of procurement methods methods identified through literature review for building maintenance which are discussed in section 3.2 of this chapter but only 13 types of procurement strategy will be considered in this research because direct labour which is also known as in-house as discussed in section 3.2.1 will not be included in this present study.

2.5.1 Direct Labour or Inhouse (Minimal outsourcing)

Wordsworth (2001) defined in-house as "a service is provided by a dedicated resource directly employed by the organization, monitoring and control of performance is normally conducted under the terms of conventional employer or employee relationships, although internal service-level agreements may be employed as regulating mechanisms". In other words, the organization employed operatives within the maintenance management organization to maintain the building in an acceptable standard. Hui and Tsang (2004) agreed and mentioned that in-house is the management process of performing a service by in-house staff. This is supported by Musa (2011) that there were many organisations that directly employed all the staff to run and maintain the building. However, these organisations will buy in specialist services such as Mechanical and Electrical (M&E) and lift maintenance.

The client organisation usually employ direct labour under the terms of conventional employee relationship to monitor and control the performance of maintenance services whereby there are some services that being outsourced as shown in Figure 2.6 (Barret and Baldry, 2003; Musa, 2011 and William 2003). William (2003) agreed that presently

there were very less organisations that employ 100% in-house operation but if it really exists, it is not on a large scale.

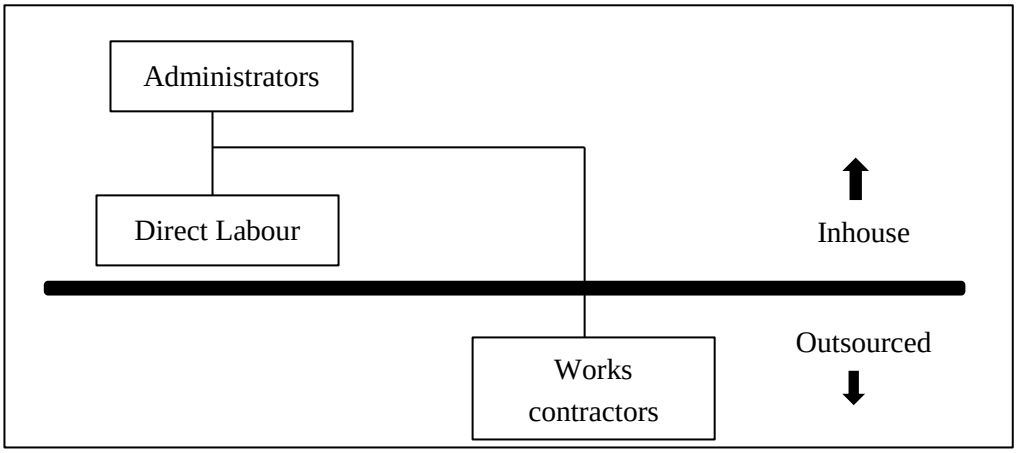

Figure 2.6: Direct Labour Organisation
Source: Musa (2011) and William (2003)

According to Sheng (2012), in-house strategy is deemed to be the most fundamental and traditional strategy for the delivery of property management and maintenance services. The operation staffs who are employed directly by the organization are recognized as part of the organization with no existence of service contract tying the relationship together except the ordinary employment contract. Through in-house strategy, the assigned property manager will need to plan, execute, coordinate and control the team members' work. Internal communication will take place both laterally and vertically. Moreover, mistakes and lessons learnt from past experience are shared among the team and members of the organization groups. The advantages and disadvantages of in-house strategy are highlighted in Table 2.5.

Table 2.5: Advantages and disadvantages of In-house strategy

Advantages	Disadvantages
Retain the authority to manage	Involve cost providing staff training
Secured confidentiality of information from disclosing to other party	Inflexibility in control variation in staff employment
Prompt responses upon emergency circumstance	Retained risk and liability
Retain internal expertise	Unavailability of complex technical support
Better responsibility and accountability owing to the degree of ownership and loyalty to organisation	Initial investment of necessary tools and equipment

Source: Sheng (2012) and Lau and Zhang (2006)

Hui and Tsang (2004) stated that the building manager would prefer to adopt the conventional approach of insourcing if resources were not a constraint. The building manager can retain the appropriate size of the organization and enjoy the convenience of people deployment. In response to changes in the business environment, the manager has full control over measures of intervention such as re-training, re-structuring and investment in assets. In addition, Yik and Lai (2005) stated that most building owners employ in-house maintenance personnel to carry out maintenance work to ensure adequate services is provided for building occupants especially when problems requiring immediate attention arise. In-house maintenance ensures a prompt response to urgent calls for remedial action and allows close monitoring of the quality of the maintenance work.

However, Hui and Tsang (2004) claimed that it is not economically viable if the inhouse manpower cannot be fully utilized most of the time. This is agreed by Yik and Lai (2005) that it is not economical to have an in-house team that can deal with every aspect of maintenance work as those aspects that require specialists or registered

contractors are typically outsourced. They further highlighted that the extent of outsourced maintenance work, both in terms of the the expenditure on it and scale of the work, is small compared to the work that is conducted by in-house teams (Yik and Lai, 2005).

As discussed earlier, presently there were very less organisations that employ 100% in-house operation because several specialist services required to be outsourced to specialists or registered contractors. Thus, this research will be mainly focusing on assisting the universities organization that wish to outsource the services. Direct labour which is also known as in-house was not included in this present study.

2.5.2 Outsourcing

Outsourcing can be defined as "the contracting-out of services that were previously performed in-house" (Ancarani and Capaldo, 2005). Hui and Tsang (2004) explained that outsourcing is a whole package of support function is off-loaded to an external service provider. In addition, outsourcing means "service is commissioned from an external supply organization which is usually under the terms of a formal contractual arrangement based upon terms and conditions derived from a service level agreement, there may be several of these contractual relationships operating in parallel for a range of services from a variety of suppliers" (Ancarani and Capaldo, 2005 and Atkin and Brooks, 2005).

Sheng (2012) stated that outsourcing prepares the organization to engage an external specialist for the provision of certain specialized trade of service under contract basis. Contract will often be awarded based on justification through a competitive tender or fee proposal from more than one shortlisted specialist. The successful and appointed external specialist from the tender exercise shall report to and be monitored by representative who is assigned with such responsibilities and will be the internal employee of the organization. Thus, the representative is responsible for the work performance and outcome of the outsourcing services (Hui and Tsang, 2004). Sheng (2012) highlighted outsourcing strategy has advantages and disadvantages. For instance, the cost of training can be avoided through outsourcing but the organisations unable to retain such internal expertise. The advantages and disadvantages of outsourcing are shown in Table 2.6.

Table 2.6: Advantages and disadvantages of outsourcing strategy

Advantages	**Disadvantages**
Organisation can focus on core competencies	Loss of authority to manage
Trained and experiences team for better quality of service	Additional services and resources charged at extra cost
Free access to special know-how	Unable to retain internal expertise
Eliminate the cost of training provision for internal employee	Greater risk to the confidentiality and security of data
Risk and liability avoidance	Diminished the accountability through intricate web of subcontracting

Source: Sheng (2012) and Hui and Tsang (2004)

Hui and Tsang (2004) also highlighted the advantages and disadvantages of outsourcing in many different aspects which is shown in Table 2.7. Hui and Tsang (2004) noted that outsourcing is a widely researched topic in supply chain management, strategic management, manufacturing, services and operations management but one has to be

aware of the advantages and disadvantages of outsourcing when it is applied to asset maintenance. A main challenge of outsourcing is managing the risk of service agents' opportunism (Hui and Tsang, 2004). Hui and Tsang (2004) quoted from Williamson (1975) defines opportunism as "self-interest seeking with guile". The examples of opportunistic behaviors given by Hui and Tsang (2004) are contract violations by way of poor workmanship, taking advantage of the client's dependence to maximize short-term gains and reluctance to meet new requirements of the client.

Table 2.7: Advantages and disadvantages of outsourcing asset maintenance

	Advantages	Disadvantages
Maintenance strategy	Focus on core competencies	Need to manage opportunism
Customer service	Improved accountability	Slower response
Financial impact	Cost saving	Increased contract cost
Internal processes	Operational flexibility	Loss of control
Innovation and learning	Access to special know-how	Lack of staff training

Source: Hui and Tsang (2004)

Outsourcing has increasingly become an important approach that can significantly assist organizations to leverage their skills and resources to achieve greater competitiveness (Lau and Zhang, 2006; Quinn and Hilmer, 1994; Weston, 1996). Lau and Zhang (2006) stated that outsourcing strategy enable organizations to gain competitive advantage through cost reduction and improved responsiveness to changing business environment and market demand. In addition, Lau and Zhang (2006) had carried out a study related to outsourcing which highlighted the obstacles and problems of outsourcing as well as the objectives and anticipated outcomes of outsourcing which are showed in Table 2.8 and Table 2.9.

Outsourcing is a supply strategy often chosen as a means of increasing organizational effectiveness and efficiency (Ancarani and Capaldo, 2005 and Steane and Walker, 2000). The organization can devote its scarce resources to develop its core competencies in a bid to sustain competitive advantages through outsourcing (Hui and Tsang, 2004 and Tsang, 2002). However, there are some risks of outsourcing which include losing in-house expertise and knowledge (Boston, 1996), unintentional loss of control and reductions in quality (Boston, 1996; Lei and Hitt, 1995 and Ancarani and Capaldo, 2005). According to Hui and Tsang (2004), a study of the failure cases has revealed that some of the outsourcing should have been administered from a strategic perspective. They also mentioned that there should have been more input from the client organization in some situations.

In some situations, outsourcing the services of an entire function might be more expensive to the company and might be risky from a strategic perspective (Hui and Tsang, 2004 and Dubbs, 1992). Hui and Tsang (2004) noted that outsourcing the services of an entire function all at once may not be in the best interest of the company if slower response cannot be tolerated, quality of outcome is essential or the skill set is important for development of future capabilities.

Table 2.8 Objectives and anticipated outcomes of outsourcing

Factor	**Objectives or anticipated outcomes**
Economic factors	
Cost reduction	To improve profitability
	To improve operating efficiency
	To add value to product
Cost saving	To improve cash flow
	To increase efficiency
Capital investment reduction	To make capital funds more available for core areas
	To improve return on assets
Strategic factors	
Acceleration of business process re-engineering	To improve performance
	To achieve competitive advantage
Focus on core competence	To improve business focus
	To increase competitiveness
	To leverage the firm's skills and
	resources
	To enhance customer satisfaction
Flexibility enhancement	To reduce constraints of organization's own productive capacity
	To convert fixed costs to variable costs
	To increase responsiveness to market change
	To reduce risks
Environmental factors	
IT development	To meet increasing demand for new information systems and resources more efficiently and economically
Globalization	To help companies gain global competitive advantage
Capability of supplier	To enable partnering to improve service quality and customer service and increase competitive advantage

Source: Lau and Zhang (2006)

Table 2.9: Main obstacles and problems of outsourcing

Obstacles and problems	**Impacts**
Loss of control	Loss of core competencies
	Risks of alienating customers
Loss of critical skills	Loss of competitive advantage
	Increased number of competitors
Inadequate capabilities of service provider	Loss of competitive advantage
Loss of flexibility	Reduced responsiveness
	Risks of alienating customers
Failure to realize hidden costs of contract	Increased operating cost
Difficulty in obtaining organizational support	Increased chances of failure
Indecisiveness on which activities to outsource	Increased chances of failure
Inadequate cost and benefit analysis systems	Lower return on investment
	Loss of competitive advantage
Fear of job loss	Increased resistance to change
	Lower staff morale

Source: Lau and Zhang (2006)

Yik and Lai (2005) stated that specialist contractors should be able to deliver the required services more economically due to their comparative advantage over in-house teams in the following aspects:

- Specialist contractors should be able to organise and manage the work more efficiently. The building owners will also be freed from such tasks to concentrate on their own core businesses.
- The overhead costs for the organisation and management of the work will be lower by virtue of economies of scale.

- Contractors' specialist knowledge can help building owners run their plant more efficiently and thus save running costs.
- Contractors can source equipment and spare parts more easily and promptly, which will help reduce downtime and enhance the reliability of plant and likewise in the recruitment of appropriate manpower.
- Contractors are in a better position to bargain with suppliers of replacement equipment and spare parts and are able to optimise the stock of spare equipment and parts which will help reduce the associated costs.

Outsourcing can trade of service under several types of contract. Chanter and Swallow (2007) explained that each type of contract designed to fit a particular set of circumstances and the major differences between various types of contract relate to the methods of evaluating work and the degree of financial risk to be borne by the parties. The types of contract that can be trade of under outsourcing include:-

(i) Lump Sum Contract

Lump sum contract exist when the contractor agree to carry out the work for an agreed sum. It is usually based on information obtained and derived from drawings, specifications, bills of quantities or site inspection. This type of procurement strategy is chosen when the works are predetermined and it is most suitable for planned maintenance programme where all the works are carried out according to the plan and schedule (Wordsworth, 2001).

In addition, Chanter and Swallow (2007) further explained that the contractor agrees to execute the whole of the work for a stated lump sum which is based on firm quantities, specifications and drawings. Chanter and Swallow (2007) also claimed that the clients' level of risk is minimized under this type of contract because supposedly there is sufficient information available prior to the tender stage to permit accurate preparation of firm bill of quantities and specification. However, this type of contract is also claimed to be inappropriate because many cases contract documentation is founded on imprecise information.

However, Straub (2007) highlighted that lump sum contract lack of flexibility in maintenance scenario. It is not suitable for building managers that employ own maintenance staff and that want to be kept in control of the maintenance process for a certain extent. In fact, if the performance agreement last for many years, it will be more risky for the contractor to meet the agreed performances. As the result, the contractor that assume greater risks will definitely charge higher prices.

(ii) Term Contract

Outsourcing under term contact, the contractors have to carry out the agreed work within certain limits of cost and certain period of time (Wordsworth, 2001 and Chanter and Swallow, 2007). The administration of Measured Term Contract, Specialist Term Contract and Day work Term Contract can be expensive if the employer chooses to check the measurement of 100 per cent of the works undertaken by contractors. For this reason, a sampling process is commonly used comprising a proportion of, 10 per cent to

20 per cent of orders raised. If such sampling shows a disproportionate rate of error then the sampling percentage should be increased. Sampling should be random with no prior indication given to the contractor. Term contracts typically have duration of between two and three years (RICS, 2009). There are typically four types of term contacts as described below:-

(a) Measured Term Contract

Measured term contract which is also known as measure and value contract is beneficial for project that has details area which are not adequate to allow the preparation of an accurate specification at the time of commencing work (Wordsworth, 2001). Under this form of contract, a detailed schedule of priced activities forms the bidding document against which each contractor tenders an adjustment percentage. Work undertaken by the successful contractor is measured on completion and valued by reference to the tender. It deals with managing and providing the service, as opposed to managing a project. When used in the public sector it is designed to be used for all contracted-out services, whether they include a physical element or not (RICS, 2009).

(b) Specialist Term Contract (STC)

The Specialist Term Contract is directly comparable to the Measured Term Contract but is defined on a narrow basis for specialist tasks such as asbestos removal, lift maintenance or single trades such as roofing, tarpaving, redecorations and other (RICS, 2009).

(c) Day work Term Contract (DTC)

This is a similar arrangement to the Measured term contract and the Specialist Term Contract, but is designed for situations where a task cannot be identified and scheduled in advance and where a 'cost plus' or day works basis is the fairest way of reimbursing contractors. Caution needs to be given when utilising dayworks as there is no incentive for a contractor to be economical with labour resources. This type of contract should be seen as a last resort or used for tasks of high specialism and uncertainty (RICS, 2009).

(d) Tendered Schedule Term contract

Under this arrangement, contractors tender against a priced schedule of activities as under the measured term contract. This schedule is then used as a basis for measuring in advance the contract price for a maintenance contract. This effectively becomes a lump-sum project contract and it has the advantage of ensuring an element of competition in the price while reducing the overall contractor selection period. Payments are measured, valued and certified as the works proceed in the conventional way. This type of contract would be used primarily when time is short and it can reduce the overall pre-contract stage by running the design and tender stages together, based upon an approximate quantities guide (RICS, 2009).

(iii) Repair and Maintenance Contract (RMC)

This contract is suitable where the work involves the repair and maintenance of a building or where no independent contract administrator is to be appointed. It is not suitable for periodic repair or maintenance over a fixed term, the regular maintenance of

plant or for work on a dwelling by a residential occupier (RICS, 2009).

(iv) Cost Reimbursement Contract

Chanter and Swallow (2007) stated that the contractor is reimbursed for the actual prime costs of labour, materials and plant used plus eiher a previously agreed percentage or a fixed fee to reimburse him for his management costs, overheads and profit under this form of contract. This is agreed by Wordsworth (2001) that this is a contract where the contractor executes the work and the charges include the prime cost of labour and material plus either a previously agreed percentage or a fixed fee to cover overhead charges and profit.

Chanter and Swallow (2007) further claimed that the disadvantage of this type of contract is the absence of an incentive for the contractor to keep his costs down. Thus, this type of contract is retricted to small or uegent jobs where the necessity to execute work very rapidly provides insufficient time to produce precise documentation and the degree of risk to the client can be justified. This type of contract requires a reputable contractor who is known by the client so that it can limit the risk.

(v) Service Level Agreement

A method used intended to reduce the considerable amount of paperwork involved in administering the other types of contract where the administrative cost can exceed the cost of actually executing the work (Wordsworth, 2001).

2.5.3 Out-tasking

Out-tasking is defined as "a management process whereby specific tasks, as opposed to a whole package of support function in the case of outsourcing, are performed by a contractor". Out-tasking is a common practice in the field of facilities management where its usage outnumbers that of outsourcing (Hui and Tsang, 2004 and Kleeman, 1994). Hui and Tsang (2004) pointed out that it is important to understand what to contract out, how to manage the process, what options are available and who should do it in out-tasking.

According to Hui and Tsang (2004), the company usually employs a small number of staff to serve as coordinators between internal customers and the external service provider when outsourcing is practised. This is in contrast to out-tasking where the internal staff members play a proactive role of planning and initiating service activities and leading the external service provider for delivery of the needed service. Thus, the internal personnel are fully responsible for the consequences of out-tasking. Hui and Tsang (2004) outlined the similarities and differences between out-tasking and outsourcing which is shown in Table 2.10.

Table 2.10: Comparison between outsourcing and out-tasking

Comparison		Outsourcing	Out-tasking
Similarities	Choice between buy or make	Buy	Buy
	Expected impact	Saving in headcount	Lean organization
Differences	Scope of work	Entire function of maintenance	Part of maintenance
	Duration	Medium to long	Short
	Control	Contract administration	Contractor management
	Size of contractor	Large	Small
	Role of in-house staff	Coordinating	Proactive

Source: Hui and Tsang (2004)

Hui and Tsang (2004) claimed that out-tasking is recommended as the risk of default by the service agent is lower. The sourcing company will still be in control as it maintains a small team of in-house staff with the capability to take over the task in case things have gone away. Besides, the time period of a service contract can be as short as a single transaction. There is always the opportunity for the company to change service agent or renegotiate the service agreement if the service agent fails to deliver the required level of performance.

2.5.4 Public Private Partnership (PPP)

Public Private Partnership (PPP) is "a partnership or strategic alliance has been formed between the organization and service provider based on a sharing of the responsibility for the delivery and performance of the service, including the sharing of the benefits arising from any efficiency gains and cost savings" (Ancarani and Capaldo, 2005 and Atkin and Brooks, 2005).

2.5.5 Total Facilities Management (TFM)

A whole range of services are bundled together and externalized to a single supplier which becomes totally responsible for the monitoring, control, delivery and attainment of performance objectives which relate to operational benefit (Ancarani and Capaldo, 2005 and Atkin and Brooks, 2005).

2.5.6 Traditional

Straub (2007) stated that the majority of maintenance projects adopted traditional procurement method where three to five competitive bids are solicited and the lowest tender price will be chosen. Espling and Olsson (2004) claimed that traditional procurement produce low productivity, litigation, an adversarial environment and a reduced ability to absorb technological and business process innovations. There are also lacks of cooperation between the parties involved which can be seen in the Figure 2.7 below.

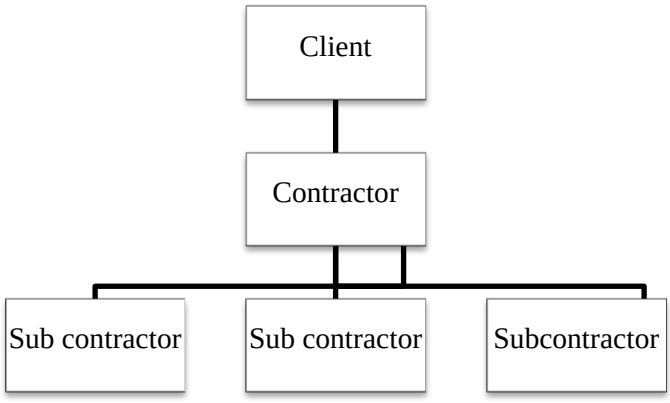

Figure 2.7: The traditional way of contracting out a project
Source: Espling and Olsson (2004)

2.5.7 Partnering

Espling and Olsson (2004) defined partnering as "a managerial approach used by two or more organisations to achieve specific business objectives by maximising the effectiveness of each participant's resources". The approach is based on mutual objectives, an agreed method of problem resolution and active search for continuous measurable improvements (Espling and Olsson, 2004 and Bennet and Jayes, 1995). In addition, Espling and Olsson (2004) also highlighted several advantages of partnering such as reduce claims and litigation, reduce cost up to 30 per cent, improve project quality and the projects can be completed on time. The partnering way of contracting out a project can be referred to the Figure 2.8 below.

Partnering is becoming increasingly used for procurement of maintenance services. RICS (2009) highlighted from the Construction Industry Institute defined partnering as "a long-term commitment between two or more organisations for the purpose of achieving specific business objectives by maximizing the effectiveness of each participant's resources". This requires changing traditional relationships to a shared culture without regard to organisational boundaries. The relationship is based on dedication to common goals, trust and an understanding of each other's individual expectations and values. Expected benefits include cost effectiveness and improved efficiency, the continuous improvement of quality products and services and increased opportunity for innovation. It should be noted that these types of arrangements do not create a business partnership (RICS, 2009).

In addition, partnering is more challenging than conventional tendering as it requires recognition of interdependence between contractors and clients, open relationships, an ongoing commitment to improvement and effective measurement of performance (Straub, 2007 and Egan, 1998).

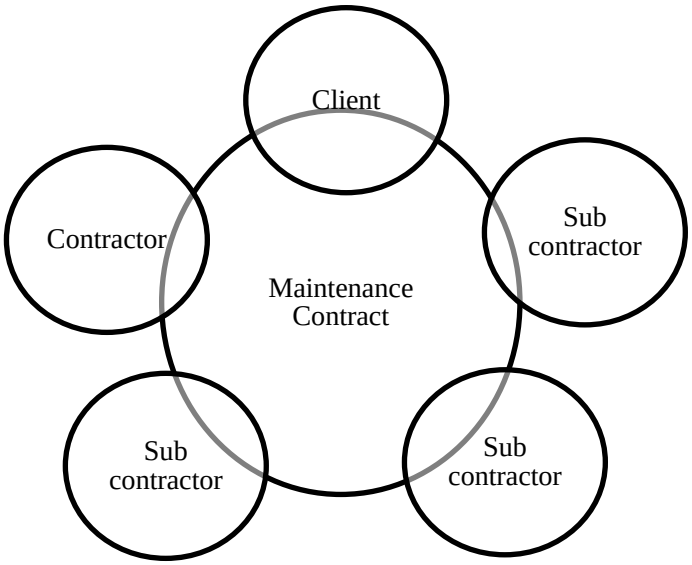

Figure 2.8: The partnering way of contracting out a project
Source: Espling and Olsson (2004)

Through the analysis of procurement methods from previous research, it can be seen that there are similarity which can be seen in Table 2.11. As mentioned earlier, this research mainly will be mainly focusing on assisting the universities organization that wish to outsource the services. Direct labour which is also known as in-house was not included in this present study. The final list of procurement methods identified and will be considered in the present study can be referred to Table 2.11.

Table 2.11: List of procurement methods identified

No.	Abbreviation used	Main type of Procurement	Abbreviation used	Sub type of Procurement	Wordsworth (2001)	RICS (2009)	Hui and Tsang (2004)	Ancarani and Capaldo (2005)	Atkin and Brooks (2005)	Straub (2007)
1	A1	Outsourcing	A1.1	Lum Sum Contract	√					√
2			A1.2	Term Contract						
			A1.2.1	Measured Term Contract (MTC)	√	√				
3			A1.2.2	Specialist Term Contract (STC)		√				
4			A1.2.3	Day work Term Contract (DTC)		√				
5			A1.2.4	Tendered Schedule Term contract		√				
6			A1.3	Repair and Maintenance Contract (RMC)		√				
7			A1.4	Cost Reimbursement Contract	√					
8			A1.5	Service Level Agreement	√					
9	A2	Out-tasking					√			
10	A3	Public Private Partnership (PPP)						√	√	
11	A4	Total Facilities Management (TFM)						√	√	
12	A5	Traditional								√
13	A6	Partnering				√				

2.6 PROCUREMENT SELECTION CRITERIA

Luu *et al.* (2003a) carried out a research and confirmed that it is essential to establish a list of Procurement Selection Criteria (PSC) before various procurement options were evaluated. This is agreed by Morledge *et al.* (2006) that a list of factors or criteria should be considered when evaluating the most appropriate procurement strategy. Procurement Selection Criteria (PSC) should reflect the characteristics and requirements of the client, project and external environment (Luu *et al.*, 2003a; Kumaraswamy and Dissanayak, 2001 and Ambrose and Tucker, 1999). This statement is agreed by Ng *et al.* (2002) and Masterman and Gameson (1994) which stated that the selection of an appropriate procurement system depends largely on the accurate identification of client requirements. Ambrose and Tucker (1999) supported that the needs of the client and the characteristics of the project are essential to be considered in determining procurement system. However, Luu *et al.* (2003b) argued that there were three constraints that were client characteristics, project requirement and external environment must be considered before selecting procurement strategy.

The procurement selection criteria were usually divided under some main criteria or factors such as clients' requirements which is known as clients' characteristics and objectives (owner's needs and preferences), project characteristics and external environment. The grouping of procurement selection criteria had similarity through the analysis of previous research which can be seen in Table 2.12.

Table 2.12: Main Procurement selection criteria

Main Criteria	Luu *et.al.* (2003b)	Ratnasabapathy and Rameezdeen (2007)	Al Khalil (2002)
Clients' requirements and characteristics	√	√	√
Project characteristics	√	√	√
External environment or factors	√	√	

Source: Luu *et.al.* (2003b), Ratnasabapathy and Rameezdeen (2007) and Al Khalil (2002)

Through the analysis of procurement selection criteria of previous research, there were similarities from the previous research done by other authors which can be seen in Table 2.13. There were 26 criteria identified to be considered in this research which were divided into three main categories that were clients' requirements, project characteristics and external environment or factors which can be referred to Table 2.14.

Table 2.13: Procurement selection criteria

	Criteria	Luu *et al.* (2003a)	Cheung *et al.* (2001)	Ng *et al.* (2002)	Hibberd and Djebarni (1996)	Hashim *et al.* (2006)	Al Khalil (2002)	Alhazmi and McCaffer (2000)	Love *et al.* (1998)	Luu *et.al.* (2003b)
1	Speed		√	√	√				√	
2	Time certainty	√		√	√	√	√	√	√	
3	Price/Cost certainty	√	√	√	√	√	√	√	√	
4	Degree of complexity		√	√		√	√	√	√	
5	Degree of flexibility	√	√	√			√	√	√	√
6	Responsibility		√	√		√	√	√	√	
7	Risk allocation/avoidance	√	√	√	√	√			√	√
8	Quality level		√	√		√			√	√
9	Price competition	√	√	√		√			√	√
10	Public accountability			√						
11	Political issues/constraint			√						√
12	Intuition and past experience of the decision maker	√		√						√
13	Dissatisfaction with previous process used				√					
14	Knowledge of the strategy				√					
15	Culture									√
16	Objective or policy of organization			√						
17	Working relationship				√					
18	Government policy	√				√				
19	Clarity of scope						√			
20	Existing building condition						√	√		
21	Involvement of owner in the project									√
22	Disputes and arbitration			√					√	
23	Experienced contractor availability									√
24	Client’s in house technical capability									√
25	Client’s financial capability									√
26	Project size									√

Table 2.14: Procurement Method Selection Criteria

Criteria			
C 1	**Client Requirements and Characteristics**		
C 1.1	Experienced contractor availability	C 1.11	Involvement of owner in the project
C 1.2	Quality level	C 1.12	Working relationship
C 1.3	Knowledge of the strategy	C 1.13	Intuition and past experience
C 1.4	Degree of responsibility	C 1.14	Client in house technical capability
C 1.5	Client's financial capability	C 1.15	Price or cost certainty
C 1.6	Price competition	C 1.16	Risk allocation or avoidance
C 1.7	Time Certainty	C 1.17	Dissatisfaction with previous process
C 1.8	Speed	C 1.18	Degree of complexity
C 1.9	Public accountability	C 1.19	Degree of flexibility
C 1.10	Clarity of scope		
C 2	**Project Characteristics**		
C 2.1	Existing building condition	C 2.2	Project size
C 3	**External environment/ factors**		
C 3.1	Objective or policy of organization	C 3.4	Political issue/constraint
C 3.2	Government policy	C 3.5	Cultural differences
C 3.3	Dispute and arbitration		

2.6.1 Client Requirements and Characteristics

Hashim *et al.* (2006) explained that there are two types of clients that are public and private clients. Public clients comprise of government-funded development agencies and local authorities while private clients comprise of owner-occupiers, property developers and investors. Public and private client have different needs and requirements. According to Hashim *et al.* (2006), public client more emphasize on the quality factor than the private clients in selecting procurement strategy because the projects are funded by the government and the functionality quality of the projects is more important to the client while the private clients do not consider quality to be an important criterion as factors of time certainty, value for money and accountability are more important to them.

2.6.1.1 Experienced contractor availability

Luu *et al.* (2003b) stated that it is essential to identify the availability of experienced contractors to perform the procurement method or the available experts to perform the task before selectiong procurement method. The decision makers need to consider whether there are available contractors that have experience in carrying out the tasks.

2.6.1.2 Quality level

Hashim *et al.* (2006) defined quality as "the degree to which a set of inherent characteristics fulfill client's requirements". Thus, the quality level required is determined by the client. Ng *et al.* (2002) highlighted that a more strict supervisory and checking process must be adopted to ensure better quality. In addition, an individual would expect that the price and speed should be more flexible to provide the quality standard required (Ng *et al.*, 2002).

2.6.1.3 Knowledge of the strategy

Moody (1983) claimed that the decision maker tend to use the knowledge he has to make desion. He further stated that knowledge is very important in making decision because the decision maker needs to seek for advice from experts in the absence of knowledge. Hashim *et al.* (2006) stated that familiarity with the various types of procurement strategy available is another factor that is affecting the selection of procurement method because the decision maker are not confident to use other procurement strategy as they are reluctant to change their mindset and take financial risk in case of failure of the new method.

2.6.1.4 Degree of Responsibility

Different type of procurement strategy has different way of responsibility allocation. Some procurement methods have single point responsibility while other procurement method may require the involvement of in-source personnel. Ng *et al.* (2002) explained that responsibility is directly related to the degree of control over the procurement process and client involvement. Some clients more prefer to have a single point of responsibility in order to reduce the risk they need to have. Cheung *et al.* (2001) stated that responsibility reflects the clarity of responsibility allocation. There are some procurement method do not have clear responsibility allocation where the parties involved are not clear of their scope of job or task. Hashim *et al.* (2006) noted that the responsibility criterion is less important for public clients in the selection of procurement strategy because public clients will have to conform to the needs of the publicly funded bodies to choose the lowest price for the project as well as satisfying public accountability but responsibility criterion is important for private clients as they focus more on criteria such as time frame, accountability and value for money.

2.6.1.5 Client's financial capability

The decision makers need to consider the financial capability of the clients to perform certain procurement method. Yik and Lai (2005) claimed that the budget for maintenance different for each type of building. It depends on the location of the property and class, which fix the management fee and rental rate that the building owner can charge the tenants where the higher the revenue, the greater the budget that

can be allocated. If the building owner has greater budget, thus client's financial capability is not an issue in selecting procurement method.

2.6.1.6 Price competition

Competition of price refers to "the degree of price competition associated with the procurement options" (Cheung *et al.*, 2001). Ng *et al.* (2002) proved in his study that price competition was vague as the definitions of low or high price competition would vary with different clients. Some client regarded saving of 10% of the originally estimated project sum due to competitive tendering activities as high price competition but some client may expect saving up to 15% or 20% is reasonable. Hashim *et al.* (2006) claimed that price competition is essential to the public clients because of public accountability, that often require them to obtain competitive tenders and also mainly due to their focus on obtaining the lowest price for a project. On the other hand, private clients mostly need competition for obvious commercial reasons (Turner, 1990).

In addition, contract pricing is also a constraint when selecting the most appropriate procurement method. Contracts may be priced as in different type of contract and way. Some procurement method might be suitable to use lump-sum contract while other type of procurement method might need different type of contract. Thus, the type of contract to be used will influence the decision of selecting the most appropriate procurement strategy (Al Khalil, 2002).

2.6.1.7 Time certainty

Time is a major constraint in most projects (Al Khalil, 2002). Ng *et al.* (2002) stated that time certainty define as "the degree of certainty that a project will be completed on the time specified in the contract and exact date". Time certainty is a critical need of clients, particularly for those involved in prestigious or large projects scheduled for a particular event or function. There is a strong connection between the certainty of time and speed as the greater speed a procurement system can offer, the higher the degree of certainty that the project can be completed on time (Ng *et al.*, 2002). Morledge et al. (2006) also claimed that most projects are needed within a time frame or by a specific date. Some project duration is lengthy because of the serial sequencing of phases while some projects require fast tracking results (Al Khalil, 2002). Thus, the owner must determine if a fast track schedule is necessary.

2.6.1.8 Speed

Speed refers to "the need to complete a project more quickly than other projects of similar nature, complexity and size" (Ng *et al.*, 2002). There are some procurement methods which require systematic procedure and takes longer time to complete a task while some procurement method can complete a task as soon as possible without considering any circumstances. However, Ng *et al.* (2002) mentioned that a strong justification for speed is required as speed may affect the price and the quality of the project.

2.6.1.9 Public accountability

Ng *et al.* (2002) carried out a study to identify the procurement selection criteria and noted that procurement method selected should be in favour of public accountability criteria such as environmental friendliness and cost reduction. In addition, local government was required to demonstrate accountability to the community.

2.6.1.10 Clarity of scope

Al Khalil (2002) stated that the clarity of the project scope and requirements of the owner can affect the decision to select a procurement strategy. Several type of procurement method requires a well-defined scope where the project requirements can be determined early while other methods are more appropriate if the scope is vague and its definition is evolving.

2.6.1.11 Involvement of owner in the project

Owners must determine how much they want to be involved. A high level of involvement may be necessary if the owner wishes to generate idea and involve in the task. However, owners must determine how much involvement they can afford to offer during the execution of the project. Some owners may have the expertise and sufficient available resources to allow for a high degree of involvement. Other owners may not have such capability or have them but cannot make them available to the project. Hence, such an owner would prefer to have minimal involvement (Al Khalil, 2002).

2.6.1.12 Working relationship

Hibberd and Djebarni (1996) referred working relationship as the type of working relationship the client required. Different type of procurement method offer different type of working relationship with the contractor because some procurement methods require more interaction between the client and contractor but some procurement methods may not need any interaction between the client and the contractor.

2.6.1.13 Intuition and past experience

Moody (1983) stated that experience provide an individual to solves a problem in a particular way and make decision using the data used for the problem with similar nature no matter the result are either poor or good. He further added that individual tend to repeat the same decision each time a similar problem arises without making a deliberate choice if the solution made is accepatable. In addition, Masterman (1992) claimed that some experience clients may also suffer if they simply select based on biased past experience and the conservative decisions of their in-house experts. Thus, past experience will influence the decision of the decision maker in selecting procurement method.

2.6.1.14 Client's in house technical capability

This refers to the technical capability of in-house maintenance personnel in monitoring the maintenance work. Luu *et al.* (2003b) explained that a client's in house technical capability govern in mobilizing the project team. There should be experience and expertise in the in house maintenance team to monitor the performance of the work

done by the contractor. If the in house team does not have the capability in carrying out certain work, thus the work should be outsourced to a specialist that may cost more.

2.6.1.15 Price or Cost certainty

Some clients require having a firm and fixed price for their project before committing the project (Ng *et al.*, 2002). Turner (1990) emphasize that the word "certainty" should not be conceived as an absolute assuredness, but instead a relative or sliding scale that is how certain the price that the procurement approach could offer. Yik and Lai (2005) stated that the cost of maintenance work depends on many factors, which include:-

- The scale, complexity and range of services systems to be operated and maintained.
- The quality of services to fulfil tenants' requirements.
- The competence of the in-house team and the contractor, both in technical knowledge and skills and in organisation and management.
- The budget that can be made available for maintenance of services systems.
- The transaction costs associated with the contractual arrangements.

Yik and Lai (2005) further explained that the first two factors in the above list determine the size of the maintenance team and the knowledge as well as the skills that they need, which together determine the expenditure on human resources. However, they claimed that the budget that can be set aside for maintenance as it is different for different type of building. It relies on the location of the building and class that determine the management fee management fee and management fee that the building

owner can charge the tenants where the higher the revenue, the greater the budget can be allocated.

2.6.1.16 Risk allocation or avoidance

Ng *et al.* (2002) stated that risk allocation or avoidance requirement reflects "the degree to which the client wishes to transfer the risks of cost and time slippage to the contractor. Some client would prefer to shift the risk to the contractor". Ng *et al.* (2002) further claimed that it is essential for the client to understand how and to what degree the risk has consciously been transferred to another organisation, how it has been shared, how the risk may not have been passed on at all or indeed how the risk to his organisation may have been increased by the employment of another organisation in selecting a certain procurement system.

Luu *et al.* (2003b) agreed that it is essential for the client to know how and to what degree risks should be passed to another organization so that a procurement strategy that best facilitates the process can be chosen. Turner (1990) agreed that it is crutial for a client to know how and to what extent of risk has consciously been passed to another organization or how it has been shared in some proportion between him and another organization. The respondent in Ng *et al.* (2002) study indicated that an interlacing relationship exists between risk allocation and responsibility, as the more responsibility one has been assigned in a project, the more risk one would have to assume. It is claimed that risk allocation could not be measured objectively.

Hashim *et al.* (2006) claimed that risk avoidance is least important for public clients but is very essential for private client. This is because private clients consider risk avoidance as a critical factor towards their project success. Private clients consider reducing and eliminating financial risk is very critical.

2.6.1.17 Dissatisfaction with previous process used

Moody (1983) stated that experience provide an individual to solves a problem in a particular way and make decision using the data used for the problem with similar nature no matter the result are either poor or good. Dissatisfaction with the previous process used will affect the decision maker to choose procurement method because individual that had poor satisfaction will think carefully if wish to adapt similar procurement method with similar nature. Luu *et al.* (2003a) and Ng *et al.* (2002) claimed that the decision-makers would recall the procurement strategy employed in the previous projects that are quite similar to the current project and the degree of success of that particular procurement strategy adopted. If the degree of success is low, then it will affect the decision of the decision maker.

2.6.1.18 Degree of Complexity

Al Khalil (2002) stated that no matter a project is a standard or complex, it is also a factor that needs to be considered in selecting a preferred procurement strategy. Different type of procurement method suits different type of complexity of project. In addition, Cheung *et al.* (2001) stated that the decision makers need to determine the suitability of the procurement method in handling complex projects. Therefore, the

decision maker needs to identify how complex the project is before selecting the procurement strategy. Ng *et al.* (2002) claimed that complexity is very difficult to define and the definition usually varied from person to person because a project could be very simple for someone who has done a similar job before, but it will be extremely complex for someone with no prior experience of the project type. Turner (1990) agreed that complexity was a non-quantifiable criterion since it could not be clearly depicted in the specification. Hashim *et al.* (2006) quoted from Songer and Molenar (1997) noted that project's complexity can be identified by the number of sub-contractors, the types of physical services involved, plant and materials, resources in terms of labour, the uniqueness of project activities and the level of technology.

2.6.1.19 Degree of Flexibility

Degree of flexibility refers to "the ability and authority of the owner to effect changes" (Cheung *et al.*, 2001). In addition, Ng *et al.* (2002) noted that flexibility is defined as "the ability to accommodate variations and flexibility is particularly needed for large and complex projects or when the exact requirements cannot be carefully established before tendering". The respondent in Ng *et al.* (2002) study explained that flexibility depends on human factors such as experience, competence, stakeholders' situation and nonhuman factors for instance project situations, project type, external factors such as political impact, weather and strikes. He added that as both human and non-human factors are unpredictable and very difficult to manage, flexibility could become relatively vague to the decision-makers.

2.6.2 Project Characteristics

2.6.2.1 Existing Building Condition

Existing building condition will affect the decision maker to select procurement method. The decision maker need to consider the ability of the procurement method to adapt the existing building condition and able to perform efficiently. Luu *et al.* (2003b) stated that some maintenance work may be complex due to the condition of the building. Thus, the decision maker need to consider project complexity in the selection of procurement method as it could affect the quality, cost and time of the project.

2.6.2.2 Project size

Project size refers to the size of the project. Morledge *et al.* (2006) highlighted that the size of project should be carefully considered because large building may have bigger risk of cost or time overrun. Luu *et al.* (2003b) highlighted that an increase in project magnitude could present escalated demands on the contractor due to the more demanding technological, administrative and quality assurance.

2.6.3 External environment or factors

2.6.3.1 Objective or policy of organization

Objective or policy of organization refers to the policy of the universities. For example, some universities would not prefer to expose to external parties. Lateef *et al.* (2011) claimed that the there are some proprietary data that the university would not prefer to expose to external parties. Thus, when selecting procurement method for universities, the decision makers need to consider the policy of university.

2.6.3.2 Government policy

Hashim *et al.* (2006) stated that the decision maker choice of procurement strategy will be affected by various Government policies. This could be seen where clients have to follow Government's procedures via Treasury's instruction in choosing a particular procurement route for government projects.

2.6.3.3 Disputes and arbitration

Ng *et al.* (2002) stated that the decision maker need to manage safety issues upfront or allocate risks so that it can be resolved easier when problems arises. Ng *et al.* (2002) also claimed that disputes and arbitration can be considered as components of risk allocation. Some approaches were favoured by clients during the disputes and arbitration processes as all the risks would have been transferred to the contractor.

2.6.3.4 Political issues or constraint

Political issues are taken into account when selecting procurement because the local government is required to demonstrate accountability to the community (Ng *et al.*, 2002). Furthermore, respondent in Ng *et al.* (2002) study claimed that some public agents representing other governmental departments' decisions or their clients' decisions in selection of procurement were mainly affected by governments' political policies.

2.6.3.5 Culture differences

Carter *et al.* (2010) stated that culture affects decision making in sourcing decisions in many disciplines such as marketing, international management, organization science, social economics and and information systems. Culture has been shown to affect decision-making processes, behaviors, values and preferences (Carter *et al.*, 2010). According to Bradley (2001), cultural influences on corporate decision makers can derive from the personal background of the decision maker, his or her corporate setting or both. It is definitely that managers from different national cultures will not perceive reason or make business decisions in the same way.

2.7 CURRENT PRACTICE OF PROCUREMENT METHOD SELECTION

A procurement strategy decision can be made by considering the scope and purpose of the procurement strategy from a strategic perspective (Hui and Tsang, 2004 and Kakabadse and Kakabadse, 2000). Ibbs and Chih (2011) stated that the chance for the decision makers to select an inappropriate procurement increases because they tend to make their choices not in a systematic way. This may not only impede the realization of certain anticipated benefits associated with the designated procurement method, but also lead to project failure (Ibbs and Chih, 2011 and Rwelamila and Meyer, 1999). Ibbs and Chih (2011) mentioned that formalized procurement method selection process consisting of four fundamental steps which are:-

(i) Identify client objectives: Common objectives include within-budget completion, on-time completion, value for money, willingness to take risks and others.

(ii) Search for alternative procurement method

(iii) Evaluate and choose between the alternative procurement method

(iv) Implement the selected procurement method

The entire selection process requires inputs such as project characteristics such as project type, size, cost, financial sources and usage of innovative technology, clients' experiences with particular procurement method and past project performance and it is constrained by market conditions, regulation and organization policies (Ibbs and Chih, 2011). In addition there are some constraints that need to be taken into consideration such as market condition, regulatory constraints and organisation policies. The flow of process for the selection of the most appropriate procurement method can be seen in Figure 2.9.

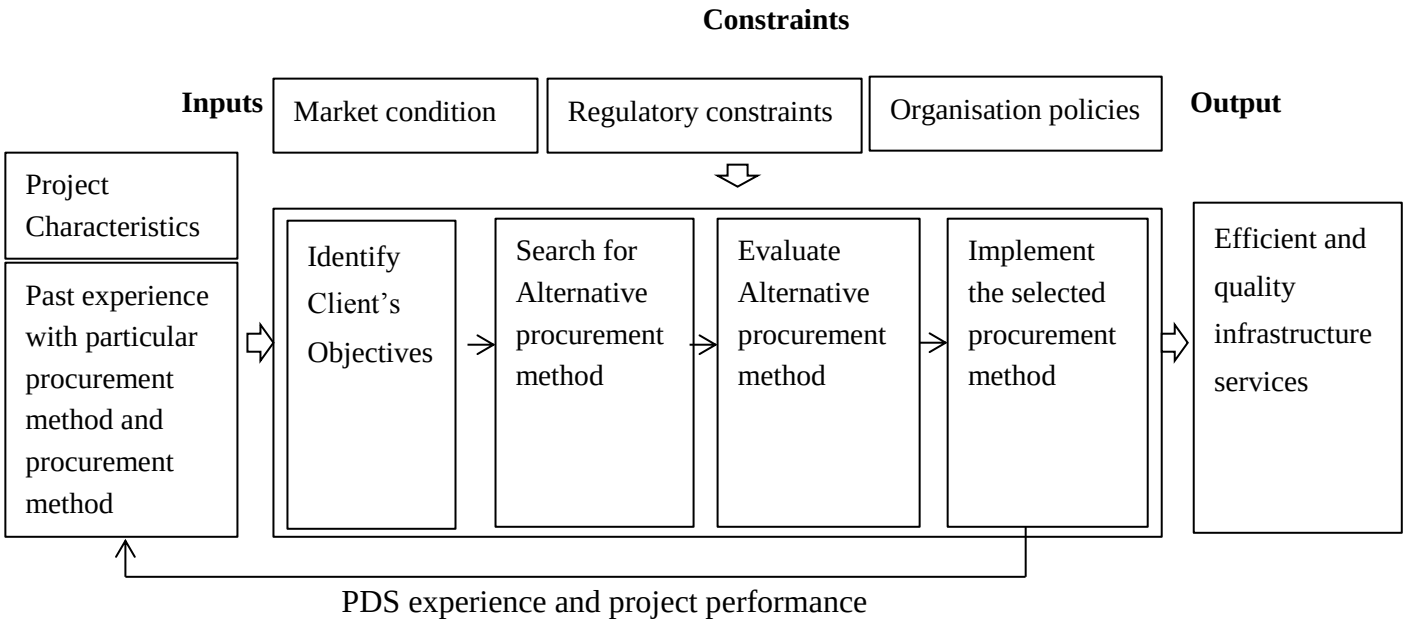

Figure 2.9: A Procurement Delivery System (PDS) selection process
Source: Ibbs and Chih (2011)

Love *et al.* (1998) stated that NEDO (1985) relates the characteristics of the most popular procurement methods used to a list of nine client priorities or needs. This technique is useful to help the decision maker to eliminate the inappropriate procurement method in order to have a better choice. A rating system which rate the ability of the available procurement method to meet seven common satisfying criteria is introduce by Franks and Harlow (1990). However, both techniques only determine clients need but do not consider the subjectivity of those criteria (Masterman, 1992 and Love, 1998).

In addition, Skitmore and Marsden (1988) applied concordance analysis and discriminant analysis where concordance analysis is employed to measure the consistency of experts ranking for each procurement method against a set predetermined criterion while discriminant analysis examined data collected under a set of criteria which are characteristics on which the various procurement methods are expected to differ (Love *et al.*, 1998). Moreover, Love *et al.* (1998) highlighted from Brandon *et al*. (1988) that there is a procurement module of the ELSIE expert system computer package which provides the recommendations on the most appropriate procurement method by using a software program. The program has a series of questions that relate to certain criteria such as design cost parameters, quality, timing and others. Based on the evaluation of the information provided in the program, recommendations are given by proposing the most suitable methods, ranked in order of suitability as well as an indication of the extent to which the various methods will satisfy the client requirements.

Luu *et al.* (2003a) and Ng *et al.* (2002) stated the decision-makers tend to recall the procurement strategy employed in the previous projects that closely similar to the current one and the degree of success of the procurement method adopted. Decision-makers would then compare the procurement strategy recalled with other available procurement options to determine the level of appropriateness of the solution and this could be done by measuring the gap between the recalled procurement methods with each of the other available procurement approaches. The one with the smallest gap would be considered the most appropriate. The degree of success of the procurement method adopted in the recalled project would also be examined. Depending upon how successful the historic project is, some modifications to the previous decision might be needed to meet the dominant requirement, and improve the chance of success of the new project. The process of selection of procurement strategy can be referred to Figure 2.10.

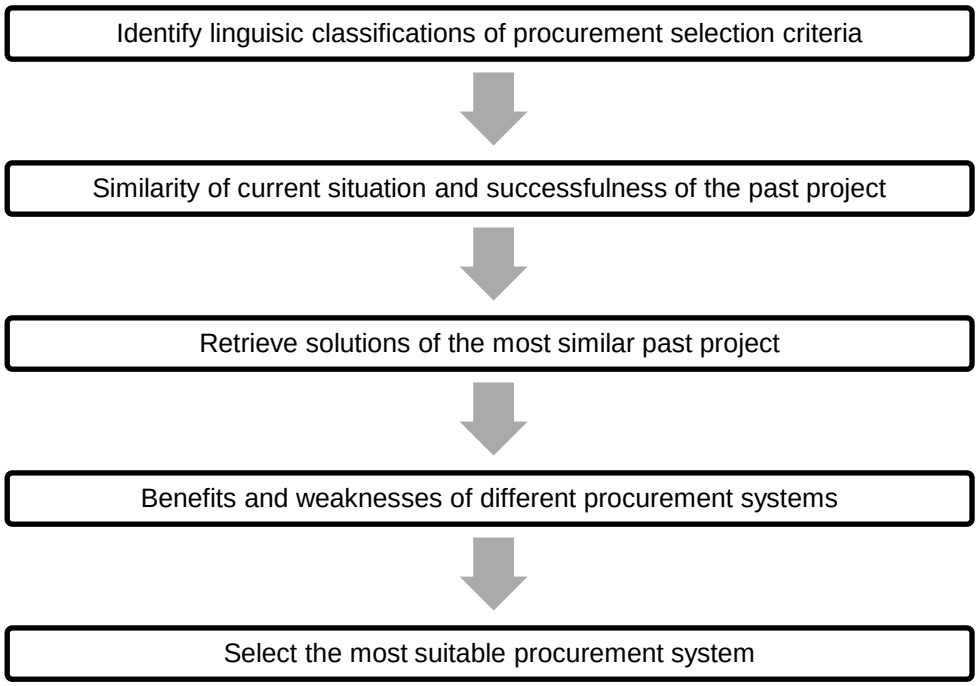

Figure 2.10: Processes in procurement selection
Source: Luu *et al.* (2003a) and Ng *et al.* (2002)

There are limited techniques available to guide the decision maker to choose the most appropriate procurement strategy. In addition, there are still a lot of room for improvement in those technique developed by the experts. Indeed, a holistic framework is crucial to guide the clients, consultant and decision maker to choose the most suitable procurement method.

There are many type of procurement method available and have been practiced by the maintenance personnel. However, maintenance personnel face a lot of challenges in order to ensure the procurement approach selected is effective. In addition, it is definitely impractical that a procurement method can suit all kind of clients and project because each type of procurement method has its own characteristic. Thus, some criteria need to be considered during the decision making of procurement method. The process of selection for procurement method is indeed very complex, thus a framework for procurement selection is very crucial.

2.8 CURRENT PRACTICE OF PROCUREMENT METHOD SELECTION OF PUBLIC UNIVERSITIES IN MALAYSIA

Hui *et al.* (2010) highlighted from "The Red Book" (The Putrajaya Committee on GLC High Performance, 2006) five common weaknesses in the Malaysian procurement system. They are as follows:-

(i) Failure to buy products in the right quantities and at the right specifications and prices, resulting in higher total cost of ownership.

(ii) Inefficient and ineffective procurement processes, resulting in long cycle times.

(iii) Opaqueness and ambiguity in the procurement process, resulting in leakages and corruption.

(iv) Inadequate infrastructure to support procurement, including flaws in organization and governance.

(v) Non-existent or ineffective vendor development programs (VDPs)

According to Hui *et al.* (2010), the procurement system in Malaysia can be divided into three systems which are direct purchase, tender and direct negotiation. The type of procurement system to be chosen is based on the value of project. According to the assistant secretary of procurement section in Ministry of Higher Education, the nature of selection of procurement method for public universities in Malaysia was autonomy and the only guidelines that need to refer was Government Circular from Ministry of Finance. The latest Government Circular found was Treasury Circular, No.5 Year 2009 (Surat Pekeliling Perbendaharaan Bilangan 5 Tahun 2009) for direct purchase and Treasury Circular, No.5 Year 2007 (Surat Pekeliling Perbendaharaan Bilangan 5 Tahun 2007 for tender; both open tender and close tender or quotation.

According to the Treasury Circular, for the purchase of RM20,000.00 to RM200,000.00 the direct purchase procurement system needs to be followed. Tendering for procurements would be applied for procurement cost RM200,000.00. In certain circumstances, the procurement could not be done through tender. Thus, the purchase would be made through direct negotiation. Direct negotiation should only be considered

only and when necessary in which it would be exempted from open tender. It is mainly due to urgent purchase and there is only one supplier thus no price and specification comparison could be made. In principle, the appointed contractor must be the expert, well-known for its credibility, have wide experience, proper planning, good pricing terms and most importantly, be the only supplier or contractor in the country for the item to be purchased. Hui et al. (2010) claimed that the process for direct negotiation is expected to be faster as compared with the open tender. Even though the process of direct negotiation is faster, every step of the procedures must also comply with the prescribed provision.

As discussed above, there was no any decision making tool or framework in helping maintenance personnels in public universities in Malaysia to choose the most appropriate procurement methods. In addition, the Treasury Circular for procurement selection only guides the decision maker to apply which type of tendering process but do not assist them to select the most appropriate procurement method for building maintenance work. The public universities were also given autonomy to select the most appropriate procurement method. Thus, this study aims to develop a framework that can assist the decision maker to select the most appropriate procurement strategy for building maintenance management for public universities in Malaysia.

2.9 PROCESS OF IMPLEMENTING SOURCING STRATEGY

Hui and Tsang (2004) highlighted that the process of implementing a sourcing strategy consists of five stages namely planning, setting of performance standards, work transactions, performance review and review of strategy. Figure 2.11 shows a flow chart of the process.

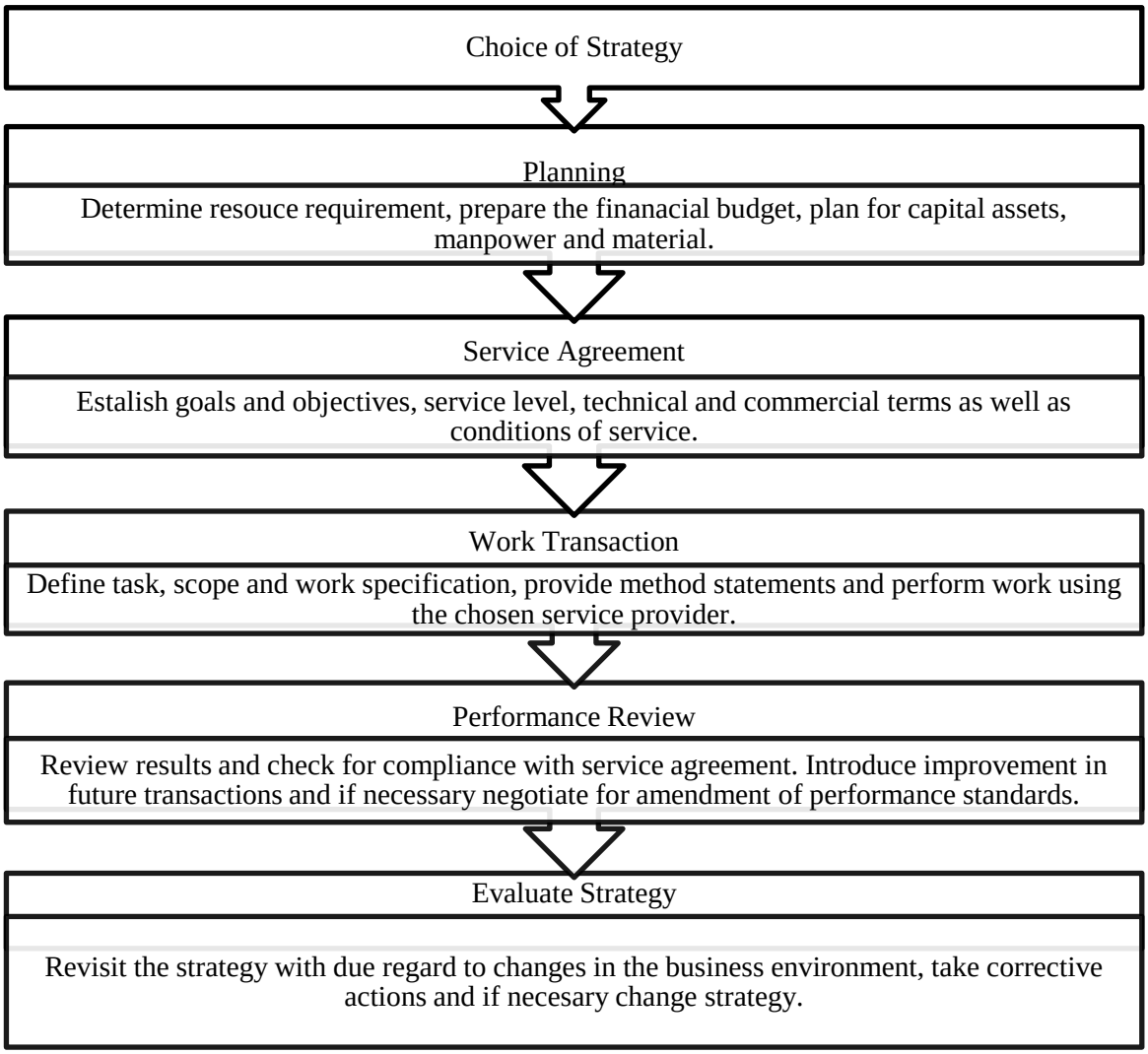

Figure 2.11: The process of implementing a sourcing strategy
Source: Hui and Tsang (2004)

2.10 PERFORMANCE OF SOURCING STRATEGY

Kestenbaum and Straight (1995) mentioned that various aspects of performance may be measured including outcomes and outputs. Outcome measures are related to the impact of services. Measurement of outcomes is used to indicate how effectively awarded contracts assist agencies in meeting their program and mission requirement. Outputs differ from outcomes in that they represent the activities, services or functions provided to support the accomplishment of an organization's stated outcomes.

Sheng (2012) noted that the effectiveness and result of sourcing strategy can be identified in term of cost effectiveness, service quality, work performance and customer satisfaction. Hui and Tsang (2004) claimed that the contractor should have the ability to deliver the service with reasonable predictability, reliability, on time performance and cost-effectiveness. Hui and Tsang (2004) further explained that the performance can only be measured through the test of time. Lateef *et al.* (2010a) added that feedback on user satisfaction can measure the quality of the service received and the requirement can be made known, which can contribute to efficiency.

Kestenbaum and Straight (1995) highlighted that service quality is the most difficult to evaluate compared to all the performance measures. Kestenbaum and Straight (1995) further stated that it is necessary to define who the customers are and to identify their expectation before quality can be measured. The key to ensure good service quality is to meet or exceed what customers expect from the service. Thus, service quality as

perceived by customers can be defined as "the extent of discrepancy between customer's expectations or desires and their perceptions" (Kestenbaum and Straight, 1995 and Zeithamel *et al.*, 1990).

There are several criteria that customer seeks as important in quality measures as shown in Table 2.15.

Table 2.15: Criteria that customer seeks as important in quality measures

Criteria	**Description**
Reliability	ability to perform the promised service dependably and accurately
Responsiveness	willingness to help customers and provide prompt service
Assurance	knowledge and courtesy of employees and their ability to convey trust and confidence
Empathy	caring, individualized attention the firm provides its customers
Tangibles	Appearance of physical facilities, equipment, personnel and communication material

Source: Kestenbaum and Straight (1995) and Zeithamel *et al.* (1990)

2.11 SUMMARY

Asset management, facility management and building maintenance management in the private and the public sector has been rapidly changing throughout the years in Malaysia. Management of all services in the building is very essential because it support the core business of an organization. It can be seen that construction industry plays an important role in the economy of Malaysia in generating wealth and improving the quality of life for Malaysians. In line with the growth of construction industry and the increase in supply of building, the amount invested in building maintenance by the government will increase as well as the numbers of building that need maintenance increases. However, the allocation for repair and maintenance works in Malaysia is

claimed to be inadequate to meet the ever-growing demand for the maintenance backlog and the management of building maintenance in Malaysia is also claimed to be ineffective. Thus, there is an urgent need to improve the ways building maintenance management executed in Malaysia to minimise building maintenance and ensure that building maintenance is effectively carried out.

In line with the intensive effort by the government of Malaysia in increasing the allocation for maintenance of public infrastructure assets and facilities, allocation for maintenance of public universities' building has increased as well. It is undeniable that university plays an important role to the nation as it is a factor of production where future leaders, captains of industry, entrepreneurs, scientists, engineers and managers are produced. A university requires functional buildings to be in business. The increase in the allocations showed part of government's commitment to improve the management of building maintenance of public universities which will preserve the importance and comfort of the campus society and users of the university's facilities. This research aim to to improve the building maintenance management of public universities in Malaysia by creating a framework which can guide the decision maker to select the most suitable procurement strategy.

Maintenance work range from very large maintenance projects to very small maintenance task. Subsequently, many different types of procurement methods have been developed to overcome the weaknesses of the existing procurement method and meet the range of services requirement. Thus, it becomes a more challenging task for

the decision maker to select the most appropriate procurement method. In addition, it is definitely impractical that a procurement method can suit all kind of clients and projects because each type of procurement method has its own characteristic. Thus, some criteria need to be considered during the decision making of procurement method.

It was confirmed from previous research that it is essential to establish a list of procurement selection criteria before various procurement options can be evaluated. Through literature, there were 26 criteria identified from literature review were divided into three main categories that were clients' requirements, project characteristics and external environment or factors. Thus, the criteria identified will be validated to clarify the variables in Phase 2 (Postal Questionnaires Survey) of the present study which will be discussed in the following chapters.

Through the analysis of of previous research, there are limited techniques available to guide the decision maker to choose the most appropriate procurement strategy. In addition, there are still a lot of room for improvement in those technique developed by the experts. Indeed, a holistic framework is crucial to guide the clients, consultants and decision makers to choose the most suitable procurement method. Thus, the next chapter will discuss the decision making methods available to select the appropriate procurement method.

CHAPTER 3

LITERATURE REVIEW: DECISION MAKING USING ANALYTIC HIERARCHY PROCESS (AHP)

3.1 INTRODUCTION

As discussed in Chapter 3, the selection of procurement method is is a multiple criteria decision-making problem. Alhazmi and McCaffer (2000) mentioned that the nature of the procurement system selection requires an effective decision-making technique to systematically evaluate procurement systems against a number of criteria. Therefore, this chapter discusses the decision making methods to select the most appropriate tool to be adapted to select the most appropriate procurement method. As selecting procurement method is a Multiple criteria decision making (MCDM), reviews were did starting with decision analysis which is the main branch of multiple criteria decision making and followed up with the tools and method available in multiple criteria decision making (MCDM).

Decision making is defined as "a study of identifying and choosing alternatives based on the values and preferences of the decision maker" (Rahmat, 1997). It is also a process that selects an ideal option or makes a choice between the available alternatives based on certain criteria or strategies (Wang and Ruhe, 2007; Wang *et al.*, 2006; Wilson and Keil, 2001). In decision making, three constituents have been identified which include the decision situation, the decision maker and the decision process (Wang and

Ruhe, 2007; Zachary *et al.*, 1982). According to Wang and Ruhe (2007), a set of alternatives need to be identified in order to produce an outcome from the decision making process by using the decision making strategy selected by the decision maker.

Ali (2009) stated that decision making is an important element in building maintenance and it set a central position in building management. In addition, he also emphasized that the amount of information available and quality is very essential in order to produce good decisions. In other words, the quality of decision made is depends on the accuracy and completeness of information obtained. Furthermore, Kam and Fischer (2004) noted that clear evaluation, quick re-formulation of alternatives and informative formulation are very vital to produce good decision.

Saaty (2008) highlighted that purpose of the decision, the need and the problem, the criteria of the decision, the sub-criteria of the decision, stakeholders and groups affected as well because the alternative actions to take need to be considered and identified in decision making. From all the information, the best alternative will be determined. While in the case of resource allocation, alternatives need to priorities in order to allocate their appropriate share of the resources (Saaty, 2008). There are many criteria and sub-criteria used to rank the alternatives of a decision. In decision making, not only the alternatives need to be priorities with respect to the criteria or sub-criteria in terms of how it needs to be evaluated. In fact, some of the criteria depend on the alternatives to achieve higher goal. The criteria may be intangible which is not precisely measureable and do not have measurements to serve as a guide to rank the alternatives

and create priorities for the criteria. Indeed, weighing the priorities of the alternatives and add over all the criteria to obtain the desired overall ranks of the alternatives is a challenging task (Saaty, 2008).

In choosing an appropriate procurement method, Ibbs and Chih (2011) stated that the decision makers require selecting the best method that fulfills their certain decision-making circumstances because every type of method has strengths and limitations. In order to achieve this, the decision makers require to firstly distinguishing what method options are available. A comprehensive understanding on how these methods work, how these methods different from each other and their strengths and limitations need to be taken into consideration.

Ibbs and Chih (2011) also stated that the selection of a procurement method which is also known as procurement method is a multiple criteria decision-making problem. Multiple Criteria decision making (MCDM) is one of the sub-category of the decision analysis (DA) method which will be discussed later.

3.2 DECISION ANALYSIS (DA)

Pirdashti *et al.* (2009) defined decision analysis (DA) as "methods that involve quantified evaluations of possible alternative courses of action". The evaluations often include an assessment of probabilities and preference elicitation using direct or indirect utility functions. Zhou *et al.* (2006) classified decision analysis method into three main

groups which include Single objective decision making (SODM), Decision support systems (DSS) and Multiple Criteria decision making (MCDM). Classification of decision analysis methods is illustrated in Figure 3.1.

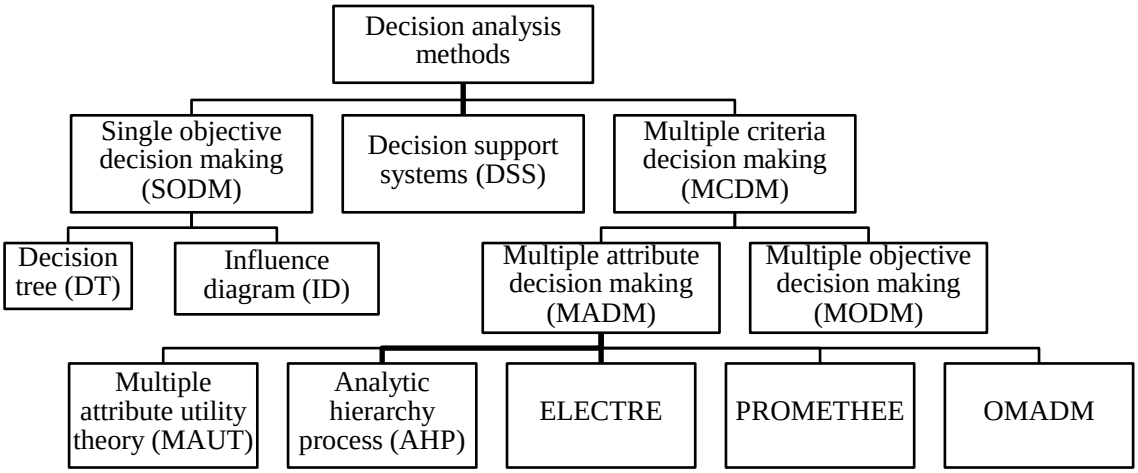

Figure 3.1: Classification of decision analysis methods
Source: Zhou *et al.* (2006)

According to Zhou *et al.* (2006), SODM consist of "a class of methods for evaluating the available alternatives with uncertain outcomes under a single objective situation". A classical approach in SODM is the Decision Tree (DT). On the other hand, the Influence Diagram (ID) provides a modest and more compact representation of decision problems (Zhou *et al.*, 2006 and Howard and Matheson, 1984).

Decision Support Systems (DSS) referred to "any interactive, flexible and adaptable software systems that integrate models, databases and other decision aiding tools and package them in a way that decision makers can use" (Turban, 1995 and Zhou *et al.*, 2006). Zhou *et al*. (2006) explained that a DSS supports the solution of unstructured and complex decision problems that are challenging to handle. The most appropriate

parameters and models is chosen based on their expertise knowledge. However, DSS developed to be more flexible to the users in order to deal with different situations by incorporating a knowledge base that contains heuristic knowledge from domain experts. As the selection of procurement method is is a multiple criteria decision-making problem, therefore this research will be mainly focusing and discussed more on Multiple criteria decision making (MCDM).

3.3 MULTIPLE CRITERIA DECISION MAKING (MCDM)

Pirdashti *et al.* (2009) stated that Multiple criteria decision making (MCDM) is "an analytic method to evaluate the advantages and disadvantages of alternatives based on multiple criteria". Pohekar and Ramachandran (2004) claimed that MCDM is a famous branch of decision making. They also defined MCDM as "a branch of a general class of operations research models which deal with decision problems under the presence of a number of decision criteria". MCDM approaches are the main parts decision analysis and theory which consider more than one criterion in supporting the decision process (Pirdashti *et al.*, 2009 and Pohekar and Ramachandran, 2004). Figure 3.2 showed the MCDM process in making decision. Pohekar and Ramachandran (2004) noted that MCDM methods deal with the decision making process in the presence of numerous objectives. The decision maker is need to select among quantifiable or non-quantifiable and multiple criteria. The objectives are typically different. Thus, the solution is greatly rely on the preferences of the decision-maker and must be a compromise. There are different groups of decision-makers where each group has different points of view and

different criteria involved in the decision making prosesses. This must be resolved within a framework of mutual compromise and understanding.

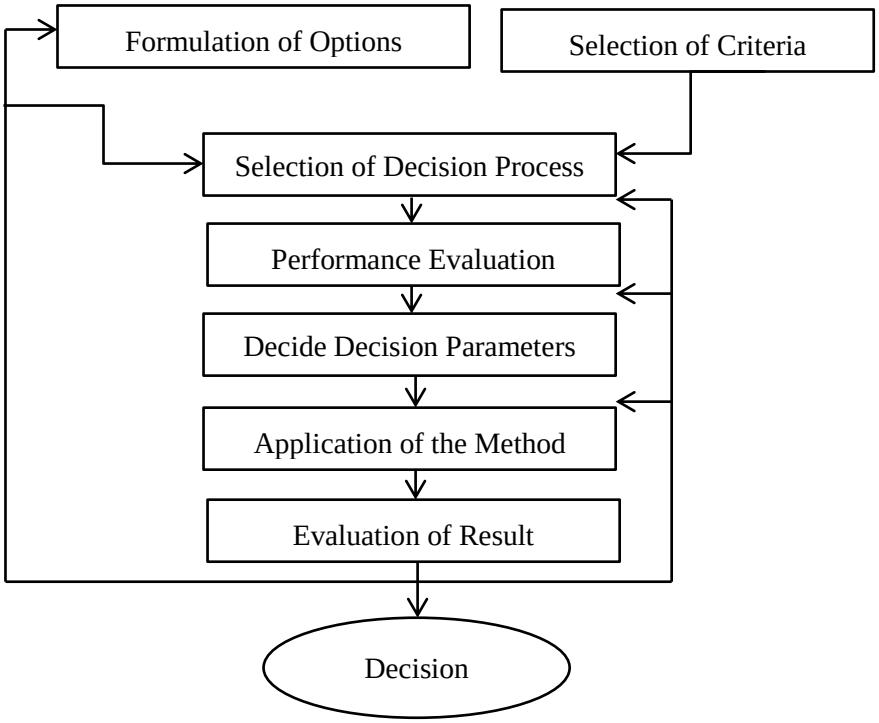

Figure 3.2: MCDM process
Source: Pohekar and Ramachandran (2004)

According to Pohekar and Ramachandran (2004), conventional single criteria decision making is usually meant to maximize the benefits and at the same time minimize the costs. On the contrary, MCDM offer better understanding of inherent features of decision problem, encourage the role of participants in decision making processes, facilitate compromise and collective decisions as well as provide a good platform to understanding the perception of models' and analysts' in a realistic scenario. This method improves the quality of decisions in term of efficient, rational and explicit. Communicating, quantifying and negotiating the priorities also facilitated with the use of these methods.

Beauchamp-Akatova (2007) also agreed that MCDM brings a lot of advnteges in making decision which includes:-

1. Provides a flexible way of dealing with the qualitative multidimensional effects of decisions, even in the absence of monetary information (Fabbri, 1998).
2. In term of transparency, MCDM clearly improves the decision process because each participant understands the personal benefits and losses and also those of other participants.
3. The analysis receives much publicity and different interest groups consider it a success because they manege to learn to identify the criteria important from the perspective of decision making, learn to think about the meanings of these criteria and for goals and objectives of different stakeholders.
4. Most conflicts between the objectives are resolved with the help of the multi criteria process.
5. Provide a "conscience in search of meaning"

Pirdashti *et al.* (2009) pointed out that MCDM becoming well-known and widely employed by researchers. Basically, each method reflects a different strategy to solve a given discrete MCDM problem of selecting the best among several preselected options or alternatives (Pirdashti *et al.*, 2009 and Janic and Reggiani, 2002). MCDM is useful in certain conditions where necessitate the consideration of different courses of action, which cannot be evaluated by the measurement of a simple and single dimension (Pirdashti *et al.*, 2009).

According to Pirdashti *et al.* (2009), MCDM enable the decision makers to select or rank alternatives based on an evaluation according to a number of criteria. The decisions are made on the basis of trading off or compromise among several criteria that are in conflict with each other. In addition, Zhou *et al.* (2006) explained that MCDM is mainly divided into two main branches that are Multiple Objective Decision Making (MODM) and Multiple Attribute Decision Making (MADM).

MODM methods are "multiple objective mathematical programming models in which a set of conflicting objectives is optimized and subjected to a set of mathematically defined constraints". The purpose is to choose the best among all the alternatives (Pirdashti *et al.*, 2009 and Zhou *et al.*, 2006). On the other hand, MADM refers to "making preference decisions by evaluating and prioritizing all the alternatives that are usually characterized by multiple conflicting attributes" (Pirdashti *et al*., 2009 and Zhou *et al.*, 2006). In MADM, several numbers of alternatives are to be evaluated against a set of attributes which are often hard to quantify. Comparisons are made between the alternatives based on each attribute in order to select the best alternative (Pohekar and Ramachandran, 2004).

The selection of procurement method has only one desire objective that is to select the most appropriate procurement method whereby the decision makers is required to derive his own set of important criteria according his preference by evaluating the criteria and prioritizing all the alternatives. Thus, this study will be adapting Multiple Attribute Decision Making (MADM) which is more suitable compared to MODM.

MADM can be classified into several methods which include Multiple Attribute Utility Theory (MAUT), Analytic Hierarchy Process (AHP), ELECTRE, Preference Ranking Organization Methods for Enrichment Evaluation (PROMETHEE) and Other Multiple Attribute Decision Making (OMADM).

Multiple Attribute Utility Theory (MAUT) is a method that "allows decision makers to consider their preferences in the form of multiple attribute utility function" whereas Analytic Hierarchy Process (AHP) is "a methodology consisting of structuring, measurement and synthesis, which can help decision makers to cope with complex situations". The elimination and choice translating reality methods are ELECTRE I, II, III and IV methods. They are a outranking methods family. The Preference Ranking Organization Methods for Enrichment Evaluation (PROMETHEE) is also another type of outranking methods. Other Multiple Attribute Decision Making (OMADM) methods such as conjunctive and disjunctive methods as well as TOPSIS are also popular in practice (Pirdashti *et al.*, 2009 and Zhou *et al.*, 2006).

Pohekar and Ramachandran (2004) stated that each method has its own distinguishing feature and the methods can be categorized as fuzzy, stochastic and deterministic methods. These methodologies share common characteristics of difficulties in selection of alternatives, incomparable units and conflict among criteria.

3.3.1 Multiple Attribute Utility Theory (MAUT)

Pirdashti *et al.* (2009) claimed that MAUT is developed by Keeney and Raiffa (1976) which "intended to maximize a decision maker's utility or value or preference which is represented by a function that maps an object measured on an absolute scale into the decision maker's utility or value relation". This is agreed by Pohekar and Ramachandran (2004) who claimed that MAUT takes into consideration the decision maker's preferences in the form of the utility function which is defined over a set of attributes. The utility value can be determined by determination of single attribute utility functions followed by verification of preferential and utility independent conditions and derivation of multi-attribute utility functions. The utility functions can be either additively separable or multiplicatively separable with respect to single attribute utility.

MAUT is "a methodology that can be used as a tool for measuring objectivity in an otherwise subjective area of management" (Cheung *et al.,* 2001 and Fellows *et al.,* 1983). The main advantage of MAUT is that the problem becomes a single objective problem once the utility function has been assessed correctly, thus ensuring achievement of the best compromise solution (Pirdashti *et al.,* 2009 and Keeny.and Raiffa, 1976). Pirdashti *et al.* (2009) outlined the procedure for utilizing MAUT in a study as follow:-

(i) Identify relevant characteristic (attributes)

(ii) Assign quantifiable variables to each of the attributes and specify their restrictions.

(iii) Select and construct utility functions for the individual attributes.

(iv) Synthesize the individual utility functions into a single additive or multiplicative utility function.

(v) Evaluate the alternatives using the function obtained in the fourth step.

3.3.2 The Elimination and Choice Translating Reality (ELECTRE)

This method is capable of handling discrete criteria of both quantitative and qualitative in nature and provides complete ordering of the alternatives (Pohekar and Ramachandran, 2004 and Pirdashti *et al.*, 2009). The problem is to be so formulated that it chooses alternatives that are preferred over most of the criteria and that do not cause an unacceptable level of discontent for any of the criteria. The concordance, discordance indices and threshold values are used in this technique. Based on these indices, graphs for strong and weak relationships are developed. These graphs are used in an iterative procedure to obtain the ranking of alternatives. This index is defined in the range (0–1), provides a judgment on degree of credibility of each outranking relation and represents a test to verify the performance of each alternative. As the system is not necessarily complete, the ELECTRE method is sometimes unable to identify the preferred alternative. It only produces a core of leading alternatives. This method has a clearer view of alternatives by eliminating less favorable ones, especially convenient while encountering a few criteria with a large number of alternatives in a decision making problem (Pohekar and Ramachandran, 2004 and Pirdashti *et al.*, 2009).

3.3.3 Preference Ranking organization Method for Enrichment Evaluation (POMETHEE)

This method uses the outranking principle to rank the alternatives, combined with the ease of use and decreased complexity. It performs a pair-wise comparison of alternatives in order to rank them with respect to a number of criteria (Pirdashti *et al.*, 2009). Pohekar and Ramachandran (2004) highlighted that Brans *et al.* (1986) have offered six generalized criteria functions for reference namely, usual criterion, quasi criterion, criterion with linear preference, level criterion, criterion with linear preference and indifference area, and Gaussian criterion. The method uses preference function P_j (a, b) which is a function of the difference d_j between two alternatives for any criterion j, i. e. d_j = f(a,j) –f(b,j), where f(a,j) and f(b, j) are values of two alternatives a and b for criterion j. The indifference and preference thresholds q' and p' are also defined depending upon the type of criterion function. Two alternatives are indifferent for criterion j as long as d_j does not exceed the indifference threshold q'. If d_j becomes greater than p', there is a strict preference. Multi-criteria preference index, π(a,b) a weighted average of the preference functions P_j (a,b) for all the criteria is defined as:-

$$\pi(a,b) = \frac{\sum_{j=1}^{J} w_j P_j(a,b)}{\sum_{j=1}^{J} w_j}$$

$$\phi^{+}(a) = \sum_{A} \pi(a,b)$$

$$\phi^{-}(a) = \sum_{A} \pi(b,a)$$

$$\phi(a) = \phi^{+}(a) - \phi^{-}(a)$$

where w_j is the weight assigned to the criterion j; ϕ^+ (a) is the outranking index of a in the alternative set ϕ^- A; (a) is the outranked index of a in the alternative set A, ϕ(a) is the net ranking of a in the alternative set A. The value having maximum ϕ(a) is considered as the best.

a outranks b iff ϕ(a) > ϕ(b), a is indifferent to b iff ϕ(a) = ϕ(b).

3.3.4 Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is "a theory of measurement through pairwise comparisons and relies on the judgements of experts to derive priority scales". The pairwise comparisons are made by a scale of absolute judgements that represents how much more one element dominates another with respect to a given attribute (Saaty, 2008). In addition, Saaty (1982) stated that AHP is "a method of breaking down complex, unstructured situation into components parts, arranging these parts or variables, into a hierarchic order, assigning numerical values to subjective judgments to determine which variables have the highest priority and should be acted upon to influence the outcome of the situation". He further explained that numerical values are assigned to each variable of the problem in AHP in order to helps the decision makers to maintain cohesive though patterns and to reach a conclusion.

Pirdashti *et al.* (2009) claimed that AHP is one of the most well-known and powerful methods for group decision making used in project selection and AHP is a multi-criteria decision making approach that simplifies complex and ill-structured problems by arranging the decision elements in a hierarchical structure. The AHP is "a theory of

measurement for dealing with quantifiable and intangible criteria that has been applied to numerous areas, such as decision theory and conflict resolution" (Pirdashti *et al.*, 2009 and Vaidya and Kumar, 2006).

The AHP is a process of systematic rationality. It allows the decision maker to take into account whole problem and to study the concurrent interaction of its elements within the hierarchy. It is a flexible model that allows the decision maker to make decision by combining judgment and personal values in a logical way (Saaty, 1982). Saaty (1982) stated that AHP enable the decision maker to make effective decision on complex issues by simplifying and expediting our natural decision-making processes. Furthermore, AHP process is a flexible model that allows gropus or individuals to form ideas and define problems by creating their own assumptions and deriving the desired solution from them. It also enables decision maker to investigate the sensitivity of the solution or the outcome to changes in information.

In addition, the AHP incorporates personal values and judgments in a logical way. The AHP is flexible enough to allow revision where decision makers can both expand the elements of a problem hierarchy and change judgments. It also allows the decision makers to test the sensitivity of the outcome to the expected changes. Each iterations of the AHP is like hypothesis making and testing, the progressive refinement of the hypotheses leads to a better understanding of the system (Saaty, 1982).

In addition, Saaty (1982) mentioned that AHP deals with both system thinking and causal thinking or explanation simultaneously. System thinking is addressed by structuring ideas hierarchically while causal thinking is developed through paired comparison of the elements in the hierarchy and through synthesis. Another advantage of the AHP is that it has a framework enable group participation in problem solving or decision making. The judgments and ideas can be look into and strengthened or weakened by evidence that other people present. Validity of the outcome can be increased by group participation if the views do not diverge widely.

3.3.4.1 Basic principles of the Analytic Hierarchy Process (AHP)

There are three basic principles of the AHP which include (Saaty, 1982):-

(i) The principle of constructing hierarchies

Saaty (1982) stated that a complicated system can be made well understood by breaking the system into constituent elements, structuring the elements hierarchically and composing or synthesizing judgments on the relative importance of the elements at each level of the hierarchy into a set of overall priorities. Hierarchic representation and decomposition breaks down the problem into separate elements. Saaty (1982) further explained that hierarchy is a fundamental tool as it involve in identifying the elements of a problem, grouping the elements into homogeneous sets and arranging these sets in different levels.

Basically, hierarchies can be divided into two main types that are structural and functional. However, Saaty (1982) pointed out that AHP will be mainly focus and used

functional hierarchies. He explained that functional hierarchies decompose complex systems into constituent parts according to essential relationships and help the decision maker towards a desired goal.

Saaty (1982) noted that each set of elements in a functional hierarchy occupies a level of the hierarchy. The top level which is known as the goal consists of one element only that is the overall objective. The subsequent levels consist of several elements but the number is usually small which is in between five and nine. The elements in each level must have the same order of magnitude because the elements are to be compared with one another against the criterion in the next higher level. If the disparity of magnitude between the elements is great it will subject to significant error. When the elements of a level cannot be compared readily, a new level with finer distinctions must be created. Saaty (1982) highlighted that there is no limit to the number of levels in a hierarchy.

In constructing a hierarchy in a matter of choosing among alternatives, Saaty (1982) suggested to start from the bottom level by listing the alternatives then the next level which consist of the criteria for judging the alternatives and followed by the top level that is the focus or overall objective. The hierarchy of AHP can be referred to Figure 3.3.

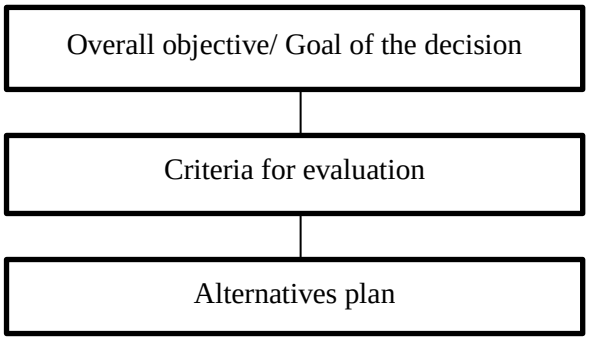

Figure 3.3: Hierarchy of Analytic Hierarchy Process (AHP)
Source: Saaty (1982) and Saaty (2008)

Relevant information and details must be included in the hierarchies. The purposes to have sufficient amount of information in the hierarchies include (Saaty, 1990 and Saaty, 1982):-

(i) To represent the problem as thoroughly as possible, but not so thoroughly as to lose sensitivity to change in the elements

(ii) To consider the environment surrounding the problem

(iii) To identify the issues or attributes those contribute to the solution

(iv) To identify the participants associated with the problem.

Saaty (1982) highlighted that the only restriction on the hierarchy arrangement of elements is that any elements in one level must capable of being related to some elements in the higher level which serves as a criterion for assessing the relative impact of elements in the level below. Saaty (1990) explained that a hierarchy can be incomplete. In fact, an element in certain level not neccessary has any function as an attribute for any elements in the level below. Each level may represent different aspect of problem.

Basicaly, AHP is employed with two types of measurement which are relative and absolute (Saaty, 1990). In both, pairwise comparisons are made to derive priorities for criteria with respect to the goal. In relative measurement, pairwise comparisons are performed throughout the hierarchy including on the alternatives in the lowest level of the hierarchy with respect to the criteria in the level above. In absolute measurement, pairwise comparisons are also performed through the hierarchy with the exceptions of the alternatives themselves. The level just above the alternatives consists of intensities or grades which are refinements of the criteria or sub criteria governing the alternatives.

(ii) The principle of establishing priorities

The first step in establishing the priorities of elements in a decision problem is to make pairwise comparison that is to compare the elements in pairs against a given criterion (Saaty, 1982). According to Saaty (1982), matrix is the preferred form in pairwise comparison because matrix is simple, well-established tool that can offer a framework for testing consistency, obtaining additional information through making all possible comparisons and analyzing the sensitivity of overall priorities to changes in judgment. Table 3.1 showed the sample matrix for pairwise comparison.

C	A_1	A_2	A_3	……	A_7
A_1	1				
A_2		1			
A_3					
..					
..					
A_7					1

Table 3.1: Sample matrix for pairwise comparison
Source: Saaty (1982)

The element A_1 in the column on the left is compared to the elements in A_1, A_2, A_3 and so on in the row with respect to the property C in the upper left-hand corner. This process is repeated with the column element A_2 and so on. The question being asked must be phrased correctly so that it reflects the proper relationship between in one level with the property in the next higher level. Numbers are used to fill in the matrix of pairwise comparison in order to represent the relative importance of one element over another with respect to the property. Table 3.2 shows the scale for pairwise comparison matrix. Besides, it also defines the value of 1 to 9 assigned to judgments in comparing pairs of like elements in each level of the hierarchy against criterion in the next higher level (Saaty, 1982). Saaty (1982) pointed out that experience has confirmed that a scale of nine units is reasonable and reflects the degree to which the intensity of relationships between elements can be discriminated.

When comparing one element in a matrix with itself, the comparison must give unity as 1. The reciprocal value is used for the comparison of the second element with the first. For instance, if two elements are compared and the first is five times favor than the second, then the second is one-fifth as the first. Generally, if the matrix deals with n elements, n unit entries are subtracted down the diagonal and are divided by 2 because half of the judgments are reciprocals that are entering automatically.

Once all the pairwise comparison judgments have been made, the judgments need to be synthesized to get an overall estimate of the relative priorities. The values in each column need to be added and each entry in each column is divided by the total of that

column to obtain the normalized matrix which permits meaningful comparison among elements. Finally, an average over the rows needed to be obtained by adding the values in each row of the normalized matrix and dividing the rows by the number of entries.

Priority discrimination and synthesis ranks the elements by relative importance. To make a decision by generating priorities in an organised way, there are four main steps to be followed (Saaty, 2008):-

1. Defining the problem and identify the kind of knowledge required.
2. Structuring the decision hierarchy begin with the top level that is the goal of the decision then followed by the objectives from a wide perspective. The intermediate levels are the criteria on which subsequent elements depend and finally the lowest level which is a set of the alternatives. The final action which is known as the alternatives plan will contribute positively or negatively to the main objective through the impact on the intermediate criteria.
3. Constructing a set of pairwise comparison matrices. Each element in an upper level is used to compare the elements in the level immediately below with respect to it.
4. Using the priorities obtained from the pairwise comparisons to weigh the priorities in the level immediately below. These steps are followed for every element. Then, add its weighed values and obtain its overall or global priority. Continue this process of weighing and adding until the final priorities of the alternatives in the bottom most level are obtained.

Table 3.2: Scale for pairwise comparison matrix

Intensity of importance	Definition	Explanation
1	Equal importance of both elements	Two criteria are of equal importance and equally contribute to the property or objectives
3	Weak importance of one over another	Experience and judgment slightly favor one criterion or element over another
5	Essential or strong importance of one element over another	Experience and judgment strongly favor one criterion or element over another
7	Very strong and demonstrated importance of one element over another	A criterion or element is strongly more important or favored and its dominance is demonstrated in practice than the other
9	Absolute importance of one element over another	The evidence favoring one criterion over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between adjacent scale values	When compromise is needed between two judgements
Reciprocals of above nonzero	If activity *i* has one of the above nonzero numbers assigned to it when compared with activity *j*, then *j* has the reciprocal value when compared with *i*	A reasonable assumption
Rational	Ratios arising from the scale	If consistency were to be forced by obtaining n numerical values to span the matrix

Source: Cheung *et al.* (2001), Saaty (1980), Saaty (1982) and Saaty (1990)

(iii) The principle of logical consistency

Logical consistency ensures that elements are grouped logically and ranked consistently according to a logical criterion. Consistency is very important in decision making process (Saaty, 1982). Cheung *et al.* (2001) explained consistency means that "when a basic amount of raw data is available then all other data can be deduced logically from it. In other words, it measures how carefully the respondent has completed the matrix".

Saaty (1982) stated that consistency is perfect if all judgments relate to each other in a perfect way. Saaty (1982) further explained that consistency can be defined in two ways. Firstly, if the ideas and objects have similarity, it can be grouped according to homogeneity and relevance. For example, a ball and a coin can be grouped into a homogeneous set if the relevant criterion is roundness but not if usage is the criterion. On the other hand, the second meaning of consistency is that the intensities of relations among ideas or objects based on a particular criterion justify each other in some logical way. For instance, if an individual say that he prefer cost to time three times more and prefer time to quality twice more in selecting procurement method, then if the individual is requested to make judgment comparing cost to quality, it should be 6 and not anything else. The greater the deviations from the value of 6, the higher the inconsistencies in the judgment. The process may need to be repeated if more accurate judgment can be obtained.

Saaty (1982) claimed that perfect consistency is hardly achieved in real life because specific circumstances often influence preferences and circumstances change. Therefore, Saaty (1982) further explained that prefect consistency may not be obtained, but as long as there is enough consistency to maintain coherence among the objects through experience the consistency need not be perfect. However, a certain degree of consistency in setting priorities for elements with respect to some criterion is necessary to get valid result in the real world (Saaty, 1982). Cheung *et al.* (2001) agreed that consistency of the comparison matrix is essential.

According Saaty (1982), the AHP measures the overall consistency of judgments by means of a consistency ratio where the value of the consistency ratio should be 10 percent or less. If it exceeds 10 percent, the judgments may be inconsistent and revised is required. The consistency of the comparison matrix is monitored by an inconsistency ratio (IR) or consistency ratio (CR) calculated by the formula below (Cheung *et al.*, 2001 and Saaty, 1982):-

Consistency Ratio (CR) = Consistency index (CI)/ Random Index (RI)

where,

CI = $(\lambda_{max} - n)/(n-1)$, with n the number of elements in the matrix

RI = the consistency index of a randomly generated reciprocal matrix within a scale of 1 to 9.

λ_{max} = the maximum eigenvalue of the comparison matrix.

The consistency ratio (CR) is acceptable if it does not exceed 0.10. Repeat and review the judgment if the CR is greater than 0.10. Table 3.3 shows Random Index (RI) for consistency index of a randomly generated reciprocal matrix within a scale of 1 to 9.

Table 3.3: The consistency index of a randomly generated reciprocal matrix within a scale of 1 to 9

Size of matrix	1	2	3	4	5	6	7	8	9	10
Random consistency	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Source: Saaty (1982)

In utililizing the three principles, Saaty (1982) stated that AHP integrates both the qualitative and quantitative aspects of human thought where the qualitative to define the

problem and its hierarchy and the quantitative to express judgements and preferences concisely. Saaty (1982) claimed that the process itself is designed to integrate these dual properties. He further explained that in making better decision making, quantitative is basic to make sound decisions in complex situations where it is necessary to determine priorities and make tradeoffs. In order to calculate priorities, a practical method of generating scales for measurement is needed.

3.3.4.2 Steps for conducting study using Analytic Hierarchy Process (AHP)

Ibbs and Chih (2011) stated that the first steps of AHP are to develop a hierarchy of criteria and to identify all possible alternatives. AHP uses a pairwise comparison procedure whereby a decision maker is required to compare all alternatives with respect to evaluation criteria in turn. The decision maker's preferences are presented in a ratio scale and are combined into an overall rating. The basic steps for conducting study using AHP are as follow (Pirdashti *et al.*, 2009; Saaty, 1982; Saaty, 1990; Saaty, 1994a and Saaty, 1994b):-

1. Define the problem and determine its goal.
2. Structure the hierarchy with the decision-maker's objective at the top with the intermediate levels capturing criteria on which subsequent levels depend and the bottom level containing the alternatives.
3. Construct a set of n × n pair-wise comparison matrices for each of the lower levels with one matrix for each element in the level immediately above. The pairwise comparisons are made using the relative measurement scale. The

pair-wise comparisons capture a decision maker's perception of which element dominates the other.

4. There are n (n-1)/2 judgments required to develop the set of matrices in step 3. Reciprocals are automatically assigned in each pair-wise comparison.
5. The hierarchy synthesis function is used to weight the eigenvectors by the weights of the criteria and the sum is taken over all weighted eigenvector entries corresponding to those in the next lower level of the hierarchy.
6. After all the pair-wise comparisons are completed, the consistency of the comparisons is assessed by using the eigenvalue, λ, to calculate a consistency index, CI: CI = (λ-n)/ (n-1) (1), where n is the matrix size. Judgment consistency can be checked by taking the consistency ratio (CR) of CI with the appropriate value. The CR is acceptable if it does not exceed 0.10. If the CR is greater than 0.10, the judgment matrix should be considered inconsistent. To obtain a consistent matrix, the judgments should be reviewed and repeated.

3.3.4.3 Advantages of Analytic Hierarchy Process (AHP)

Pohekar and Ramachandran (2004) highlighted one of the main advantages of AHP is that it calculates the inconsistency index as a ratio of the decision maker's inconsistency and randomly generated index. This index is essential for the decision maker to ensure that his judgments were consistent and that the final decision is made well. In addition, Imoto *et al.* (2006) claimed that AHP is one available method for forming a systematic framework for group interaction and group decision-making. Dyer (1990) and Pirdashti *et al.* (2009) highlighted the advantages of AHP in a group setting as follows:-

- both tangibles and intangibles, individual values and shared values can be included in an AHP-based group decision process
- the discussion in a group can be focused on objectives rather than alternatives
- the discussion can be structured so that every factor relevant to the discussion is considered in turn
- in a structured analysis, the discussion continues until all relevant information from each individual member in a group has been considered and a consensus choice of the decision alternative is achieved.

Ibbs and Chih (2011) highlighted from Belton and Stewart (2002) two main advantages of AHP. Firstly, it allows the problem to be broken down into hierarchical levels, which assists a decision maker to develop detailed insights about the problem he or she intends to solve. In addition, the pairwise comparison procedure enables a decision maker to make his or her judgments in a systematic manner. In addition, Saaty (1982) outlined the advantages of AHP which include:-

1. Unity

   The AHP provides a single, easily understood, flexible model for a wide range of unstructured problems.

2. Complexity

   The AHP integrates deductive and systems approaches in solving complex problems.

3. Interdependence

   The AHP can deal with the interdependence of elements in a system and does

not insist on linear thinking.

4. Hierarchic structuring

   The AHP reflects the natural tendency of the mind to sort elements of a system into different levels and to group like elements in each level.

5. Measurement

   The AHP provides a scale for measuring intangibles and a method for establishing priorities.

6. Consistency

   The AHP tracks the logical consistency of judgments used in determining priorities.

7. Synthesis

   The AHP leads to an overall estimate of the desirability of each alternative.

8. Tradeoffs

   The AHP takes into consideration the relative priorities of factors in a system and enables people to select the best alternative based on their goals.

9. Judgment and consensus

   The AHP does not insist on consensus but synthesizes a representative outcome from diverse judgments

10. Process repetition

    The AHP enables people to refine their definition of a problem and to improve their judgment and understanding through repetition.

3.4 JUSTIFICATION FOR USING ANALYTIC HIERARCHY PROCESS (AHP)

There are several leading researches that have developed model for procurement selection in construction industry but none research found is related to maintenance industry. Masterman (1992) mentioned that most of the clients have been choosing procurement methods in a cursory manner simply based upon biased past experience and the conservative decisions and some clients even employ certain procurement method by default without making a deliberate choice. Although past experience might be an essential influential factor in selecting procurement strategy but experiences and solutions to problems retrieved from past projects may not be relevant to the current projects because each building have different characteristic. In addition, Morledge et al. (2006) highlighted that criteria for selecting procurement method will be in conflict and priorities need to be decided. The application of AHP which decision based on multiple criteria enables the decision maker to derive his own set of importance weightings for the selection criteria according to the building or project characteristics. Thus, AHP is suitable in selecting the most appropriate procurement strategy.

Cheung *et al.* (2001) claimed that the selection of procurement strategy is depends on biases of the decision maker as it had been mostly judgmental. Hence, it is indeed very critical to have a more objective and systematic framework in selection of procurement strategy for self-evident. There are several researches that have developed framework for procurement selection in other industry adapting AHP as development tool but none of the research found is related to building maintenance industry and university building.

Cheung *et al.* (2001) and Musa (2011) integrated AHP techniques and principles as a development tool in selecting the most appropriate service delivery system. Both researches received good comments and are well accepted by the respondents during the implementation and validation stage.

It is essential to derive a set of numerical weights representing the relative importance of the criteria with respect to the goal in procurement strategy selection because it is a decision based on multiple criteria (Cheung *et al*. 2001). Love *et al.* (1998) suggested that clients with similar nature do not necessarily have similar needs. In fact, the requirements of the clients rely on many other factors and usually are project specific. For instance, if the project requires early completion, then the client needs to weigh speed higher than the other selection criterion. This means that deriving a standard set of importance weightings would overlook the project characteristics specific to a particular selection decision. In the proposed framework, each decision-maker is required to derive his own set of importance weightings for the selection criteria. This allows the project characteristics to be considered when selecting the most appropriate procurement method. The AHP assists clients in determining the importance weightings for the selection criteria. The employment of the AHP technique allows the decision-maker to structure a complex problem in the form of a simple hierarchy and to evaluate a large number of qualitative and quantitative factors in a systematic manner under multiple criteria. It is a logical way for people to make decisions. In addition, Al Khalil (2002) also agreed that AHP is suitable to choose the most appropriate procurement method. He mentioned that there are two main reasons for his justification.

First, the ability of the method to incorporate tangible and intangible factors that would otherwise be difficult to take into consideration and the second reason is the structure of the hierarchy. The problem is broken down into its constituent parts going down the hierarchy from large elements to small elements. Such structure clarifies the problem and exhibits the contribution of each of the elements to the final decision.

As discussed earlier, AHP has shown many advantages in a lot of aspects. In the development of decision making framework to select the most appropriate procurement method for building maintenance management of public universities covered two important components that were the possible assessment criteria and the procurement methods available for selection whereby the assessment criteria are used to evaluate the alternatives. In the present study, AHP is chosen because it enables the decision maker to derive his own set of important criteria for the selection according to the characteristics of the building. In addition, the application of AHP which able to calculate the judgment consistency assure that the decision makers' judgments are consistent and the final decision is made well. The detail of theoretical framework used in this study as shown in Figure 3.4.

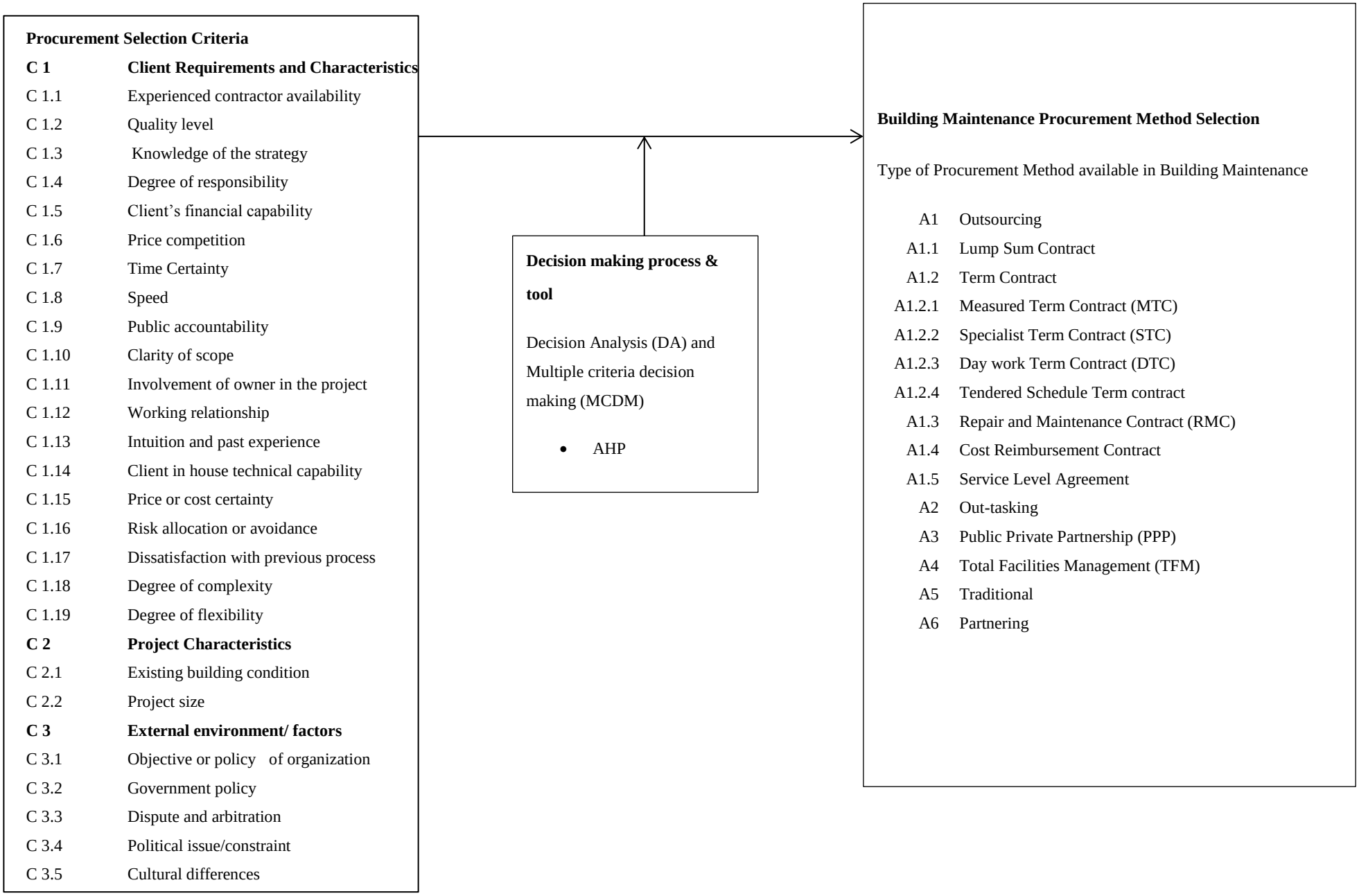

Figure 3.4: Theoretical Framework

3.5 SUMMARY

Various types of MCDM methods have been discussed in this chapter. Having studied and compared all the methods under MCDM, AHP is the most suitable decision making tools in constructing the procurement method decision making framework. The development of the decision making framework will be integrating the AHP techniques and principles as well as the two important components for procurement selection that are the possible assessment criteria and the procurement methods available for selection that are discussed in Chapter 2. The theoretical framework used in this study is shown in Figure 3.4. In order to validate the variables obtained from extensive literature review and shortlist the most popular and important procurement selection criteria, obtain the current and available building maintenance procurement method used in public universities in Malaysia as well as understand the current practices adapted in selecting procurement method, a questionnaire survey was conducted among all public universities in Malaysia and the methodology to conduct this research are presented in the following chapter and the findings of research are presented in Chapter 5 and Chapter 6.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 INTRODUCTION

This chapter presents the research design and the methodology adopted in the present study. The methodologies for this research aim to achieve the objectives formulated and lead to valid conclusions. The methodology approach implemented for this research is mixed method.

The present study is divided into four main phases whereby phase 1 is literature review. The literature review is divided into two main chapters which include procurement method for maintenance project in chapter 2 and decision making using AHP in chapter 3. The main purpose of phase 1 is to get an overview of asset management, facility management and building maintenance whereby the definition, importance and relationship of the three components are discussed. In addition, the development of building maintenance management in Malaysia and the background of universities in Malaysia and their management system are discussed as well. The procurement method selection, potential procurement selection criteria, types of procurement method available and the current procurement method selection practice are reviewed as well. In addition, decision making tools are studied as well in order to select the most suitable tool to be adapted to select the most appropriate procurement method. As selecting procurement method is a multiple criteria decision making, reviews were did starting

with decision analysis which is the main branch of multiple criteria decision making and followed up with the tools and method available in Multiple Criteria Decision Making (MCDM). Review was also carried out on research methodology to discuss on mixed method approach.

This is followed by phase 2 that is postal questionnaires survey to validate the variables obtained from phase 1 and shortlist the most popular and important procurement selection criteria, obtain the current and available building maintenance procurement method used in public universities in Malaysia as well as understand the current process, tools used and method adapted in selecting procurement method. Phase 3 is developed decision making framework based on AHP technique and principles. Expert Choice Software was employed as development tool where the shortlisted criteria and alternatives from phase 2 was integrated into the framework. Finally phase 4 is structured interview to validate the framework developed.

This chapter discussed in three main sections which include research design, identification of research population and criteria for selecting respondents as well as data transformation.

4.2 RESEARCH DESIGN

Creswell (2009) explained that research designs are plans and the procedures for research that span the decisions from broad assumptions to detailed methods of data collection and analysis. As mentioned, mixed method is employed in this study. Mixed method is the combination of both qualitative and quantitative method. According to Osborne (2008), mixed method is the combination of best aspects of both qualitative and quantitative method or research that involving multiple methods. Bergman (2008) also agreed that the main aim of mixed method is taking the best aspects of qualitative and quantitative methods and combine them. Creswell (2009) agreed that mixed methods incorporates elements of both qualitative and quantitative approaches. Johnson and Onwuegbuzie (2004) defined mixed method as "the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study" while Creswell (2009) explained mixed method is "an approach to inquiry that combines or associates both qualitative and quantitative forms which involves philosophical assumptions, the use of qualitative and quantitative approaches and the mixing of both approaches in a study".

In social science, both qualitative and quantitative developed and perceived legitimacy which lead mixed method that employ the combination of both qualitative and quantitative gained popularity because it utilized the strength of both qualitative and quantitative (Creswell, 2009). In addition, Creswell (2009) pointed out that social science researches are complex whereby the use of either qualitative or quantitative is

inadequate to address the complexity. He also claimed that mixed method involves the use of both qualitative and quantitative approaches in tandem in order to have greater overall strength of the study than either only adapted one of the approaches.

The rationale of using mixed method includes (Johnson and Onwuegbuzie, 2004):-

i. Provide and incorporate the strength of both quantitative and qualitative research method and minimize the weaknesses.
ii. The research problem can be answered in broader and complete range as the research is not restricted to only single approach.
iii. Stronger evidence can be provided at the end of the research as the conclusion through convergence and corroboration of findings.

There are several different aspects between qualitative, quantitative and mixed method such as forms of data collection, analysis and interpretation. The differences are highlighted by Creswell (2009) as shown Table 4.1.

Table 4.1: Differences between qualitative, quantitative and mixed method

Quantitative Methods	**Mixed Methods**	**Qualitative Methods**
Pre-determined	Both pre-determined and emerging methods	Emerging methods
Instrument based questions	Both open- and closed-ended questions	Open-ended questions
Performance data, attitude data, observational data and census data	Multiple forms of data drawing on all possibilities	Interview data, observation data, document data and audio visual data
Statistical analysis	Statistical and text analysis	Text and image analysis
Statistical interpretation	Across databases interpretation	Themes, patterns interpretation

Source: Creswell (2009)

Creswell (2009) referred qualitative research as a means of exploring and understanding the meaning individuals or groups ascribe to a social or human problem. He further added that the process of research using qualitative approach involves emerging questions and procedures, data typically collected in the participant's setting, data analysis inductively building from particulars to general themes and the researcher interpretations of the meaning of the data. In addition, qualitative data refer to information gathered in a narrative form through interviews and observations (Sekaran and Bougie, 2009). Qualitative method is conducted using interview either with individual or focus groups, observations and data collected from documents while quantitative methods use experiments and questionnaires or surveys (Osborne, 2008).

On the other hand, quantitative research is defined as "testing objective theories by examining the relationship among variables whereby the variables can be measured, typically on instruments so that numbered data can be analyzed using statistical procedures" (Creswell, 2009). Creswell (2009) stated that researchers need to decide the strategies of inquiry either using qualitative, qualitative or mixed method. He further explained strategies of inquiry are "type of qualitative, quantitative and mixed methods designs or models that provide specific direction for procedures in the research design". There are several types of strategies of inquiry for each qualitative, quantitative and mixed method that can be seen in Table 4.2.

Table 4.2: Alternative Strategies of Inquiry

Quantitative	Qualitative	Mixed Methods
• Experimental designs • Non-experimental designs, such as surveys	• Narrative research • Phenomenology • Ethnogrphies • Grounded theory studies • Case study	• Sequential • Concurrent • Transformative

Source: Creswell (2009)

As we can referred to Table 4.2, quantitative strategies are divided into two alternatives which are survey and experimental research. Creswell (2009) quoted from Babbie (1990) explained that survey research provides a quantitative or numeric description of trends, attitudes or opinions of a population by studying a sample of that population which include cross-sectional and longitudinal studies using questionnaires or structured interviews for data collection with the intent of generalizing from the sample to a population. In contrast, experimental research seeks to determine if a specific treatment influences an outcome (Creswell, 2009).

The explanations for the alternatives of qualitative approach are as follow (Creswell, 2009):-

i. Ethnography: a strategy of inquiry in which the researcher studies an intact cultural group in a natural setting over a prolonged period of time by collecting, primarily, observational and interview data.

ii. Grounded theory: a strategy of inquiry where the researcher derives a general, abstract theory of a process, action or interaction grounded in the views of participants. Two primary characteristics of this design are the constant

comparison of data with emerging categories and theoretical sampling of the different groups to maximize the similarities and differences of information.

iii. Case studies: strategy of inquiry where the researcher explores in depth a program, event, activity, process or one or more individual.

iv. Phenomenological research: a strategy that researcher identifies the essence of human experiences about a phenomenon as described by participants.

v. Narrative research: a strategy in which the researcher studies the lives of individuals and asks one or more individuals to provide stories about their lives. The information obtained is then often retold and restoried by the researcher into a narrative chronology.

On the other hand, mixed methods strategies are divided into three main alternatives. In sequential mixed methods, the researcher seeks to elaborate on or expand on the findings of one method with another method where the researcher may either begin the research by qualitative interview for exploratory purposes and followed up by a quantitative survey method with a large sample so that the researcher can generalize results to a population or start a study with quantitative method in which a theory or concept is tested followed by a qualitative method involving exploration with few cases or individuals (Creswell, 2009).

Whereby in concurrent mixed method, the researcher converges or merges quantitative and qualitative data in order to provide a comprehensive analysis of the research problem. The data are collected in both forms at the same time by the investigator and

then the information is generated in the interpretation of the overall results. Finally, transformative mixed methods procedures are those in which the researcher uses a theoretical lens as an overarching perspective within a design that contain both quantitative and qualitative data. The lens provides a framework for a topics of interest, methods for collecting data and outcomes or changes anticipated by the study. Within this lens could be a data collection method that involves a sequential or concurrent approach (Creswell, 2009).

The present study was designed using sequential mixed methods. As mentioned, sequential mixed method may either begin the research by qualitative or start a study with quantitative method. There are three main types of sequential design as shown in Figure 4.1. This study carried out according to sequential explanatory strategy. It is categorized by the collection and analysis of quantitative results in the first phase which is followed up with qualitative data in the second phase that is builds depending the results of the first phase (Creswell, 2009). Creswell (2009) further explain that this design usually give weight to quantitative data and the mixing of the data occurs when the initial quantitative results informs the secondary qualitative data collection. Although the two forms of data are separate but connected.

Generally, there are two types of data collection that is primary and secondary data. According to McNabb (2008), primary data are data that the researcher generates while secondary data are the data collected by other parties but is used by the researcher to have more understanding for the research. In addition, Sekaran and Bougie (2009)

explained in more detail that secondary data are obtained from published records and other resources such as government publications, published or unpublished information available from either within or outside the organization, data available from previous research, statistical bulletins, case studies and library records, online data, company websites and the internet in general where the data already exist and do not have to be collected by the researcher. Several case studies are selected and information about the case studies are gathered through interviews, questionnaire and any other sources to obtain primary data.

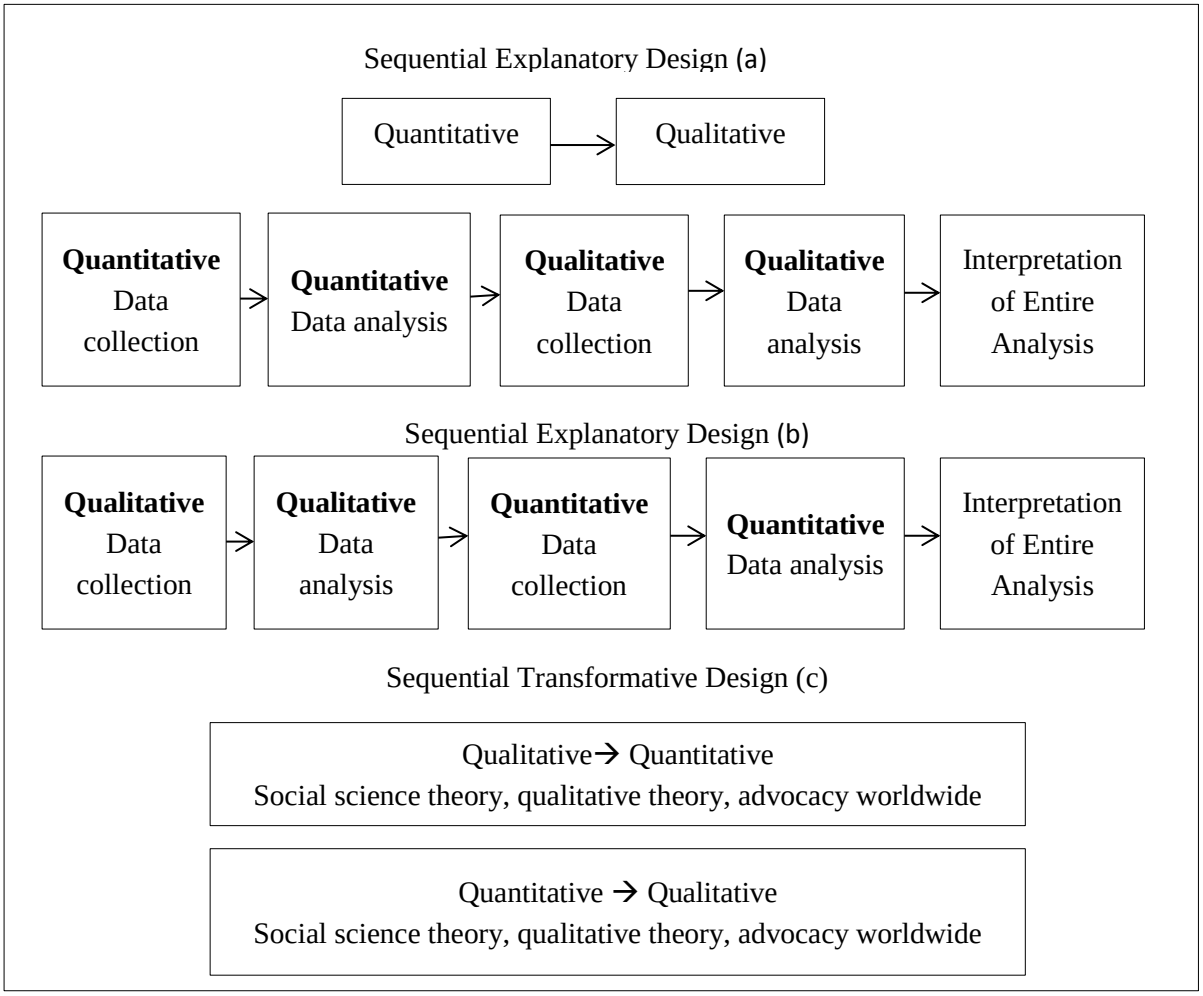

Figure 4.1: Sequential Design
Source: Creswell (2009) adapted from Creswell *et al*. (2003)

On the other hand, Sekaran and Bougie (2009) explained primary data as data gathered for research from the actual site of occurrence of events such as observing events, people and objects or by administering questionnaires to individuals. Sekaran and Bougie (2009) also noted that primary and secondary data are beneficial to gather simultaneously because secondary data can help the researcher to focus further interviews more meaningfully on relevant aspects found to be important in the literature while the data from primary data such as data from interview may help the researcher to search for relevant topics in secondary sources.

Generally, the present study is carried out step by step where the flow can be seen in Figure 1.1 while the research design can be referred to Figure 1.2. The first phase of the research started with the identification of secondary data collected through the extensive literature review. Sekaran and Bougie (2009) defined literature review as a step-by-step process that involves the identification of published and unpublished work from secondary data sources on the topic of interest, the evaluation of this work in relation to the problem and the documentation of the work. According to Creswell (2009) the main purpose of literature review is to provide a framework for establishing the importance of the study and benchmark for comparing the results obtained from the study with other findings done by other researchers. Literature review is obtained from secondary data which include journals, article, books and many other resources. Literature review is completed first before starting the primary data collection. It is an important source of data to provide an overview of the research and related information relating to the topic.

Through literature search, there is very limited study found for maintenance procurement in Malaysia. Thus, postal questionnaires survey was carried out in phase 2 to clarify the variables, to get a general overview of the characteristics of building maintenance procurement strategy implemented in this country and short-list the type of procurement, criteria that maintenance personnel take into consideration when selecting procurement method and the process in selecting procurement method in building maintenance management in Malaysia. As according to sequential explanatory design, the data obtained from the preliminary questionnaires survey was analyzed and was employed to third phase of this study that is to develop decision making framework based on AHP technique and principles. Expert Choice Software was employed as development tool. After developing the framework, secondary stage of data collection which involved structured interview which was the fourth phase of the study was carried out to demonstrate the framework to the interviewees and test the framework produced. Finally, the interviewees were asked to evaluate the framework.

The information obtained from data collection will be analysed using mixed method measures as mentioned earlier. The information and data obtained is processed and discussed in order to achieve the objectives of this research. Statistical Package for the Social Science (SPSS) software will be used for statistical analysis. Once the data analysis completed, recommendations are provided based on proper justification of the author in order to ensure the research can be reviewed in the future. The research is then concluded by fulfilling the objectives formulated.

4.3 IDENTIFICATION OF RESEARCH POPULATION AND CRITERIA FOR SELECTING RESPONDENTS

It is essential to identify the research population which reflects the true picture of the study. Sekaran and Bougie (2009) explained the population refers to "the entire group of people, events or things of interest that the researcher wishes to investigate". They further explained that the process of selecting the right individuals, objects or events as representatives for the entire population is known as sampling. This indicated that sample is a subset of the population. Therefore, the researcher will be able to draw a conclusion by studying the sample to generalize the population of interest (Sekaran and Bougie, 2009).

Since this research mainly focusing on the selection of procurement method in building maintenance management for public universities in Malaysia based on experience from each specific university, the decision to choose which procurement method to be adopted is usually made by the maintenance department that are in charge to plan the maintenance work for that particular university. According to Ministry of Higher Education (MOHE), the current total population of public universities in Malaysia is 20, which comprise of 5 research universities, 4 comprehensive universities and 11 focused universities. The list of public universities can be referred to Table 2.2

As the size of population is small and manageable, census survey will be employed. Census is a count of all elements in the population (Sekaran and Bougie, 2009). It is

also a process of obtaining responses from or about each of the members of the population (Panneerselvam, 2006). Bless and Higson-Smith (2005) also agreed that census is a survey of the whole population which will be more accurate than a survey using a restricted sample but it will be more costly and time consuming.

As this research obtained information from specific target group which were the decision maker in maintenance department of public universities, therefore this research adopted purposive sampling design. According to Sekaran and Bougie (2009), purposive sampling confined to specific types of people who can provide the desired information because they are the only ones who have it or conform to some criteria set by the researcher. There are two major types of purposive sampling design which include judgment sampling and quota sampling. Sekaran and Bougie (2009) explained judgment sampling involves the choice of subjects who are most advantageously placed or in the best position to provide the information required while quota sampling ensures that certain groups are adequately represented in the study through the assignment of quota. In other word, judgment sampling select subject based on their expertise in the subject investigated (Sekaran and Bougie, 2009).

In this current study, the respondent of this survey should be people who involved in the decision making process of selection of procurement method in building maintenance for public universities. The researcher called each universities maintenance department to identify the name and position for the decision maker for procurement method selection in building maintenance work. However, each university suggested posting the

questionnaires to the director's office of Department of Development and Maintenance. The director or deputy director in the university maintenance department is appropriate to respond to the questionnaire because they are people who are involved in the decision making process. Director of development is the highest managerial postion in the Department of Development and Maintenance. The director of development is responsible to plan, execute and monitor development projects, maintenance works, building and infrastructure upgrading works in the university. They are belief afford to provide valid, factual and unbiased information. Therefore, this research will be based on judgment purposive sampling process because the subject of this research will be the directors or deputy directors in the universities maintenance department as they are people who are involved in the decision making process and in the best position to provide the information required.

As there are only 20 public universities in Malaysia, 20 sets of questionnaires were sent out to the maintenance department of all the public universities specifically addressed to the director or deputy director by identifying their names and positions which were believe to encourage high participation. Lateef *et al.* (2010) claimed that postal questionnaire that addressed to a specific name encourage high participation. However, it was discovered that the maintenance department of each university is named differently. The names of maintenance departments are shown in Table 4.3.

Table 4.3: Public Universities' Maintenance Department Name

No	University	Maintenance Department
1	University of Malaya (UM)	Department Of Development and Estate Maintenance
2	University of Science, Malaysia (USM)	Development Department
3	National University of Malaysia (UKM)	Department of Development and Maintenance
4	Putra University, Malaysia (UPM)	Department of Development and Asset Management
5	University of Technology, Malaysia (UTM)	Office of Asset and Development
6	MARA University of Technology (UiTM)	Department of Facilities Management
7	International Islamic University of Malaysia (UIA)	Development Division
8	University of Malaysia, Sabah (UMS)	Department of Development and Maintenance
9	University of Malaysia, Sarawak (UNIMAS)	Asset Management Division
10	Northern University of Malaysia (UUM)	Department of Development and Maintenance
11	Sultan Idris University of Education (UPSI)	Department Of Development and Estate Maintenance
12	Tun Hussein Onn University of Malaysia (UTHM)	Development & Property Management Office
13	Technical University of Malaysia, Melaka (UTeM)	Development Office
14	University of Malaysia, Perlis (UniMAP)	Department Of Development
15	University of Malaysia, Terengganu (UMT)	Office of Asset And Development
16	University of Malaysia, Pahang (UMP)	Property Management and Development
17	Islamic Science University of Malaysia (USIM)	Department of Development and Facilities Management
18	Sultan Zainal Abidin University (UniSZA)	Development and Maintenance Department
19	University of Malaysia, Kelantan (UMK)	Department of Development, Infrastructure and Services
20	National Defense University of Malaysia (UPNM)	Development and Maintenance Department

4.4 PHASE 1: LITERATURE REVIEW

The present study start with first phase that is identification of secondary data collected through the extensive literature review. Creswell (2009) outlined that literature review is essential in a research because it helps to determine the worthiness of the topic to be studied and it provides insight into ways where the researcher can limit the study scope to a needed area of inquiry. Literature review achieves several purposes which include (Creswell, 2009 and Sekaran and Bougie, 2009):-

- Shares with the reader the results of the other studies that are closely related to the one being undertaken.
- Provides a framework for establishing the importance of the study as well as a benchmark for comparing the results with other findings.
- Ensure that important variables that influence the problem situation are not left out of the study.
- Assist the researcher to emerge more clear idea to determine the most important variables in development of the theoretical framework.
- The problem statement can be made with precision and clarity.
- Avoid the researcher to rediscover something that is already known or done by others.

The literature review for the development of decision making framework mainly focused on two important components that are the possible assessment criteria and the alternatives available for selection. In addition, the research reviewed the maintenance

management in both international and Malaysia context. The background of study including the definition of asset management, facility management and building maintenance, importance of building maintenance, type of building maintenance, development of Building Maintenance Management in Malaysia and development of Building Maintenance for Public Universities in Malaysia are studied to understand the current situation of Building Maintenance Management in Malaysia. However, literature review provides information within certain periods of time. Thus, the current stage of information will be investigated in phase 2 (Postal Questionnaires Survey).

The type of procurement which is categorized as the alternatives of selection which was one of the important components in development of decision making framework was discussed by reviewing the available procurement strategy building maintenance and facilities management to determine the available alternative of selection. Then, literature reviews are employed to identify the assessment criteria to select the most appropriate procurement method. There are 26 assessment criteria identified in literature review which were divided into three main categories that were clients' requirements, project characteristics and external environment or factors which can be referred to Table 2.14.

The assessment criteria and alternatives for selection are evaluated by the maintenance personnel in public universities in Malaysia in phase 2 of research which is postal questionnaires survey in order to determine and shortlist the assessment criteria and alternatives which are considered important to select the most appropriate procurement

method for building maintenance management specifically public universities in Malaysia. On the other hand, the main purpose to evaluate assessment criteria and alternatives for selection is to eliminate those criteria and alternatives that are considered less or not important for the development of the decision making framework in phase 3 of the present study.

In addition, decision making tools are reviewed as well in order to select the most appropriate tool to be adapted to select the most appropriate procurement method. As selecting procurement method is a Multiple criteria decision making (MCDM), reviews were did starting with decision analysis which is the main branch of multiple criteria decision making and followed up with the tools and method available in multiple criteria decision making (MCDM).

4.5 PHASE 2: MAIN DATA COLLECTION (POSTAL QUESTIONNAIRES SURVEY)

The Postal Questionnaires Survey is developed on the basis of extensive literature reviews. Creswell (2009) claimed that survey design provides a quantitative or numeric description of trends, attitudes or opinions of a population by studying a sample of that population. The primary aim of this survey is to investigate the current information in regards to building maintenance management in Malaysian's Public Universities.

Through literature search, it is found out that there is very limited study found for maintenance procurement in Malaysia. Thus, this postal questionnaires survey is carried out to clarify the variables, to get a general overview of the characteristics of building maintenance procurement strategy implemented in this country and short-list the type of procurement, criteria that maintenance personnel take into consideration when selecting procurement method and the process in selecting procurement method in building maintenance management in Malaysia.

The main objectives of the preliminary questionnaire survey are as follow:-

(i) To get a general overview of the characteristics of building maintenance procurement strategy implemented in this country

(ii) To short-list the type of procurement and criteria that maintenance personnel take into consideration when selecting procurement method for AHP purposes.

(iii) To verify some of the main independent and intervening variables described in the theoretical framework.

(iv) To establish contact with and information about the potential respondents for the structured interview.

4.5.1 Piloting the questionnaire

Before the postal questionnaires survey data collection was conducted, a pilot study was conducted to assure that the questionnaires achieve the objectives of the survey and to test the ease of understanding of the questions. It was also taken into consideration whether the time allocated to complete the survey is appropriate and any ambiguities

arising from the wording of the questiona was also addressed. The questionnaires has been conducted for pilot testing on the particular experts including supervisors, PhD students and maintenance personnels from universities which is considered as the target group of this study. Their invaluable comments were summarized in Table 4.4. After considering all the comments received, the questionnaire was modified.

Table 4.4: Pilot testing comments

Experts	**Questionnaire design**			
	Overall appearance	**Instructions**	**Question and Layout**	**Time to complete**
Supervisors/PhD students	• Add in UM logo, reference number and research topic • Highlight and bold the research topic and instruction • Font size smaller and make the questionnaire fit into three to four pages only • Arrange the questionnaire according to partition and	• Make instruction simple and clear • Include instruction at every part of question if there is any different way of answering	• Take out some question that are not necessary to ask • Arrange the layout of the question accordingly to the flow of research • Use Likert scale to rate the importance of variables	• Reasonable
Maintenance personnel from university	• Attach a glossary of terms used for respondent reference	• Fine	• Some questions are not clear	• Acceptable

4.5.2 Questionnaire Design

The questionnaires consist of four pages and are divided into six parts. The questionnaire has a total of 34 questions. The structure of the questionnaire can be referred to Table 4.5. The questionnaire is attached as Appendix C.

Table 4.5: The structure of the questionnaire

Part	**Question No.**	**Description**
1.Respondent's particular	1.1-1.5	This part seeks to establish the knowledge and experience of interviewees. In addition, this background provides the respondents with wide experience capable of providing independent and unbiased opinion on information that were addressed to them.
2.Building and project characteristic	2.1-2.5	Building and project characteristic reveal the project characteristic which may affect the selection of procurement method
3.Criteria for procurement selection	3.1-3.5	Criteria for procurement selection reveals the criteria influencing the decision maker choices in selecting procurement systems
4. Procurement	4.1-4.7	Type of procurement is to identify the type of procurement method available and most recent used in building maintenance management
5.Decision making in procurement strategy selection	5.1-5.6	This part determine the appropriateness for adapting AHP in the study
6. Performance of procurement method	6.1-6.7	Performance of procurement method reveal the performance measurement used to evaluate the performance of a specific procurement method adapted

Each questionnaire was labeled with different reference number (UM/FBE/BHA1100007/0XX) at the right top of first page for different public university and to identify which university replied and which has not replied to take further action such as reminder. Most of the questions were designed as closed-ended format question which alternative of answers were listed and the respondent can select

one or more answer that they think relevant. There are several types of closed format questions were employed in the present study including single answer, multiple answers, numerical and Likert style questions. The examples of each type of questions were shown as below:-

(a) Single answer question

1.1 What is your job title? (Please answer all the following questions by ticking [/] in appropriate bracket)

[ ] Facility Manager [ ] Maintenance Manager

[ ] Administration manager [ ] Maintenance Executive

[ ] Director of development [ ] General manager

[ ] Others, please specify_____

(b) Multiple answer question

4.5 If out-source is the procurement method of this university, what is the reasons to outsource the services? (May choose more than 1 answer)

[ ] Reduce maintenance task to corrective maintenance

[ ] In-house staff less competent and inactive

[ ] The number of in-house staff is not adequate

[ ] It can reduce the maintenance cost

[ ] University management considers the management of building as non-core activities

[ ] Others, please specify_____

(c) Numerical question

5.3 Please justify how much time do you think is appropriate to make a decision to select the most appropriate procurement method?

_____

(d) Likert style question

Please indicate to what extent the following variables are important in evaluating the degree of performance of the procurement method.

6.1	Cost effectiveness	Least Important	1	2	3	4	5	Very Important
6.2	Service quality	Least Important	1	2	3	4	5	Very Important
6.3	Work performance	Least Important	1	2	3	4	5	Very Important
6.4	Customer satisfaction	Least Important	1	2	3	4	5	Very Important
6.5	Ability to fulfill client's need and requirement	Least Important	1	2	3	4	5	Very Important
6.6	Ability to deliver the service with reasonable reliability and predictability	Least Important	1	2	3	4	5	Very Important

There are three questions were open-ended questions to identify any variables were not mentioned in the questionnaire. The example of open-ended question as shown below:-

3.5 Please state any other criteria that not being mentioned above which you consider as important criteria that need to be considered in selecting the most appropriate procurement method.

_____

4.5.3 Conducting the survey

Once the questionnaire has been completed, an official covering letter from the Faculty of Built Environment, University of Malaya (as shown as Appendix A) and a cover letter (as shown as Appendix B) which contains the objectives of the research, the importance of the information requested and when the respondents are expected to return the completed questionnaire are attached as well. The respondents are also promised a summary report of the findings of the survey for their corporation by requiring them to provide their name and email address at the end of the questionnaire. These contact information will then be used to forward them the findings of the survey. A set of questionnaires with the letter was posted to all respondents on the same day together with a self-addressed prepaid envelope which was provided in order to expedite and facilitate return. However, the respondents were also allowed to return their completed questionnaire by email. All the questionnaire sets were sent using Faculty of Built Environment, University Malaya addresses as a return address to reflect the importance of the work and also to indicate that the survey was official in nature.

The data collection and collation commenced on 15th September 2012. A call was made to the all universities' director's office of maintenance department 2 weeks after the questionnaires posted to ensure all the public universities in Malaysia received the questionnaires. However, 11 universities claimed that they did not receive the questionnaire. Thus, registered post was used to post to the 11 universities in order to provide more control than regular mail as registration process is computerized with

barcode registration labels which can track the progress of the registered letter. Many calls and reminders were made every week to ensure all the respondents reply.

The data collection lasted until end of December 2012. This long period of the survey duration was as a result of the respondents' inabilities to complete and return the questionnaire on time because that period was universities' convocation whereas the maintenance department was busying preparing tools and facilities for that ceremony. There were 17 questionnaires returned and analyzed for this study where 15 questionnaires returned using self-addressed envelope and 1 questionnaire returned using email and 1 questionnaire was answered by using Kwik Surveys. Online questionnaire was created using Kwik Surveys as requested by one of the university as he claimed that he was too busy and it will be easier to answer online. The online questionnaire link was e-mailed to the other 3 universities that did not response as well. However, those universities claimed that they were too busy and do not have any time to respond although many reminders were made. This marks the response rate at 85%. This high response rate is possible because of the long survey duration of time given and the numerous reminders which were sent to the respondents. All the university responded except University Putra Malaysia (UPM), University Malaysia Terengganu (UMT) and University Malaysia Perlis (UniMAP).

This 85% response rate is considered satisfactory for a postal survey. Sekaran and Bougie (2009) claimed that 30% response rate is common and acceptable for postal survey. In addition, Sekaran and Bougie (2009) provided a table which simplified the

size decision that ensures a good decision model introduced by Krejcie and Morgan (1970) which indicated that if the total number of population is 20, the appropriate number of sampling should be 19. However, this research only managed to obtain 17 questionnaires returned and analyzed. A lot of efforts and reminders were made in order to achieve at least 19 universities replied but 3 universities claimed that they were too busy and do not have any time to response thus the research proceeded as there was no action can be taken. The summary of the details pertaining to the administration of the preliminary questionnaire survey are given shows in Table 4.6.

Table 4.6: Summary of the details pertaining to the administration of the preliminary questionnaire survey

Description	**Frequencies**
Number of questionnaire sent out	20
Total returned questionnaires using self-addressed envelope	15
Total returned questionnaires using email	1
Questionnaire answered using Kwik Surveys	1
Total questionnaire answered and returned	17
Overall percentage questionnaires answered	85%
Valid percentage questionnaires answered	85%

The feedbacks from the preliminary postal questionnaires survey were analysed using computer packages, namely Statistical Package for Social Science (SPSS) version 17.0 to produce descriptive statistics. Descriptive Statistics provide information regarding the distributions of datasets or variables. It measure average (mean, median and mode), spread (variance and standard variation), skewness, kurtosis, maximum and minimum of values. Each of the statistics is require for achieving different objectives (Lateef et al., 2010).

Findings from the preliminary questionnaire survey showed that almost 30 percent of the respondents are Directors or Deputy Directors of development and 76.4% of them have more than 5 years of experience in in building maintenance works. In addition, the results revealed that all (100%) of the respondents have at least a bachelor's degree. Therefore, it can be deduced that the majority of the respondents have satisfactory working experience and knowledge in providing required information. This indicated that the respondents' role, knowledge and extensive background provide valid, factual and unbiased information which contribute to the high reliability and validity of the conclusion which has been drawn from the research findings. An in-depth discussion of the preliminary survey results are presented in Chapter 6 of this thesis.

4.6 PHASE 3: DEVELOPING DECISION MAKING FRAMEWORK

The main objective of this present study is to develop a decision making framework for selecting the most appropriate procurement method for building maintenance management specifically for public universities in Malaysia through the use of Multiple criteria decision making (MCDM) particularly Analytic Hierarchy Process (AHP). The framework was developed based on AHP technique and principles. Expert Choice software was employed as development tool and the shortlisted criteria and alternatives from phase 2 (Postal Questionnaires Survey) was adapted into the framework.

As mentioned previously, AHP is "a theory of measurement through pairwise comparisons and relies on the judgements of experts to derive priority scales" where

comparisons were made using a scale of absolute judgements that indicate how much more one element dominates another with respect to a given attribute (Saaty, 2008). There are three basic principles of the AHP. The first principle was constructing hierarchies. In AHP, a complex system was structured hierarchically by decomposing the elements into constituent parts according to essential relationships towards a desired goal which can make the whole system well understood (Saaty, 1982).

The second principle of AHP is establishing priorities. The first step in establishing the priorities of elements in a decision problem is to make pairwise comparison that is to compare the elements in pairs against a given criterion (Saaty, 1982). The third is principle of logical consistency. Saaty (1982) pointed out that logical consistency ensures that elements are grouped logically and ranked consistently according to a logical criterion. The development of decision making framework using AHP mainly focused on two important components that are the possible assessment criteria and the alternatives available for selection. The assessment criteria were used to evaluate the alternatives. All the assessment criteria and type of procurement available were identified in phase 1 (Literature review) and were validated in term of their applicability in phase 2 (Postal Questionnaires Survey). The assessment criteria and type of procurement shortlisted in phase 2 were employed in the development of the framework. The discussion on development of the framework is presented in Chapter 6 of this thesis.

4.7 PHASE 4: VALIDATION OF THE FRAMEWORK (STRUCTURED INTERVIEW)

The main aim of this phase is to validate the framework developed in phase 3. The framework produced was demonstrated to the interviewees. Then, the interviewees were asked to run the framework and were asked to evaluate the framework in term of capability, applicability and validity.

Basically there are two main type of interview that is unstructured interview and structured interview. Sekaran and Bougie (2009) explained that in unstructured interviews, the researcher carry out an interview without a planned sequence of questions to be asked to the respondents. The main purpose of unstructured interview is to bring some preliminary issues to the surface so that the researcher can determine which variable need to have further in-depth investigation. On the other hand, structured interviews are conducted when the researchers are clear what information is needed. Sekaran and Bougie (2009) stressed that the interviewer usually has a list of pre-determined questioned to be asked to the respondents in structured interviews.

Structure interview is chosen in this phase so that the researcher can explain the framework in detail to the respondents, clarify any doubts arises by the interviewees and at the same time the researcher able to examine the level of understanding of the respondents towards the topic and the framework. All the interviewees were explained and asked the same questions in the same manner to standardize in order to make it

easier to repeat the interview and provide a reliable source of qualitative data. The two main purposes of this structured interview are:-

(i) The interviewees are requested to do a pair-wise comparison with the assessment criteria and procurement option which has been developed in the Expert Choice software

(ii) The interviewees also requested to evaluate the proposed decision making framework in term of its capability, applicability and validity.

4.7.1 Interviewee Selection

As mentioned previously, the total population of public universities in Malaysia are 20, comprise of 5 research universities, 4 comprehensive universities and 11 focused universities which can be seen in Table 2.2. However, there are only 17 universities replied in the in phase 2 (Preliminary Postal Questionnaires Survey). The interviewees for phase 4 (Structured Interview) are selected from phase 2 (Preliminary Postal Questionnaires Survey) which only the universities that have responded.

Table 4.7: Selected universities for structured interview

No	University	Replied Preliminary Postal Questionnaires Survey	Selected for structured interview
	Research Universities		
1	Universiti Malaya (UM)	√	√
2	Universiti Sains Malaysia (USM)	√	
3	Universiti Kebangsaan Malaysia (UKM)	√	√
4	Universiti Putra Malaysia (UPM)		
5	Universiti Teknologi Malaysia (UTM)	√	√
	Comprehensive Universities		
1	Universiti Teknologi MARA (UiTM)	√	√
2	Universiti Islam Antarabangsa Malaysia (UIA)	√	√
3	Universiti Malaysia Sabah (UMS)	√	
4	Universiti Malaysia Sarawak (UNIMAS)	√	
	Focussed Universities		
1	Universiti Utara Malaysia (UUM)	√	
2	Universiti Pendidikan Sultan Idris (UPSI)	√	√
3	Universiti Tun Hussein Onn Malaysia (UTHM)	√	√
4	Universiti Teknikal Malaysia Melaka (UTeM)	√	√
5	Universiti Malaysia Perlis (UniMAP)		
6	Universiti Malaysia Terengganu (UMT)		
7	Universiti Malaysia Pahang (UMP)	√	
8	Universiti Sains Islam Malaysia (USIM)	√	√
9	Universiti Sultan Zainal Abidin (UniSZA)	√	
10	Universiti Malaysia Kelantan (UMK)	√	
11	Universiti Pertahanan Nasional Malaysia (UPNM)	√	

There were 9 universities equivalent to 52.9% selected from 17 universities responded in phase 2 (Preliminary Postal Questionnaires Survey) as shown in Table 4.7. The 9 universities are selected from the 3 main categories of universities so that this research covers different type and category of university. According to Sekaran and Bougie (2009), the researcher that conduct structured interview may stops the interview when a sufficient number of structured interviews has been conducted and adequate information obtained to understand and describe the important factors operating in the situation. Piaw (2011) highlighted that in qualitative research, the sample size is usually small and

5 subjects are accepted if the demography data are same. Besides, Musa (2011) research on determining the best options for Facilities Management (FM) service delivery in UK shopping centres which also integrated AHP and Expert Choice in developing the framework did 5 interviews on shopping complexes for validation of his research framework. Thus, 9 universities are considered satisfactory and accepted because the evaluation done by the 9 universities were quite equivalent. The interviewees' profiles are tabulated in Table 4.8 according to the 3 main types of public universities categories.

Table 4.8: Interviewees Profiles

Name of Universities	Nos. of Interviewees	Position	Experience (years)
Research Universities			
University RA	3	➢ Head of Civil Engineering Division ➢ Head of Contract & Quantity Surveying Division ➢ Quantity Surveyor	20 30 10
University RB	1	➢ Assistant Head of Quantity Surveying Department	17
University RC	1	➢ Head of Contract Department	31
Comprehensive Universities			
University CA	1	➢ Head of Contract Management And Cost Control Section	12
University CB	1	➢ Acting Senior Facilities Engineer	7
Focussed Universities			
University FA	1	➢ Head of Quantity Surveying Department	10
University FB	1	➢ Deputy Director of Facility and Estate Management Department	25
University FC	1	➢ Head Department of Building Maintenance Section	11
University FD	1	➢ Deputy Director of Development & Facilities Management Department	23

4.7.2 Interviewee Instrument

As mentioned previously, the main aim of this phase is to validate the framework developed in phase 3. The development of the framework includes employment of procurement selection criteria and procurement method option, integration of Analytic Hierarchy Process (AHP) technique and principles and adaption of Expert Choice Software as development tool. The AHP implementation steps will be simplified by using the Expert Choice professional software.

The first purpose of this structured interview is the interviewees are requested to do a pair-wise comparison with the assessment criteria and procurement option which has been developed in the Expert Choice software. Thus, the Decision Making Framework for Procurement Method Selection of Building Maintenance Management for Public Universities was stored in Expert Choice software as an interview instrument. This Expert Choice software instrument offers a questionnaire with scale of 1 to 9 to perform pair-wise comparison as shown in Figure 4.2. The judgments can be performed in three ways by numerical, verbal and graphical in Expert Choice software. The interviewees were requested to perform pairwise comparisons for all levels of hierarchy in the framework produced. This instrument brings a lot of advantages in term of time saving, simple, easy to explained and understand as well as well-structured. In addition, it also facilitates the processing data stage compared to other structured interview instruments.

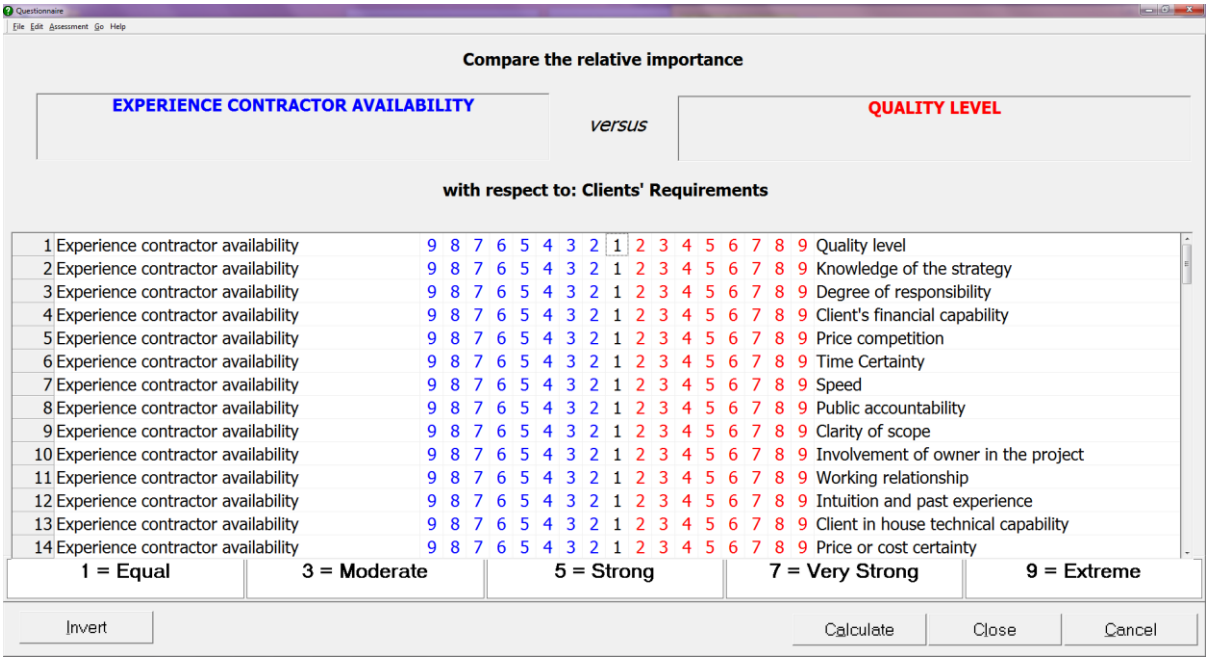

Figure 4.2: Example of questionnaire with scale of 1 to 9 to perform pair-wise comparison

As discussed previously, the second purpose of this structured interview was the interviewees requested to evaluate the proposed decision making framework in term of its capability, applicability and validity after they obtained the best procurement method proposed. Thus, another instruments used during the interview was the evaluation form. The Form has a rating from very poor to excellent. The interviewees were requested to rate the Decision Making Framework for Procurement Method Selection of Building Maintenance Management for Public Universities in term of capability, applicability and validity. Each evaluation form was labeled with different reference number (UM/FBE/BHA1100007/FBF/0XX) at the right top for different public university and to identify which university gave what evaluation and comments. The interviewees can also provide comments, cop and sign the form after evaluation done. The example of evaluation form as shown in Appendix E.

4.7.3 Conducting Structured interview (Validation of the framework)

Before the structured interview was conducted, a pilot study was conducted to assure that the interview achieve the objectives, test the ease of understanding of the framework and examine the approximate time needed to complete the interview. The pilot testing was conducted on the particular experts including supervisors, PhD students and lecturer that have knowledge in AHP and Expert Choice. After considering all the comments received and once the number of respondents has been confirmed, the researcher contacted the director's office of Department of Development and Maintenance to find the appropriate person to interview. The interviewees were contacted by phone using the phone number obtained from director's office or each university website or email provided from the replied questionnaires in phase 2 (Preliminary Postal Questionnaires Survey). The date of interviews was fixed according to the interviewees schedule as shown in Table 4.9. The structured interview commenced in April 2013 and lasted until May 2013. An official covering letter from Faculty of Built Environment, University Malaya and a cover letter which contain the objectives of the interview and the importance of the interviewees participation in this structured interview was emailed to the interviewees before the interview conducted. A call was also made as a reminder to the interviewees one week before the fixed date of interview and also to inform the approximate time length of interview so that the interviewees were well-prepared and their schedule will not be interrupted.

The researcher explained the results obtained from phase 2 (Postal Questionnaires Survey) and highlighted the set of procurement selection criteria and procurement

methods that were shortlisted and adapted in the framework to the interviewees. Then, the researcher explained the framework produced to the interviewees and also explain how AHP and Expert Choice work. Finally, the interviewees were asked to run the framework and were asked to evaluate the framework in term of capability, applicability and validity. The findings of the structured interviews and the result on the validation of the framework are presented in Chapter 6 of this thesis.

Table 4.9: Dates of structured interview

Name of Universities	Date of interview	Sequence of interview
Research Universities		
University RA	17/4/2013	2
University RB	25/4/2013	4
University RC	3/5/2013	7
Comprehensive Universities		
University CA	26/4/2013	5
University CB	18/4/2013	3
Focussed Universities		
University FA	9/5/2013	9
University FB	2/5/2013	6
University FC	9/4/2013	1
University FD	7/5/2013	8

4.8 DATA TRANSFORMATION

The information and data obtained from the present study was processed and discussed in order to achieve the objectives of this research. Statistical Package for the Social Science (SPSS) software was employed for statistical analysis. The statistical technique used in this study was descriptive statistics. Descriptive statistic is a very common technique used to summaries the data in tables and graphic forms which provide a complete view of the result. To shortlist and rank the variables, calculation of central

tendency using the mean was carried out. In addition, mode which determines the value that appears most often in a set of data also employed to identify the most popular variables.

4.9 SUMMARY

The present study adapted mixed method which combined of best aspects of both qualitative and quantitative method. This study is divided into four main phases whereby phase 1 is literature review, phase 2 that is postal questionnaires survey to validate the variables obtained from phase 1 which had marks a response rate of 85%, Phase 3 is develop decision making framework based on AHP technique and principles and finally phase 4 is structured interview to validate the framework developed with nine selected public universities. The identification of research population and criteria for selecting respondents were discussed as well. Finally, data transformation was discussed at the end of the chapter. The results of postal questionnaires survey will be discussed in Chapter 5 while the results of structured interview will be discussed in Chapter 6.

CHAPTER 5

QUANTITATIVE DATA ANALYSIS AND FINDINGS

5.1 INTRODUCTION

This chapter provides the results from the postal questionnaires survey that was conducted to investigate the current information in regards to building maintenance management in Malaysian's Public Universities. This include to get general overview of the characteristics of building maintenance procurement strategy implemented in this country and short-list the type of procurement and criteria that maintenance personnel take into consideration when selecting procurement method. In addition, this questionnaire also aims to understand the current processes and tools used in selecting procurement method in public universities in Malaysia. Apart from that, the perception of maintenance personnel from the Department of Development and Maintenance of each public university towards the identified criteria and procurement strategies from extensive literature reviews are investigated as well in order to validate the applicability of these criteria as assessment criteria in selecting the most appropriate procurement method. The results discussed were based on descriptive statistics using Statistical Package for Social Science (SPSS).

5.2 DESCRIPTIVE STATISTIC ANALYSIS

5.2.1 Respondent's Particular and Background

The analysis of the data shows that majority (29.4%) of the respondents are Director or Deputy Director of development as shown in Table 5.1. Director of development is the highest management post in Department of Development and Maintenance. Director of development are responsible to plan, execute and monitor development projects, maintenance works, building and infrastructure upgrading works in the university. In addition, they need to manage the administration and operations of the department and assist the university Vice Chancellor in planning the strategy and direction of development in and around the vicinity of the University as well as to plan and implement development initiatives. Thus, the director or deputy director of the development and maintenance is appropriate to respond to the questionnaire because they are people who are involved in the decision making process and are belief afford to provide valid, factual and unbiased information. There are 17.6 % of the respondents were facility manager and 17.6% are maintenance executive, 11.8% were maintenance manager while 23.5% respondents has others position such as head of contract division, assistant bursar (finance officer), engineer and quantity surveyor. It can be seen that all of the respondents involved in building maintenance work and in the decision making process.

Table 5.1: Distribution of respondents' position

Job title	**Percentage (N=17)**
Facilities Manager	17.6
Maintenance Manager	11.8
Maintenance Executive	17.6
Director or Deputy Director of Development	29.4
Others	23.5
Total	100.0

In addition, Table 5.2 shows that 35.3% of the respondents have more than 15 years of experience in building maintenance works and there are 76.4% of the respondents have more than 5 years of experience in the said field. Hence, there is no doubt that the respondents have sufficient experience to provide valid feedback.

Table 5.2: Distribution of respondents' working experience in building maintenance works

Experience in building maintenance works	**Percentage (N=17)**
Less than 5 years	23.5
5-10 years	23.5
10-15 years	17.6
More than 15 years	35.3
Total	100.0

An analysis was also carried out on the number of universities buildings had been managed by the respondents prior to the current university which they are managing to study the respondents' experience in managing university buildings. It can be seen in Table 5.3 that nearly half of the respondents (41.2%) managed more than 15 buildings. With this, there is no doubt as to the respondents' experience in managing university buildings. Hence, majority of the respondents have satisfactory working experience and knowledge in providing required information.

Table 5.3: Distribution of number of university buildings have been managed by the respondents before this university

Number of university buildings have been managed before this university	**Percentage (N=17)**
Less than 5 Buildings	58.8
More than 15 Buildings	41.2
Total	100.0

Besides, all of the respondents are knowledgeable as all of the respondents hold at least a bachelor degree academic background in facility management, engineering, quantity surveying, property management and finance as shown in Table 5.4 and Table 5.5. In term of education background, three respondents had learned more than one course. Thus, multiple response analysis was performed. It can be seen from Table 5.4 that most of the respondents had engineering background. There are only 2 respondents had quantity surveying background and 1 had property management and 1 had finance background.

Table 5.4: Distribution of respondents' education background

Education Background	**Responses**		**Percent of Cases**
	N	**Percentage**	
Facility Management	3	15.0	17.6
Engineering	13	65.0	76.5
Quantity Surveying	2	10.0	11.8
Property Management	1	5.0	5.9
Finance	1	5.0	5.9
Total	20	100.0	117.6

Table 5.5: Distribution of respondents' highest academic background

Highest academic qualification	**Percentage (N=17)**
Bachelor Degree	64.7
Master Degree	23.5
PhD	11.8
Total	100.0

An analysis on academic qualification of the respondents reveals that 64.7% of respondents who have obtained their bachelor's degree while 23.5% of them have obtained their master's degree. A total of 11.8% of the respondents have a PhD. From Table 5.5, the results revealed that all (100%) of the respondents have at least a bachelor's degree. Therefore, it can be deduced that the majority of the respondents have satisfactory working experience and knowledge in providing required information.

From the analysis obtained from the respondent's particular and background, it can be conclude that the majorities (29.4%) of the respondents were Director or Deputy Director of development who got more than 5 years of experience (76.4%) in building maintenance works and 41.2% of the respondents had managed more than 15 university buildings before managing this particular university as shown in Table 5.6. In addition, all of the respondents hold at least a bachelor's degree in facility management, engineering, quantity surveying, property management or finance. This indicated that the respondents' role, knowledge and extensive background provide valid, factual and unbiased information which contribute to the high reliability and validity of the conclusion which has been drawn from the research findings.

Table 5.6: Summary of respondent's particular and background

Majority	**Percentage (N=17)**
Director or Deputy Director of development	29.4%
More than 5 years of experience	76.4%
Had managed more than 15 university buildings before managing this particular university	41.2%
Hold at least a bachelor's degree in facility management, engineering, quantity surveying, property management or finance	100%

5.2.2 Building and Project Characteristic

At first, the postal questionnaires survey was planned to distribute to public and private universities but after consideration that there were different universities policies between public and private universities, thus this research will be mainly focus on public universities. The analysis shown in Table 5.7 revealed that the survey was mainly focused on public universities.

Table 5.7: Ownership of the university

Ownership of the university	Percentage (N=17)
Government	100.0

Table 5.8 shows that most (70.6%) of the universities that participated in this research occupied more than 100,001m^2 build area. There was only 1 university occupied for each size of built area that were 40,000-50,000m^2, 50,001-60,000m^2 and 60,001-70,000m^2 while there were 2 universities occupied for 70,001-80,000m^2 built area. This indicated that the universities participated in this survey were large.

Table 5.8: Distribution of size of the university built area

Size of the university built area	Percentage (N=17)
40,000-50,000m^2	5.9
50,001-60,000m^2	5.9
60,001-70,000m^2	5.9
70,001-80,000m^2	11.8
80,001-90,000m^2	0.0
90,001-100,000m^2	0.0
100,001m^2 and Above	70.6
Total	100.0

Ali (2009) claimed that the level of maintenance work required depends on the age of building. He further explained that the older the building, more attention and focus is needed. Among the universities that participated in this research, 6 of the universities were in between 10-20 years old (Figure 5.1). There were 3 universities less than 10 years old, 3 more than 50 years and 1 university in between 41-50 years old. The remaining were 2 universities in between the age of 21-30 years and 2 universities in between the age of 31-40 years. This results deduced that more than 80% of the universities participated in this survey is more than 10 years old therefore more efforts needed in maintenance work to ensure that the buildings and its services in an operable and optimal condition.

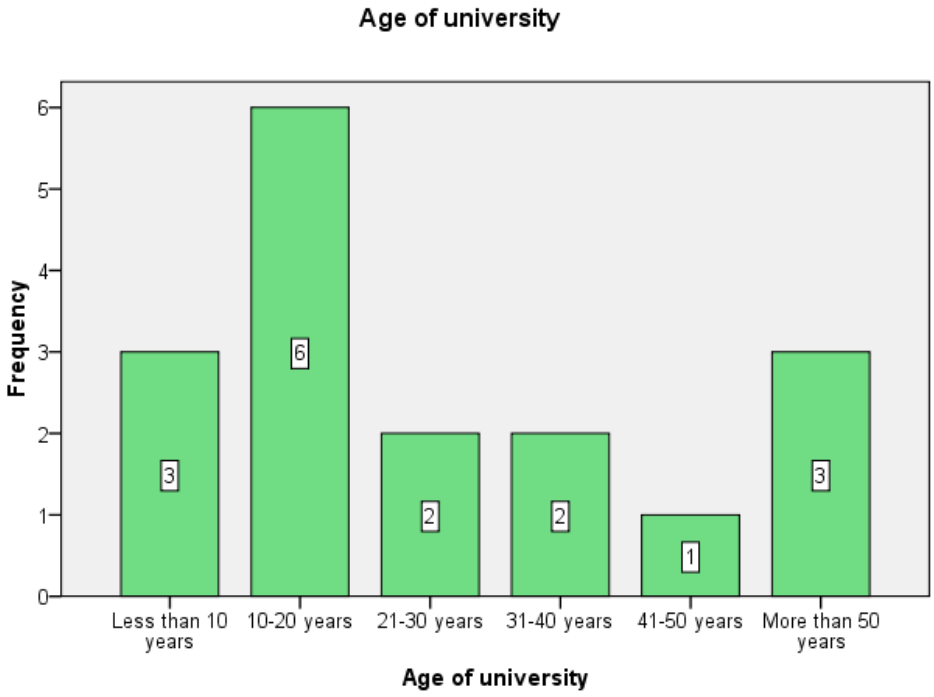

Figure 5.1: Distribution of universities' age

In addition, there are two universities which are more than 50 years old and the buildings have been listed under the National Heritage Act 2005 and gazetted as heritage buildings. The buildings that have been gazetted are Suluh Budiman Building which is known as Bangunan Suluh Budiman in Malay located in Sultan Idris University of Education (UPSI) and Chancellery building and Tunku Chancellor Hall which is known as Dewan Tunku Chancellor (DTC) in Malay located in University of Malaya. Suluh Budiman Building was built in August 1919 and completed in June 1922 while Chancellery building and Tunku Chancellor Hall was completed and officiated in 1966. The buildings have historical value, cultural heritage significance and represent the nature of the universities. This indicated that building maintenance is indeed very essential for buildings in public universities to preserve the historical buildings. In fact, the management of universities' building maintenance should be improved in order to provide better quality and increase on user satisfaction.

Lateef *et al.* (2010a) claimed that maintenance department of universities in Malaysia is understaffed and the staffs are also inadequately qualified. Thus, the number of full time employee was investigated in this survey. Table 5.9 showed that 35.3% of the universities had more than 150 full-time employees while 29.4% had less than 30 full-time employees. There were 11.8% of the universities had in between 30 to 60 and 61 to 90 each of full-time employees and 5.6% universities had in between 91-120 and 121 to 150 of full-time employees.

Table 5.9: Distribution of number of full time employee in the maintenance organization

No. of full-time employee in the maintenance organisation	**Percentage (N=17)**
Less than 30	29.4
30-60	11.8
61-90	11.8
91-120	5.9
121-150	5.9
More than 150	35.3
Total	100.0

The results in Table 5.9 deduced that majority of the universities have more than 150 but the percentage of universities that have less than 30 was quite high. Therefore, cross-tabulation between size of the university built area and number of full time employee was presented in Table 5.10 to see is there any relationship between the size of the university built area and number of full time employee. It can be seen from the result that there were 5 universities that had more than 100,001m^2 university's built area had more than 150 number of full-time employee in the maintenance organization. The only university that had the least 40,000-50,000m^2 university's built area had less than 30 number of full-time employee in the maintenance organization. Thus, the result indicated that the the larger the university, more number of full-time employees is needed and vice versa.

Table 5.10: Relationship between size of the university built area and number of full-time employee in the maintenance organization

Size of the university built area	**No. of full-time employee in the maintenance organisation**						**Total**
	Less than 30	**30-60**	**61-90**	**91-120**	**121-150**	**More than 150**	
40,000-50,000m^2	1	0	0	0	0	0	1
50,001-60,000m^2	0	0	0	0	0	1	1
60,001-70,000m^2	0	0	1	0	0	0	1
70,001-80,000m^2	1	0	1	0	0	0	2
80,001-90,000m^2	0	0	0	0	0	0	0
90,001-100,000m^2	0	0	0	0	0	0	0
100,001m^2 and Above	3	2	0	1	1	5	12
Total	5	2	2	1	1	6	17

From the result obtained from Figure 5.2, more than half (58.8%) of the universities participated in this survey have less than RM10 million for annual maintenance budget. There are 23.5% universities allocated RM11-20 million, 11.8% for more than RM40 million and 5.9% universities allocated in between RM31-40 million. There was none university allocated in between RM21-30 million. Lateef et al. (2010a) highlighted that the maintenance of universities in Malaysia is budget driven where maintenance work only will be carried out when there is fund available. In addition, in many cyclical cases is put off until there is available fund to carry out the tasks. He further claimed that the budget allocated is not sufficient and not effectively managed. Thus, it proves that the management of building maintenance in public universities in Malaysia should be improved to increase the functionality of building and at the same time reduce the cost of maintenance.

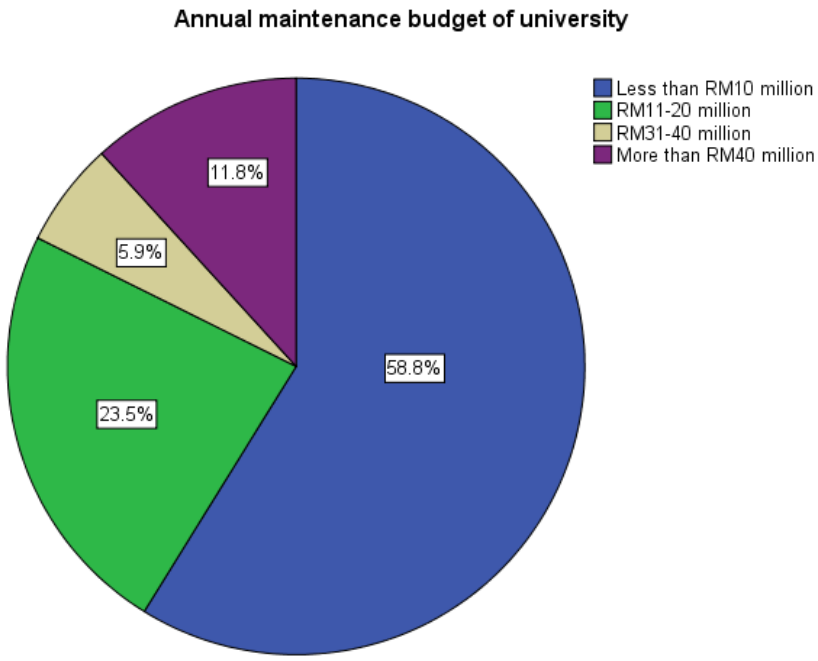

Figure 5.2: Distribution of annual maintenance budget of university

Lateef (2009) claimed that building's age is one of the most important elements that need to be considered in allocation of maintenance resources. Thus, cross-tabulation is performed to determine whether age of building influences the allocation of annual maintenance budget of the university. The results in Table 5.11 revealed that only 11.8% of the universities which were more than 50 years old, are allocated the most annual maintenance budget at more than RM40 million. It also revealed that university which have in existence for at least 31 years were allocated more than RM10 million for annual maintenance budget. This proves that the older the building, the higher the allocation of annual maintenance budget for the university.

Table 5.11: Relationship between age of university and annual maintenance budget of university

Age of university	**Annual maintenance budget of university**					**Total Percentage (N=17)**
	Less than RM10 million	**RM11-20 million**	**RM21-30 million**	**RM31-40 million**	**More than RM40 million**	
Less than 10 years	11.8	5.9	0	0	0	17.6
10-20 years	29.4	5.9	0	0	0	35.3
21-30 years	5.9	5.9	0	0	0	11.8
31-40 years	0	5.9	0	5.9	0	11.8
41-50 years	0	0	5.9	0	0	5.9
More than 50 years	5.9	0	0	0	11.8	17.6
Total	52.9	23.5	5.9	5.9	11.8	100.0

In addition, cross-tabulation was also performed to determine whether a larger university is provided more annual maintenance budget. The result in Table 5.12 indicated that the smallest university which was 40,000-50,000m^2 allocated the least annual maintenance budget that was less than RM10 million. However, the majority of the universities that had built-up area 100,001m^2 and above also allocated less than RM10 million for maintenance budget. It can be seen that the maintenance budget allocation is not much depend on the size of university. This may caused the budget allocated is not sufficient for large university.

Table 5.12: Relationship between the size of the university built area and annual maintenance budget of university

Size of the university built area	**Annual maintenance budget of university**					**Total Percentage (N=17)**
	Less than RM10 million	**RM11-20 million**	**RM21-30 million**	**RM31-40 million**	**More than RM40 million**	
40,000-50,000m^2	5.9	0	0	0	0	5.9
50,001-60,000m^2	0	0	0	5.9	0	5.9
60,001-70,000m^2	0	5.9	0	0	0	5.9
70,001-80,000m^2	11.8	0	0	0	0	11.8
100,001m^2 and Above	35.3	17.6	5.9	0	11.8	70.6
Total	52.9	23.5	5.9	5.9	11.8	100.0

Multiple response analysis was employed for questionnaires contain items in a form of checklist where the respondent can choose more than 1 item or measurement (Gray and Kinnear, 2012). This analysis was employed to determine the most frequent used method to estimate universities' maintenance budget. Based on Table 5.13, it can be seen that majority of the universities estimate maintenance budget based on previous expenditure (34.4%), building condition (28.1%) and university budget (31.3%). Only 1 university estimates maintenance budget based on maintenance contract and work to be carried out.

Table 5.13: Distribution on method to estimate universities' maintenance budget

Method to estimate universities' maintenance budget	**Responses**		**Percent of Cases**
	N	**Percentage**	
Based on previous expenditure	11	34.4	64.7
Based on building condition	9	28.1	52.9
Based on university budget	10	31.3	58.8
Based on maintenance contract	1	3.1	5.9
Based on work to be carried out	1	3.1	5.9
Total	32	100.0	188.2

5.2.3 Criteria for Procurement Selection

Likert scale and ranking analysis were employed to rate the importance of procurement selection criteria. As mentioned earlier in literature review, there are 26 criteria to be considered in this study. The respondents were asked to rate the degree of importance of criteria to be considered for procurement method selection for Universities' building maintenance. The likert scales of 5, from which 1 indicates "least important" to 5 which indicates "very important" were employed. Ranking of the importance of procurement selection criteria use the mean score to indicate the degree of importance of the criteria. The mean, standard deviation and ranking can be referred to Table 5.14.

It can be seen in Table 5.14 that there were 7 criteria that obtained the highest mode (mode=5) which include availability of experience contractor, existing building condition, quality level, knowledge of the strategy, degree of responsibility, client's financial capability and working relationship. This deduced that those criteria are very essential whereby the decision maker need to be taken into consideration when selection procurement method. On the other hand, there were 3 criteria that were considered least important compared to other criteria which obtained mode equals to 3 which include degree of flexibility, political issue or constraint and culture. In addition, those 3 criteria also obtain the lowest mean value and ranking among the 26 criteria.

Table 5.14: Ranking of procurement selection criteria

Procurement Selection Criteria	Mean	Std. Deviation	Ranking	Mode
Experience contractor availability	4.71	.470	1	5
Existing building condition	4.59	.618	2	5
Objective or policy of organisation	4.53	.514	3	4
Quality level	4.47	.717	4	5
Government policy	4.41	.618	5	4
Knowledge of the strategy	4.41	.712	6	5
Degree of responsibility	4.41	.712	6	5
Client's financial capability	4.41	.795	7	5
Price competition	4.35	.606	8	4
Time Certainty	4.35	.493	9	4
Speed	4.35	.493	9	4
Public accountability	4.29	.686	10	4
Clarity of scope	4.29	.686	10	4
Involvement of owner in the project	4.24	.752	11	4
Working relationship	4.24	.831	12	5
Project size	4.18	.636	13	4
Intuition and pass experience	4.12	.781	14	4
Client in house technical capability	4.06	.827	15	4
Price or cost certainty	4.00	1.061	16	4
Risk allocation or avoidance	3.94	.748	17	4
Dispute and arbitration	3.88	.697	18	4
Dissatisfaction with previous process	3.76	.903	19	4
Degree of complexity	3.71	.985	20	4
Degree of flexibility	3.59	1.004	21	3
Political issue/constraint	3.53	.717	22	3
Culture	3.47	.800	23	3

5.2.4 Type of Procurement

Likert scale was also used to rate the importance of the each type procurement method identified from the literature review. Ranking analysis was also performed to indicate the degree of importance of building maintenance procurement method. The mean, standard deviation and ranking can be referred to Table 5.15. Table 5.15 revealed that there were only 3 procurement methods; outsourcing by specialist term contract, outsourcing by tendered schedule term contract and outsourcing by repair and

maintenance contract obtained mean value more than 4 and 1 procurement method obtained mean value almost 4 that was outsourcing by measured term contract. This result deduced that the respondents considered outsourcing is the most important procurement strategy for public universities.

Table 5.15: Ranking of building maintenance procurement method

Procurement Method	**Mean**	**Std. Deviation**	**Ranking**	**Mode**
Outsourcing by Specialist Term Contract	4.18	.728	1	4
Outsourcing by Tendered Schedule Term Contract	4.12	.781	2	4
Outsourcing by Repair and Maintenance Contract	4.06	.659	3	4
Outsourcing by Measured Term Contract	3.94	.966	4	4
Outsourcing by Service Level Agreement	3.47	1.007	5	3
Total Facilities Management	3.24	1.200	6	4
Outsourcing by Lump Sum Contract	3.24	1.251	7	3
Outsourcing by Day Work Contract	3.06	.899	8	3
Traditional	3.00	1.000	9	3
Outsourcing by Cost Reimbursement Contract	2.88	.928	10	3
Public Private Partnership (PPP)	2.82	.809	11	3
Out-tasking	2.82	.809	11	3
Partnering	2.71	1.263	12	3

In order to identify the procurement methods that are currently adapted by public universities in Malaysia, multiple response analysis was performed. The results can be referred to Table 5.16 and Figure 5.3. Outsourcing by repair and maintenance contract (18.2%) and outsourcing by specialist term contract (16.9%) were the most popular procurement methods adapted in public universities. Out of 17 universities participated in this survey, 14 universities employed outsourcing by repair and maintenance contract and only 3 universities do not adapt this two procurement method. In addition, outsourcing by tendered schedule term contract (15.6%) and outsourcing by measured term contract (14.3%) were also quite popular among the procurement methods. On the

other hand, out-tasking (1.1%) and total facilities management (1.1%) is the least used in public universities in Malaysia. The ranking of the procurement method used in public universities in Malaysia can be referred to Figure 5.3.

Table 5.16: Distribution on procurement methods currently employed in Malaysia's public universities

Procurement method used in universities	**Responses**		**Percent of Cases**
	N	**Percentage**	
Outsourcing by Repair and Maintenance Contract	14	18.2%	82.4%
Outsourcing by Specialist Term Contract	13	16.9%	76.5%
Outsourcing by Tendered Schedule Term Contract	12	15.6%	70.6%
Outsourcing by Measured Term Contract	11	14.3%	64.7%
Outsourcing by Lump Sum Contract	6	7.8%	35.3%
Traditional	6	7.8%	35.3%
Outsourcing by Day Work Contract	5	6.5%	29.4%
Outsourcing by Service Level Agreement	4	5.2%	23.5%
Public Private Partnership (PPP)	2	2.6%	11.8%
Outsourcing by Cost Reimbursement Contract	2	2.6%	11.8%
Out-tasking	1	1.3%	5.9%
Total Facilities Management	1	1.3%	5.9%
Partnering	0	0	0
Total	77	100.0%	452.9%

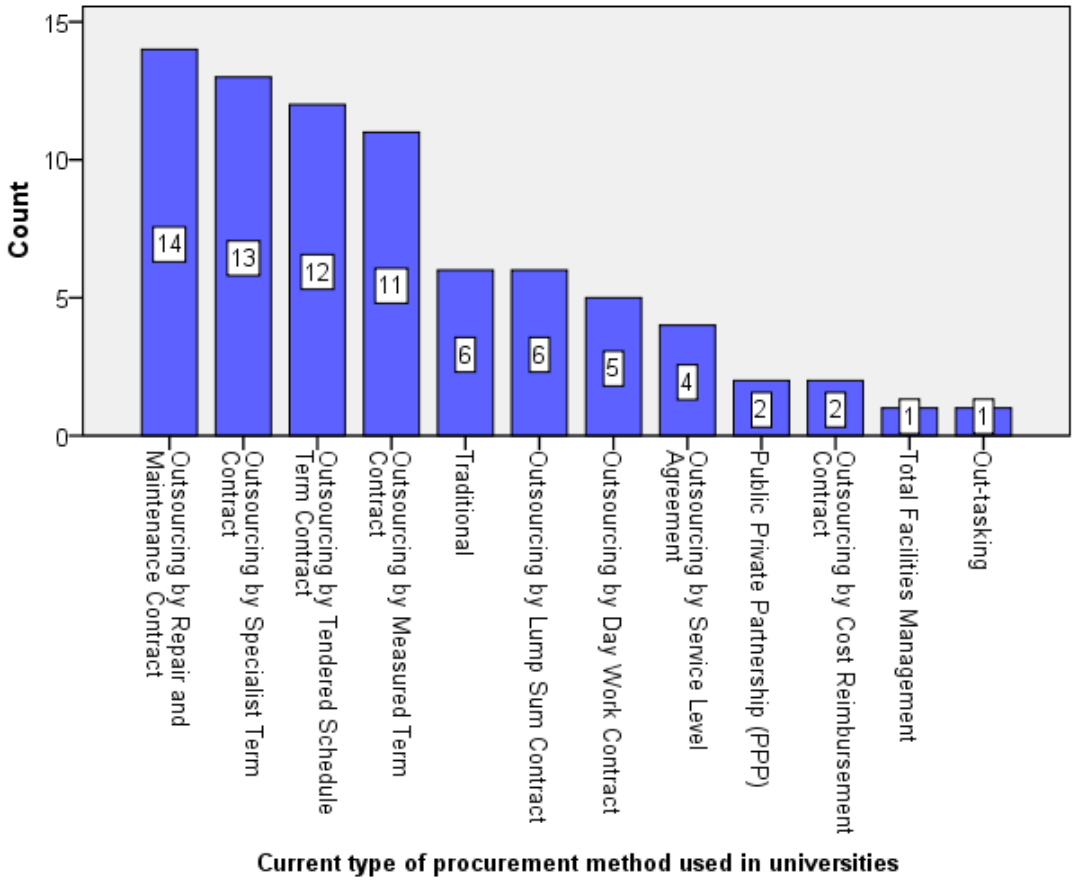

Figure 5.3: Ranking of procurement methods currently employed in Malaysia's public universities

From the results in Table 5.15 and Table 5.16, it can be seen that there were 4 procurements methods which include outsourcing by specialist term contract, outsourcing by tendered schedule term contract, outsourcing by repair and maintenance contract and outsourcing by measured term contract were the most popular procurement methods adapted by public universities currently (Percent of Cases > 50%) and at the same time were considered most important (mean >4 or almost equal to 4). In addition, these 4 procurements methods obtained mode equals to 4.

There are some ways that the decision maker applied to select the most appropriate procurement method. Some respondents may choose the procurement method based on previous experiences, based on the maintenance budget allocation, based on the age of the building or based on government policies. While some may think the best way is to select a procurement method which carries the least risk and which deliver optimum efficiency. Based on the data collected from 17 universities that participated in this survey, some universities depend on more than one way in choosing a suitable procurement method. Thus, a multiple response analysis was performed on this analysis. From the results obtained in Table 5.17, the majority of the universities choose their procurement method based on the maintenance budget allocation (45.7%) and based on previous experiences (31.4%). The minority of the universities considered government policies (2.9%) and select the procurement method that provide lower risk and optimizes efficiency (2.9%). In addition, some universities consider the age of the building (17.1%) as well in selecting their procurement method.

Table 5.17: Distribution on ways to select procurement method

Ways to select procurement method	**Responses**		**Percent of Cases**
	N	**Percentage**	
Based on previous experience	11	31.4	64.7
Based on maintenance budget allocation	16	45.7	94.1
Based on age of the building	6	17.1	35.3
Based on government policy	1	2.9	5.9
To minimise risk and optimise efficiency	1	2.9	5.9
Total	35	100.0	205.9

Lateef et al. (2011) pointed out that university organizations prefer to outsource the larger part of maintenance services and it seems that outsourcing is the most common used procurement method for universities in Malaysia. It also can be seen from Table 5.16 and Figure 5.3 that most of the universities prefer to outsource their building maintenance services to contractors. The reasons for this are identified in Table 5.18. The results showed that the main reason that the universities outsourced their maintenance services was because of the inadequacy of in-house staff. There were 14 universities out of the 17 universities which participated in this survey claimed that the number of in-house staff is not adequate to carry out all the maintenance work in the university. Thus, the university organizations prefer to outsource the maintenance services to contractors to carry out the maintenance task and the in-house maintenance team only focuses on monitoring and planning the building maintenance task.

In addition, the universities also claimed that outsourcing reduces maintenance task to corrective maintenance (25.6%) because the maintenance task will be carried out by a trained and experienced team for a service of better quality. This is supported by Sheng (2012) that external specialists are engaged to provide certain specialized trade of service which can improve the quality of maintenance work, reduce corrective maintenance and reduce maintenance cost. The universities also claimed that in-house staff were less competent and inactive (12.8) and university managements consider the management of building as a non-core activities (12.8%), thus the services were outsourced. However, some universities argued that outsourcing can reduce maintenance cost (10.3%) as it can eliminate the cost of training provision for internal

employee while some universities claimed that and the complexity of work (2.6%) caused them to outsource the work to experts.

Table 5.18: Distribution on reason to outsource building maintenance services

Reasons to outsource building maintenance	Responses		Percent of Cases
	N	Percentage	
Reduce maintenance task to corrective maintenance	10	25.6%	58.8%
In-house staff less competent and inactive	5	12.8%	29.4%
The number of in-house staff is not adequate	14	35.9%	82.4%
It can reduce maintenance cost	4	10.3%	23.5%
University management consider the management of building as non-core activities	5	12.8%	29.4%
Complexity of the maintenance work	1	2.6%	5.9%
Total	39	100.0%	229.4%

Likert scale was also employed to rate some justification found from the literature review. When the respondents were asked to what extend they agree that the number of employee is adequate for the selected procurement method, more than 50% of the universities opined that the number of employee available is adequate for the selected procurement method (Table 5.19). However, Table 5.18 showed that the number of in-house staff is not adequate therefore most of the services were outsourced. In addition, Lateef *et al.* (2010a) claimed that maintenance department of universities in Malaysia is understaffed and the staffs are also inadequately qualified. This issue occured because the respondents consider that the number of employee was adequate for the selected procurement as most of the services were outsourced and the internal maintenance personnel only responsible to monitor and plan the maintenance task.

Table 5.19: Respondents' opinion on the adequacy of the number of employee for the selected procurement

No. of employee is adequate for the selected procurement	**Percentage (N=17)**
Disagree	23.5
Partially agree	11.8
Agree	35.3
Strongly agree	29.4
Total	100.0

In addition, the respondents were also asked to what extend they agree that the procurement currently adapted was reasonable. There were 29.4% of the respondents strongly agree and 41.2% agree while 29.4% partially agree that the procurement currently adapted was reasonable as shown in Table 5.20.

Table 5.20: Respondents' opinion on the reasonability of procurement adapted

Procurement adapted reasonable	**Percentage (N=17)**
Partially agree	29.4
Agree	41.2
Strongly agree	29.4
Total	100.0

On the other hand, 58.8% (N=10) of the respondents opined that they were satisfied with the procurement method adapted and 11.8% strongly agree while 29.4% partially agree (Table 5.21). This indicated that 29.4% (N=5) of the respondents were not really satisfied with the procurement method employed currently. Thus, it is essential to improve the selection procurement process in order to select the most appropriate procurement method.

Table 5.21: Respondents' satisfaction with the procurement method employed

Satisfaction with the procurement method employed	**Percentage (N=17)**
Partially agree	29.4
Agree	58.8
Strongly agree	11.8
Total	100.0

There are some researcher opined that in-house is the most suitable procurement strategy for university as university should not expose to external parties. However, Lateef *et al.* (2011) proven in his research that 66.7% of the universities in Malaysia combined in-house and outsource for maintenance activities and 21.1% adapted outsource only as well as 9.12% adapted in-house only. In order to justify this, the respondents of this survey were asked to what extend they agree that in-house is the most suitable procurement strategy for university as university should not expose to external parties. The results in Table 5.22 showed that majority of the respondents disagree this statement. There were 29.4% of the respondents strongly disagree and 29.4% of the respondents disagree while only 17.6% of the respondents partially agree and 17.6% of the respondents agree each. However, there was 5.9% of the respondents strongly agree that in-house is the most suitable procurement strategy due to university policy that university should not expose to external parties. From the analysis, it can be seen that the majority (almost 60%) of the respondents disagree that in-house is the most suitable procurement strategy due to university policy that university should not expose to external parties.

Table 5.22: Respondents' opinion on the statement that In-house is the most suitable procurement strategy for university as university should not expose to external parties

In-house is the most suitable procurement strategy for university as university should not expose to external parties	**Percentage (N=17)**
Strongly disagree	29.4
Disagree	29.4
Partially agree	17.6
Agree	17.6
Strongly agree	5.9
Total	100.0

5.2.5 Decision Making in Procurement Strategy Selection

The respondents were asked whether there was any guidance available to select the most suitable procurement method to determine whether there is any proper guidance available. From the survey, 58.8% (N=10) of the respondents opined that there was no proper guidance available to select the most appropriate procurement method as hown in Table 5.23. This result provides an impetus for this research. However, 41.2% (N=7) of the respondents stated that there were some guidance available such as government policies which were produced by ministry of finance and and public works department, also known as Jabatan Kerja Raya (JKR). Some respondents stated that experience and training were important as well.

Table 5.23: The availability of guidance to select the most suitable procurement method

Is there any guidance available to select the most suitable procurement method?	**Percentage (N=17)**
No	58.8
Yes	41.2
Total	100.0

In addition, respondents were asked whether there was any decision making theory or tool in selecting procurement strategy for university. The analysis from Table 5.24 revealed that majority (52.9%) of the respondents opined that there is no decision making theory or tool available in helping them to select procurement strategy for university. However, 47.1% of the respondents stated that there were some tools available to help them in selecting procurement methods such as problem solving and priority selection (Pareto Ishikawa 80:20), cut-off statistic, appointment of procurement committee members, urgency level, total asset management, evaluation criteria based on Quantity Surveyor and public works department as well as strategic planning.

Table 5.24: The availability of decision making theory or tools in selecting procurement strategy for university

The availability of decision making theory or tools in selecting procurement strategy for university	**Percentage (N=17)**
No	52.9
Yes	47.1
Total	100.0

The findings in Table 5.23 and Figure 5.24 have proven that the selection of procurement method by university organization is not in any strategic way nor not systematic as there is no guidance available for the decision maker to select the most appropriate procurement strategy. The nature of selection of procurement method for public universities in Malaysia was autonomy and the only guideline that needs to refer is Government Circular from Ministry of Finance. In addition, the decision makers will hold a few meetings to discuss which procurement method to be adopted before final decision is made which is quite time consuming. It is indeed very vital to develop a systematic approach that can assist the maintenance personnel in the decision making

process of selecting the most suitable procurement method in building maintenance management for public university.

Furthermore, when the respondents were asked whether there was any useful procedure to select the most appropriate procurement method for building maintenance, 52.9% answered yes and 47.1% answered no (Table 5.25). The respondents stated that the procedure that they found useful include PLOC and escalation, experience, JKR-cutoff, planning with all levels of management and stakeholder, open tender, study the critical success factor of building maintenance then decide, record and experience as well as specialist in handling the same project. It also deduced that almost half of the respondents conveyed that there are none useful procedure to select the most appropriate procurement method for building maintenance currently. The outcome of the current study that is to produce a decision making framework to select the most appropriate procurement method by adapting AHP theory and principle will be helpful for the decision maker of public universities to select the most appropriate procurement method.

Table 5.25: The availability of useful procedure to select the most appropriate procurement method for building maintenance

Is there any procedure that you have found useful to select the most appropraite procurement method for building maintenance?	**Percentage (N=17)**
No	47.1
Yes	52.9
Total	100.0

This study planned to adopt Analytic Hierarchy Process (AHP) as decision making tool in selecting the most appropriate procurement strategy for public university in Malaysia.

Thus, an analysis was carried out to investigate the suitability of Analytic Hierarchy Process (AHP) to be used as a tool to select the most suitable procurement method. The result in Table 5.26 revealed that 64.7% of the respondents do not have any idea what is AHP, 29.4% opined that AHP was suitable and only 5.9 (N=1) respondent argued that AHP was too complicated and take long time to make decision. This indicated that the understanding of AHP is still very limited among the respondents. However, about 30% of the respondents that have knowledge in AHP considered AHP is appropriate to be adapted as a decision making tool to select the most appropriate procurement method.

Table 5.26: The suitability of Analytic Hierarchy Process (AHP) to be used as a tool to select the most suitable procurement method

Do you think Analytic Hierarchy Process (AHP) is appropriate to be used as a tool to select the most suitable procurement method?	**Percentage (N=17)**
No	5.9
Yes	29.4
Do not have any idea what is AHP	64.7
Total	100.0

5.2.6 Performance of Procurement Method

Likert scale and ranking analysis was employed to rate the importance of several variables in evaluating the performance of procurement method. The ranking is shown in Table 5.27. There are some evaluation measures suggested by the respondents which include ability to avoid disturbance and collateral damage, time (service response), financial or budget capability, manpower and machineries availability, constraint, restriction, limit and boundaries, contractor attitude, key performance indicator (KPI), supply of expertise staff in related area as well as technical and conical valve. The result in Table 5.27 revealed that customers' satisfaction is most important in delivering the procurement method and followed by work performance.

Table 5.27: Ranking of measure of procurement method performance

Variables	Mean	Std. Deviation	Ranking
Customers' satisfaction	4.76	.437	1
Work performance	4.71	.470	2
Ability to fulfill client's need and requirement	4.65	.493	3
Service quality	4.65	.493	3
Ability to deliver the service with reasonable reliability and predictability	4.59	.618	4
Cost effectiveness	4.59	.618	4

5.3 SUMMARY

From the analysis, it can be conclude that the majorities (29.4%) of the respondents were Director or Deputy Director of development who got more than 5 years of experience (76.4%) in building maintenance works and 41.2% of the respondents had managed more than 15 university buildings before managing this particular university. In addition, all of the respondents hold at least a bachelor's degree in facility management, engineering, quantity surveying, property management or finance. This indicated that the respondents' role, knowledge and extensive background provide valid, factual and unbiased information which contribute to the high reliability and validity of the conclusion which has been drawn from the research findings. In addition, the findings also deduced that more than 80% of the universities participated in this survey is more than 10 years old therefore more efforts needed in maintenance work to ensure that the buildings and its services in an operable and optimal condition.

The development of the proposed decision making framework focused on two important components that are the possible assessment criteria and the alternatives

available for selection. The assessment criteria are used to evaluate the alternatives. From the preliminary questionnaire survey, there were 19 criteria ontained mean value more than 4 (>4) and at the same time obtained mode equals to 4.

In addition, there were 4 procurements methods which include outsourcing by specialist term contract, outsourcing by tendered schedule term contract, outsourcing by repair and maintenance contract and outsourcing by measured term contract were the most popular procurement methods adapted by public universities currently (Percent of Cases > 50%) and at the same time were considered most important (mean >4 or almost equal to 4). In addition, these 4 procurements methods obtained mode equals to 4. Thus, these 19 criteria and 4 fore procurement methods that are considered as important and very important according to Llikert scales of 5 (from 1 which indicate “least important” to 5 which indicate “very important”) are included in this study for the proposed decision making framework which will be discussed in Chapter 6.

The findings of the survey also proved that the selection of procurement method by university organization is not in any strategic way nor not systematic as there is no guidance available for the decision maker to select the most appropriate procurement strategy. It is indeed very vital to develop a systematic approach that can assist the maintenance personnel in the decision making process of selecting the most suitable procurement method in building maintenance management for public university. The implementation and validation of the proposed framework will be discussed in Chapter 6.

CHAPTER 6

DEVELOPMENT AND VALIDATION OF DECISION MAKING FRAMEWORK USING AHP AND EXPERT CHOICE SOFTWARE

6.1 INTRODUCTION

This chapter discusses the development of decision making framework for selecting the most appropriate procurement method in building maintenance management of public university in Malaysia. The framework is developed based on Multiple criteria decision making (MCDM) particularly Analytic Hierarchy Process (AHP). The framework employed AHP techniques and principles using Expert Choice 11 Software as development tool.

The development of decision making framework using AHP mainly focused on two important components that are the possible assessment criteria and the alternatives available for selection. The assessment criteria were used to evaluate the alternatives. Luu *et al.* (2003a) confirmed that it is essential to establish a list of Procurement Selection Criteria (PSC) before various procurement options were evaluated. Furthermore, Alhazmi and McCaffer (2000) agreed that effective decision-making technique is required in procurement method selection to systematically evaluate procurement methods against a number of criteria. All the assessment criteria and building maintenance procurement methods available were identified in phase 1 (Literature review) and were validated in term of their applicability in phase 2 (Postal

Questionnaires Survey). The assessment criteria and building maintenance procurement methods shortlisted in phase 2 were employed in the development of the framework. Once the framework was developed, the framework was validated.

This chapter also provides the results obtained from phase 4 (structured interview) which aim to validate the framework developed. The validation process was carried out through structured interview with 9 universities selected. The result obtained from pair-wise comparison with the assessment criteria and procurement option which has been developed in the Expert Choice software. The Decision Making Framework for Procurement Method Selection of Building Maintenance Management for Public Universities was stored in Expert Choice software. The interviewees requested to perform pairwise comparisons for all levels of hierarchy in the framework. Once the interviewees implemented the pair-wise comparison with the assessment criteria and procurement option and obtained the proposed procurement method from the framework, the interviewees requested to evaluate the proposed decision making framework in term of its capability, applicability and validity using the evaluation form.

The interviewees were selected from the maintenance and facilities maintenance management department of university. The interviewees must be someone involved in the decision making process for selection of procurement method for maintenance works. Therefore, the interviewees should be director or deputy director of the development and maintenance department of the university or head or assistant head of contract department who invole in the decision making process. Director of

development is the highest managerial position in Department of Development and Maintenance who are responsible to plan, execute and monitor development projects, maintenance works, building and infrastructure upgrading works in the university. On the other hand, head or assistant head of contract and quantity surveying department are people administer matters relating for contract procurement, tender and quotation. Lateef (2010a) highlighted that quantity surveyor could provide professional advice on alternative procurement strategies and make decisions on contractual matters. Thus, the director or deputy director of the development and maintenance or head or assistant head of contract and quantity surveying department were appropriate to be interviewed because they are people involved in the decision making process who have knowledge and experience in matters relating for contract procurement and are belief afford to provide valid, factual and unbiased information.

6.2 DETERMINATION OF SELECTION CRITERIA

Literature reviews were employed to identify the assessment criteria to select the most appropriate procurement method. There are 26 assessment criteria identified in phase 1 (Literature review) which were divided into into three main categories that were clients' requirements, project characteristics and external environment or factors which can be referred to Table 2.14.

The assessment criteria were validated in term of their applicability and shortlisted in phase 2 (Postal Questionnaires Survey). The respondents of the study were asked to rate

the importance of the 26 criteria identified in the literature review on a Likert scale of 1 to 5 (1 as least important to 5 as very important) and include any other criteria as they considered important but was not include in the questionnaire. The result of the evaluation was shown in Table 5.14 and there were no any other criteria suggested by the respondents. The criteria will be eliminated based on the mean value and mode value obtained. Only those criteria obtained both mean rating and mode equivalent to or above 4 which were considered as important and very important according to likert scales of 5 (from which 1 indicate “least important” to 5 indicate “very important”) are included in this study for the proposed decision making framework. This method of criteria elimination using the mean rating value was employed by Cheung et al. (2010) in developing a model for the selection of construction procurement. Thus, there are only 19 criteria will be considered in the development of decision making framework on this present study as shown in Table 6.1.

Table 6.1: Final Procurement Method Selection Criteria

No	Procurement Selection Criteria	Mean	Mode
1	Experience contractor availability	4.71	5
2	Existing building condition	4.59	5
3	Objective or policy of organization	4.53	4
4	Quality level	4.47	5
5	Government policy	4.41	4
6	Knowledge of the strategy	4.41	5
7	Degree of responsibility	4.41	5
8	Client's financial capability	4.41	5
9	Price competition	4.35	4
10	Time Certainty	4.35	4
11	Speed	4.35	4
12	Public accountability	4.29	4
13	Clarity of scope	4.29	4
14	Involvement of owner in the project	4.24	4
15	Working relationship	4.24	5
16	Project size	4.18	4
17	Intuition and pass experience	4.12	4
18	Client in house technical capability	4.06	4
19	Price or cost certainty	4	4

6.3 DETERMINATION OF PROCUREMENT METHOD OPTION

Through literature review, there were 13 building maintenance procurement strategy found. The procurement method options were validated in term of their applicability and shortlisted in phase 2 (Postal Questionnaires Survey). The respondents of the study were asked to rate the importance of the 13 procurement strategy identified in the literature review on a Likert scale of 1 to 5 (1 as least important to 5 as very important) and include any other procurement method as they considered important. In addition, multiple response analysis was performed to identify the procurement methods that are currently adapted by public universities in Malaysia. The result of the evaluation was

shown in Table 5.15, Table 5.16 and Figure 5.3. There were 4 procurements methods which include outsourcing by specialist term contract, outsourcing by tendered schedule term contract, outsourcing by repair and maintenance contract and outsourcing by measured term contract were the most popular procurement methods adapted by public universities currently (Percent of Cases > 50%) and at the same time were considered most important (mean >4 or almost equal to 4) as hown in Table 6.2. In addition, these 4 procurements methods obtained mode equals to 4. Therefore only four procurement method alternatives will be considered in the development of decision making framework on this present study.

Table 6.2: Final Procurement Method Alternative

No	Procurement method used in universities	Mean	Mode	Percent of Cases
1	Outsourcing by Repair and Maintenance Contract	4.06	4	82.40%
2	Outsourcing by Specialist Term Contract	4.18	4	76.50%
3	Outsourcing by Tendered Schedule Term Contract	4.12	4	70.60%
4	Outsourcing by Measured Term Contract	3.94	4	64.70%

6.4 DEVELOPING THE DECISION-MAKING FRAMEWORK

One of the objectives of this present study is to develop a decision making framework for selection of procurement method in building maintenance management for public universities in Malaysia. The proposed decision making framework was shown in Figure 6.1. The development of the framework includes employment of procurement selection criteria and procurement method option, integration of Analytic Hierarchy

Process (AHP) technique and principles and adaption of Expert Choice Software as development tool.

6.4.1 Integration of Analytic Hierarchy Process (AHP) technique and principles

In this present study, the selection of procurement method for building maintenance management adapted Multiple criteria decision making (MCDM) particularly Analytic Hierarchy Process (AHP). As discussed in Chapter 3, there are three basic principles of the AHP which include the principle of constructing hierarchies where a complex system was structured hierarchically by decomposing the elements into constituent parts according to essential relationships towards a desired goal which can make the whole system well understood, the principle of establishing priorities where priorities of elements in a decision problem is established to make pairwise comparison that is to compare the elements in pairs against a given criterion and finally the principle of logical consistency to ensure that elements are grouped logically and ranked consistently according to a logical criterion (Saaty, 1982).

Input

Procurement Criteria Selection
Clients' Requirements
Experienced contractor availability
Quality level
Knowledge of the strategy
Degree of responsibility
Client's financial capability
Price competition
Time Certainty
Speed
Public accountability
Clarity of scope
Involvement of owner in the project
Working relationship
Intuition and pass experience
Client in house technical capability
Price or cost certainty
Project Characteristics
Existing building condition
Project size
External Environment/Factors
Objective or policy of organization
Government policy

Procurement method used in universities
Outsourcing by Repair and Maintenance Contract
Outsourcing by Specialist Term Contract
Outsourcing by Tendered Schedule Term Contract
Outsourcing by Measured Term Contract

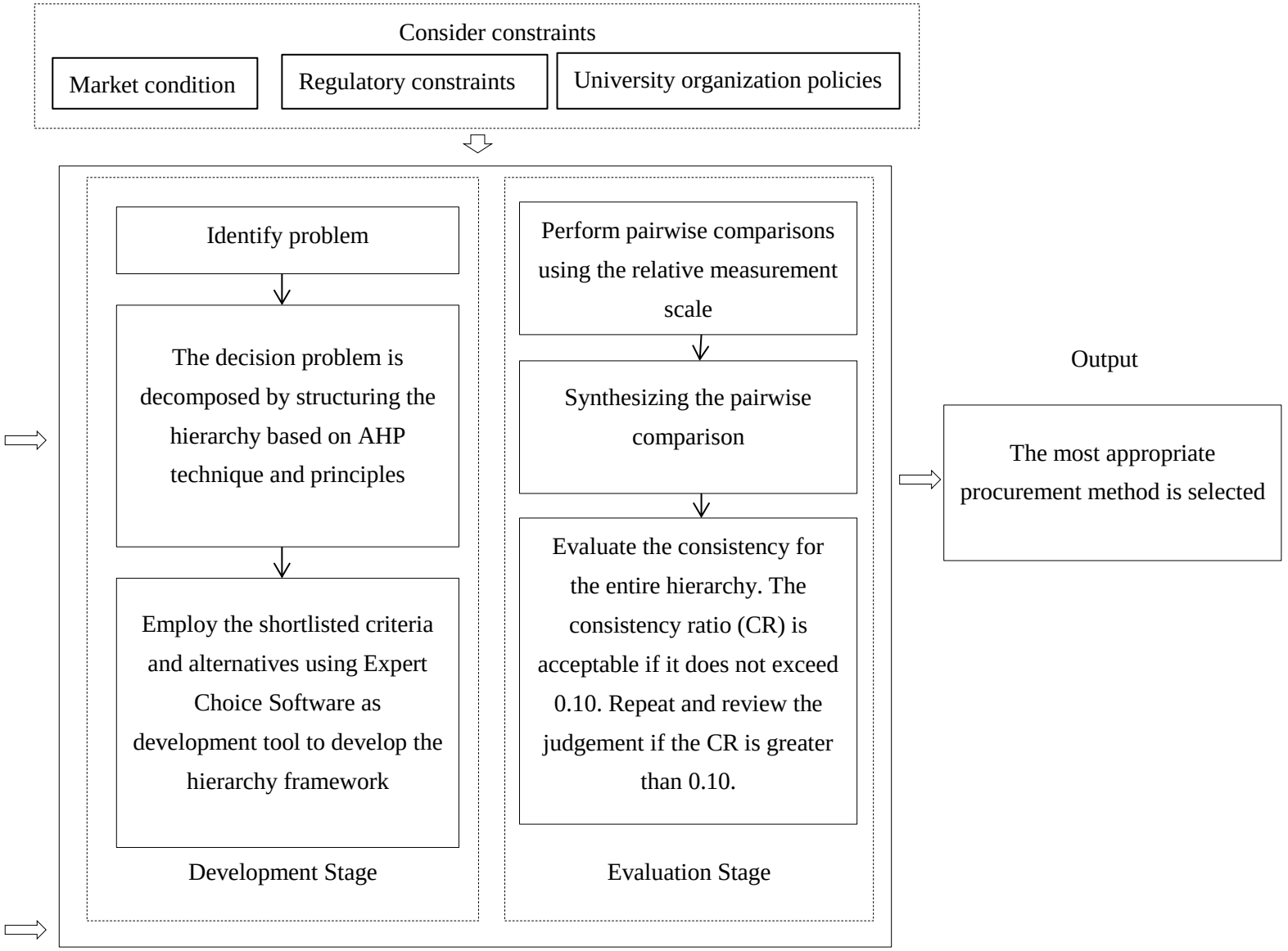

Figure 6.1: Decision Making Framework for Procurement Method Selection of Building Maintenance Management for Public Universities

The decision maker is requested to construct a hierarchy of criteria and to identify all possible alternatives and then employ AHP to make pairwise comparison which requires a decision maker to compare all alternatives with respect to evaluation criteria. The comparison made will then give rise to priorities and finally through synthesis to overall priorities. Next, the consistency is measured and dealt with interdependence. The procedure and step for adapting AHP was illustrated in Figure 6.2.

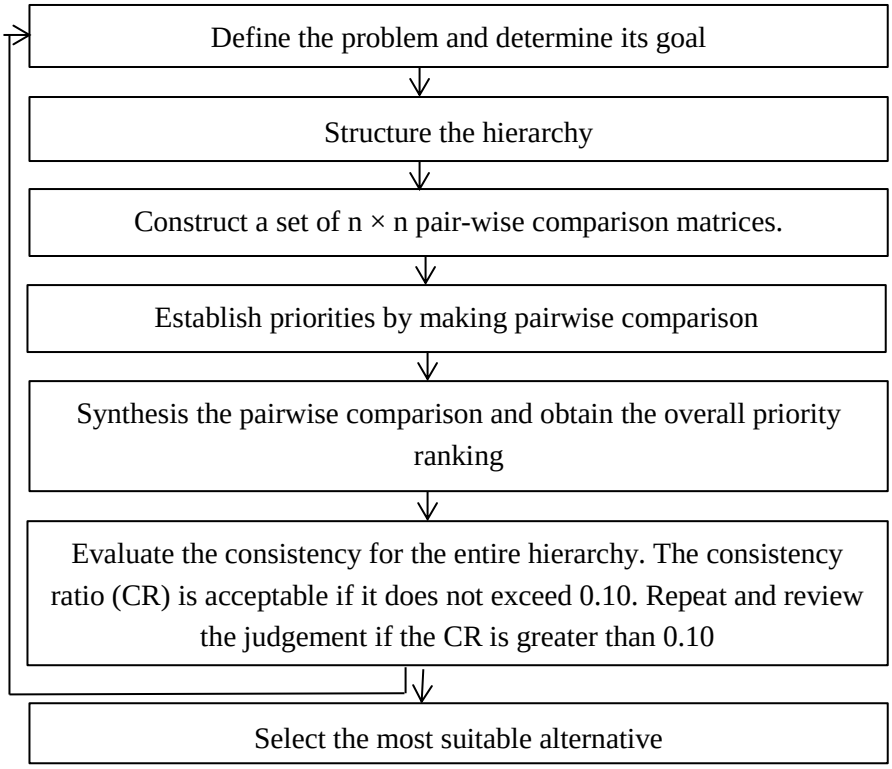

Figure 6.2: Steps for adapting Analytic Hierarchy Process (AHP)

6.4.1.1 Define the problem and determine its goal

There are a large number of different types of procurement methods have been developed for building maintenance management services to overcome the weaknesses of the existing procurement method. The problem exists when public universities' maintenance department to select the most appropriate procurement method for a

specific building as different type of procurement method suit different type of project. Analytic Hierarchy Process (AHP) was employed in this study to develop a tool for assessing decision maker to choose the most appropriate procurement method.

6.4.1.2 Structure the hierarchy

In AHP, the problem is decomposed into constituent parts according to essential relationships towards a desired goal which can make the whole system well understood (Saaty, 1982). The hierarchy for this present study was structured in four levels whereby objective or goal at the top with the intermediate levels capturing criteria and the bottom level containing the alternatives. The goal for the present study is to select the most appropriate procurement method which was at level 1. This was followed by three main criteria which include client requirements, project characteristics and external environment or factors at level 2. There are only 19 criteria in the intermediate level (Level 3) and 4 alternatives will be at the bottom level (Level 4). The four levels hierarchy decision process was illustrated in Figure 6.3. As shown in Figure 6.3, the criteria and alternatives used abbreviation in the hierarchy structure because of space limitation. The list of criteria and explanation were tabulated in Table 6.3 and Table 6.4.

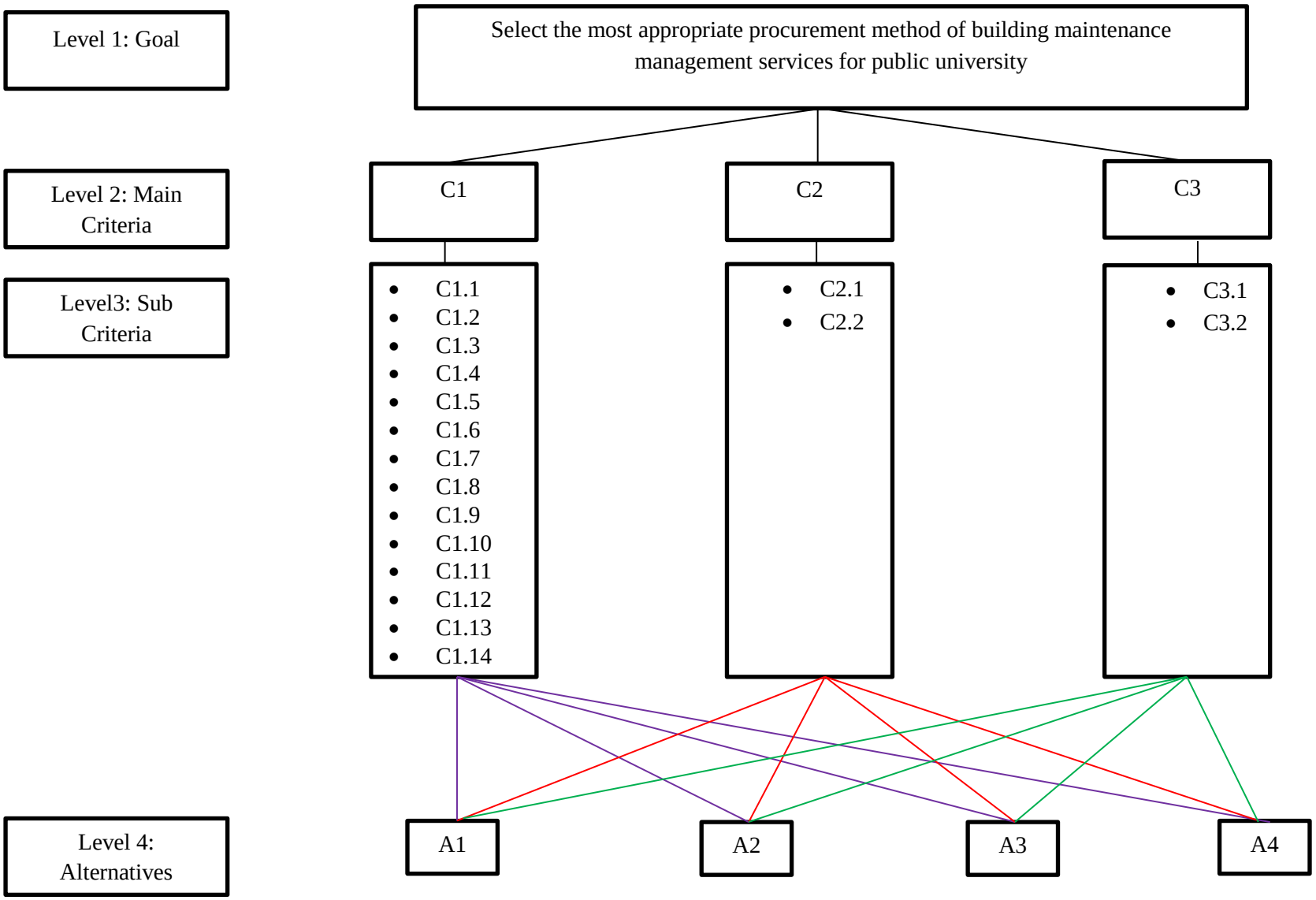

Figure 6.3: Hierarchy structure for selecting the most appropriate procurement method for building maintenance management of public universities in Malaysia

Table 6.3: List of criteria

Abbreviation used	Criteria	Description
C1	**Clients' Requirements**	
C1.1	Experience contractor availability	The availability of the experience contractor to perform the procurement method or the available expertise to perform the task.
C1.2	Quality level	Quality related to the degree to which a set of inherent characteristics fulfill client's requirements.
C1.3	Knowledge of the strategy	Familiarity with the type of procurement method
C1.4	Degree of responsibility	Different type of procurement strategy has different way of responsibility allocation. Some procurement methods have single point responsibility while other procurement method may require the involvement of in-source personnel. . There are some procurement method do not have clear responsibility allocation where the parties involved are not clear of their scope of job or task.
C1.5	Client's financial capability	This refers to the financial capability of the client to perform the procurement method.
C1.6	Price competition	Competition of price refers to the degree of price competition associated with the procurement options. Price competition was vague as the definitions of low or high price competition would vary with different clients. Some client focus on obtaining the lowest price for a project.
C1.7	Time Certainty	Time certainty relates to the degree of certainty that a project will be completed on the exact date and time specified in the contract.
C1.8	Speed	Speed refers to the need to complete a project more quickly than other projects of similar nature, complexity and size
C1.9	Public accountability	Favour of public accountability criteria such as cost reduction and environmental friendliness.
C1.10	Clarity of scope	Several type of procurement method requires a well-defined scope where the project requirements can be determined early while other methods are more appropriate if the scope is vague and its definition is evolving.
C1.11	Involvement of owner in the project	Involvement of owner in the project reflects how much the owner wants to be involved. A high level of involvement may be necessary if the owner wishes to generate idea and involve in the task. However, owners must determine how much involvement they can afford to offer during the execution of the project. Some owners may have the expertise and sufficient available resources to allow for a high degree of involvement. Other owners may not have such capability or have them but cannot make them available to the project.
C1.12	Working relationship	This refers to the type of working relationship the client required. Different type of procurement method offer different type of working relationship.
C1.13	Intuition and pass experience	The experience the client encounter for certain type or procurement method. Some client had experience in certain type of procurement method and more confident to perform it.

C1.14	Client in house technical capability	This refers to the technical capability of in-house maintenance personnel in monitoring the maintenance work.
C1.15	Price or cost certainty	Price certainty refers to how certain the price that a procurement approach could offer whereby some clients may need to have a firm price for their project before committing to it.
C2	**Project Characteristic**	
C2.1	Existing building condition	The ability of the procurement method to adapt the existing building condition and able to perform efficiently.
C2.2	Project size	This refers to the size of the project.
C3	**External Environment/Factor**	
C3.1	Objective or policy of organisation	This refers to the policy of the universities. For example, some universities would not like to expose to external parties.
C3.2	Government policy	Client's choice of procurement method could be affected by the various Government policies. Clients have to follow Government's procedures in choosing a particular procurement route for government projects.

Table 6.4: List of alternatives

Abbreviation used	Alternative	Description
A1	Outsourcing by Repair and Maintenance Contract	This contract is suitable where the work involves the repair and maintenance of a building or where no independent contract administrator is to be appointed. It is not suitable for periodic repair or maintenance over a fixed term, the regular maintenance of plant or for work on a dwelling by a residential occupier.
A2	Outsourcing by Specialist Term Contract	The Specialist Term Contract is defined on a narrow basis for specialist tasks such as asbestos removal, lift maintenance or single trades such as roofing, tar paving, redecorations and other.
A3	Outsourcing by Tendered Schedule Term Contract	Under Tendered Schedule Term Contract, contractors tender against a priced schedule of activities as under the measured term contract. This schedule is then used as a basis for measuring in advance the contract price for a maintenance contract. This effectively becomes a lump-sum project contract and it has the advantage of ensuring an element of competition in the price while reducing the overall contractor selection period. Payments are measured, valued and certified as the works proceed in the conventional way. This type of contract would be used primarily when time is short and it can reduce the overall pre-contract stage by running the design and tender stages together, based upon an approximate quantities guide.
A4	Outsourcing by Measured Term Contract	Measured term contract which is also known as measure and value contract is beneficial for project that has details area which are not adequate to allow the preparation of an accurate specification at the time of commencing work. Under this form of contract, a detailed schedule of priced activities forms the bidding document against which each contractor tenders an adjustment percentage. Work undertaken by the successful contractor is measured on completion and valued by reference to the tender. It deals with managing and providing the 'service', as opposed to managing a 'project'. When used in the public sector it is designed to be used for all contracted-out services, whether they include a physical element or not.

6.4.1.3 Construct a set of n × n pair-wise comparison matrices

Construct a set of n × n pair-wise comparison matrices for each of the lower levels with one matrix for each element in the level immediately above. Saaty (1982) matrix is a simple and well-established tool that offers framework for testing consistency, obtaining additional information through making all possible comparisons and analyzing the sensitivity of the overall priorities to change in judgment. The number of matrices depends on the number of elements at each level.

6.4.1.4 Establish priorities by making pairwise comparison

The first step in establishing the priorities of elements in a decision problem is to make pairwise comparison (Saaty, 1982). The pairwise comparisons are made using the pairwise comparison scale as shown in Table 6.5 to compare each element. The pair-wise comparisons capture a decision maker's perception of which element dominates the other (Pirdashti *et al*., 2009; Saaty, 1990, Saaty, 1994a and Saaty, 1994b). If the matrix deals with *n* number of elements, the number of judgments needed to fill the entries is [(*n* x *n*)-*n*] ÷ 2. The *n* units of entries down the diagonal are subtracted and divide by 2 because half of the judgments are reciprocals. Reciprocals are automatically assigned in each pair-wise comparison.

Table 6.5: Scale for pairwise comparison matrix

Intensity of importance	Definition	Explanation
1	Equal importance of both elements	Two criteria are of equal importance and equally contribute to the property or objectives
3	Weak importance of one over another	Experience and judgment slightly favor one criterion or element over another
5	Essential or strong importance of one element over another	Experience and judgment strongly favor one criterion or element over another
7	Very strong and demonstrated importance of one element over another	A criterion or element is strongly more important or favored and its dominance is demonstrated in practice than the other
9	Absolute importance of one element over another	The evidence favoring one criterion over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between adjacent scale values	When compromise is needed between two judgements
Reciprocals of above nonzero	If activity *i* has one of the above nonzero numbers assigned to it when compared with activity *j*, then *j* has the reciprocal value when compared with *i*	A reasonable assumption
Rational	Ratios arising from the scale	If consistency were to be forced by obtaining n numerical values to span the matrix

6.4.1.5 Synthesis the pairwise comparison and obtain the overall priority ranking

Synthesize the judgments made in the pairwise comparison is crucial in order to obtain the set of overall priorities for a decision problem (Saaty, 1982). Some weighting and adding are done to obtain a single number to indicate the priority of each element. The average of normalized column method is used to calculate the vector of priority. The average normalized column is to divide the elements of each column by the sum of the column and then add the element in each resulting row and divide this sum by the number of elements in the row (n). This is the process of averaging over the normalized columns. The relative weights of evaluation elements are aggregated to obtain an

overall rating for the alternatives. The overall priority vector for the alternatives with respect to the criteria is ranked accordance to the highest value. The highest value of the alternative indicates that is the best alternative in accordance to the criteria used in the evaluation process. The selection is based on the finding of the result.

6.4.1.6 Evaluate the consistency for the entire hierarchy

Logical consistency ensures that elements are grouped logically and ranked consistently according to a logical criterion (Saaty, 1982). The consistency of the comparison matrix is monitored by an inconsistency ratio (IR) or consistency ratio (CR) calculated by the formula below (Cheung *et al.*, 2001 and Saaty, 1982). Table 6.6 showed the Random Index (RI) for consistency index of a randomly generated reciprocal matrix within a scale of 1 to 9. Saaty (1980) suggests that the CR is acceptable if it does not exceed 0.10. If the CR is greater than 0.10, the judgment matrix should be considered inconsistent. To obtain a consistent matrix, the judgments should be reviewed and repeated.

Consistency Ratio (CR) = Consistency index (II)/ Random Index (RI)

where, II = $(\lambda_{max} - n)/(n-1)$, with n the number of elements in the matrix

RI=the consistency index of a randomly generated reciprocal matrix within a scale of 1 to 9.

λ_{max} = the maximum eigenvalue of the comparison matrix.

Table 6.6: The Consistency Index (RI) of a randomly generated reciprocal matrix within a scale of 1 to 9

Size of matrix	1	2	3	4	5	6	7	8	9	10
Random consistency	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Source: Saaty (1982)

6.4.2 Adaption of Expert Choice Software as Development Tool

The AHP implementation steps of the framework will be simplified by using the Expert Choice professional software that is available commercially and designed for implementing AHP. Expert Choice 11 software was employed as a development tool to assist in developing the decision making framework. Expert Choice software offers a model view containing either a tree view or cluster view of the decision hierarchy. Figure 6.4 illustrates a model tree view of the decision hierarchy of the proposed framework in Expert Choice software.

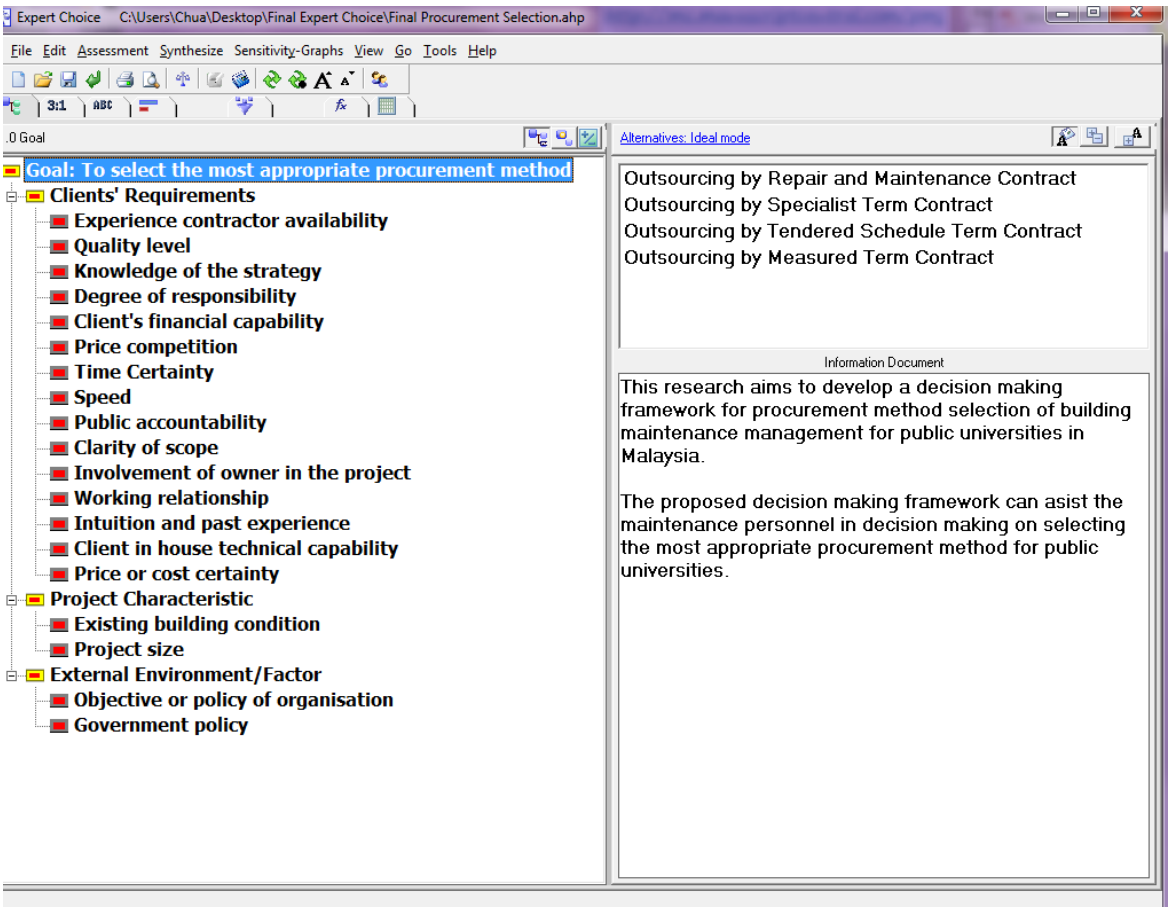

Figure 6.4: A model tree view of the decision hierarchy in Expert Choice software

In addition, one of the AHP strength is the possibility to evaluate qualitative as well as qualitative criteria and alternatives on the same preference scale of nine levels (Ishizaka, and Labib, 2009). The judgments can be perform in three ways by numerical (Figure 6.5), verbal (Figure 6.6) and graphical (Figure 6.7) in Expert Choice. Furthermore, this software works by examining judgments made by the decision makers and measuring the consistency of those judgments.

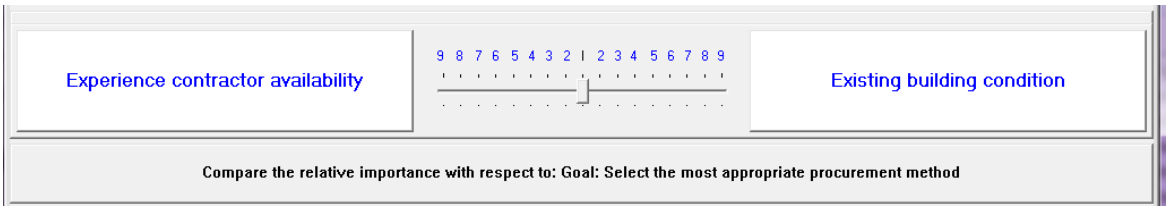

Figure 6.5: The numeric pairwise comparison in Expert Choice software

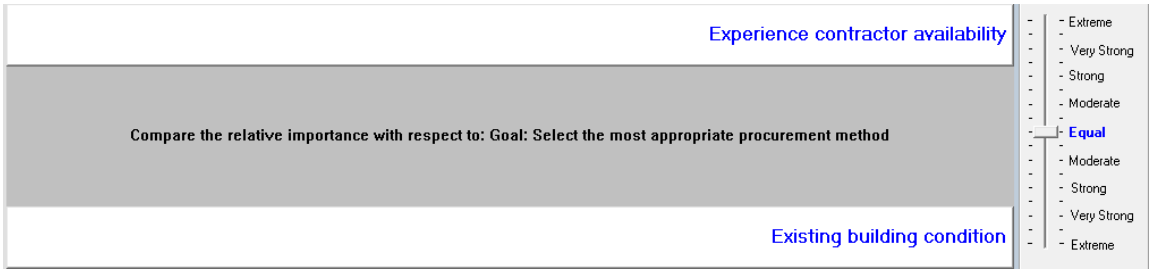

Figure 6.6: The verbal pairwise comparison in Expert Choice software

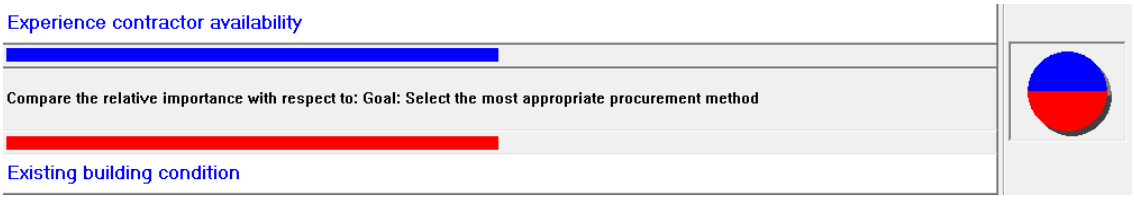

Figure 6.7: The graphical pairwise comparison in Expert Choice software

Expert Choice allows the decision maker to re-examination and revises the judgments for all level of the hierarchy and shows where inconsistency exists and how to minimize it in order to improve the decision. The inconsistency value will be shown once the judgement is done. The location of inconsistency reading can be referred to Figure 6.8.

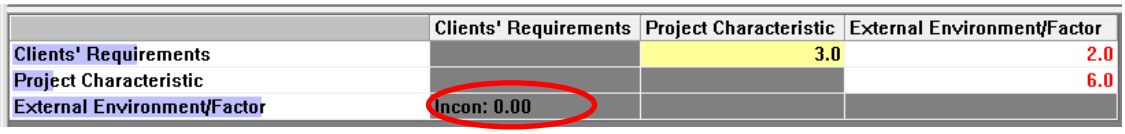

Figure 6.8: Location of inconsistency value in Expert Choice

Another best feature of Expert Choice is that it provides tools for performing sensitivity analysis which helps the decision maker to see how different weights assigned to each criterion could affect the outcome of the model. In sensitivity analysis, the input data are slightly modified in order to observe the impact on the result (Ishizaka and Labib, 2009). The main purpose of the sensitivity analyses is graphically seen by how the alternative changes in respect to the importance of the criteria. Generally, there are five types of sensitivity analyses that can be performed in Expert Choice where the main difference is the various graphical representations which include:-

(i) Performance sensitivity: displays how the alternatives perform with respect to all criteria

(ii) Dynamic sensitivity: displays how the choice priorities of alternatives changes when the priority of one criterion is varies

(iii) Gradient sensitivity: displays the composite priority of the alternatives with respect to the priority of single criterion

(iv) Head to head sensitivity: displays how any two alternatives compare with respect to each criterion and the goal

(v) Two-dimensional sensitivity: displays how alternatives perform with respect to any two criteria

The example of sensitive analysis performed in Expert Choice for the current study by using judgements done by one of the interviewee was illustrated in Figure 6.9.

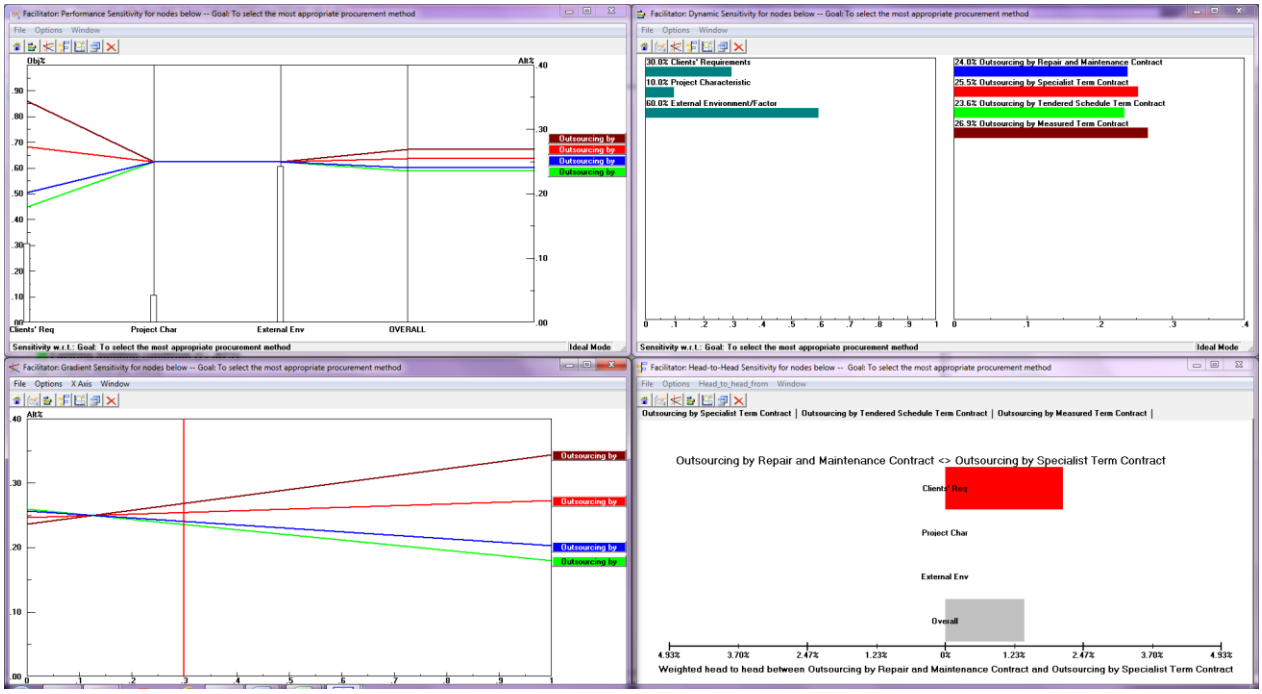

Figure 6.9: Sentive Displays for Performance, Dynamis, Gradient and Head to Head performed by Expert Choice Software

6.5 IMPLEMENTATION AND VALIDATION OF DECISION MAKING FRAMEWORK

The validation process was carried out through structured interview with 9 universities selected. The result obtained from pair-wise comparison with the assessment criteria and procurement option which has been developed in the Expert Choice software. The Decision Making Framework for Procurement Method Selection of Building Maintenance Management for Public Universities was stored in Expert Choice software. The interviewees requested to perform pairwise comparisons for all levels of hierarchy in the framework. Once the interviewees implemented and obtained the proposed procurement method from the framework, the interviewees requested to evaluate the proposed decision making framework in term of its capability, applicability and validity using the evaluation form.

The interviewees were selected from the maintenance and facilities maintenance management department of university. The interviewees must be someone involved in the decision making process for selection of procurement method for maintenance works. Therefore, the interviewees should be director or deputy director of the development and maintenance department of the university or head or assistant head of contract department. Director of development is the highest management post in Department of Development and Maintenance who are responsible to plan, execute and monitor development projects, maintenance works, building and infrastructure upgrading works in the university. In addition, they need to manage the administration and operations of the department and assist the university Vice Chancellor in planning the strategy and direction of development in and around the vicinity of the University as well as to plan and implement development initiatives. On the other hand, head or assistant head of contract and quantity surveying department are people administer matters relating for contract procurement, tender and quotation. Lateef (2010a) highlighted that quantity surveyor could provide professional advice on alternative procurement strategies and make decisions on contractual matters. Thus, the director or deputy director of the development and maintenance or head or assistant head of contract and quantity surveying department were appropriate to be interviewed because they are people involved in the decision making process who have knowledge and experience in matters relating for contract procurement and are belief afford to provide valid, factual and unbiased information.

6.5.1 Interviewees Profiles

As mentioned previously, a pilot study was conducted before the structured interview to assure that the interview achieve the objectives, test the ease of understanding of the framework and examine the approximate time needed to complete the interview. After considering all the comments received from the pilot study and the number of respondents has been confirmed, the researcher contacted the director's office of Department of Development and Maintenance to find the appropriate person for interview. The interviewees were contacted by phone using the phone number obtained from director's office or each university website or email provided from the replied questionnaires in phase 2 (Postal Questionnaires Survey). Once the interviewees confirmed the date of interview, an official covering letter from Faculty of Built Environment, University Malaya and a cover letter (as shown as Apendix D) which contained the objectives of the interview and the importance of the interviewees' participation in this structured interview was emailed to the interviewees. A call was also made as a reminder to the interviewees one week before the fixed date of interview and also to inform the approximate time length of interview so that the interviewees were well-prepared and their schedule will not be interrupted.

The interview commenced on 9th of April 2013 and lasted on 9th of May 2013. The structured interview took exactly 1 month time. The interview was scheduled so that 2 universities were interviewed in a week. The interviewees profile as shown in Table 6.7. The interviewees had at least 5 years experiences in selecting procurement method for building maintenance work and had been involved in the decision making process.

Table 6.7: Interviewees Profile

Name of Universities	Nos. of Interviewees	Position	Experience (years)	Date of interview
Research Universities				
University RA	3	➢ Head of Civil Engineering Division ➢ Head of Contract & Quantity Surveying Division ➢ Quantity Surveyor	20 30 10	17/4/2013
University RB	1	➢ Assistant Head of Quantity Surveying Department	17	25/4/2013
University RC	1	➢ Head of Contract Department	31	3/5/2013
Comprehensive Universities				
University CA	1	➢ Head of Contract Management And Cost Control Section	12	26/4/2013
University CB	1	➢ Acting Senior Facilities Engineer	7	18/4/2013
Focussed Universities				
University FA	1	➢ Head of Quantity Surveying Department	10	9/5/2013
University FB	1	➢ Deputy Director of Facility and Estate Management Department	25	2/5/2013
University FC	1	➢ Head Department of Building Maintenance Section	11	9/4/2013
University FD	1	➢ Deputy Director of Development & Facilities Management Department	23	7/5/2013

6.5.2 Results

6.5.2.1 Research Universities

6.5.2.1 (a) University RA

The building maintenance department in University RA namely Department of Development & Estate Maintenance (Jabatan Pembangunan & Penyelenggaraan Harta Benda, JPPHB) coordinates all efforts to preserve the importance and comfort of the campus society and users of the university's facilities by forming an effective,

committed and dynamic university property management system to execute university developmental projects proficiently and at minimum cost.

There are 9 divisions in JPPHB which include administrative, electrical and electronic engineering, mechanical engineering, civil engineering, development, contract & quantity surveying, property management, planning & architecture and finance. JPPHB provide many specialized fields which include management of engineering services, maintenance of building and compounds, indoors and outdoors engineering facilities, transportation systems, estate management, renovation works and development projects.

The structured interview for University RA was conducted on 17th of April 2013 with head of civil engineering division who is responsible in building maintenance work and head of contract and quantity surveying division as well as one quantity surveyor. Contract and quantity surveying division of University RA administer matters relating to contracts while civil engineering division deals with upgrading and maintenance work. Thus, they were appropriate to be interviewed because they are people involved in the decision making process in selecting the most appropriate procurement strategy. The interview session was held in a meeting room and the all the pairwise comparison judgments and evaluation process was made after discussion.

(A) Overall Priority Ranking and selection of the best option of procurement method

All the pairwise comparison judgments made in Expert Choice software were synthesis to obtain vector of priorities. All the vector of priority for main criteria, sub criteria and alternatives were tabulated in Table 6.8. Based on the result obtained, the interviewees priority main factor in selecting the most appropriate procurement method for maintenance of waterproofing are external environment or factors (0.600), clients' requirements (0.300) and project characteristics (0.100). The abbreviation used for sub criteria can be referred to Table 6.9. All main criteria judgments consistency ratio (CR) were 0.00 that were less than 0.10 (<0.10) which represent good consistency.

The result of priority obtained for pairwise comparison among sub criteria under clients' requirements in selecting the most appropriate procurement method for maintenance of waterproofing and ranking can be referred to Table 6.9. The consistency ratio value is 0.08 which was lesser than 0.10 (<0.10), therefore the judgments consistency is acceptable. The two sub criteria under project characteristics (C2) which were existing building condition (C2.1) and project size (C2.2), existing building condition obtained 0.875 priority vector compared to project size obtained 0.125. This result revealed that existing building condition was more taken into consideration compared to project size when selecting the most appropriate procurement method for maintenance of waterproofing. While for objective or policy of organization (C3.1) and government policy (C3.2) which were under external environment or factors (C3), the interviewees feel that government policy (0.875) are more important compared to objective or policy

of organization (0.125). Both judgments for sub criteria under C2 and C3 obtained 0.00 (<0.10) consistency ratio, thus the consistency ratio was accepted.

From table 6.8, the result indicated that for sub criteria under clients' requirements (C1) that were C1.1 and C1.12 has more strength when performing outsourcing by repair and maintenance contract. Sub criteria C1.2, C1.4, C1.8, C1.9 and C1.13 perform better under outsourcing by specialist term contract while only sub criteria C1.5 perform better under outsourcing by tendered schedule term contract. There are 5 sub criteria have more strength under outsourcing by measured term contract which were C1.3, C1.6, C1.7, C1.10 and C 1.11. While for sub criteria C1.14 and C1.15, the four alternatives have equal strength. Sub criteria under project characteristics (C2) and external environment or factors (C3) have equal strength for the four alternatives. All the judgments made obtained value of CR less that 0.10 (<0.10) that was acceptable.

Table 6.8: All vector of priorities for main criteria, sub criteria and alternative

Level 1: Goal	**Select the most appropriate procurement method of building maintenance management services for public university**																		
Level 2: Main Criteria	**Clients' Requirements (C1)**															**Project Characteristic (C2)**		**External Environment or Factors (C3)**	
Vector of Priorities	0.300															0.100		0.600	
CR	0.00															0.00		0.00	
Level3: Sub Criteria	**C1.1**	**C1.2**	**C1.3**	**C1.4**	**C1.5**	**C1.6**	**C1.7**	**C1.8**	**C1.9**	**C1.10**	**C1.11**	**C1.12**	**C1.13**	**C1.14**	**C1.15**	**C2.1**	**C2.2**	**C3.1**	**C3.2**
Vector of Priorities	0.071	0.068	0.042	0.023	0.025	0.092	0.070	0.040	0.017	0.168	0.063	0.065	0.078	0.070	0.109	0.875	0.125	0.125	0.875
CR	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.00	0.00	0.00	0.00
Level 4: Alternatives	**Vector of Priorities**																		
Outsourcing by Repair and Maintenance Contract	0.532	0.053	0.079	0.063	0.216	0.265	0.046	0.06	0.118	0.116	0.091	0.426	0.055	0.250	0.250	0.250	0.250	0.250	0.250
Outsourcing by Specialist Term Contract	0.061	0.585	0.219	0.501	0.112	0.265	0.147	0.619	0.487	0.245	0.266	0.111	0.532	0.250	0.250	0.250	0.250	0.250	0.250
Outsourcing by Tendered Schedule Term Contract	0.095	0.121	0.200	0.120	0.350	0.094	0.296	0.215	0.118	0.073	0.091	0.171	0.213	0.250	0.250	0.250	0.250	0.250	0.250
Outsourcing by Measured Term Contract	0.312	0.242	0.503	0.316	0.322	0.375	0.511	0.107	0.276	0.567	0.552	0.292	0.200	0.250	0.250	0.250	0.250	0.250	0.250
CR	0.02	0.04	0.05	0.04	0.04	0.05	0.05	0.04	0.06	0.07	0.09	0.07	0.02	0.00	0.00	0.00	0.00	0.00	0.00

*CR= Consistency Ratio

Table 6.9: Vector of overall priorities and ranking of Clients' Requirements sub criteria

Abbreviation used	Description	Vector of Priorities	Ranking
C1.1	Experienced contractor availability	0.071	5
C1.2	Quality level	0.068	7
C1.3	Knowledge of the strategy	0.042	10
C1.4	Degree of responsibility	0.023	13
C1.5	Client's financial capability	0.025	12
C1.6	Price competition	0.092	3
C1.7	Time Certainty	0.070	6
C1.8	Speed	0.040	11
C1.9	Public accountability	0.017	14
C1.10	Clarity of scope	0.168	1
C1.11	Involvement of owner in the project	0.063	9
C1.12	Working relationship	0.065	8
C1.13	Intuition and pass experience	0.078	4
C1.14	Client in house technical capability	0.070	6
C1.15	Price or cost certainty	0.109	2

Table 6.10: Vector of overall priorities with respect to main criteria

Main Criteria	Clients' Requirements (C1)	Project Characteristics (C2)	External Environment/Factors (C3)	Vector of Overall Priorities
Vector of Priorities	0.300	0.100	0.600	
CR	0.00	0.00	0.00	
Alternatives	**Vector of Priorities**			
Outsourcing by Repair and Maintenance Contract	0.203	0.250	0.250	0.240
Outsourcing by Specialist Term Contract	0.273	0.250	0.250	0.255
Outsourcing by Tendered Schedule Term Contract	0.18	0.250	0.250	0.236
Outsourcing by Measured Term Contract	0.344	0.250	0.250	0.269
CR	0.07	0.00	0.00	0.03

*CR= Consistency Ratio

Table 6.10 revealed vectors of priorities for the alternatives with respect to the main factor and alternatives' vector of overall priorities. The results indicated that outsourcing by measured term contract (0.344) was more preferable among the four alternatives for clients' requirements. As the value of consistency is 0.07<0.10, the consistency judgment was acceptable. While for both project characteristic (C2) and external environment or factor (C3), the four alternatives performed equally and has 0.00 (<0.10) consistency ratio that was acceptable.

The vector of overall priorities for the four alternatives as shown in Table 6.10 indicated that outsourcing by measured term contract (0.269) which obtained the highest of vector of overall priorities is the best procurement method for maintenance of waterproofing in University RA. This is followed by outsourcing by specialist term contract (0.255), outsourcing by repair and maintenance contract (0.240) and outsourcing by tendered schedule term contract (0.236). The ranking of the alternatives were shown in Table 6.11.

Table 6.11: Result of Selection

Alternatives	Vector of Overall Priorities	Rank
Outsourcing by Repair and Maintenance Contract	0.240	3
Outsourcing by Specialist Term Contract	0.255	2
Outsourcing by Tendered Schedule Term Contract	0.236	4
Outsourcing by Measured Term Contract	0.269	1

6.5.2.1 (b) University RB

The building maintenance department in University RB named as Department of Development and Maintenance (Jabatan Pembangunan & Penyelenggaraan, JPP). University RB was established on 18th of May 1970 and operates in Institute of Language, Lembah Pantai. Subsequently, Treasury Handling Unit was established to carry out the maintenance of buildings and areas. When University RB was built and developed in Bangi, Development Unit was established and two employees from Public Work Department known as Jabatan Kerja Raya (JKR) who were Encik Bakri Abdullah (first JPP's director) who is and architect and an engineer, Encik Edward Chia who served in development unit to develop Bangi campus. Handling unit also continued to eternal treasure under Title Bendahari. In end of 1984, development unit and maintenance unit were merged.

In between 1790-1995, Development Unit had moved to several different places. However, a new building was built in 1996 for Department of Development and Maintenance through the provisions of the 6th Malaysian Plan (RMKe-6) and was occupied until now.

University's Management Meeting (MPU) was held on 12th of December 2001 and has agreed and approved the renaming of the title and departments' as well as units name in the University. Development Unit has changed its name to Department of Development which is known as Jabatan Pengurusan Pembangunan (JPP) from 1st of January 2002 onwards. However, the meeting of the Board of University's Management (LPU) has

which was held on 7th of July 2011 agreed and approved the application of Department of Development to change its name to Department of Development and Maintenance.

The structured interview with University RB was conducted on 25th of April 2013 with an assistant head of quantity surveying department. Quantity surveying department deals matters relating to contracts, thus the interviewee who had 17 years of experience were appropriate to be interviewed because she involved in the decision making process in selecting the most appropriate procurement strategy. The interview session was held in a meeting room and the all the pairwise comparison judgments was done and evaluation process was made after discussion.

(A) Overall Priority Ranking and selection of the best option of procurement method

All the pairwise comparison judgments made in Expert Choice software were synthesis to obtain vector of priorities. All the vector of priority for main criteria, sub criteria and alternatives were tabulated in Table 6.12. Based on the result obtained, the interviewee priority main factor in selecting the most appropriate procurement method for maintenance of air-conditioning services are project characteristics (0.540), external environment or factors (0.297) and clients' requirements (0.163). The abbreviation used for sub criteria can be referred to Table 6.13. All main criteria judgments consistency ratio (CR) were 0.01 that were less than 0.10 (<0.10) which represent good consistency.

Table 6.12: All vector of priorities for main criteria, sub criteria and alternative

Level 1: Goal	**Select the most appropriate procurement method of building maintenance management services for public university**																		
Level 2: Main Criteria	**Clients' Requirements (C1)**															**Project Characteristics (C2)**		**External Environment or Factors (C3)**	
Vector of Priorities	0.163															0.540		0.297	
CR	0.01															0.01		0.01	
Level3: Sub Criteria	**C1.1**	**C1.2**	**C1.3**	**C1.4**	**C1.5**	**C1.6**	**C1.7**	**C1.8**	**C1.9**	**C1.10**	**C1.11**	**C1.12**	**C1.13**	**C1.14**	**C1.15**	**C2.1**	**C2.2**	**C3.1**	**C3.2**
Vector of Priorities	0.015	0.016	0.019	0.015	0.186	0.228	0.044	0.074	0.01	0.056	0.033	0.059	0.012	0.093	0.141	0.500	0.500	0.250	0.750
CR	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.00	0.00	0.00	0.00
Level 4: Alternatives	**Vector of Priorities**																		
Outsourcing by Repair and Maintenance Contract	0.130	0.088	0.054	0.057	0.256	0.483	0.23	0.207	0.175	0.208	0.118	0.077	0.617	0.368	0.494	0.276	0.208	0.368	0.368
Outsourcing by Specialist Term Contract	0.08	0.342	0.332	0.659	0.531	0.276	0.601	0.619	0.523	0.487	0.487	0.534	0.148	0.368	0.27	0.487	0.487	0.368	0.368
Outsourcing by Tendered Schedule Term Contract	0.292	0.060	0.095	0.185	0.138	0.141	0.058	0.111	0.227	0.208	0.276	0.316	0.059	0.096	0.082	0.118	0.096	0.096	0.096
Outsourcing by Measured Term Contract	0.499	0.509	0.519	0.099	0.075	0.101	0.112	0.063	0.071	0.096	0.118	0.074	0.176	0.169	0.154	0.118	0.208	0.169	0.169
CR	0.04	0.04	0.07	0.07	0.07	0.08	0.05	0.07	0.04	0.06	0.06	0.07	0.08	0.06	0.09	0.06	0.06	0.06	0.06

*CR= Consistency Ratio

The result of priority obtained for pairwise comparison among sub criteria under clients' requirements in selecting the most appropriate procurement method for maintenance of air-conditioning services and ranking can be referred to Table 6.13. The consistency ratio value is 0.09 which was lesser than 0.10 (<0.10), therefore the judgments consistency is acceptable. The two sub criteria under project characteristics (C2) which were existing building condition (C2.1) and project size (C2.2) obtained equally 0.500 priority vector. This result revealed that existing building condition and project size were equally important when selecting the most appropriate procurement method for maintenance of air-conditioning services. While for objective or policy of organization (C3.1) and government policy (C3.2) which were under external environment or factors (C3), the interviewees feel that policy of organization government policy (0.750) are more important compared to objective or policy of organization (0.250). Both judgments for sub criteria under C2 and C3 obtained 0.00 (<0.10) consistency ratio, thus the consistency ratio was accepted.

From table 6.12, the result indicated that for sub criteria under clients' requirements (C1) that were C1.6, C1.13, C1.14 and C1.15 has more strength when performing outsourcing by repair and maintenance contract. Sub criteria C1.4, C1.5, C1.7, C1.8, C1.9, C1.10, C1.11, C1.12 and C1.14 perform better under outsourcing by specialist term contract while none perform better under outsourcing by tendered schedule term contract. There are 3 sub criteria have more strength under outsourcing by measured term contract which were C1.1, C1.2 and C1.3. While for sub criteria under project characteristic (C2) and external environment or factor (C3), C2.1, C2.2, C3.1 and C3.2

perform better under outsourcing by specialist term contract although C3.1 and 3.2 has equally performance for outsourcing by specialist term contract and outsourcing by repair and maintenance Contract. All the judgments made obtained value of CR less that 0.10 (<0.10) that was acceptable.

Table 6.13: Vector of overall priorities and ranking of Clients' Requirements sub criteria

Abbreviation used	**Description**	**Vector of Priorities**	**Ranking**
C1.1	Experienced contractor availability	0.015	12
C1.2	Quality level	0.016	11
C1.3	Knowledge of the strategy	0.019	10
C1.4	Degree of responsibility	0.015	12
C1.5	Client's financial capability	0.186	2
C1.6	Price competition	0.228	1
C1.7	Time Certainty	0.044	8
C1.8	Speed	0.074	5
C1.9	Public accountability	0.01	14
C1.10	Clarity of scope	0.056	7
C1.11	Involvement of owner in the project	0.033	9
C1.12	Working relationship	0.059	6
C1.13	Intuition and pass experience	0.012	13
C1.14	Client in house technical capability	0.093	4
C1.15	Price or cost certainty	0.141	3

Table 6.14: Vector of overall priorities with respect to main criteria

Main Criteria	Clients' Requirements (C1)	Project Characteristics (C2)	External Environment/Factors (C3)	Vector of Overall Priorities
Vector of Priorities	0.163	0.540	0.297	
CR	0.01	0.01	0.01	
Alternatives	**Vector of Priorities**			
Outsourcing by Repair and Maintenance Contract	0.328	0.242	0.368	0.300
Outsourcing by Specialist Term Contract	0.402	0.487	0.368	0.432
Outsourcing by Tendered Schedule Term Contract	0.14	0.107	0.096	0.108
Outsourcing by Measured Term Contract	0.13	0.163	0.169	0.160
CR	0.09	0.06	0.06	0.05

*CR= Consistency Ratio

Table 6.14 revealed vectors of priorities for the alternatives with respect to the main factor and alternatives' vector of overall priorities. The results indicated that outsourcing by specialist term contract (0.402) was more preferable among the four alternatives for clients' requirements. As the value of consistency is 0.09<0.10, the consistency judgment was acceptable. While for project characteristics (C2), outsourcing by specialist term contract (0.487) was also more preferable. On the other hand, external environment or factors (C3) obtained 0.368 priority vector for both outsourcing by specialist term contract and outsourcing by repair and maintenance contract. The consistency ratio for both project characteristics (C2) and external environment or factors (C3) obtained 0.06 (<0.10) consistency ratio that was acceptable.

The vector of overall priorities for the four alternatives as shown in Table 6.14 indicated that outsourcing by specialist term contract (0.432) which obtained the highest of vector

of overall priorities is the best procurement method maintenance of air-conditioning services in University RB. This is followed by outsourcing by repair and maintenance contract (0.300), outsourcing by Measured Term Contract (0.160) and outsourcing by tendered schedule term contract (0.108). The ranking of the alternatives were shown in Table 6.15.

Table 6.15: Result of Selection

Alternatives	Vector of Overall Priorities	Rank
Outsourcing by Repair and Maintenance Contract	0.300	2
Outsourcing by Specialist Term Contract	0.432	1
Outsourcing by Tendered Schedule Term Contract	0.108	4
Outsourcing by Measured Term Contract	0.160	3

6.5.2.1 (c) University RC

The Office of Asset and Development (OAD) was established on 27th of December 1973. Its function was not only as the provider for the maintenance for the University but was also responsible for the ongoing campus planning, development, upgrading, renovations, space and vehicle booking services. The office was divided into 5 divisions which include Maintenance & Upgrading Division, Development Division, Contract Division, Services Division and Administration & Human Resource Division. The Maintenance and Upgrading Division is the largest division in terms of manpower and its scope of work. The division has 5 units which take care of all the aspects of maintenance concerning campus facilities, which include buildings, upgrading works, electrical and air-conditioning systems, water supply, waste management,

infrastructures and landscaping. The Development Division is responsible for the planning of infrastructural facilities for University RC campus in order to meet the university requirements as well as the implementation of capital projects. At present, in the division there is a Project Unit which manages the construction of several projects under 9th Malaysian Plan (RMK9) budget amounting to nearly RM 1.0 billion.

The other unit which was the Planning unit manages the budget submission for 10th Malaysian Plan (RMK 10) projects which was submitted to the Higher Education Ministry in November 2009. The Contract Division is a new division established to be independent of other divisions to manage matters related to procurement and contractual. While the Administration and Human Resource Division provides administrative support to the OAD. The Division oversees the administration, finance, human resources and public relations. It manages activities such as training, IT resources, preparation of financial statements, preparation of publications, despatching of documents, preparation of OAD internal space working facilities and office equipment rental. Another new division is the Services Division which was in charge of the Ecotourism Campus initiative, fleet booking, space booking, space rental, managing technical preparations for the university official functions as well as provide other support services for events and activities organized by the university community.

The structured interview with University RC was conducted on 3rd of May 2013 with Head of Contract Department who manage matters related to procurement and contractual. He had 31 years of experience so he was appropriate to be interviewed

because he involved in the decision making process in selecting the most appropriate procurement strategy. The interview session was held in a meeting room and the all the pairwise comparison judgments was done and evaluation process was made after discussion.

(i) Overall Priority Ranking and selection of the best option of procurement method

All the pairwise comparison judgments made in Expert Choice software were synthesis to obtain vector of priorities. All the vector of priority for main criteria, sub criteria and alternatives were tabulated in Table 6.16. Based on the result obtained, the interviewee priority main factor in selecting the most appropriate procurement method for housekeeping services are clients' requirements (0.481), external environment or factors (0.405) and project characteristics (0.114). The abbreviation used for sub criteria can be referred to Table 6.17. All main criteria judgments consistency ratio (CR) were 0.03 that were less than 0.10 (<0.10) which represent good consistency.

Table 6.16: All vector of priorities for main criteria, sub criteria and alternative

Level 1: Goal	**Select the most appropriate procurement method of building maintenance management services for public university**																		
Level 2: Main Criteria	**Clients' Requirements (C1)**															**Project Characteristics (C2)**		**External Environment or Factors (C3)**	
Vector of Priorities	0.481															0.114		0.405	
CR	0.03															0.03		0.03	
Level3: Sub Criteria	**C1.1**	**C1.2**	**C1.3**	**C1.4**	**C1.5**	**C1.6**	**C1.7**	**C1.8**	**C1.9**	**C1.10**	**C1.11**	**C1.12**	**C1.13**	**C1.14**	**C1.15**	**C2.1**	**C2.2**	**C3.1**	**C3.2**
Vector of Priorities	0.010	0.077	0.028	0.027	0.107	0.045	0.080	0.052	0.142	0.244	0.017	0.017	0.017	0.027	0.109	0.900	0.100	0.500	0.500
CR	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.00	0.00	0.00	0.00
Level 4: Alternatives	**Vector of Priorities**																		
Outsourcing by Repair and Maintenance Contract	0.048	0.13	0.09	0.136	0.061	0.368	0.110	0.125	0.250	0.125	0.110	0.125	0.120	0.110	0.11	0.417	0.125	0.250	0.250
Outsourcing by Specialist Term Contract	0.621	0.525	0.502	0.543	0.569	0.368	0.651	0.625	0.250	0.625	0.651	0.625	0.696	0.651	0.651	0.417	0.625	0.250	0.250
Outsourcing by Tendered Schedule Term Contract	0.165	0.288	0.270	0.252	0.264	0.169	0.119	0.125	0.250	0.125	0.119	0.125	0.099	0.119	0.119	0.083	0.125	0.250	0.250
Outsourcing by Measured Term Contract	0.165	0.057	0.138	0.070	0.106	0.096	0.119	0.125	0.250	0.125	0.119	0.125	0.085	0.119	0.119	0.083	0.125	0.250	0.250
CR	0.08	0.02	0.06	0.06	0.03	0.06	0.01	0.00	0.00	0.00	0.01	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00

*CR= Consistency Ratio

Table 6.17: Vector of overall priorities and ranking of Clients' Requirements sub criteria

Abbreviation used	Description	Vector of Priorities	Ranking
C1.1	Experienced contractor availability	0.010	12
C1.2	Quality level	0.077	6
C1.3	Knowledge of the strategy	0.028	9
C1.4	Degree of responsibility	0.027	10
C1.5	Client's financial capability	0.107	4
C1.6	Price competition	0.045	8
C1.7	Time Certainty	0.080	5
C1.8	Speed	0.052	7
C1.9	Public accountability	0.142	2
C1.10	Clarity of scope	0.244	1
C1.11	Involvement of owner in the project	0.017	11
C1.12	Working relationship	0.017	11
C1.13	Intuition and pass experience	0.017	11
C1.14	Client in house technical capability	0.027	10
C1.15	Price or cost certainty	0.109	3

The result of priority obtained for pairwise comparison among sub criteria under Clients' Requirements in selecting the most appropriate procurement method for housekeeping services and ranking can be referred to Table 6.17. The consistency ratio value was 0.08 which is lesser than 0.10 (<0.10), therefore the judgments consistency is acceptable. The two sub criteria under project characteristics (C2) which were existing building condition (C2.1) obtained priority vector 0.900 and project size (C2.2) obtained 0.100. This result revealed that existing building condition was considered more important than project size when selecting the most appropriate procurement method for housekeeping services. While for both objective or policy of organization (C3.1) and

government policy (C3.2) which were under external environment or factors (C3), the interviewees conceived both were equally important that had 0.500 priority vector. Both judgments for sub criteria under C2 and C3 obtained 0.00 (<0.10) consistency ratio, thus the consistency ratio was good.

From table 6.16, the result indicated that for all sub criteria under Clients' Requirements (C1) that has more strength when performing outsourcing by specialist term contract except C1.9 that has equally performance for all the four alternatives and C1.6 that has equal performance for outsourcing by specialist term contract and outsourcing by repair and maintenance contract. While for sub criteria under project characteristics (C2), C2.1 perform better under outsourcing by specialist term contract and outsourcing by repair and maintenance contract while C2.2 perform better under outsourcing by specialist term contract. Under external environment or factors (C3), C3.1 and C3.2 has equally performance for all the four alternatives. All the judgments made obtained value of CR less that 0.10 (<0.10) that was acceptable.

Table 6.18: Vector of overall priorities with respect to main criteria

Main Criteria	Clients' Requirements (C1)	Project Characteristics (C2)	External Environment/Factors (C3)	Vector of Overall Priorities
Vector of Priorities	0.481	0.114	0.405	
CR	0.03	0.03	0.03	
Alternatives	**Vector of Priorities**			
Outsourcing by Repair and Maintenance Contract	0.165	0.397	0.250	0.235
Outsourcing by Specialist Term Contract	0.492	0.431	0.250	0.349
Outsourcing by Tendered Schedule Term Contract	0.193	0.086	0.250	0.216
Outsourcing by Measured Term Contract	0.149	0.086	0.250	0.201
CR	0.06	0.00	0.00	0.04

*CR= Consistency Ratio

Table 6.18 revealed vectors of priorities for the alternatives with respect to the main factor and alternatives' vector of overall priorities. The results indicated that outsourcing by specialist term contract (0.492) was more preferable among the four alternatives for clients' requirements. As the value of consistency is 0.06<0.10, the consistency judgment was acceptable. While for project characteristic (C2), outsourcing by specialist term contract (0.431) was also more preferable. On the other hand, external environment or factor (C3) obtained equal priority vector for all the four alternatives. The consistency ratio for both project characteristic (C2) and external environment or factor (C3) obtained 0.00 (<0.10) consistency ratio that was acceptable.

The vector of overall priorities for the four alternatives as shown in Table 6.18 indicated that outsourcing by specialist term contract (0.349) which obtained the highest of vector of overall priorities is the best procurement method maintenance for housekeeping

services in University RC. This is followed by outsourcing by repair and maintenance contract (0.235), outsourcing by tendered schedule term contract (0.216) and outsourcing by Measured Term Contract (0.201). The ranking of the alternatives were shown in Table 6.19.

Table 6.19: Result of Selection

Alternatives	**Vector of Overall Priorities**	**Rank**
Outsourcing by Repair and Maintenance Contract	0.235	2
Outsourcing by Specialist Term Contract	0.349	1
Outsourcing by Tendered Schedule Term Contract	0.216	3
Outsourcing by Measured Term Contract	0.201	4

6.5.2.2 Comprehensive Universities

6.5.2.2 (a) University CA

The Facilities Management Office was established in 1972 and it was known as Engineer's Office at the time. Engineer's office changed its name to Development and Maintenance Department in 1982. In 1994, the Development and Maintenance Department was known as the Development and Maintenance Office. The Development and Maintenance Office was separated under different administrative head on 15th of September 1995. This is because the functions of Development Office and Maintenance Office increased rapidly. Both of these departments were placed directly under the Office of Chancellery. In August 1999, the university has been declared as University CA and this makes the role of the Development and Maintenance Office roles became

wider as the department was directly involved in the growth, development and advancement of the university. In enhancing the achievement of University CA's vision in becoming a world-class public education institution globally, the Development and Maintenance Office was restructured and renamed as Facilities Management Office officially on 4th of January 2006.

The structured interview with University CA was conducted on 26th of April 2013 with Head of Contract Management and Cost Control Section who had 12 years experiences. The section was known as Bahagian Kontrak & Kawalan Kos. The section was responsible in managing and coordinating with treasury procurement tender for privatization purposes, managing contractor and consultant appointment after the board approved the acquisition and monitoring of projects or operations or consulting contractual terms, reviewing and monitor the progress payments and the operation of the contractual terms, managing the department budget as well as providing advice in terms of the contract. The interview session was held in a meeting room and the all the pairwise comparison judgments was done and evaluation process was made after discussion.

(A) Overall Priority Ranking and selection of the best option of procurement method

All the pairwise comparison judgments made in Expert Choice software were synthesis to obtain vector of priorities. All the vector of priority for main criteria, sub criteria and alternatives were tabulated in Table 6.20. Based on the result obtained, the interviewee

priority main factor in selecting the most appropriate procurement method for general repair work for residential college are clients' requirements (0.444), external environment or factors (0.444) and project characteristics (0.111). All main criteria judgments consistency ratio (CR) were 0.00 that were less than 0.10 (<0.10) which represent good consistency. The abbreviation used for sub criteria can be referred to Table 6.21.

The result of priority obtained for pairwise comparison among sub criteria under Clients' Requirements in selecting the most appropriate procurement method for general repair work for residential college and ranking can be referred to Table 6.21. The consistency ratio value was 0.07 which is lesser than 0.10 (<0.10), therefore the judgments consistency is acceptable. The two sub criteria under project characteristics (C2) which were existing building condition (C2.1) obtained priority vector 0.667 and project size (C2.2) obtained 0.333. This result revealed that existing building condition was considered more important than project size when selecting the most appropriate procurement method for general repair work for residential college. While for both objective or policy of organization (C3.1) and government policy (C3.2) which were under external environment or factors (C3), the interviewees conceived both were equally important that had 0.500 priority vector. Both judgments for sub criteria under C2 and C3 obtained 0.00 (<0.10) consistency ratio, thus the consistency ratio was good.

From table 6.20, the result indicated that for sub criteria under clients' requirements (C1) that were C1.1, C1.6, C1.8, C1.10, C1.14 and C1.15 has more strength when

performing outsourcing by repair and maintenance contract. Sub criteria C1.2, C1.3, C1.4, C1.7, C1.9, C1.12 and C1.13 perform better under outsourcing by specialist term contract while only C1.5 perform better under outsourcing by tendered schedule term contract. There was none sub criteria have more strength under outsourcing by measured term contract. Sub criteria C 1.11 perform equally for 3 other alternatives except under outsourcing by specialist term contract. While for sub criteria under project characteristics (C2), C2.1 perform better under outsourcing by tendered schedule term contract while C2.2 has more strength under outsourcing by specialist term contract. Sub criteria under external environment or factors (C3), C3.1 perform better for outsourcing by repair and maintenance contract and C3.2 has equally performance for outsourcing by repair and maintenance contract and outsourcing by specialist term contract. All the judgments made obtained value of CR less that 0.10 (<0.10) that was acceptable.

Table 6.22 revealed vectors of priorities for the alternatives with respect to the main factor and alternatives' vector of overall priorities. The results indicated that outsourcing by specialist term contract (0.285) was more preferable among the four alternatives for clients' requirements. As the value of consistency is 0.06<0.10, the consistency judgment was acceptable. While for project characteristics (C2), outsourcing by tendered schedule term contract (0.305) was also more preferable. On the other hand, external environment or factors (C3), outsourcing by repair and maintenance contract (0.294) obtained the best performance. The consistency ratio for both project characteristics (C2) and external environment or factors (C3) obtained 0.09 and 0.05 which was less than 0.10 (<0.10) that was acceptable.

Table 6.20: All vector of priorities for main criteria, sub criteria and alternative

Level 1: Goal	**Select the most appropriate procurement method of building maintenance management services for public university**																		
Level 2: Main Criteria	**Clients' Requirements (C1)**															**Project Characteristics (C2)**		**External Environment or Factors (C3)**	
Vector of Priorities	0.444															0.111		0.444	
CR	0.00															0.00		0.00	
Level3: Sub Criteria	**C1.1**	**C1.2**	**C1.3**	**C1.4**	**C1.5**	**C1.6**	**C1.7**	**C1.8**	**C1.9**	**C1.10**	**C1.11**	**C1.12**	**C1.13**	**C1.14**	**C1.15**	**C2.1**	**C2.2**	**C3.1**	**C3.2**
Vector of Priorities	0.029	0.060	0.040	0.099	0.083	0.075	0.055	0.079	0.075	0.130	0.057	0.057	0.058	0.039	0.065	0.667	0.333	0.500	0.500
CR	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.00	0.00	0.00	0.00
Level 4: Alternatives	**Vector of Priorities**																		
Outsourcing by Repair and Maintenance Contract	0.460	0.239	0.213	0.205	0.288	0.346	0.198	0.346	0.233	0.338	0.300	0.209	0.243	0.497	0.343	0.254	0.254	0.299	0.289
Outsourcing by Specialist Term Contract	0.136	0.340	0.432	0.462	0.205	0.205	0.395	0.205	0.428	0.288	0.100	0.345	0.343	0.100	0.243	0.245	0.334	0.239	0.289
Outsourcing by Tendered Schedule Term Contract	0.318	0.281	0.190	0.188	0.338	0.286	0.239	0.286	0.175	0.205	0.300	0.248	0.172	0.191	0.243	0.334	0.245	0.209	0.175
Outsourcing by Measured Term Contract	0.086	0.14	0.165	0.144	0.169	0.163	0.168	0.163	0.164	0.169	0.300	0.198	0.243	0.212	0.172	0.167	0.167	0.253	0.246
CR	0.04	0.02	0.04	0.03	0.02	0.07	0.02	0.07	0.03	0.02	0.00	0.07	0.05	0.01	0.05	0.09	0.09	0.07	0.02

*CR= Consistency Ratio

Table 6.21: Vector of overall priorities and ranking of Clients' Requirements sub criteria

Abbreviation used	Description	Vector of Priorities	Ranking
C1.1	Experienced contractor availability	0.029	13
C1.2	Quality level	0.060	7
C1.3	Knowledge of the strategy	0.040	11
C1.4	Degree of responsibility	0.099	2
C1.5	Client's financial capability	0.083	3
C1.6	Price competition	0.075	5
C1.7	Time Certainty	0.055	10
C1.8	Speed	0.079	4
C1.9	Public accountability	0.075	5
C1.10	Clarity of scope	0.130	1
C1.11	Involvement of owner in the project	0.057	9
C1.12	Working relationship	0.057	9
C1.13	Intuition and pass experience	0.058	8
C1.14	Client in house technical capability	0.039	12
C1.15	Price or cost certainty	0.065	6

Table 6.22: Vector of overall priorities with respect to main criteria

Main Criteria	Clients' Requirements (C1)	Project Characteristics (C2)	External Environment/Factors (C3)	Vector of Overall Priorities
Vector of Priorities	0.444	0.111	0.444	
CR	0.00	0.00	0.00	
Alternatives	**Vector of Priorities**			
Outsourcing by Repair and Maintenance Contract	0.291	0.254	0.294	0.289
Outsourcing by Specialist Term Contract	0.285	0.275	0.265	0.274
Outsourcing by Tendered Schedule Term Contract	0.245	0.305	0.192	0.225
Outsourcing by Measured Term Contract	0.179	0.167	0.250	0.213
CR	0.06	0.09	0.05	0.04

*CR= Consistency Ratio

The vector of overall priorities for the four alternatives as shown in Table 6.22 indicated that outsourcing by repair and maintenance contract (0.289) which obtained the highest of vector of overall priorities is the best procurement method maintenance for general repair work for residential college in University CA. This is followed by outsourcing by specialist term contract (0.274), outsourcing by tendered schedule term contract (0.225) and outsourcing by Measured Term Contract (0.213). The ranking of the alternatives were shown in Table 6.23.

Table 6.23: Result of Selection

Alternatives	**Vector of Overall Priorities**	**Rank**
Outsourcing by Repair and Maintenance Contract	0.289	1
Outsourcing by Specialist Term Contract	0.274	2
Outsourcing by Tendered Schedule Term Contract	0.225	3
Outsourcing by Measured Term Contract	0.213	4

6.5.2.2 (b) University CB

The Development Division of University CB was divided into five main sections which include Administrative and Finance Unit, Facilities Monitoring Unit, Renovation and Upgrading Work Unit, Campus Development Unit and Estate Management Unit with a total of 26 personnel staff. The division aims to provide a conducive, safe and beautiful campus towards educational excellences and develop a physical environment conducive to learning and thinking community.

The maintenance work of University CB was carried out and managed by Daya Bersih Sdn. Bhd. Daya Bersih Sdn Bhd (Daya Bersih) was established and incorporated on 14th of January 2004 with the vision to be the leading service provider in the field of cleaning, landscaping and ground maintenance services industry. In December 2007, the management of University CB Holdings Sdn Bhd, a wholly owned subsidiary of University CB decided that Daya Bersih to be wholly owned by University CB Properties Sdn Bhd (subsidiary of University CB Holdings). Being the subsidiary, Daya Bersih is given the tasks of handling the non-technical parts of Facilities Management Services (FMS) in University CB Campuses while the technical matter is fully handled by University CB Properties themselves.

The structured interview with University CB was conducted on 18th of April 2013 with Acting Senior Facilities Engineer who had 7 years experiences. The interview session was held in a meeting room and the all the pairwise comparison judgments was done and evaluation process was made after discussion.

(i) Overall Priority Ranking and selection of the best option of procurement method

All the pairwise comparison judgments made in Expert Choice software were synthesis to obtain vector of priorities. All the vector of priority for main criteria, sub criteria and alternatives were tabulated in Table 6.24. Based on the result obtained, the interviewee priority main factors in selecting the most appropriate procurement method for roof repair work are project characteristics (0.667), clients' requirements (0.222) and

external environment or factors (0.111). All main criteria judgments consistency ratio (CR) were 0.00 that were less than 0.10 (<0.10) which represent good consistency. The abbreviation used for sub criteria can be referred to Table 6.24.

The result of priority obtained for pairwise comparison among sub criteria under Clients' Requirements in selecting the most appropriate procurement method for roof repair work and ranking can be referred to Table 6.25. The consistency ratio value was 0.09 which is lesser than 0.10 (<0.10), therefore the judgments consistency is acceptable. The two sub criteria under project characteristics (C2) which were existing building condition (C2.1) obtained priority vector 0.833 and project size (C2.2) obtained 0.167. This result revealed that existing building condition was considered more important than project size when selecting the most appropriate procurement method for roof repair work. While for both objective or policy of organization (C3.1) and government policy (C3.2) which were under external environment or factors (C3), the interviewees conceived objective or policy of organization (0.833) was more important than government policy (0.167). Both judgments for sub criteria under C2 and C3 obtained 0.00 (<0.10) consistency ratio, thus the consistency ratio was good.

From table 6.24, the result indicated that for sub criteria under clients' requirements (C1) that was only C1.13 has more strength when performing outsourcing by repair and maintenance contract. Sub criteria C1.2, C1.3, C1.4, and C1.8 perform better under outsourcing by specialist term contract while only C1.5 and C1.15 perform better under outsourcing by tendered schedule term contract and sub criteria C1.1 has more strength

under outsourcing by measured term contract. Sub criteria C1.6, C1.9 and C1.12 perform equally for outsourcing by repair and maintenance contract and outsourcing by measured term contract while sub criteria C1.7 and C1.11 perform equally for outsourcing by repair and maintenance contract and outsourcing by tendered schedule term contract. There were also two sub criteria that were C1.10 and C1.14 perform equally for outsourcing by tendered schedule term contract and outsourcing by measured term contract. While for sub criteria under project characteristics (C2), C2.1 perform better under outsourcing by measured term contract while C2.2 has more strength under outsourcing by specialist term contract. Sub criteria under external environment or factors (C3), C3.1 has equally performance for outsourcing by repair and maintenance contract and outsourcing by tendered schedule term contract while C3.2 perform equally for outsourcing by tendered schedule term contract and outsourcing by measured term contract. All the judgments made obtained value of CR less that 0.10 (<0.10) that was acceptable.

Table 6.24: All vector of priorities for main criteria, sub criteria and alternative

Level 1: Goal	**Select the most appropriate procurement method of building maintenance management services for public university**																		
Level 2: Main Criteria	**Clients' Requirements (C1)**															**Project Characteristics (C2)**		**External Environment or Factors (C3)**	
Vector of Priorities	0.222															0.667		0.111	
CR	0.00															0.00		0.00	
Level3: Sub Criteria	**C1.1**	**C1.2**	**C1.3**	**C1.4**	**C1.5**	**C1.6**	**C1.7**	**C1.8**	**C1.9**	**C1.10**	**C1.11**	**C1.12**	**C1.13**	**C1.14**	**C1.15**	**C2.1**	**C2.2**	**C3.1**	**C3.2**
Vector of Priorities	0.059	0.185	0.017	0.019	0.012	0.169	0.067	0.078	0.056	0.061	0.030	0.022	0.063	0.021	0.142	0.833	0.167	0.833	0.167
CR	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.00	0.00	0.00	0.00
Level 4: Alternatives	**Vector of Priorities**																		
Outsourcing by Repair and Maintenance Contract	0.208	0.124	0.074	0.118	0.222	0.368	0.368	0.118	0.368	0.096	0.368	0.368	0.680	0.096	0.208	0.208	0.256	0.368	0.096
Outsourcing by Specialist Term Contract	0.096	0.408	0.611	0.487	0.087	0.096	0.096	0.487	0.096	0.169	0.096	0.096	0.096	0.169	0.096	0.096	0.531	0.096	0.169
Outsourcing by Tendered Schedule Term Contract	0.208	0.408	0.140	0.276	0.609	0.169	0.368	0.276	0.169	0.368	0.368	0.169	0.368	0.368	0.487	0.208	0.138	0.368	0.368
Outsourcing by Measured Term Contract	0.487	0.06	0.175	0.118	0.082	0.368	0.169	0.118	0.368	0.368	0.169	0.368	0.169	0.368	0.208	0.487	0.075	0.169	0.368
CR	0.06	0.09	0.07	0.06	0.08	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.06	0.06

*CR= Consistency Ratio

Table 6.25: Vector of overall priorities and ranking of Clients' Requirements sub criteria

Abbreviation used	Description	Vector of Priorities	Ranking
C1.1	Experienced contractor availability	0.059	8
C1.2	Quality level	0.185	1
C1.3	Knowledge of the strategy	0.017	14
C1.4	Degree of responsibility	0.019	13
C1.5	Client's financial capability	0.012	15
C1.6	Price competition	0.169	2
C1.7	Time Certainty	0.067	5
C1.8	Speed	0.078	4
C1.9	Public accountability	0.056	9
C1.10	Clarity of scope	0.061	7
C1.11	Involvement of owner in the project	0.030	10
C1.12	Working relationship	0.022	11
C1.13	Intuition and pass experience	0.063	6
C1.14	Client in house technical capability	0.021	12
C1.15	Price or cost certainty	0.142	3

Table 6.26: Vector of overall priorities with respect to main criteria

Main Criteria	Clients' Requirements (C1)	Project Characteristics (C2)	External Environment/Factors (C3)	Vector of Overall Priorities
Vector of Priorities	0.222	0.667	0.111	
CR	0.00	0.00	0.00	
Alternatives	**Vector of Priorities**			
Outsourcing by Repair and Maintenance Contract	0.246	0.216	0.323	0.238
Outsourcing by Specialist Term Contract	0.198	0.163	0.108	0.164
Outsourcing by Tendered Schedule Term Contract	0.319	0.198	0.368	0.251
Outsourcing by Measured Term Contract	0.237	0.423	0.202	0.347
CR	0.08	0.06	0.06	0.05

*CR= Consistency Ratio

Table 6.26 revealed vectors of priorities for the alternatives with respect to the main factor and alternatives' vector of overall priorities. The results indicated that outsourcing by tendered schedule term contract (0.319) was more preferable among the four alternatives for clients' requirements. As the value of consistency is 0.08<0.10, the consistency judgment was acceptable. While for project characteristics (C2), outsourcing by measured schedule term contract (0.423) was also more preferable. On the other hand, external environment or factors (C3), outsourcing by tendered schedule term contract (0.368) obtained the best performance. The consistency ratio for both project characteristics (C2) and external environment or factors (C3) obtained 0.06 was less than 0.10 (<0.10) that was acceptable.

The vector of overall priorities for the four alternatives as shown in Table 6.26 indicated that outsourcing by measured term contract (0.347) which obtained the highest of vector of overall priorities is the best procurement method maintenance for roof repair in University CB. This is followed by outsourcing by tendered schedule term contract (0.251), outsourcing by repair and maintenance contract (0.238) and outsourcing by specialist term contract (0.164). The ranking of the alternatives were shown in Table 6.27.

Table 6.27: Result of Selection

Alternatives	**Vector of Overall Priorities**	**Rank**
Outsourcing by Repair and Maintenance Contract	0.238	3
Outsourcing by Specialist Term Contract	0.164	4
Outsourcing by Tendered Schedule Term Contract	0.251	2
Outsourcing by Measured Term Contract	0.347	1

6.5.2.3 Focused Universities

6.5.2.3 (a) University FA

Department of Development and Estate Maintenance (JPPHB) in University FA was established in line with the establishment of the university. JPPHB was formerly known as the Department of Development and Maintenance Division. Its function is to manage the physical development and maintenance for the entire campus. On 1st of March 2002, this department was upgraded to Department of Development and Estate Management.

JPPHB role was to implement the physical and infrastructural development of the university in order to support the teaching and learning process based on the mission and vision of the University which include:-

- serve as a reference source or advisors in the technical aspects related to the physical development of the university
- addressed the planning and implementation of projects involved in the 5-year Malaysia Plan to be consistent with long-term plans of the University
- manage the planning and execution of maintenance for all infrastructure projects including university assets
- plan and implement development projects and maintenance of all buildings, particularly those involved in the process of teaching and learning such as lecture hall, laboratory systems and others.
- monitor and oversee projects ranging from the development and maintenance of the briefing followed by implementation on site up to the end user.
- arrange the purchase and registration of assets.

The structured interview with University FA was conducted on 9th of May 2013 with Head of Contract and Quantity Surveying Department who had 10 years experiences. This section deals with procurement contract and quotation. The interview session was held in the interviewee's room and the all the pairwise comparison judgments was done and evaluation process was made after discussion.

(A) Overall Priority Ranking and selection of the best option of procurement method

All the pairwise comparison judgments made in Expert Choice software were synthesis to obtain vector of priorities. All the vector of priority for main criteria, sub criteria and alternatives were tabulated in Table 6.28. Based on the result obtained, the interviewees priority main factor in selecting the most appropriate procurement method for building cleaning are external environment or factors (0.528), clients' requirements (0.333) and project characteristics (0.140). The abbreviation used for sub criteria can be referred to Table 6.29. All main criteria judgments consistency ratio (CR) were 0.05 that were less than 0.10 (<0.10) which considered acceptable.

The result of priority obtained for pairwise comparison among sub criteria under clients' requirements in selecting the most appropriate procurement method for building cleaning and ranking can be referred to Table 6.29. The consistency ratio value is 0.09 which was lesser than 0.10 (<0.10), therefore the judgments consistency is acceptable. The two sub criteria under project characteristic (C2) which were existing building condition (C2.1) and project size (C2.2), existing building condition obtained 0.800

priority vector compared to project size obtained 0.200. This result revealed that existing building condition was more taken into consideration compared to project size when selecting the most appropriate procurement method for building cleaning. While for objective or policy of organization (C3.1) and government policy (C3.2) which were under external environment or factors (C3), the interviewees feel that government policy (0.800) are more important compared to objective or policy of organization (0.200). Both judgments for sub criteria under C2 and C3 obtained 0.00 (<0.10) consistency ratio, thus the consistency ratio was good.

From table 6.28, the result indicated that for sub criteria under clients' requirements (C1) that were none sub criteria perform the best under outsourcing by repair and maintenance contract. Sub criteria C1.3, C1.8, C1.10, C1.11, C1.12, C1.13 and C1.14 perform better under outsourcing by specialist term contract while only sub criteria C1.5 perform better under outsourcing by tendered schedule term contract. There are 3 sub criteria have more strength under outsourcing by measured term contract which were C1.1, C1.2 and C 1.5. While for sub criteria C1.4, outsourcing by repair and maintenance contract and outsourcing by specialist term contract have equal strength. Sub criteria C1.6, C1.7 and C1.9 perform equally for outsourcing by repair and maintenance contract and outsourcing by measured term contract. Sub criteria C2.1 and C3.1 under project characteristics (C2) and external environment or factors (C3) perform better and equally under outsourcing by repair and maintenance contract and outsourcing by measured term contract while C2.2 and C3.2 perform the best under

outsourcing by measured term contract have equal strength for the four alternatives. All the judgments made obtained value of CR less that 0.10 (<0.10) that was acceptable.

Table 6.30 revealed vectors of priorities for the alternatives with respect to the main factor and alternatives' vector of overall priorities. The results indicated that outsourcing by specialist term contract (0.319) was more preferable among the four alternatives for clients' requirements. As the value of consistency was 0.08<0.10, the consistency judgment was acceptable. While for both project characteristics (C2) and external environment or factors (C3), outsourcing by measured term contract was more preferable among the four alternatives and has obtained 0.06 (<0.10) consistency ratio that was acceptable.

The vector of overall priorities for the four alternatives as shown in Table 6.30 indicated that outsourcing by measured term contract (0.384) which obtained the highest of vector of overall priorities is the best procurement method for building cleaning in University FA. This is followed by outsourcing by repair and maintenance contract (0.266), outsourcing by specialist term contract (0.181) and outsourcing by tendered schedule term contract (0.169). The ranking of the alternatives were shown in Table 6.31.

Table 6.28: All vector of priorities for main criteria, sub criteria and alternative

Level 1: Goal	**Select the most appropriate procurement method of building maintenance management services for public university**																		
Level 2: Main Criteria	**Clients' Requirements (C1)**															**Project Characteristics (C2)**		**External Environment or Factors (C3)**	
Vector of Priorities	0.333															0.140		0.528	
CR	0.05															0.05		0.05	
Level3: Sub Criteria	**C1.1**	**C1.2**	**C1.3**	**C1.4**	**C1.5**	**C1.6**	**C1.7**	**C1.8**	**C1.9**	**C1.10**	**C1.11**	**C1.12**	**C1.13**	**C1.14**	**C1.15**	**C2.1**	**C2.2**	**C3.1**	**C3.2**
Vector of Priorities	0.029	0.080	0.050	0.081	0.023	0.039	0.060	0.087	0.153	0.04	0.113	0.029	0.098	0.024	0.093	0.800	0.200	0.200	0.800
CR	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.00	0.00	0.00	0.00
Level 4: Alternatives	**Vector of Priorities**																		
Outsourcing by Repair and Maintenance Contract	0.208	0.097	0.118	0.368	0.208	0.368	0.368	0.118	0.368	0.276	0.276	0.208	0.276	0.208	0.118	0.368	0.208	0.368	0.208
Outsourcing by Specialist Term Contract	0.208	0.335	0.487	0.368	0.096	0.096	0.169	0.487	0.096	0.487	0.487	0.487	0.487	0.487	0.276	0.169	0.096	0.096	0.096
Outsourcing by Tendered Schedule Term Contract	0.096	0.187	0.276	0.169	0.487	0.169	0.096	0.118	0.169	0.118	0.118	0.096	0.118	0.096	0.118	0.096	0.208	0.169	0.208
Outsourcing by Measured Term Contract	0.487	0.381	0.118	0.096	0.208	0.368	0.368	0.276	0.368	0.118	0.118	0.208	0.118	0.208	0.487	0.368	0.487	0.368	0.487
CR	0.06	0.04	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06

*CR= Consistency Ratio

Table 6.29: Vector of overall priorities and ranking of Clients' Requirements sub criteria

Abbreviation used	Description	Vector of Priorities	Ranking
C1.1	Experienced contractor availability	0.029	12
C1.2	Quality level	0.080	7
C1.3	Knowledge of the strategy	0.050	9
C1.4	Degree of responsibility	0.081	6
C1.5	Client's financial capability	0.023	14
C1.6	Price competition	0.039	11
C1.7	Time Certainty	0.060	8
C1.8	Speed	0.087	5
C1.9	Public accountability	0.153	1
C1.10	Clarity of scope	0.040	10
C1.11	Involvement of owner in the project	0.113	2
C1.12	Working relationship	0.029	12
C1.13	Intuition and pass experience	0.098	3
C1.14	Client in house technical capability	0.024	13
C1.15	Price or cost certainty	0.093	4

Table 6.30: Vector of overall priorities with respect to main criteria

Main Criteria	Clients' Requirements (C1)	Project Characteristics (C2)	External Environment/Factors (C3)	Vector of Overall Priorities
Vector of Priorities	0.333	0.140	0.528	
CR	0.05	0.05	0.05	
Alternatives	**Vector of Priorities**			
Outsourcing by Repair and Maintenance Contract	0.257	0.343	0.248	0.266
Outsourcing by Specialist Term Contract	0.319	0.157	0.096	0.181
Outsourcing by Tendered Schedule Term Contract	0.152	0.113	0.199	0.169
Outsourcing by Measured Term Contract	0.272	0.387	0.458	0.384
CR	0.08	0.06	0.06	0.07

*CR= Consistency Ratio

Table 6.31: Result of Selection

Alternatives	Vector of Overall Priorities	Rank
Outsourcing by Repair and Maintenance Contract	0.266	2
Outsourcing by Specialist Term Contract	0.181	3
Outsourcing by Tendered Schedule Term Contract	0.169	4
Outsourcing by Measured Term Contract	0.384	1

6.5.2.3 (b) University FB

Development and Property Management Office of University FB was established to support the university's development into a dynamic and advance educational center. The department was known as Pejabat Pembangunan dan Pengurusan Hartabina (PPH). PPH committed to provide teaching and learning space, transportation and a conducive campus environment. It was agreed that 90% of maintenance of the equipment and spaces was carried out according to the planned schedule in order to achieve current standards, preserve the utility and safe to be used. There were three main sections in PPH namely Facility and Property Management Unit, Design and Development Unit and Administration Unit.

The interviewee was Deputy Director of PPH who is also the Head of Facility and Property Management Unit. Facility and Property Management Unit is fully in-charge in managing the maintenance of physical facilities, assets and existing university's infrastructure so that all the facilities are in good condition and functional as well as the university's operation will not be interrupted. The interviewee was from Contract and

Quantity Surveying Department which deal with preparation and monitoring the development of contract from initial stage until the project completed and provide expertise to ensure compliance with the relevant standards. The interviewee had 25 years of experience in dealing procurement and contract matters and involved in facilities and property management, so she was appropriate to be interviewed because he involved in the decision making process in selecting the most appropriate procurement strategy. The interview session was held in the interviewee's room and the all the pairwise comparison judgments was done and evaluation process was made after discussion. The structured interview was help on 2nd of May 2013.

(i) Overall Priority Ranking and selection of the best option of procurement method

All the pairwise comparison judgments made in Expert Choice software were synthesis to obtain vector of priorities. All the vector of priority for main criteria, sub criteria and alternatives were tabulated in Table 6.32. Based on the result obtained, the interviewees priority main factor in selecting the most appropriate procurement method for maintenance of electrical system of building services are clients' requirements (0.455), project characteristics (0.455) and external environment or factors (0.091). The abbreviation used for sub criteria can be referred to Table 6.33. All main criteria judgments consistency ratio (CR) were 0.00 that were less than 0.10 (<0.10) which represent good consistency.

The result of priority obtained for pairwise comparison among sub criteria under clients' requirements in selecting the most appropriate procurement method for maintenance of electrical system of building services and ranking can be referred to Table 6.33. The consistency ratio value is 0.09 which was lesser than 0.10 (<0.10), therefore the judgments consistency is acceptable. The two sub criteria under project characteristics (C2) which were existing building condition (C2.1) and project size (C2.2), existing building condition obtained 0.875 priority vector compared to project size obtained 0.125. This result revealed that existing building condition was more taken into consideration compared to project size when selecting the most appropriate procurement method for maintenance of electrical system of building services. While for objective or policy of organization (C3.1) and government policy (C3.2) which were under external environment or factors (C3), the interviewees conceived both were equally important that scored 0.500 priority vector. Both judgments for sub criteria under C2 and C3 obtained 0.00 (<0.10) consistency ratio, thus the consistency ratio was accepted.

Table 6.32: All vector of priorities for main criteria, sub criteria and alternative

Level 1: Goal	**Select the most appropriate procurement method of building maintenance management services for public university**																		
Level 2: Main Criteria	**Clients' Requirements (C1)**															**Project Characteristics (C2)**		**External Environment or Factors (C3)**	
Vector of Priorities	0.455															0.455		0.091	
CR	0.00															0.00		0.00	
Level3: Sub Criteria	**C1.1**	**C1.2**	**C1.3**	**C1.4**	**C1.5**	**C1.6**	**C1.7**	**C1.8**	**C1.9**	**C1.10**	**C1.11**	**C1.12**	**C1.13**	**C1.14**	**C1.15**	**C2.1**	**C2.2**	**C3.1**	**C3.2**
Vector of Priorities	0.113	0.095	0.091	0.046	0.046	0.033	0.101	0.100	0.111	0.114	0.024	0.023	0.018	0.037	0.048	0.875	0.125	0.500	0.500
CR	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.00	0.00	0.00	0.00
Level 4: Alternatives	**Vector of Priorities**																		
Outsourcing by Repair and Maintenance Contract	0.129	0.118	0.230	0.098	0.574	0.391	0.209	0.067	0.627	0.278	0.520	0.240	0.217	0.273	0.533	0.149	0.277	0.117	0.368
Outsourcing by Specialist Term Contract	0.504	0.276	0.179	0.285	0.232	0.276	0.591	0.541	0.054	0.097	0.122	0.496	0.286	0.075	0.051	0.538	0.147	0.269	0.369
Outsourcing by Tendered Schedule Term Contract	0.100	0.118	0.493	0.114	0.100	0.138	0.148	0.207	0.159	0.522	0.082	0.186	0.286	0.137	0.289	0.223	0.507	0.507	0.368
Outsourcing by Measured Term Contract	0.267	0.487	0.097	0.503	0.094	0.195	0.052	0.185	0.159	0.102	0.275	0.078	0.210	0.515	0.126	0.090	0.069	0.107	0.096
CR	0.08	0.06	0.04	0.06	0.05	0.05	0.05	0.06	0.05	0.05	0.06	0.08	0.09	0.09	0.09	0.06	0.07	0.05	0.06

*CR= Consistency Ratio

Table 6.33: Vector of overall priorities and ranking of Clients' Requirements sub criteria

Abbreviation used	Description	Vector of Priorities	Ranking
C1.1	Experienced contractor availability	0.113	2
C1.2	Quality level	0.095	6
C1.3	Knowledge of the strategy	0.091	7
C1.4	Degree of responsibility	0.046	9
C1.5	Client's financial capability	0.046	9
C1.6	Price competition	0.033	11
C1.7	Time Certainty	0.101	4
C1.8	Speed	0.100	5
C1.9	Public accountability	0.111	3
C1.10	Clarity of scope	0.114	1
C1.11	Involvement of owner in the project	0.024	12
C1.12	Working relationship	0.023	13
C1.13	Intuition and pass experience	0.018	14
C1.14	Client in house technical capability	0.037	10
C1.15	Price or cost certainty	0.048	8

From table 6.32, the result indicated that for sub criteria under clients' requirements (C1) that were C1.5, C1.6, C1.9, C1.11 and C1.15 have more strength when performing outsourcing by repair and maintenance contract. Sub criteria C1.1, C1.7, C1.8 and C1.12 perform better under outsourcing by specialist term contract while only sub criteria C1.3 and C1.10 perform better under outsourcing by tendered schedule term contract. There are 3 sub criteria have more strength under outsourcing by measured term contract which were C1.2, C1.4 and C1.14. While for sub criteria C1.13, outsourcing by specialist term contract and outsourcing by tendered schedule term contract perform better and equally. Sub criteria under project characteristics (C2) and

external environment or factors (C3), which were existing building condition (C2.1) and government policy (C3.2) had better strength but project size (C2.2) and objective or policy of organization (C3.1) perform better under outsourcing by tendered schedule term contract. All the judgments made obtained value of CR less that 0.10 (<0.10) that was acceptable.

Table 6.34: Vector of overall priorities with respect to main criteria

Main Criteria	**Clients' Requirements (C1)**	**Project Characteristic (C2)**	**External Environment/Factor (C3)**	**Vector of Overall Priorities**
Vector of Priorities	0.455	0.455	0.091	
CR	0.00	0.00	0.00	
Alternatives	**Vector of Priorities**			
Outsourcing by Repair and Maintenance Contract	0.269	0.166	0.262	0.223
Outsourcing by Specialist Term Contract	0.288	0.487	0.211	0.367
Outsourcing by Tendered Schedule Term Contract	0.228	0.260	0.426	0.264
Outsourcing by Measured Term Contract	0.215	0.087	0.100	0.146
CR	0.08	0.06	0.05	0.06

*CR= Consistency Ratio

Table 6.34 revealed vectors of priorities for the alternatives with respect to the main factor and alternatives' vector of overall priorities. The results indicated that outsourcing by specialist term contract (0.288) was more preferable among the four alternatives for clients' requirements. As the value of consistency was 0.08<0.10, the consistency judgment was acceptable. While for project characteristics (C2),

outsourcing by specialist term contract (0.288) was also more preferable. The interviewee conceived that outsourcing by tendered schedule term contract (0.426) had more strength under external environment or factor (C3). The judgments made obtained value of consistency 0.06 and 0.05 which were less than 0.10(<0.10) that was acceptable.

The vector of overall priorities for the four alternatives as shown in Table 6.34 indicated that outsourcing by specialist term contract (0.367) which obtained the highest of vector of overall priorities is the best procurement method for maintenance of electrical system of building services for University FB. This is followed by outsourcing by tendered schedule term contract (0.264), outsourcing by repair and maintenance contract (0.223) and outsourcing by measured term contract (0.236). The ranking of the alternatives were shown in Table 6.35.

Table 6.35: Result of Selection

Alternatives	**Vector of Overall Priorities**	**Rank**
Outsourcing by Repair and Maintenance Contract	0.223	3
Outsourcing by Specialist Term Contract	0.367	1
Outsourcing by Tendered Schedule Term Contract	0.264	2
Outsourcing by Measured Term Contract	0.146	4

6.5.2.3 (c) University FC

The establishment of the Development Office in University FC was in line with the establishment of the university on 1st of December 2000. The Development Office was established for the main function to support the development of a dynamic technical education center. Initially Development Office was headed by a Director of Development but the name had changed to Office of Development and Asset Management on 9th of September 2002, where the vehicles unit was transferred from the Office of the Registrar to the Office of Development and Asset Management. Thus, the restructuring process has been led Office of Development and Asset Management to be headed by a Head of Development and Asset Management. However, the department was restructured on 12th of February 2010 accordance with the Administrative Circular No. 13 in 2010 and the department d became the Development Office to smoothen the operation of the University.

Development Office has three main divisions which include development division, maintenance division and administration division as well as a few units in each division according to their respective functions. Development Office plays critical role to ensure successful development and realization of excellent teaching and learning. In addition, effective maintenance is required to ensure that the facilities and infrastructure always at an optimal level and will achieve a satisfying life span.

The structured interview with Head Department of Building Maintenance Section of University FC was conducted on 9th of April 2013. He had 11 years of experience in

building maintenance work and involve in decision making for procurement strategy selection. The interview session was held in the interviewee's room and the all the pairwise comparison judgments was done and evaluation process was made after discussion.

(A) Overall Priority Ranking and selection of the best option of procurement method

All the pairwise comparison judgments made in Expert Choice software were synthesis to obtain vector of priorities. All the vector of priority for main criteria, sub criteria and alternatives were tabulated in Table 6.36. Based on the result obtained, the interviewees priority main factor in selecting the most appropriate procurement method for maintenance of road were clients' requirements (0.427), external environment or factors (0.318), and project characteristics (0.254). The abbreviation used for sub criteria can be referred to Table 6.37. All main criteria judgments consistency ratio (CR) were 0.01 that were less than 0.10 (<0.10) which represent good consistency.

The result of priority obtained for pairwise comparison among sub criteria under clients' requirements in selecting the most appropriate procurement method for maintenance of road and ranking can be referred to Table 6.37. The consistency ratio value is 0.08 which was lesser than 0.10 (<0.10), therefore the judgments consistency is acceptable. The two sub criteria under project characteristics (C2) which were existing building condition (C2.1) and project size (C2.2), both obtained equal priority vector (0.500). This result revealed that both existing building condition and project size were equally

important when selecting the most appropriate procurement method for maintenance of road. While for objective or policy of organization (C3.1) and government policy (C3.2) which were under external environment or factors (C3), the interviewees felt that objective or policy of organization (0.750) are more important compared to government policy (0.250). Both judgments for sub criteria under C2 and C3 obtained 0.00 (<0.10) consistency ratio, thus the consistency ratio was accepted.

From table 6.36, the result indicated that for sub criteria under clients' requirements (C1) that was only C1.14 has more strength when performing outsourcing by repair and maintenance contract. Sub criteria C1.1, C1.2, C1.3 and C1.8 perform better under outsourcing by specialist term contract while sub criteria C1.4, C1.5, C1.6, C1.7 and C1.9 perform better under outsourcing by tendered schedule term contract. There was only one sub criteria have more strength under outsourcing by measured term contract which was C 1.11. While for sub criteria C1.10, outsourcing by tendered schedule term contract and outsourcing by measured term contract perform better and had equal strength. Sub criteria C1.12, C1.13 and C1.15 have equal strength for the four alternatives. Sub criteria under project characteristics (C2), C2.1 obtained highest priority vector for outsourcing by measured term contract while C2.2 obtained highest for outsourcing by specialist term contract. While for sub criteria under external environment or factors (C3), outsourcing by tendered schedule term contract obtained the highest priority vector for both C3.1 and C3.2. All the judgments made obtained value of CR less that 0.10 (<0.10) that was acceptable.

Table 6.36: All vector of priorities for main criteria, sub criteria and alternative

Level 1: Goal	**Select the most appropriate procurement method of building maintenance management services for public university**																		
Level 2: Main Criteria	**Clients' Requirements (C1)**															**Project Characteristics (C2)**		**External Environment or Factors (C3)**	
Vector of Priorities	0.427															0.254		0.318	
CR	0.01															0.01		0.01	
Level3: Sub Criteria	**C1.1**	**C1.2**	**C1.3**	**C1.4**	**C1.5**	**C1.6**	**C1.7**	**C1.8**	**C1.9**	**C1.10**	**C1.11**	**C1.12**	**C1.13**	**C1.14**	**C1.15**	**C2.1**	**C2.2**	**C3.1**	**C3.2**
Vector of Priorities	0.021	0.056	0.094	0.092	0.098	0.055	0.068	0.089	0.058	0.062	0.056	0.057	0.072	0.050	0.070	0.500	0.500	0.750	0.250
CR	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.00	0.00	0.00	0.00
Level 4: Alternatives	**Vector of Priorities**																		
Outsourcing by Repair and Maintenance Contract	0.120	0.174	0.137	0.136	0.239	0.276	0.247	0.222	0.233	0.167	0.205	0.250	0.250	0.368	0.250	0.285	0.138	0.278	0.246
Outsourcing by Specialist Term Contract	0.418	0.423	0.423	0.287	0.140	0.138	0.159	0.444	0.124	0.167	0.286	0.250	0.250	0.150	0.250	0.186	0.391	0.124	0.210
Outsourcing by Tendered Schedule Term Contract	0.271	0.266	0.266	0.340	0.340	0.391	0.436	0.111	0.366	0.333	0.163	0.250	0.250	0.282	0.250	0.203	0.276	0.366	0.298
Outsourcing by Measured Term Contract	0.191	0.137	0.174	0.237	0.281	0.195	0.159	0.222	0.278	0.333	0.346	0.250	0.250	0.200	0.250	0.325	0.195	0.233	0.246
CR	0.03	0.05	0.05	0.07	0.02	0.05	0.06	0.00	0.02	0.00	0.07	0.00	0.00	0.03	0.00	0.08	0.05	0.02	0.02

*CR= Consistency Ratio

Table 6.37: Vector of overall priorities and ranking of Clients' Requirements sub criteria

Abbreviation used	Description	Vector of Priorities	Ranking
C1.1	Experienced contractor availability	0.021	14
C1.2	Quality level	0.056	11
C1.3	Knowledge of the strategy	0.094	2
C1.4	Degree of responsibility	0.092	3
C1.5	Client's financial capability	0.098	1
C1.6	Price competition	0.055	12
C1.7	Time Certainty	0.068	7
C1.8	Speed	0.089	4
C1.9	Public accountability	0.058	9
C1.10	Clarity of scope	0.062	8
C1.11	Involvement of owner in the project	0.056	11
C1.12	Working relationship	0.057	10
C1.13	Intuition and pass experience	0.072	5
C1.14	Client in house technical capability	0.050	13
C1.15	Price or cost certainty	0.070	6

Table 6.38: Vector of overall priorities with respect to main criteria

Main Criteria	Clients' Requirements (C1)	Project Characteristics (C2)	External Environment/Factors (C3)	Vector of Overall Priorities
Vector of Priorities	0.427	0.254	0.318	
CR	0.01	0.01	0.01	
Alternatives	**Vector of Priorities**			
Outsourcing by Repair and Maintenance Contract	0.220	0.218	0.269	0.235
Outsourcing by Specialist Term Contract	0.255	0.279	0.149	0.227
Outsourcing by Tendered Schedule Term Contract	0.285	0.236	0.346	0.293
Outsourcing by Measured Term Contract	0.240	0.266	0.237	0.246
CR	0.06	0.06	0.02	0.04

*CR= Consistency Ratio

Table 6.38 revealed vectors of priorities for the alternatives with respect to the main factor and alternatives' vector of overall priorities. The results indicated that outsourcing by tendered schedule term contract (0.285) was more preferable among the four alternatives for clients' requirements. As the value of consistency is 0.06<0.10, the consistency judgment was acceptable. While for both project characteristic (C2), outsourcing by specialist term contract (0.279) obtained the highest vector of priority. Outsourcing by tendered schedule term contract (0.346) was more preferable under external environment or factors (C3). Both C2 and C3 obtained consistency ratio less than 0.10 (<0.10) that was acceptable.

The vector of overall priorities for the four alternatives as shown in Table 6.38 indicated that outsourcing by tendered schedule term contract (0.293) which obtained the highest of vector of overall priorities is the best procurement method for maintenance of road for University FC. This is followed by outsourcing by measured term contract (0.246), outsourcing by repair and maintenance contract (0.235) and outsourcing by specialist term contract (0.227). The ranking of the alternatives were shown in Table 6.39.

Table 6.39: Result of Selection

Alternatives	**Vector of Overall Priorities**	**Rank**
Outsourcing by Repair and Maintenance Contract	0.235	3
Outsourcing by Specialist Term Contract	0.227	4
Outsourcing by Tendered Schedule Term Contract	0.293	1
Outsourcing by Measured Term Contract	0.246	2

6.5.2.3 (d) University FD

Department of Development and Facilities Management of University FD was formerly known as Development Unit and was officially changed to Department of Development and Facilities Management (Jabatan Pembangunan dan Pengurusan Fasiliti, JPPF) in accordance to the service provided to the users. JPPF currently has eight units with 130 employees. JPPF was divided into three main divisions which include Administration Division, Engineering Division and Contract, Architect and Landscape Management Division.

The structured interview was help on 7th of May 2013. The interviewee was Deputy Director of JPPF who is the Head of Contract, Architect and Landscape Management Division. Contract, Architect and Landscape Management Division is divided into three units that are Contract and Quantity Surveying Unit, Architect Unit and Landscape Unit. The division deals with procurement management work, supply and consultancy, management of tenders and quotation, contract administration and financial management of procurement or supply, managing the development and renovation projects and repairs, manage and coordinate the procurement of furniture, signboard and office equipment, monitor defects in the defect liability period as well as manage landscape projects and monthly landscape maintenance.

The interviewee had 23 years of experience in dealing procurement and contract matters as well as involved in the decision making process in selecting procurement strategy so she was appropriate to be interviewed. The interview session was held in the meeting

room and the all the pairwise comparison judgments was done and evaluation process was made after discussion.

(A) Overall Priority Ranking and selection of the best option of procurement method

All the pairwise comparison judgments made in Expert Choice software were synthesis to obtain vector of priorities. All the vector of priority for main criteria, sub criteria and alternatives were tabulated in Table 6.40. Based on the result obtained, the interviewees priority main factor in selecting the most appropriate procurement method for maintenance of lift were external environment or factors (0.600), clients' requirements (0.200) and project characteristics (0.200). The abbreviation used for sub criteria can be referred to Table 6.41. All main criteria judgments consistency ratio (CR) were 0.00 that were less than 0.10 (<0.10) which represent good consistency.

The result of priority obtained for pairwise comparison among sub criteria under clients' requirements in selecting the most appropriate procurement method for maintenance of lift and ranking can be referred to Table 6.41. The consistency ratio value is 0.09 which was lesser than 0.10 (<0.10), therefore the judgments consistency is acceptable. The two sub criteria under project characteristics (C2) which were existing building condition (C2.1) and project size (C2.2), existing building condition obtained 0.167 priority vector compared to project size obtained 0.833. This result revealed that project size was more taken into consideration compared to existing building condition when selecting the most appropriate procurement method for maintenance of lift. While for

objective or policy of organization (C3.1) and government policy (C3.2) which were under external environment or factors (C3), the interviewees feel that government policy (0.875) are more important compared to objective or policy of organization (0.125). Both judgments for sub criteria under C2 and C3 obtained 0.00 (<0.10) consistency ratio, thus the consistency ratio was accepted.

From table 6.40, the result indicated that for sub criteria under clients' requirements (C1) that was none sub criteria have more strength in performing outsourcing by repair and maintenance contract and outsourcing by tendered schedule term contract. Sub criteria C1.1, C1.2, C1.3, C1.4, C1.7, C1.10, C1.11, C1.13 and C1.14 perform better under outsourcing by specialist term contract while only sub criteria C1.5 and C1.6 perform better under outsourcing by measured term contract. While for sub criteria C1.9, the four alternatives have equal strength. Sub criteria C1.8 and C1.12 perform better and equally for outsourcing by repair and maintenance contract and outsourcing by specialist term contract while C1.15 perform better and equally for outsourcing by tendered schedule term contract and outsourcing by measured term contract. Sub criteria under project characteristics (C2) and external environment or factors (C3) that were C2.1, C3.1 and C3.2 have equal strength for the four alternatives and only C2.2 obtained the highest vector of priority. All the judgments made obtained value of CR less that 0.10 (<0.10) that was acceptable.

Table 6.40: All vector of priorities for main criteria, sub criteria and alternative

Level 1: Goal	**Select the most appropriate procurement method of building maintenance management services for public university**																		
Level 2: Main Criteria	**Clients' Requirements (C1)**															**Project Characteristics (C2)**		**External Environment or Factors (C3)**	
Vector of Priorities	0.200															0.200		0.600	
CR	0.00															0.00		0.00	
Level3: Sub Criteria	**C1.1**	**C1.2**	**C1.3**	**C1.4**	**C1.5**	**C1.6**	**C1.7**	**C1.8**	**C1.9**	**C1.10**	**C1.11**	**C1.12**	**C1.13**	**C1.14**	**C1.15**	**C2.1**	**C2.2**	**C3.1**	**C3.2**
Vector of Priorities	0.074	0.082	0.110	0.116	0.105	0.037	0.154	0.077	0.050	0.091	0.019	0.017	0.020	0.029	0.020	0.167	0.833	0.125	0.875
CR	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.00	0.00	0.00	0.00
Level 4: Alternatives	**Vector of Priorities**																		
Outsourcing by Repair and Maintenance Contract	0.096	0.118	0.276	0.118	0.208	0.208	0.118	0.417	0.250	0.118	0.118	0.368	0.118	0.118	0.169	0.250	0.276	0.250	0.250
Outsourcing by Specialist Term Contract	0.487	0.487	0.487	0.487	0.208	0.096	0.487	0.417	0.250	0.487	0.487	0.368	0.487	0.487	0.096	0.250	0.487	0.250	0.250
Outsourcing by Tendered Schedule Term Contract	0.208	0.118	0.118	0.118	0.096	0.208	0.118	0.083	0.250	0.118	0.118	0.169	0.118	0.118	0.368	0.250	0.118	0.250	0.250
Outsourcing by Measured Term Contract	0.208	0.276	0.118	0.276	0.487	0.487	0.276	0.083	0.250	0.276	0.276	0.096	0.276	0.276	0.368	0.250	0.118	0.250	0.250
CR	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.00	0.00	0.06	0.06	0.06	0.06	0.06	0.06	0.00	0.06	0.00	0.00

*CR= Consistency Ratio

Table 6.41: Vector of overall priorities and ranking of Clients' Requirements sub criteria

Abbreviation used	Description	Vector of Priorities	Ranking
C1.1	Experienced contractor availability	0.074	8
C1.2	Quality level	0.082	6
C1.3	Knowledge of the strategy	0.110	3
C1.4	Degree of responsibility	0.116	2
C1.5	Client's financial capability	0.105	4
C1.6	Price competition	0.037	10
C1.7	Time Certainty	0.154	1
C1.8	Speed	0.077	7
C1.9	Public accountability	0.050	9
C1.10	Clarity of scope	0.091	5
C1.11	Involvement of owner in the project	0.019	13
C1.12	Working relationship	0.017	14
C1.13	Intuition and pass experience	0.020	12
C1.14	Client in house technical capability	0.029	11
C1.15	Price or cost certainty	0.020	12

Table 6.42: Vector of overall priorities with respect to main criteria

Main Criteria	Clients' Requirements (C1)	Project Characteristics (C2)	External Environment/Factors (C3)	Vector of Overall Priorities
Vector of Priorities	0.200	0.200	0.600	
CR	0.00	0.00	0.00	
Alternatives	**Vector of Priorities**			
Outsourcing by Repair and Maintenance Contract	0.188	0.269	0.250	0.245
Outsourcing by Specialist Term Contract	0.407	0.421	0.250	0.295
Outsourcing by Tendered Schedule Term Contract	0.141	0.155	0.250	0.222
Outsourcing by Measured Term Contract	0.263	0.155	0.250	0.238
CR	0.08	0.05	0.00	0.03

*CR= Consistency Ratio

Table 6.42 revealed vectors of priorities for the alternatives with respect to the main factor and alternatives' vector of overall priorities. The results indicated that outsourcing by specialist term contract was more preferable among the four alternatives for clients' requirements (0.407) and project characteristic (0.421). As the value of consistency is less than 0.1 (<0.10), the consistency judgment was acceptable. While for external environment or factors (C3), the four alternatives performed equally and has 0.00 (<0.10) consistency ratio that was acceptable.

The vector of overall priorities for the four alternatives as shown in Table 6.42 indicated that outsourcing by specialist term contract (0.295) which obtained the highest of vector of overall priorities is the best procurement method for maintenance of lift in University FD. This is followed by outsourcing by repair and maintenance contract (0.245), outsourcing by measured term contract (0.238) and outsourcing by tendered schedule term contract (0.222). The ranking of the alternatives were shown in Table 6.43.

Table 6.43: Result of Selection

Alternatives	**Vector of Overall Priorities**	**Rank**
Outsourcing by Repair and Maintenance Contract	0.245	2
Outsourcing by Specialist Term Contract	0.295	1
Outsourcing by Tendered Schedule Term Contract	0.222	4
Outsourcing by Measured Term Contract	0.238	3

6.6 SUMMARY OF THE RESULTS IN COMPARISON WITH INTERVIEWEES'S DECISION

The interviewees' decisions on vector of priorities for main criteria were different in selecting procurement method for different type of building maintenance services. Table 6.44 and Table 6.45 showed the summary results to compare all interviewees' priority vector to select the most appropriate procurement method for different type of building maintenance services.

Table 6.44: Summary results to compare all interviewees' priority vector to select the most appropriate procurement method for different type of building maintenance services

Priority Ranking	Universities and Maintenance Services				
	University RA	University RB	University RC	University CA	University CB
	Maintenance of Waterproofing System	Maintenance of Air-conditioning Services	Housekeeping	General Repair Work	Roof Repair Work
1	EEF	PC	CR	CR=EEF	PC
2	CR	EEF	EEF	CR=EEF	CR
3	PC	CR	PC	PC	EEF

*EEF= External Environment or Factor, CR= Clients' Requirement, PC= project characteristic

Table 6.45: Summary results to compare all interviewees' priority vector to select the most appropriate procurement method for different type of building maintenance services

Priority Ranking	Universities and Maintenance Services			
	University FA	University FB	University FC	University FD
	Building Cleaning	Maintenance of electrical system	Maintenance of road	Maintenance of Lift
1	EEF	CR	CR	EEF
2	CR	PC	EEF	PC=CR
3	PC	EEF	PC	PC=CR

*EEF= External Environment or Factor, CR= Clients' Requirement, PC= project characteristic

It can be seen in Table 6.44 and Table 6.45 that owners of a similar nature do not necessarily have similar needs. In fact, the needs are usually specific to the particular

project. The proposed decision making framework derive a set of procurement selection criteria that were considered essential and four procurement methods that were considered as most commonly used (percentage of cases more than 50%) and categorized as important and very important with both mean rating and mode equal or above 4. The proposed decision making framework also applied AHP whereby the decision making process is based on multiple criteria that enables the decision maker to derive his own set of important criteria for the selection according to the characteristics of the building. Therefore, the proposed decision making framework will act as a tool to asist the university organization to select the most suitable and appropriate procurement method which will then improve the building maintenance management of universities in Malaysia.

6.7 PROCUREMENT METHODS COMPARISON

The validation process was carried out through structured interview with 9 public universities selected. The interviewee were introduced the decision making framework and the concepts underlying the selection process. The interviewees were regarded as the decision makers for building maintenance procurement method were asked to consider the last project which they required to decide upon a procurement method for building maintenance work. The interviewees requested to perform pairwise comparisons for all levels of hierarchy in the framework. The inconsistency of judgements was checked throughout the process and adjustment was made where necessary so that the inconsistency value is equivalent or lesser than 0.1. Once the judgements completed and obtained the proposed procurement method from the

framework, the respondents compare the proposed option with the actually adopted in that particular project. Table 6.46 showed the procurement strategy proposed by the decision making framework and actual method used.

Table 6.46: Procurement Methods Comparison (Actual versus Proposed)

No.	University	Type of building maintenance services	Actual Procurement method used	Procurement Method proposed by the Framework	Similarity
1	RA	Maintenance of Waterproofing System	Outsourcing by Measured Term Contract	Outsourcing by Measured Term Contract	√
2	RB	Maintenance of Air-conditioning Services	Outsourcing by Repair and Maintenance Contract	Outsourcing by Specialist Term Contract	X
3	RC	Housekeeping	Facilities Management Condition of Contract	Outsourcing by Specialist Term Contract	X
4	CA	General Repair Work	Outsourcing by Repair and Maintenance Contract	Outsourcing by Repair and Maintenance Contract	√
5	CB	Roof Repair Work	Outsourcing by Measured Term Contract	Outsourcing by Measured Term Contract	√
6	FA	Building Cleaning	Outsourcing by Measured Term Contract	Outsourcing by Measured Term Contract	√
7	FB	Maintenance of Electrical System	Outsourcing by Repair and Maintenance Contract	Outsourcing by Specialist Term Contract	X
8	FC	Maintenance of Road	Outsourcing by Tendered Schedule Term Contract	Outsourcing by Tendered Schedule Term Contract	√
9	FD	Maintenance of Lift	Outsourcing by Specialist Term Contract	Outsourcing by Specialist Term Contract	√

From Table 6.46, out of 9 assessments conducted there were 6 matching and 3 non-matching. For all the 6 matching universities' respondents stated that they are satisfied with the result proposed by the framework. While for the non-matching, the University RB interviewee stated that the proposed procurement method was very suitable as the maintenance work for air-conditioning services required specialist to carry out. The University RC interviewee also claimed that the proposed framework was very useful and a new knowledge for him to make a more deliberate decision compared to the decision made previously. On the other hand, the respondent of University FB clarified that she was satisfied with the proposed framework as the maintenance of electrical system should be done by specialist who are certified.

In summary, the proposed framework was well received by the interviewees. The interviewees admitted that the selection of procurement process proposed was decided on a judgemental basis which was not simply based on previous experience and perception. Ng et al. (2002) noted that clients may suffer if their selection simply based upon biased past experience and the conservative decisions of their in-house experts. Although past experiences may be an essential factor that influences the selection of procurement strategy but experiences and solutions to problems retrieved from previous projects may not be applicable to the current projects because each building has its own distinct characteristic. Thus, the proposed decision making framework will be able to assist the decision makers to select the most appropriate procurement method as the decision maker able to derive his set of important criteria for the selection according to the characteristics of the building.

6.8 Overall Evaluation Results for Decision Making Framework for Procurement Method Selection of Building Maintenance Management for Public Universities

Table 6.47: Nine universities evaluation towards Decision Making Framework for Procurement Method Selection of Building Maintenance Management for Public Universities

No.	Evaluation Question	Rating				
		Very Poor	**Poor**	**Satisfactory**	**Good**	**Excellent**
1	The capability of the framework			11%	75%	14%
1.1	How well the framework in supporting the decision process?			2 (22%)	7 (78%)	
1.2	How reliable the assessment procurement selection criteria employed in the framework?			1 (11%)	8 (89%)	
1.3	How well the framework reflect the real situation in decision making process for procurement method selection?			1 (11%)	7 (78%)	1 (11%)
1.4	How useful was the Expert Choice software employed in the framework?				5 (56%)	4 (44%)
2	The applicability of the framework			10%	63%	27%
2.1	How relevant the framework in selecting the most appropriate procurement method?				6 (67%)	3 (33%)
2.2	How appropriate was the assessment criteria employed in the selection process?			1 (11%)	7 (78%)	1 (11%)
2.3	How appropriate was the framework to act as an alternative decision making for a supporting system?			1 (11%)	6 (67%)	2 (22%)
2.4	How relevant was the framework in improving the existing decision making process?				7 (78%)	2 (22%)
2.5	How relevant was the framework in term of:-					
2.5.1	Speed			3 (33%)	4 (44%)	2 (22%)
2.5.2	Flexibility			1 (11%)	4 (44%)	4 (44%)
2.5.3	Consistency				6 (67%)	3 (33%)
3	The validity of the result			33%	50%	17%
3.1	How convinced were you with the result produced by this framework?			3 (33%)	4 (44%)	2 (22%)
3.2	How confident were you in using the result as a selection making process in real situation?			3 (33%)	5 (56%)	1 (11%)
Overall score		**0%**	**0%**	**14%**	**65%**	**21%**

The summary of the evaluations done by the 9 universities were shown in Table 6.47. The results in Table 6.47 revealed that majority of the interviewees perceived that the Decision Making Framework for Procurement Method Selection of Building Maintenance Management for Public Universities developed was good (65%) and excellent (21%) in term of capability, applicability and validity in assisting the decision makers to select the most appropriate procurement method in building maintenance work. In term of capability, the majority (75%) of the interviewees considered that the framework has capability to assist them to select the most appropriate procurement method and 89% of the interviewees conceived that the assessment procurement selection criteria employed in the framework were reliable. In addition, majority of the interviewees (78%) also perceived that the framework was well in supporting the decision process and reflect the real situation in decision making process for procurement method selection.

In evaluating the applicability of the framework, 63% of the interviewees considered the framework had good applicability and 27% of the interviewees conceived that the framework had excellent applicability in selecting the most appropriate procurement method. Majority thinks that the framework was good (78%) and excellent (22%) in improving the existing decision making process. The results also indicated that the framework was good (67%) and excellent (22%) to act as an alternative decision making for a supporting system.

In term of evaluating the results obtained from the framework, the interviewees conceived that the results obtained were good (44%) and excellent (22%) in convincing them to employ the result obtained. There were 56% (good) and 11% (excellent) of the interviewees were confident in using the result as a selection making process in real situation.

6.9 SUMMARY

The proposed decision making framework mainly focused on two important components that are the possible assessment criteria and the alternatives available for selection. The framework employed AHP techniques and principles using Expert Choice 11 Software as development tool. There were 19 criteria which were categorized into 3 main criteria and 4 procurement method alternatives considered in the development of decision making framework on this present study. Once the framework was developed, the framework was validated. The validation process was carried out through structured interview with 9 public universities selected. The interviewee were introduced the decision making framework and the concepts underlying the selection process. The interviewees were regarded as the decision makers for building maintenance procurement method were asked to consider the last project which they required to decide upon a procurement method for building maintenance work. The interviewees requested to perform pairwise comparisons for all levels of hierarchy in the framework. The inconsistency of judgements was checked throughout the process and adjustment was made where necessary so that the inconsistency value is equivalent

or lesser than 0.1. Once the judgements completed and obtained the proposed procurement method from the framework, the respondents compare the proposed option with the actually adopted in that particular project. The results revealed that majority of the interviewees perceived that the Decision Making Framework for Procurement Method Selection of Building Maintenance Management for Public Universities developed was good (65%) and excellent (21%) in term of capability, applicability and validity in assisting the decision makers to select the most appropriate procurement method in building maintenance work.

CHAPTER 7

CONCLUSION AND RECOMMENDATION

7.1 INTRODUCTION

This chapter presents the conclusion and recommendations for the study. The conclusions are drawn from the findings which were discussed in the previous chapter in the present study. This chapter will discuss on the overall summary of the objectives and make some recommendations for potential area in decision making for procurement methods.

7.2 SUMMARY OF FINDING

The study began with the investigation on the issue in selecting procurement method for building maintenance management. As revealved by the literature search, there is very limited study found for maintenance procurement in Malaysia. Most researches for procurement methods selection are focusing more on construction and project management field. Globally, limited empirical research found with regards to procurement for maintenance. In addition, it was found that relatively few professionals fully understood the differences between the various procurement systems and would be unable to make sensible recommendations as to which system would be most appropriate for a specific project. Many decision makers have been selecting

procurement systems in a cursory manner simply based upon biased past experience and the conservative decisions without making a deliberated choice.

Changes in business environment and the ever evolving market trend resulting emergence of varying sourcing strategies. Thus, it is becomes more challenging for the decision maker to select the most appropriate procurement method for a specific building as different types of procurement method suit different types of project. In fact, some researches indicate that the selection of procurement strategy for building maintenance is more challenging and complex. The growing importance of maintenance sector not only in Malaysia but also increasingly globalized, the difficulty in selecting an appropriate procurement method and lack of research in this area provide an impetus for this research.

This research adopted mixed method that is the combination of both qualitative and quantitative method. This study was divided into four main phases whereby phase 1 is literature review to get an overview of the study and most importantly to identify two important components that were the possible assessment criteria and the procurement method available for selection. In addition, decision making tools are studied as well in order to select the most suitable tool to be adapted to select the most appropriate procurement method. Fom the literature review, a theoretical framework was produced to provide the framework for this study. There were 26 procurement selection criteria identified from literature review that were divided into three main categories that were

clients' requirements, project characteristics and external environment or factors. In addition, there were 13 types of procurements methods identified in literature review.

Then, the study was followed by postal questionnaires survey to validate the variables obtained from phase 1 and shortlist the most popular and important procurement selection criteria, obtain the current and available building maintenance procurement method used in public universities in Malaysia as well as understand the current practices adapted in selecting procurement method. The questionnaire survey was conducted among all (twenty) public universities in Malaysia with 85 per cent response rate. The finding of this research proves that the selection of procurement methods by university organizations is neither strategic nor systematic as there is no guidance available for the decision maker to rely on in order to select the most appropriate procurement strategy thus provides impetus for this study.

The study moves on with Phase 3 that was to develope decision making framework based on AHP technique and principles. Expert Choice Software was employed as development tool where the shortlisted criteria and alternatives from phase 2 was integrated into the framework. There were 19 criteria which were categorized into 3 main criteria and 4 procurement method alternatives considered in the development of decision making framework on this present study. Finally, the research moved to phase 4 that was structured interview to validate the framework developed. The validation process was carried out through structured interview with 9 public universities selected. The evaluations done by the 9 universities revealed that majority of the interviewees

perceived that the Decision Making Framework for Procurement Method Selection of Building Maintenance Management for Public Universities developed was good (65%) and excellent (21%) in term of capability, applicability and validity in assisting the decision makers to select the most appropriate procurement method in building maintenance work.

In this research, the objectives have been achieved and discussed as below:-

7.2.1: Objective 1: To identify criteria for procurement methods selection in building maintenance project

There were 26 procurement selection criteria identified from literature review that were divided into three main categories that were clients' requirements, project characteristics and external environment or factors. Through the analysis of procurement selection criteria of previous research, it can be seen that there are similarity which can be seen in Table 2.13. In addition, the criteria were usually divided under some main criteria or factors such as clients' requirements which is known as clients' characteristics and objectives (owner's needs and preferences), project characteristics and external environment. The grouping of procurement selection criteria had similarity through the analysis of previous research which can be seen in Table 2.12. In this research, the 26 criteria identified from literature review were divided into three main categories that were clients' requirement, project characteristic and external environment or factor which can be referred to Table 2.14.

The assessment criteria were validated in term of their applicability and shortlisted in phase 2 (Postal Questionnaires Survey). In order to derive a set of procurement selection criteria that were considered essential, only those criteria obtained both mean rating and mode equivalent to or above 4 which were considered as important and very important according to likert scales of 5 (from which 1 indicate “least important” to 5 indicate “very important”) are included in this study for the proposed decision making framework. There were 19 criteria which were categoriesed in three main criteria were considered as important and very important in selecting the most appropriate procurement method as shown in Table 7.1.

Table 7.1: List of final procurement selection criteria

Abbreviation used	**Criteria**
C1	**Clients’ Requirements**
C1.1	Experience contractor availability
C1.2	Quality level
C1.3	Knowledge of the strategy
C1.4	Degree of responsibility
C1.5	Client's financial capability
C1.6	Price competition
C1.7	Time Certainty
C1.8	Speed
C1.9	Public accountability
C1.10	Clarity of scope
C1.11	Involvement of owner in the project
C1.12	Working relationship
C1.13	Intuition and pass experience
C1.14	Client in house technical capability
C1.15	Price or cost certainty
C2	**Project Characteristic**
C2.1	Existing building condition
C2.2	Project size
C3	**External Environment/Factor**
C3.1	Objective or policy of organization
C3.2	Government policy

7.2.2: Objective 2: To investigate the current procurement method option for public universities in Malaysia

Through literature review, there were 13 building maintenance procurement strategy found. The procurement method options were validated in term of their applicability and shortlisted in phase 2 (Postal Questionnaires Survey). The respondents of the study were asked to rate the importance of the 13 procurement strategy identified in the literature review on a Likert scale of 1 to 5 (1 as least important to 5 as very important) and include any other procurement method as they considered important. In addition, multiple response analysis was performed to identify the procurement methods that are currently adapted by public universities in Malaysia. There were 4 procurements methods which include outsourcing by specialist term contract, outsourcing by tendered schedule term contract, outsourcing by repair and maintenance contract and outsourcing by measured term contract were the most popular procurement methods adapted by public universities currently (Percent of Cases > 50%) and at the same time were considered most important (mean >4 or almost equal to 4). In addition, these 4 procurements methods obtained mode equals to 4. The most popular procurement methods adapted by public universities currently and were considered most important as shown in Table 7.2.

Table 7.2: List of final alternative

Abbreviation used	Alternative
A1	Outsourcing by Repair and Maintenance Contract
A2	Outsourcing by Specialist Term Contract
A3	Outsourcing by Tendered Schedule Term Contract
A4	Outsourcing by Measured Term Contract

7.2.3: Objective 3: To review the current practices adapted by public universities organization in selecting procurement method

A postal questionnaire survey was conducted to determine ways, tools and methods used by the decision makers for public universities organization in selecting procurement method. It was identified that the decision makers choose the procurement method based on previous experiences, based on the maintenance budget allocation, based on the age of the building and based on government policies. While some may think the best way is to select a procurement method which carries the least risk and which will deliver optimum efficiency. Based on the data collected from 17 universities that participated in this survey, some universities depend on more than one way in choosing a suitable procurement method. Majority of the universities choose their procurement method based on maintenance budget allocation (45.7%) and based on previous experiences (31.4%). The minority of the universities considered government policies (2.9%) and select the procurement method that provide lower risk and optimizes efficiency (2.9%). In addition, some universities consider the age of the building (17.1%) as well in selecting their procurement method.

From the survey, it also revealved that 58.8% (N=10) of the respondents opined that there was no proper guidance available to select the most appropriate procurement method. This result provides an impetus for this research. However, 41.2% (N=7) of the respondents stated that there are some guidance available such as government policies which were produced by ministry of finance and public works department, also known as Jabatan Kerja Raya (JKR). Furthermore, majority (52.9%) of the respondents opined

that there is no decision making theory or tool available in helping them to select procurement strategy for university. The nature of selection of procurement method for public universities in Malaysia was autonomy and the only guideline that needs to refer is Government Circular from Ministry of Finance. In addition, the decision makers will hold a few meetings to discuss which procurement method to be adopted before final decision is made which is quite time consuming.

The finding of this research has proven that the selection of procurement method by university organization is not in strategic way nor systematic as there is no guidance available for the decision maker to select the most appropriate procurement strategy. It is indeed very vital to develop a systematic approach that can assist the maintenance personnel in the decision making process of selecting the most suitable procurement method in building maintenance management for public university.

7.2.4: Objective 4: To establish a decision making framework using AHP as a basis of development

The development of the decision making framework integrated AHP techniques and principles mainly focussing on two important components that are the possible assessment criteria and the alternatives available for selection. The assessment criteria are used to evaluate the alternatives. In order to derive a set of procurement selection criteria that were considered essential, only those criteria obtained both mean rating and mode equivalent to or above 4 which were considered as important and very important according to likert scales of 5 (from which 1 indicate “least important” to 5 indicate

"very important") are included in this study for the proposed decision making framework. There were only 19 criteria will be considered in the development of decision making framework on this present study. On the other hand, the procurement methods that were considered as most commonly used (percentage of cases more than 50%) and categorized as important and very important with both mean rating and mode equal or above 4 will be considered for the proposed decision making framework. The procurement selection criteria and procurement option that were selected are provided in summary in Table 7.3. The proposed decision making framework is discussed in Chapter 6 and shown in Figure 6.1.

Result obtained from the implementations of the decision making framework revealved that owners of a similar nature do not necessarily have similar needs. In fact, the needs are usually specific to the particular project. The proposed decision making framework applied AHP whereby the decision making process is based on multiple criteria enables the decision maker to derive his own set of important criteria for the selection according to the characteristics of the building.

In addition, the application of AHP which able to calculate the judgment consistency assure that the decision makers' judgments are consistent and the final decision is made well. The proposed decision making framework introduced is expected to be a useful tool for the maintenance organizations that provide alternatives and procurement selection criteria. This is critical during the decision making process of selecting the most appropriate procurement strategy.

Table 7.3: Selected procurement selection criteria and procurement options for the proposed decision making framework

Procurement Selection Criteria	Mean	Mode	Procurement method used in universities	Mean	Mode	Percent of Cases
Experience contractor availability	4.71	5	Outsourcing by Repair and Maintenance Contract	4.06	4	82.4%
Existing building condition	4.59	5	Outsourcing by Specialist Term Contract	4.18	4	76.5%
Objective or policy of organization	4.53	4	Outsourcing by Tendered Schedule Term Contract	4.12	4	70.6%
Quality level	4.47	5	Outsourcing by Measured Term Contract	3.94	4	64.7%
Government policy	4.41	4				
Knowledge of the strategy	4.41	5				
Degree of responsibility	4.41	5				
Client's financial capability	4.41	5				
Price competition	4.35	4				
Time Certainty	4.35	4				
Speed	4.35	4				
Public accountability	4.29	4				
Clarity of scope	4.29	4				
Involvement of owner in the project	4.24	4				
Working relationship	4.24	5				
Project size	4.18	4				
Intuition and pass experience	4.12	4				
Client in house technical capability	4.06	4				
Price or cost certainty	4.00	4				

The development of the decision making framework includes the employment of procurement selection criteria and procurement method option, integration of Analytic Hierarchy Process (AHP) technique and principles as well as the adaption of Expert Choice Software as development tool. The AHP implementation steps were simplified by using the Expert Choice Expert Choice 11 software. The software was employed as a development tool to assist in development the decision making framework. Once the

decision making framework developed, structured interviews were conducted to validate the framework developed. The validation process was carried out through structured interview with 9 public universities selected. The interviewee were introduced the decision making framework and the concepts underlying the selection process. The interviewees requested to perform pairwise comparisons for all levels of hierarchy in the framework. The inconsistency of judgements was checked throughout the process and adjustment was made where necessary so that the inconsistency value is equivalent or lesser than 0.1.

The proposed framework was well received by the interviewees and they admitted that the selection of procurement process proposed was decided on a judgemental basis which was not simply based on previous experience and perception. The evaluations done by the 9 universities regarding the proposed decision making framework revealed that majority of the interviewees perceived that the Decision Making Framework for Procurement Method Selection of Building Maintenance Management for Public Universities developed was good (65%) and excellent (21%) in term of capability, applicability and validity in assisting the decision makers to select the most appropriate procurement method in building maintenance work. Thus, the proposed decision making framework will be able to assist the decision makers to select the most appropriate procurement method.

7.3 CONTRIBUTION OF THE RESEARCH

From the research, it was found that there are several important contributions that are beneficial to the maintenance personnels involve in procurement method selection. The contributions are as follow:-

(i) The study produce an Analytic Hierarchy Process (AHP) decision making framework for the selection of procurement strategy in building maintenance management for public universities which can bring a lot of benefits to the maintenance personnel, clients or owner of the buildings, building users and the academicians that are related to maintenance industry. The study can contribute to academic organizations, professional bodies and building maintenance organizations by incorporating the finding into the body of knowledge.

(ii) Most researches for procurement methods selection are focusing more on construction and project management field. This research has bridged the gap in the existing research gap and also contributed to the knowledge on procurement method selection for building maintenance management.

(iii) This study provides the available building maintenance procurement options and the criteria to be considered before deciding which procurement strategy to be adapted to the maintenance personnels.

(iv) This research contributed to the decision maker of public universities' maintenance department in choosing the best procurement method.

(v) The proposed decision making framework also contributed to the public universities' organization by improving the maintenance management of public universities by selecting the most appropriate procurement method.

7.4 RECOMMENDATION FOR FUTURE RESEARCH

This study presents a study of the selection of procurement method for building maintenance management for public universities in Malaysia through the use of Multiple Criteria Decision Making (MCDM) particularly the Analytic Hierarchy Process (AHP). It would be useful to continue this study in the following areas:-

1. The similar study should be carried out in other countries to have a comparative study to further validate the research findings and theoretical framework.
2. A similar study could be carried out on private universities in Malaysia to compare the output between public and private organisations.
3. Further study can be carried out on different type of buildings such as office buildings or commercial buildings. This would allow a comparative analysis to be made for different type of buildings.
4. Comparative study can be carried on advantages and disadvantages of the four main procurement methods employed in the decision making framework; outsourcing by specialist term contract, outsourcing by tendered schedule term contract, outsourcing by repair and maintenance contract and outsourcing by measured term contract.

5. An in-depth study is required to study the role of building maintenance management in public universities in supporting the core business of universities' organisations.

7.5 SUMMARY

In conclusion, this research has achieved the aim and objectives formulated. The research proposed a decision making framework to assist the decision makers to select the most appropriate procurement method in building maintenance management. The proposed decision making framework introduced expected to be a useful tool for maintenance organization that can assist them in decision making on selecting the most appropriate procurement method. The framework is created to be flexible in which the decision makers are recommended to assert or eliminate the procurement selection criteria that they think appropriate for a particular project.

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UNIVERSITI
MALAYA

Appendix A

BHA110007

25th September 2012

TO WHOM IT MAY CONCERN

Sir,

PERMISSION TO PURSUE RESEARCH AND SEEK INFORMATION

The abovementioned matter refers.

2. Please be informed that the candidate below is currently registered as a postgraduate student of the Faculty of Built Environment, University of Malaya:-

Name	:	Shirley Chua Jin Lin (BHA110007)
Programme	:	Doctof of Philosophy

3. She is conducting a research on **"A Decision Making Model fo Procurement Method Selection in Building Maintenance Management for Public University in Malaysia"** under the supervision of Accociate Professor Dr. *Sr* Azlan Shah Ali and Accociate Professor Dr. *Sr* Anuar Alias (03-79676835) currently in the process of data collection.

4. The Faculty of Built Environment, University of Malaya believes that the knowledge and expertise that your organization / office holds would be suitable in assisting the research. Thus, we would appreciate if you could assist his research at your premise.

5. Research findings and results would be made available to your organization / office upon request to the Faculty. All information obtained pertaining to the research would be treated with the strictest confidentiality, kept anonymous and be used for academic purposes only.

Your kind cooperation towards this matter is highly appreciated.

Thank you.

Yours faithfully,

ASSOCIATE PROFESSOR DR. *Sr* AZLAN SHAH ALI
Deputy Dean (Higher Degree)

September 2012 (Date)

Name of interviewee

Institution Address

Dear Sir/Madam,

TITLE OF RESEARCH: A DECISION MAKING MODEL FOR PROCUREMENT METHOD SELECTION IN BUILDING MAINTENANCE MANAGEMENT FOR PUBLIC UNIVERSITY IN MALAYSIA

My name is Shirley Chua Jin Lin, a PhD candidate from University of Malaya is conducting this research as part of my PhD research project with the title stated above which intends to develop a decision making model for selection of procurement method in building maintenance management particularly public university building in Malaysia.

The scope of university building maintenance in Malaysia is huge and is increasing alarmingly. At the same time, a large number of different types of procurement methods have been developed to overcome the shortcoming of the existing procurement method. Thus, it is more challenging for you (as the representative in the decision making for your university) to select the most appropriate procurement method. It is indeed very vital to develop a systematic approach that can assist you in decision making on selecting the most appropriate procurement method for a university building. It is undoubtedly that you have made an assessment of the criteria considered essential in decision making process in order to select the most appropriate procurement method as different type of procurement method suit different type of project. Thus, your response in this survey can greatly contribute to some extent of the main objectives of this study which are as follow:-

(i) To investigate the current practice of procurement method selection for building maintenance and identify the available procurement method for building maintenance in Malaysia.

(ii) To identify the procurement selection criteria in building maintenance management for University in Malaysia.

There are several types of procurement methods and procurement selection criteria had been identified by reviewing the journal articles and other reliable reference sources both locally and internationally. Through your feedback, the information shall be used to seek the relationship of your selected type of procurement method and procurement selection criteria.

Your participation in this survey is much needed and appreciated and of course it is on voluntary basis. I would like to assure that your responses will be treated strict confidentiality and anonymity for academic purposes only. Return of the survey to me is your consent for your responses to be compiled with others. The use of data from this questionnaire survey will be limited to this research as authorized by University of Malaya. You have the right to express concerns to me or if you have any queries regarding this survey, please feel free to contact me or my supervisors at the contact number and address below.

Thank you for your participation in this survey and your effort as well as your time is sincerely appreciated. **Please return the questionnaire within two (2) weeks** to me through the self-addressed envelope or email below. Kindly leave your particular at the end of the questionnaire survey form if you wish to have a copy of the summary of this final research results.

Thank you for your interest and participation.

Yours faithfully,

Supervisors:-

Shirley Chua Jin Lin
PhD Candidate
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Faculty of Built Environment Building,
University of Malaya,
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Appendix C

QUESTIONNAIRE ON DECISION MAKING FOR PROCUREMENT METHOD SELECTION OF BUILDING MAINTENANCE MANAGEMENT

Return Address:

SHIRLEY CHUA JIN LIN
C/O : Assoc Prof Dr. AZLAN SHAH ALI
Department of Building Surveying,
Faculty of Built Environment Building,
University of Malaya,
50603 Kuala Lumpur.

Telephone : 010-3665058
Email: shirleychua01@yahoo.com

NOTE ABOUT THE QUESTIONNAIRE:-

- Please answer all the following questions by ticking [/] in appropriate bracket or circle at the scale from 1 to 5 by referring the following scales:-

1	Strongly Disagree / Least Important	2	Disagree/ Less Important	3	Partially agree/ Partially important	4	Agree/ Important	5	Strongly agree/ Very Important

- If you are unable to answer the questions due to your consideration that they are irrelevant or unclear, please put a question mark next to them.
- Please return the completed questionnaire in the envelope provided.
- Your identity and any information of your firm will remain strictly confidential to us.

Definitions:-

(i) **Building maintenance** refers to the combination of technical and administrative work executed to retain or repair the items and components of a building in a satisfactory standard so that it is in a state of functional.

(ii) **Building maintenance management** is a process which involves the interaction or combination of technical, social, legal and fiscal determinants that govern and manage the use of buildings.

(iii) **Procurement** is defined as an organisational system that assigns specific responsibilities and authorities to people and organisations.

(iv) **Maintenance procurement** refers to the process by which required maintenance works are carried out. The procurement process is concerned with the form of procurement whether by contract or direct labour and the quality of delivery of both the work carried out as well as the level of service provided.

PART 1: RESPONDENT'S PARTICULAR

1.1 What is your job title?

[ ] Facility Manager [ ] Maintenance Manager [ ] Administration manager
[ ] Maintenance Executive [ ] Director of development [ ] General manager
[ ] Others, please specify_____

1.2 How long have you involved in the building maintenance works?

[ ] less than 5 years [ ] 5 to 10 years [ ] 10 to 15 years [ ] more than 15 years

1.3 What is your education background?

[ ] Facility management [ ] Building Surveying [ ] Engineering
[ ] Quantity Surveying [ ] Others, please specify_____

1.4 Your highest academic qualification

[ ] Diploma [ ] Bachelor degree [ ] Master degree [ ] PhD
[ ] Others, please specify_____

1.5 How many university buildings have you have been managed before this university?

[ ] less than 5 [ ] 5-10 [ ] 10-15 [ ] more than 15

*****Please answer the following sections based on the particular of maintenance management of the university you are managing now*****

PART 2: BUILDING AND PROJECT CHARACTERISTIC

2.1 Ownership of the university

[ ] Government [ ] Private [ ] Others, please specify_____

2.2 What is the size of the university built area?

[ ] Less than 40,000m^2 [ ] 40,000-50,000m^2 [ ] 50,001-60,000m^2 [ ] 60,001-70,000m^2
[ ] 70,001-80,000m^2 [ ] 80,001-90,000m^2 [ ] 90,001-100,000m^2 [ ] 100,001m^2 and above

2.3 Please indicate the age of this University

[ ] Less than 10 years [ ] 10-20 years [ ] 21-30 years [ ] 31-40 years
[ ] 41-50 years [ ] more than 50 years, please indicate_____

2.4 Annual maintenance budget of this University

[ ] Less than RM 10 million [ ] RM11-20 million[ ] RM21-30 million [ ] RM31-40 million
[ ] More than RM40 million, please indicate_____

2.5 Method to estimate maintenance budget of this University

[ ] Based on previous expenditure [ ] Based on building condition [ ] Based on university budget
[ ] Others, please specify_____

PART 3: CRITERIA FOR PROCUREMENT SELECTION

To what extent the following criteria are essential for selection of the most appropriate procurement method.

	Criteria							
3.1	**Client Requirement**							
3.1.1	Speed	Least Important	1	2	3	4	5	Very Important
3.1.2	Time certainty	Least Important	1	2	3	4	5	Very Important
3.1.3	Price/Cost certainty	Least Important	1	2	3	4	5	Very Important
3.1.4	Degree of complexity	Least Important	1	2	3	4	5	Very Important
3.1.5	Degree of flexibility	Least Important	1	2	3	4	5	Very Important
3.1.6	Responsibility	Least Important	1	2	3	4	5	Very Important
3.1.7	Risk allocation/avoidance	Least Important	1	2	3	4	5	Very Important
3.1.8	Quality level	Least Important	1	2	3	4	5	Very Important
3.1.9	Working relationship	Least Important	1	2	3	4	5	Very Important
3.1.10	Clarity of scope	Least Important	1	2	3	4	5	Very Important
3.2	**Owner/ Client/ Decision Maker Characteristic**							
3.2.1	Intuition and past experience of the decision maker	Least Important	1	2	3	4	5	Very Important
3.2.2	Dissatisfaction with previous process used	Least Important	1	2	3	4	5	Very Important
3.2.3	Knowledge of the strategy	Least Important	1	2	3	4	5	Very Important
3.2.4	Involvement of owner in the project	Least Important	1	2	3	4	5	Very Important
3.3	**Project Characteristic**							
3.3.1	Existing building condition	Least Important	1	2	3	4	5	Very Important
3.3.2	Project size	Least Important	1	2	3	4	5	Very Important
3.3.3	Client's in house technical capability	Least Important	1	2	3	4	5	Very Important
3.3.4	Client's financial capability	Least Important	1	2	3	4	5	Very Important
3.4	**External environment/ factor**							
3.4.1	Price competition	Least Important	1	2	3	4	5	Very Important
3.4.2	Public accountability	Least Important	1	2	3	4	5	Very Important
3.4.3	Political issues/constraint	Least Important	1	2	3	4	5	Very Important
3.4.4	Culture	Least Important	1	2	3	4	5	Very Important
3.4.5	Objective or policy of organization	Least Important	1	2	3	4	5	Very Important
3.4.6	Government policy	Least Important	1	2	3	4	5	Very Important
3.4.7	Disputes and arbitration	Least Important	1	2	3	4	5	Very Important
3.4.8	Experience contractor availability	Least Important	1	2	3	4	5	Very Important

3.5 Please state any other criteria that not being mentioned above which you consider as important criteria that need to be considered in selecting the most appropriate procurement method.

PART 4: PROCUREMENT

You may choose more than 1 answer for Q4.3, Q4.4 & Q4.5.

4.1 The following type of procurement methods were identified for building maintenance management in literature review. In your opinion, to what extent the following type of procurement method are critical for building maintenance industry.

	Type of Procurement							
4.1.1	Outsourcing by Lump Sum Contract	Not Important	1	2	3	4	5	Very Important
4.1.2	Outsourcing by Measured Term Contract	Not Important	1	2	3	4	5	Very Important
4.1.3	Outsourcing by Specialist Term Contract	Not Important	1	2	3	4	5	Very Important
4.1.4	Outsourcing by Day work Term Contract	Not Important	1	2	3	4	5	Very Important
4.1.5	Outsourcing by Tendered Schedule Term contract	Not Important	1	2	3	4	5	Very Important
4.1.6	Outsourcing by Repair and Maintenance Contract	Not Important	1	2	3	4	5	Very Important
4.1.7	Outsourcing by Cost Reimbursement Contract	Not Important	1	2	3	4	5	Very Important
4.1.8	Outsourcing by Service Level Agreement	Not Important	1	2	3	4	5	Very Important
4.1.9	Out-tasking	Not Important	1	2	3	4	5	Very Important
4.1.10	Public Private Partnership (PPP)	Not Important	1	2	3	4	5	Very Important
4.1.11	Total Facilities Management (TFM)	Not Important	1	2	3	4	5	Very Important
4.1.12	Traditional	Not Important	1	2	3	4	5	Very Important
4.1.13	Partnering	Not Important	1	2	3	4	5	Very Important

4.2 Please state any other type of procurement method that not being mentioned above

_____

4.3 Please indicate the type of procurement strategy used in this university

[ ] Outsourcing by Lump Sum Contract
[ ] Outsourcing by Measured Term Contract
[ ] Outsourcing by Specialist Term Contract
[ ] Outsourcing by Day work Term Contract
[ ] Outsourcing by Tendered Schedule Term contract
[ ] Outsourcing by Cost Reimbursement Contract
[ ] Outsourcing by Repair and Maintenance Contract
[ ] Outsourcing by Service Level Agreement
[ ] Out-tasking
[ ] Public Private Partnership (PPP)
[ ] Total Facilities Management (TFM)
[ ] Traditional
[ ] Partnering
[ ] Others, please specify_____

4.4 Based on your answer in Q4.3, please justify the reason why this particular procurement strategy is used for this university.

[ ] Based on previous experience
[ ] Based on the maintenance budget allocation
[ ] Based on the age of the building
[ ] Others, please specify_____

4.5 If out-source is the procurement method of this university, what is the reasons to outsource the services?

[ ] Reduce maintenance task to corrective maintenance
[ ] In-house staff less competent and inactive
[ ] The number of in-house staff is not adequate
[ ] It can reduce the maintenance cost
[ ] University management consider the management of building as non-core activities
[ ] Others, please specify_____

4.6 How many full-time employees in the maintenance organization of this university?

[ ] Less than 30 [ ] 30-60 [ ] 60-90 [ ]90-120 [ ]120-150 [ ] More than 150

4.7 To what extend you agree the following statements.

4.7.1 The number of employee is adequate for the selected procurement method?	Strongly disagree	1	2	3	4	5	Strongly agree
4.7.2 The procurement adapted reasonable.	Strongly disagree	1	2	3	4	5	Strongly agree
4.7.3 You are satisfied with the procurement method being employed?	Strongly disagree	1	2	3	4	5	Strongly agree
4.7.4 In-house is the most suitable procurement strategy for university as university should not expose to external parties.	Strongly disagree	1	2	3	4	5	Strongly agree

PART 5: DECISION MAKING IN PROCUREMENT STRATEGY SELECTION

5.1 Is there any proper guidance available to select the most suitable procurement method?
[ ] No [ ] Yes. Please specify_____

5.2 Do you use any decision making theory or tools in selecting the procurement strategy for this university?
[ ] No [ ] Yes. Please specify_____

5.3 Please justify how much time do you think is appropriate to make a decision to select the most appropriate procurement method?
_____

5.4 Is there any procedure that you have found useful to select the most appropriate procurement method for building maintenance?
[ ] No [ ] Yes. Please specify_____

5.5 In your opinion, do you think Analytic Hierarchy Process (AHP) is appropriate to be used as a tool to select the most suitable and appropriate procurement method?
[ ] No. Please specify your reason _____
[ ] Yes.
[ ] Do not have any idea what is Analytic Hierarchy Process (AHP)

5.6 In your opinion, do you think Multi-attribute utility technology (MAUT) is appropriate to be used as a tool to select the most suitable and appropriate procurement method?
[ ] No. Please specify your reason _____
[ ] Yes.
[ ] Do not have any idea what is Multi-attribute utility technology (MAUT)

PART 6: PERFORMANCE OF PROCUREMENT METHOD

Please indicate to what extent the following variables are important in evaluating the degree of performance of the procurement method.

6.1	Cost effectiveness	Least Important	1	2	3	4	5	Very Important
6.2	Service quality	Least Important	1	2	3	4	5	Very Important
6.3	Work performance	Least Important	1	2	3	4	5	Very Important
6.4	Customer satisfaction	Least Important	1	2	3	4	5	Very Important
6.5	Ability to fulfill client's need and requirement	Least Important	1	2	3	4	5	Very Important
6.6	Ability to deliver the service with reasonable reliability and predictability	Least Important	1	2	3	4	5	Very Important

6.7 Please state any other variables not being mentioned above which you think is important to evaluate the procurement method performance.
_____

Please provide some useful comment concerning the questionnaire or the research topic at the box provided below.

THANK YOU VERY MUCH FOR SPENDING YOUR PRECIOUS TIME TO TAKING PART IN THIS SURVEY

If you would like to get the summary of this **final research results**, free of charge, please fill in your name and email address below.

Name: Emai:

April 2013

Respondent Name
Respondent Address

Dear Sir/Madam,

TITLE OF RESEARCH: A DECISION MAKING FRAMEWORK FOR PROCUREMENT METHOD SELECTION FOR BUILDING MAINTENANCE MANAGEMENT OF PUBLIC UNIVERSITIES IN MALAYSIA

My name is Shirley Chua Jin Lin, a PhD candidate from University of Malaya is conducting this research as part of my PhD research project with the title stated above which intends to develop a decision making framework for selection of procurement method in building maintenance management particularly public university building in Malaysia.

The scope of university building maintenance in Malaysia is huge and is increasing alarmingly. At the same time, a large number of different types of procurement methods have been developed to overcome the shortcoming of the existing procurement method. Thus, it is more challenging for you (as the representative in the decision making for your university) to select the most appropriate procurement method. It is indeed very vital to develop a systematic approach that can assist you in decision making on selecting the most appropriate procurement method for a university building.

This structured interview aims to validate the applicability of the decision making framework developed based on the finding obtained from the previous questionnaire conducted. The development of the framework includes employment of procurement selection criteria and procurement method option, integration of Analytic Hierarchy Process (AHP) technique and principles and adaption of Expert Choice Software as development tool. The two main purposes of this interview are:-

(i) The interviewees are requested to do a pair-wise comparison with the assessment criteria and procurement option which has been developed in the Expert Choice software

(ii) The interviewees also requested to evaluate the proposed decision making framework in term of its capability, applicability and validity

Your participation in this interview is much needed and appreciated and of course it is on voluntary basis. I would like to assure that your responses will be treated strict confidentiality and anonymity for academic purposes only. The use of data from this semi-structured interview will be limited to this research as authorized by University of Malaya. You have the right to express concerns to me or if you have any queries regarding this survey, please feel free to contact me or my supervisors at the contact number and address below.

Thank you for your participation in this semi-structured interview and your effort as well as your time is sincerely appreciated. Thank you for your interest and participation.

Yours faithfully,

Shirley Chua Jin Lin

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Evaluation Form for Decision Making Framework for Procurement Method Selection of Building Maintenance Management for Public Universities

Please answer all the following questions by ticking [/] in appropriate box.

No.	Evaluation Question	Rating				
		Very Poor	Poor	Satisfactory	Good	Excellent
1	The capability of the framework					
1.1	How well the framework in supporting the decision process?					
1.2	How reliable the assessment procurement selection criteria employed in the framework?					
1.3	How well the framework reflect the real situation in decision making process for procurement method selection?					
1.4	How useful was the Expert Choice software employed in the framework?					
2	The applicability of the framework					
2.1	How relevant the framework in selecting the most appropriate procurement method?					
2.2	How appropriate was the assessment criteria employed in the selection process?					
2.3	How appropriate was the framework to act as an alternative decision making for a supporting system?					
2.4	How relevant was the framework in improving the existing decision making process?					
2.5	How relevant was the framework in term of:-					
2.5.1	Speed					
2.5.2	Flexibility					
2.5.3	Consistency					
3	The validity of the result					
3.1	How convinced were you with the result produced by this framework?					
3.2	How confident were you in using the result as a selection making process in real situation?					

Type of project used to validate:

Project Amount:

Actual procurement method adapted: Signature:

Comments: Cop:

List of Presentations

Shirley Chua Jin Lin, Azlan Shah Ali and Anuar Alias (2012). Selection of Procurement Method for Building Maintenance Management: A Decision Making Model. Asean Post Graduate Seminar, University of Malaya, Kuala Lumpur, 4 Dec 2012, pp.264-270 (Non-ISI/Non-SCOPUS Cited Publication).

List of Publications

Shirley Chua Jin Lin and Azlan Shah Ali (2013). Issues and Challenges in Implementation of Planned Maintenance in Malaysia. *The Surveyors, Malaysia*. *Institution of Surveyors Malaysia, Malaysia*, *46* (4), 33-37.

Shirley Chua Jin Lin, Azlan Shah Ali & Anuar Alias (2013). An analytic hierarchy process (AHP) decision making framework for procurement strategy selection in building maintenance work. *Journal of Performance of Constructed Facilities, ASCE* (Accepted with correction 19.6.13) (ISI/SCOPUS Cited Publication)