PROJECT SELECTION FOR GROUP DECISION MAKING USING ANALYTICAL HIERARCHY PROCESS: A PRIVATE COLLEGE PERSPECTIVE

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ABSTRACT

Selection of the right projects is considerably critical for organizations to successfully achieve their competitive advantages and corporate strategies. Due to limited resources and dynamic changes in the business environment, selection of projects is quite challenging. The main purpose of this case study was to identify the project selection criteria that best meet the requirements of a well-diversified group of companies. Decision makers need a structured approach for decision making that allows the necessary trade-offs in a systematic fashion, in light of all of the considerations at hand. One structured approach to decision making that may work well is Analytical Hierarchy Process (AHP) which uses simple judgment known as pair-wise comparison. This paper reports the results of a case study where the AHP technique was employed to support the project selection in a multi-criteria environment. Six selection criteria and four alternatives projects were identified. The selection criteria include financial aspect, strategy, risk, urgency, contractor availability and technical knowledge. The AHP technique successfully helped the group decision makers to single out the most appropriate project that best suits the organization's operational needs and prioritize these projects accordingly.

Keywords: Project selection, Analytical Hierarchy Process, Multi-criteria decision making

ABSTRAK

Pemilihan yang tepat bagi sesebuah projek adalah kritikal bagi organisasi untuk mencapai kelebihan daya saing dan mencapai strategi korporat. Disebabkan sumber yang terhad dan perubahan dinamik dalam persekitaran perniagaan, proses pemilihan projek adalah mencabar. Tujuan utama kajian kes ini adalah untuk mengenal pasti kriteria pemilihan projek yang paling sesuai memenuhi keperluan organisasi. Teknik berstruktur dan bersistematik diperlukan bagi membolehkan pihak pengurusan membuat keputusan dengan mempertimbang faktor-faktor yang mempengaruhi pemilihan tersebut dengan sewajarnya. Antaranya ialah Proses Analisis Hierarki yang menggunakan perbandingan. Laporan kajian ini memperincikan keputusan satu kes kajian di mana teknik AHP digunakan untuk memilih projek yang mempunyai pelbagai kriteria. Enam kriteria pemilihan projek dan empat projek dipertimbangkan. Kriteria pemilihan projek terdiri daripada kewangan, strategi, risiko, urgensi, kesediaan kontraktor dan pengetahuan teknikal. Teknik AHP telah berjaya membantu sekumpulan pembuat keputusan membuat keputusan dalam memilih projek yang paling sesuai bagi memenuhi keperluan operasi organisasi dan menilai projek yang perlu diberi keutamaan.

Kata Kunci: Pemilihan projek, Proses Analisis Hierarki, Kriteria berbilang membuat keputusan

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LIST OF ABBREVIATIONS

AHP	Analytical Hierarchy Process
CA	Contractor Availability
CI	Consistency Index
CR	Consistency Ratio
FN	Financial
IRR	Internal Rate Return
IT	Information Technology
NPV	Net Present Value
PPM	Project Portfolio Management
R&D	Research and Development
RI	Random Index
RK	Risk
ROI	Return on Investment
ST	Strategic
TK	Technical Knowledge
UR	Urgency

CHAPTER ONE

INTRODUCTION

Chapter one gives an overview of decision making, group decision making, project selection, importance of project selection and issues in project selection. This chapter also highlights the problem statement, objectives, research questions and the scope of this study.

1.1 Decision Making

Decision making is important for any organization. Many organizations are now expanding their operations involving project management. To implement the project management and the expansion of the operations, a manager must choose the best segment or project among the existing projects. In complex project environments, decision making can be challenging (Ricardo, 2010). Therefore, making a good decision is imperative for the project to be successful (Al-Subhi, 2001).

Ang (2005) defined decision making as the cognitive process of selecting an action from several alternatives that exist. According to Wikipedia (2014), decision making can also be regarded as a problem-solving activity through a follow-up action. Explicit in this assumption is that decision making is a reasoning or emotional process which can be rational or irrational.

Making a decision is the result of a mental process of choosing some actions from several alternatives. Every decision-making process produces a final choice of action or opinion.

If a person neither takes nor acts nor gives an opinion, a decision is also made. Most decisions involve analyzing the existing selection set or using a part of the criteria set. These criteria may benefit or cost the organization.

Decision making is a part of managerial task and for a good decision to be made, all information regarding planning and the environment must be known. Decision making currently is a mathematical science. It formalizes our thinking so that we can make better decisions. To make a good decision, we need have some fundamental understanding of the valuable processes (Saaty, 2008).

Decision making always involves with a choice between alternatives. A decision maker needs information on which to base his/her judgment; without information, decisions are no more than an inspired guesswork. According to Simon (2011), knowledge management is a part with the whole process of managerial decision making. According to Saaty (2008), a good decision means making the right choice that satisfy many needs, for the greatest advantage.

Generally, there are three levels of decision making. They are strategic, tactical and operational. The strategic level is the highest level of decision, the least structured, most imaginative, risky, and produces the most uncertain outcome. Such decision is taken mostly at the Board of Director's level. The tactical level supports the strategic level. Tactical decisions are medium range and have medium significance with moderate

consequences. The operational level is the lowest level, used in operational, short range and usually involves low cost (Ang, 2005).

In making decision, a manager is responsible in identifying problems, determining the types of problem, finding the right solutions, assessing potential solutions and formulating strategies for solving the problems. According to Ricardo (2010), due to ever changing in dynamic current environment, selecting and making the right choices based on aligned objectives is a critical factor for the organizational survival.

Group Decision Making

Decision making does not necessarily made by an individual person; currently, many organizations involve group decision making. Making decisions as a group is known as collaborative decision making, which occurs when individuals join together in selecting from a range of choices. In group decision making, a member's contribution directly affects the decision made (Sa, 2011).

Group decision making provides two advantages over decisions made by individuals which is synergy and sharing of information. Synergy is the idea that the whole is greater than the sum of its parts. When a group makes a decision collectively, its judgment can be keener than that of any of its members. The sharing of information among group members is another advantage of the group decision-making process. Group decisions take into account a broader scope of information since each group member may contribute unique information and expertise. Sharing information can increase

understanding, clarify issues, and facilitate movement toward a collective decision. (Boundless, 2015).

According to Ang (2005), group decisions have a greater risk or opportunity than individual decisions and it typically requires numerous meetings. Therefore, what the decision makers needs is a better approach to decision making that allows the necessary requirements on the alternatives. One structured approach to decision making that may work well is Analytical Hierarchy Process (AHP), which uses simple judgment known as pair-wise comparison. An example of decision making is human resource decision (Rubin, 1991), decision making on supplier selection (Athawale, Mukherjee & Chakraborty , 2009) and project selection (Palcic & Lalic, 2009).

1.2 Project Selection

Oxford Dictionary defines a project as an individual and collaborative enterprise that is carefully planned to achieve a particular aim. According to Cambridge Dictionary, selection is the act of choosing someone or something. One of a major components of portfolio management is selecting a project to be executed by a company. The aim of project selection is to achieve a company's portfolio, taking into account its characteristics and relationships (Marcio, 2012).

According to Powers, Ruwanpura, Dolhan, and Chu (2002), project selection is the process of assessing individual projects, that is, selecting projects based on a specific analysis on how best to achieve the organizational objectives. It involves an analysis of

the importance of the financial aspects of the project to determine the most optimum of the available alternatives.

Srivannaboon and Milosevic (2006) showed that most organizations try to implement their corporate strategies through projects. Archer and Ghasemzadeh (1999) said that successful selection of a project is the result of the right set of projects for implementation of corporate strategies.

1.2.1 Importance of Project Selection

With limited resources and capabilities, selecting the right project and right mix of projects in the portfolio is an important task for the organization to achieve its corporate goal (Englund & Graham, 1999).

According to Parcic and Lalic (2009), to save cost and enjoy maximum benefits, selection of a project must be made. A project can be very complex or very routine; regardless of the nature of the project, it involves constraints in terms of time, budget and resources. According to Clifford (2003), one of the aims of a project is to meet the stakeholder's needs. According to Mwosa (1987), projects are like planning to build blocks, which success depends on translating the plans into reality. Managers can plan effectively on how the available resources can be used to meet the organizational objectives.

If an organization can minimize risk and maximize opportunities, it means that the organization is implementing a strategic approach to project selection. Project selection is very important in a project life cycle in an environment that has a lot of resource constraint.

1.2.2 Issues in Project Selection

There are several issues in project selection, which will influence decision making. These issues are discussed as follows.

1.2.2.1 Unreliable information

Information on project selection is sometimes unreliable or unavailable. Radulescul and Radulescu (2001), and Cooper et al. (2001) said that in the process of project selection, organizations may confront many problems such as lack of information, unreliable data, timing and availabilities of resource, and benefits of the projects. This is commonly faced by organizations that are new in the market, or that have a new business where they have no database, information and experiences.

Most information required in making decisions is uncertain and unreliable because project portfolio deals with future events and opportunities (Danmei, 2010). According to Danmei (2010), research and development (R&D) projects are an example that is sometimes hard to be evaluated and selected.

1.2.2.2 Lack of strategic planning

In many organizations, the selection and management of a project often fail to help them plan. In general, while strategic planning is determined by a group of managers, its implementation is carried out by others. The different groups on project selection can create a variety of problems such as conflicts, which could affect consumers. As a result, resources on non-value added on the projects are wasted (Morris, 2007).

Managers need to be wise in choosing alternative projects which are likely to satisfy the organizational goals (Render et al., 2006). With limited resource allocation, conflicts among projects may occur as the organization may have difficulty assessing which projects should be given priority. As a result, in prioritizing the projects, managers commonly rely on intuitive judgment rather than the organizational requirements.

Failure in choosing a project and hence the achievement of the organizational objectives reflects the weakness of the organization as a whole. A well-developed strategic plan can clearly define the project selection criteria. Lack of strategic plan and ill-defined strategic plan result in ineffective organization (Seeber, 2011).

1.2.2.3 Uncertainty

In an uncertain environment, organizations need to be dynamic to compete against their competitors. Deciding on a right project will therefore has a significant impact on the organization. However, for the project to be successful, organizations need to have a holistic planning or model. In addition, they also need to ensure that the timing for

change is correct and communication among various groups is facilitated (Bolman & Deal, 1991). Project selection involves a comprehensive financial analysis to determine the most valuable project among available alternatives. Since some projects have high uncertainty due to incomplete information about the trend of the market or due to lack of knowledge about the current technical development (Santos, 2009, a simulation-based project selection analysis can be used to evaluate the projects with greater confidence (Powers, Dulhan, Ruwanpura, & Chu, 2002).

1.3 The Case Environment

The case study involved a private college company, called Prima[1], which has been since 15 years ago. The college offers more than 10 programs. It has three faculties: Faculty of Science and Health, Faculty of Business, and Faculty Social Science & Technology.

The college wants to diversify its operations. To achieve this, strategic plans have been devised in line with the existing environment. Four projects will be executed. These projects are the Solar Project (Project A), the University College (Project B), the Hospitality Project (Project C), and Travel Tours Project (Project D). All these projects require strategic planning and good decision making.

To prioritize the best project to be executed, the project managers are currently using their judgment and experience and without considering the important factors in project

[1] Prima is a fictitious name to preserve anonymity.

prioritization. The focus of this study is on the project selection decision making process in Prima.

1.4 Problem Statement

Currently, there is fierce competition within the education environment. To survive, many projects have been planned. But, they are without risks and challenges. The role of project managers is to select which projects are more important than the others in order to maximize profit and minimize costs.

The four projects planned have their own set of challenges and problems, as follows: (a) lack of information on financial matters; (b) lack of strategic alliances with the project objectives; (c) procedural requirements from regulatory bodies; and (d) lack of resources. Due to these factors and limited resources, prioritization of the project is the first strategy that the college needs to decide. Selecting the best project that optimizes the college's resources is very important. To achieve this, determining the project criteria and important factor is crucial. However, many project managers today use their judgment selecting the best project.

Selection of projects is a very important decision because if the projects are not able to be completed on time and incur more costs, it can affect the image and effectiveness of the company (Iman & Siew, 2008). Therefore, the present research recommends that decision makers use Analytical Hierarchy Process (AHP) method to select the criteria and prioritize the projects.

1.5 Research Questions

The key research questions to be addressed in this study are as follows:

1. What are the selection criteria that are the most appropriate and relevant in project selection?
2. Which are the projects that best meet the requirements of the organization?

1.6 Objectives of Study

The purpose of this study to recommend managers about the selection criteria that need to be considered in prioritizing the project and assisting them in evaluating and selecting the project that can maximize the resources the company has. Hence, the objectives of this study are:

1. To identify the criteria for selecting the most appropriate and relevant projects; and
2. To determine the projects those best meet the criteria of the organization.

1.7 Significance of Study

This study was carried out with the intention of providing a structured decision making methodology for decision makers of Prima Company in prioritizing projects. Such methodology will help the decision makers to consider all factors in order to come up with a better decision. In addition, the study stresses on the problems and challenges that arise from these projects so that better understanding of the flow of the projects and their requirements is enhanced.

Moreover, this research recommends that the decision makers using the AHP method to determine the criteria when selecting a project. By using this method, the company be able to prioritize the projects well and allocate the limited resources effectively. In addition, this research also benefits the company or management in the long run in its project management when it comes to prioritizing projects.

1.8 Scope of the Study

The present study aimed to identify the project selection criteria that are most appropriate and relevant in project selection in Prima Company. Once the selection criteria have been identified, which projects should be prioritized can be determined. To determine the project selection criteria, the AHP method was used. The project selection criteria were identified from previous studies.

1.9 Limitation of the Study

There are many project selection criteria to be chosen, but the selection criteria outcome in this study was based on previous research works. In addition, there were a few people who were involved in making decision on a project, but most decisions actually are made by the upper management.

1.10 Organization of the Thesis

Chapter 1 explains the introduction, background of the study, and research problem. It then outlines the research questions, objectives, significance, scope, limitations, and finally, the structure of this research.

In Chapter 2, literature reviews on project selection criteria and research methodology are presented. In addition, the AHP method is discussed in this chapter. Chapter 3 discusses the research methodology applied in the present study together with the research design and research framework. Results of data analysis will be presented and discussed in Chapter 4 and Chapter 5 will offer some concluding remarks.

CHAPTER TWO

LITERATURE REVIEW

In this chapter, literatures relevant to this study are explored. Sekaran (2003) stated that a literature review is a documentation of the inclusive reviews from the published work and is obtained from secondary sources of data in the specific areas of the researcher. This section hence reviews project selection criteria, techniques in project selection and other commonly used group decision making methods.

2.1 Project Selection Criteria

The term ‘selection’ may be defined as a process of choosing from a group of people or things (Oxford, 2005). The term ‘criterion’, on the other hand, is defined in the Oxford dictionary (2005), as a standard or principle determinant in decision making or judgment. Therefore, ‘selection criteria’ used in this research is defined as a list of criteria used to evaluate projects for a good selection.

Ricardo (2010) identified six criteria of selection of projects. In his case study on ACME organization, the criteria and sub-criteria for selecting projects were stakeholder’s commitment (team commitment, organizational commitment and project manager commitment), financial (return on investment, profit and net present value), strategic of the companies (improve ability to compete in international markets, improve internal processes and improve reputation) and other criteria (lower threat for the organization, urgency, and internal technical knowledge). Melone and Wharton (1984) discussed three

criteria of project selection. They are financial benefits, contribution to organizational strategy, and contribution to IT structure. Pinto (2007) suggested the following criteria of project selection: technical risk, financial criteria, safety criteria, quality and legal exposure, expected return on investment, payback period of the investment, potential market share and ability to generate new projects.

2.2 Discussion on Variables

This section reviews literatures on project selection criteria. They are financial, strategy, risk, urgency, contractor availability and technical knowledge.

2.2.1 Financial Aspect

Palcic and Lalic (2009) used financial benefit as a criterion in selecting and evaluating projects. Financial benefit focuses on the physical benefits of the project, which are subdivided into short term and long term benefits. Commonly, many organizations or business today develop standard ROI calculator using Net Present Value (NPV) and Internal Rate of Return (IRR) to measure the performance of the projects.

Motta and Quintella (2012) used financial and non-financial criteria to select an investment project. An example of a financial criterion was need for capital, while non-financial criteria were assessment of team and technology. Other financial criteria include assessment of market and divestment, which were combine with market size, volume of transactions, and availability of investment resources. Other non-financial aspects like

qualitative market evolution and strategic interests of players in the area were also considered.

In general, many organizations select projects based on financial criteria. If a project can resolve issues relating to the user and allows the aid in the growth of the organization, the projects are selected, otherwise they are rejected. Larson and Gray (2011) argued that when there is high confidence in the estimates of future benefits in terms of profit, financial measures are used. To them, profit return is important for a project, but this return should not be the only criterion in a project selection process. A firm's core competencies and long term performance should also be considered.

2.2.2 Strategy

This criterion is very important to achieve corporate strategy because the projects are the manifestation of the company's strategy. Cooper et al. (2000) argued that corporate strategy must be aligned in the project selection and resource allocation to those projects. However, to assess the effectiveness of a particular project that contributes to the objectives of the company or its corporate strategy is not a simple matter since strategy is dynamic and constantly changing. Furthermore, strategy is different from one organization to the other.

According to Le and Nguyen (2007), to select the right projects which contribute to the successful implementation of the corporate strategy is very challenging. Seeber (2011) stated that one of the criteria to be considered in selecting a project is strategic fit with the

mission of the projects. To him, if the organization lacks strategic fit with the mission, the organization has failed in project selection.

Palcic and Lalic (2009) used contribution to organizational strategy as one of the criteria, which was subdivided into three: increasing market share, retaining existing customers and improve cost management.

According to Ricardo (2010), one of the criteria that can be used in prioritizing projects is strategy. The common method used to measure corporate strategy is Balanced Scorecard. This method is different from financial criteria because strategic criteria are specific to an organization. Not all organizations have the same strategy and these strategies have different prioritization criteria. Examples of different strategies and goal are to increase the production, to compete in international markets, to optimum internal processes, less in costing and can compare and be benchmark to competitors and to improve the reputation of products and services.

2.2.3 Risk

According to Zou (2007), the selection process is unique because it always has to deal with risk and risk management. These selection criteria have to be considered when making selection decision. According to Pinto (2010), risk in project selection criteria are technical risk, financial risk, safety risk, quality risk, and legal exposure.

The AHP, as shown by Mustafa and Al-Bahar (1991), provides both a subjective and objective approach to risk analysis using expert judgment. However, this approach cannot integrate these risk analysis with the project management processes. Recently, Zayed et al. (2008) applied the AHP to assessing risk in Chinese highway projects. The framework prioritizes risk factors and ranks alternative projects. However, their approach does not discuss on how to manage risk during the planning and implementation phases of the projects as indicated in the project risk management standards.

Dey (2008) used the AHP method to identify five risks in oil redefining industry. They were technical risk, financial and economical risk, organizational risk, natural hazards and statutory clearance risk.

2.2.4 Urgency

According Juran, (2012), urgent projects issue performance problems in core services, problems that cause the organization to not highly focus on competition or issues that are crucial to key customers. According to Ricardo (2011), urgency is directly related to the results within the shortest time. He said that a decision maker or manager must have a good sense of urgency even when facing a good situation. This sense of urgency not only comes from an emerging problem, but also from the need to be ready for any situation, including opportunities. Given this situation, it is important that the project managers respond immediately to requests from customers and from other interested. So, the challenge is how to balance between urgency and pressure for time in developing the projects.

Ricardo (2010) stated that urgency is one of the criteria in prioritizing the projects. To him, projects that have a higher priority is considered to be urgent that require immediate decision and action.

2.2.5 Contractor availability

In case study conducted by Al Subhi, (2001), contractor availability was used as a selection criterion in project management. To determine a set of criteria that are necessary to determine the contractor's competence and ability in project bid, the screening by construction contractors was used. The contractor availability criteria such as experience, financial stability, quality performance, manpower resources, equipment resources, and current workload were determined for these project selection criteria.

Bertolini et al. (2006), and Mahdi and Alreshaid (2005) proposed the application of the AHP method in their work. In their case studies, they used this method to select the service providers in the public sector and highlighted 31 decision criteria, of which the most important were cost, public work contract type involving penalties, price and changes during work, risk, type of work, availability of material and taskforce and conflict of interests between owner and contractor.

Finally, El-Sawalhi et al. (2007) highlighted a contractor pre-qualification model in which they used the following selection criteria: financial stability, management and technical ability, experience in terms of type, size, number, location and business

duration of projects, skilled manpower, client satisfaction, record of failure and claims and availability of manpower and equipment.

2.2.6 Technical Knowledge

Technical knowledge necessary to execute a project. The more technical knowledge available for the projects and environment, the easier it will be to execute any given project and, consequently, it will cause the project to use fewer resources (Ricardo, 2010). Ricardo used technical knowledge criteria to prioritize the projects.

Wheeler (2013) identified several criteria in project selection. They were culture of the organization, process incurred in the projects, knowledge of the business and works, experience gained on projects, corporate governance, risk awareness on the projects, and time pressures. All these factors had significant effect especially on public sector organizations, private sector organizations and government-owned corporations. As a result, these corporations must have a strong linkage to research on strategic decision making.

2.3 Techniques in Project Selection

To help organizations select their projects, there are many tools and techniques available (Archer & Ghasemzadeh, 1999). These tools and techniques have their advantages and disadvantages. So, the organization has to choose the most suitable one. To ensure successful implementation of the projects, a better approach should be applied to project

selection. This approach is involves three factors: people or decision makers, tools and techniques, and selection process or framework (Le and Nguyen, 2007).

Ultimately, what the decision maker needs is a structured approach to decision making that allows the necessary trade-offs in a systematic fashion, in light of all of the considerations at hand (Ang, 2005). One structured approach to decision making that may work well is Analytical Hierarchy Process (AHP), which uses simple judgment known as pair-wise comparison. The present study used this method for selecting the projects.

2.3.1 Checklist Model

Checklist is the simplest and commonly used method of project screening and selection. It uses a list of criteria that pertain to the choice of projects, then applying them to different projects. A checklist method can evaluate the project opportunities involved using a simple tool for recording opinions and encouraging discussion. This method is suitable to promote conversation, stimulate discussion and exchange of ideas and fine-tune the priority groups (Pinto, 2010).

According to Pearson (2007), a checklist method uses a list of criteria applied to possible projects. It requires agreed on criteria and assumes all criteria are equally important. It uses a list of questions to review potential projects and to determine their acceptance or rejection. Unfortunately, this method cannot answer the relative importance or give the value of a potential project and does not to allow for comparison with other potential projects.

2.3.2 Direct Scoring Method

This method requires decision makers to specify numerical values for the expected performance of decision alternatives measured against multiple objectives. It involves commonly point allocation used for scoring sporting events. This method uses the scores of the alternatives given with different maximum points for each criterion. Then, all the points are summed to produce a ranking of the alternatives. As it is the easiest and simplest method to use, this method is frequently applied to evaluate environmental problems. Unfortunately, this method is biased and produce misleading results (Suedel, Kim, & Banks, 2009).

2.3.3 The Analytical Hierarchy Process

The Analytical Hierarchy Process (AHP) was developed by Dr. Thomas Saaty in the late 1960's. His goal was to develop a simple, consistent way to make complex decisions. The AHP is an effective method developed to overcome decision difficulties by using weighted criteria. Analytic Hierarchy Process relies on three fundamental assumptions deduced from the words of the technique (Mahdi, 2005):

i. **Analytic**: the decision alternatives are described analytically using number and logic.
ii. **Hierarchy**: the score for a given criterion is calculated from its sub-criteria. That is, the criteria can be arranged in a hierarchy, and the numerical score at each level of the hierarchy.
iii. **Process**: in any real problem involving decision making, a process is required to gather information.

The AHP benefits group decision making because group members can use their experience, values and knowledge to break down a problem into a hierarchy and solve it by the AHP steps.

There are four advantages to using AHP over other alternative project selection and prioritization techniques (David, 2007):

i. AHP uses a hierarchical structure; it enables decision makers to define high level strategic objectives.
ii. AHP can integrate quantitative and qualitative criteria.
iii. AHP enables decision makers to measure the relative importance of projects, including their benefits, costs, risks and opportunities to develop the ranking.
iv. AHP can be applied to any organization at any level.

In 2005, Mahdi, an Associate Professor from Chemical Engineering Department, College of Engineering and Petroleum, Kuwait University, presented a case study on the use of AHP method in Kuwait's Power Station Air Pollution Control. He found that AHP allows the use of non-quantifiable parameters such as environmental, social and political criteria besides quantifiable cost-effective technical and economic factors.

Palcic and Lalic (2009) used AHP in project selection in assigning priority and for making appropriate decisions. In his case study on information technology oriented

company, Henny (2006) applied the AHP approach to design a structural model of the decision making process in which AHP plays a role.

2.3.4 Comparison of Project Selection Techniques

A summary of the techniques described from 2.3.1 to 2.3.3 is presented in Table 2.1.

Table 2.1
Summary of Project Selection Techniques

Method	**Advantage**	**Disadvantage**
Checklist	• Time and labor efficient • It is comprehensive (it may cover many developmental areas) • A documentation of development • A clear illustration of the developmental continuum	• Loses details of the event • May be biased by the recorder • It depends on the criteria to be clearly observable • May have many items to check, making it time consuming
Direct scoring method	• It allows multiple criteria to be used for evaluation • Recognizes that some criteria are more important than others • Structurally simple and relatively easy to understand • Direct reflection of management policy • Easily altered to accommodate change in management policy or priorities	• Ease of use can lead to the inclusion of too many criteria • Output of a scoring model is strictly a relative measure rather than an absolute go/no go indication
Analytical hierarchy process (AHP)	• Flexibility and easy to use • Can be used in two distinctive ways and with weight • Can aggregate the priority for all levels of the hierarchy structures	• Large problems with too many pair-wise comparison

2.4 Other Commonly Used Group Decision Making Methods

Decision making is not exclusively made by an individual person. Decision making commonly is a group activity. Below are commonly used group decision making methods.

2.4.1 Delphi Method

This method is used in the structure of the communication process that involves a group of individuals as a whole when facing complex problems. According to Okoli (2004), the Delphi method has proven to be a famous tool in information systems in identifying and prioritizing issues for managerial decision making. It is commonly used in the areas of forecasting, broad or long-range policy creation and in the development of management strategies. In general, this method consists of obtaining individual answers to pre-formulated questions from the experts, typically by questionnaire, accumulating the answers and feeding them back to the participants. Lai et al. (2002) reported that their participants considerd AHP to be more acceptable than Delphi in six different areas – information utilization, goal elicitation, problem clarification, task comprehensiveness, decision process contention and result contention.

2.4.2 Voting system

Voting system is a system in which a group of people choose one person or one of the many options available depending on the majority decision. It is commonly used in elections, awarding prizes, selecting between different plans of action, or as a means for computer programs to evaluate which solution is best for a complex problem (Wikipedia, 2015). The will of the majority is seen as the will of the whole group, with the minority expected to accept and carry out the decision, even if it is against their most deeply held convictions and principles (Wikipedia, 2015). However, the decision can be biased because of the element of peer influence that exists during the voting sessions, which

may cause the voting outcome not entirely representing the group's decision. Furthermore, although criteria could be set as guidelines for voting, they are not ranked according to importance to the voting objective.

2.5 Summary

This chapter reviewed the relevant literatures on project selection criteria, which are considered as the independent variables in this study. They are financial criterion, corporate strategy, risk, urgency, contractor availability, and technical knowledge. These criteria have been widely used by past researchers. These criteria were used because they are commonly used in the study organization, while other criteria are relevant to execute the projects. The chapter also discussed the approaches of project selection including AHP.

Based on the literature review, it is clear that the AHP method is more effective in decision making than the other methods as it involves multi-criteria and multi-factor problems. Since the project selection problem is a multi-criteria decision making problem, AHP was be the most suitable methodology to be applied in the selection process for the case study company.

CHAPTER THREE

RESEARCH METHODOLOGY

This chapter explains the research methodology adopted in this study. It starts with research design and research framework, followed by the development of questionnaire, survey implementation and data analysis using AHP.

3.1 Research Design

This study combined both the qualitative and quantitative approaches to data collection where the respondents (decision makers in project selection) were asked about their position and their role as a decision maker in the company. The research used AHP to determine the criteria in selecting and prioritizing the projects. Before the present study was carried out, prior permission from the organization was asked. A preliminary survey was conducted to identify decision maker requirements using the structured interview method. Decision makers from top management, purchasing department and logistic department at the corporate level were interviewed. A total of five managers was involved.

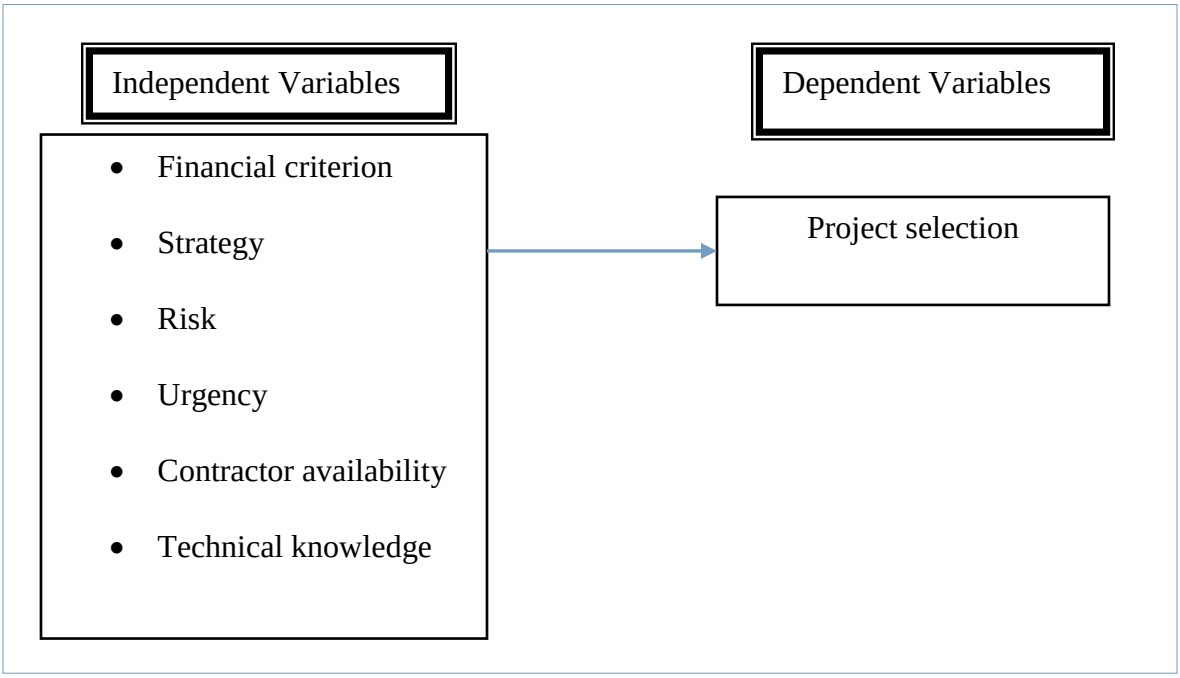
Data were collected using an open-ended project selection survey form (Appendix 1). Position, department, years of services and educational qualification and experience in decision making were collected.

As mentioned earlier, previous researchers used quantitative method to examine the project selection criteria such as financial criterion, strategy, risk, urgency, contractor availability and technical knowledge. These criteria were used in this case study to meet the research objectives. To determine which projects to be executed, the respondent or decision maker were explained about the four projects namely Project A, B, C and D, as discussed in Chapter 1.

3.2 Research Framework

Six project selection criteria were used in this study. They were financial criterion, strategy, risk, urgency, contractor availability and technical knowledge.

Figure 3.1
Project selection criteria



The six major selection criteria are as follows:

i. Financial aspect - A group of criteria with the objective of capturing the financial benefits of the projects. They are directly associated with costs, productivity and profit measures.
ii. Strategy - A group of criteria directly associated with the strategic objectives of the organization.
iii. Risk includes the level of risk tolerance that an organization accepts to execute a project.
iv. Urgency determines the urgency level of the project.
v. Contractor availability includes contractor equipment, expert, consultant and their quality.
vi. Technical knowledge includes knowledge necessary and executes the projects.

These selection criteria are shown at level one in Figure 3.2 of the decision hierarchy structure.

3.2.1 Selection of alternatives

There were four projects to be implemented and executed. These projects were shortlisted based on prescreening criteria set by the upper management. They were:

a. Project A - Solar Project
b. Project B - College University
c. Project C – Hospitality
d. Project D – Travel Tours

The upper management has considerable knowledge about the projects. These decision alternatives are shown at level three in Figure 3.2.

3.2.2 Development of questionnaire

Questionnaire (Appendix II) was prepared to collect data. The respondents were required to do a pair-wise comparison to indicate the appropriate degree of importance of each pair of the selection criteria. Then they were asked to indicate their preferences of the alternatives set against the respective selection criteria. The respondents compared the selection criteria indicated on the left with another indicated at the top. The comparison scale (Saaty, 1977), as depicted in Table 3.2, ranged from 1 = equally preferred/important to 9 = extremely preferred/important.

Table 3.2
Comparison Scale

Value	Definition	Explanation
1	Equally preferred/important	Two activities contribute equally to the objective
3	Moderately preferred/important	Experience and judgment slightly favor one activity over other
5	Strongly preferred/important	Experience and judgment strongly favor one activity over other
7	Very strongly preferred/important	An activity is strongly favored and its dominance is demonstrated in practice
9	Extremely preferred/important	The evidence favoring one activity over another is of the highest possible order
2,4,6,8	For compromise between the above values	When a compromise needed

Source: Saaty (1977)

The data collected were then used for AHP analysis (details in Chapter 4).

3.3 Survey Implementation

Prior to the project evaluation, the respondents were briefed on the purpose of the questionnaire and how it should be answered. The respondents were then requested to respond one day after the distribution of the questionnaire to allow sufficient time for them to understand the instruction. It was also to allow them to seek clarification before answering the survey.

3.4 Data Analysis

The next step was to estimate the relative weights (priorities) of decision elements using the data collected. These weights represented the decision maker's judgment on the relative importance or preference of the elements in the hierarchy (Ang, 2005). This is called pair-wise comparison.

The eigenvector and the weighted score of each alternative were computed with the help of Excel before project selection was done. The detailed data analysis is described in Chapter 4.

When using AHP, the first step is to establish priorities as guidance for the interviewer and ranking. The following was carried out:

i. To measure how much more important a criterion than the other criterion, AHP uses a scale with values from 1 to 9. Table 3.3 shows how the decision maker's verbal description of the relative importance between the two criteria was converted into a numerical rating

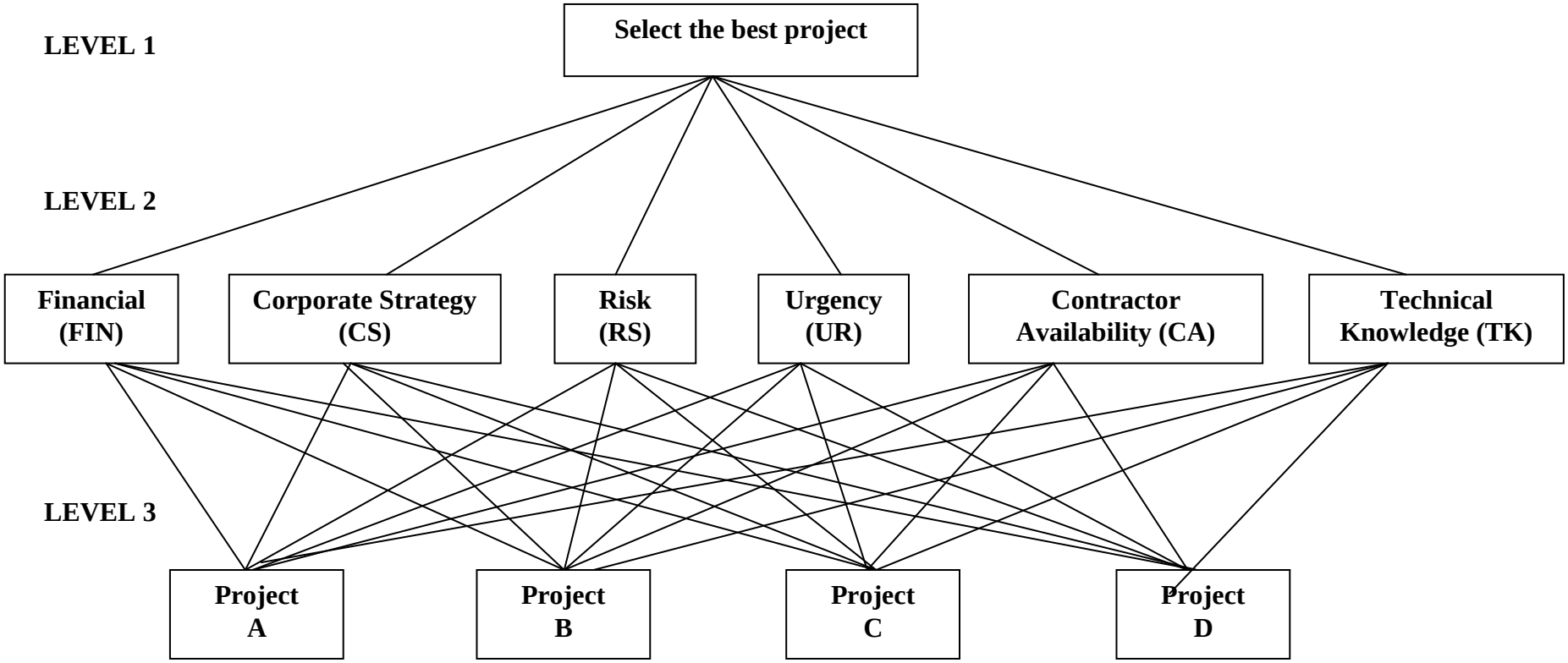


Figure 3.2
Decision hierarchy structure

Table 3.3
Preference Scale of AHP Technique

Verbal judgment	Numerical rating
Extremely more important	9
	8
Very strongly more important	7
	6
Strongly more important	5
	4
Moderately more important	3
	2
Equally important	1

ii. Next, a structured interview with the respondents was carried out to understand the preferences to rank the priority of the criteria.

iii. The arithmetic mean of a set of values is the ratio of their sum to the total number of values in the set. The disadvantage of mean is that it is sensitive to extreme values especially when the sample size is small. Therefore, it is not an appropriate measure of central tendency for skewed distribution (Swinscow & Campbell, 2003). As the interviews were conducted amongst a team of decision makers and as a group, the geometric mean was used (Forman & Peniwati, 1998). The geometric mean in AHP enables aggregating individual judgments and ranking decision criteria based on its weight (Subramaniam, 2010).

iv. A different AHP matrix was formulated for the main criteria to determine its corresponding weights. The same approach was used to solve the entire formulated matrix.

v. Next, a consistency test in AHP was used to measure the degree of inconsistency in pair-wise comparison (Taylor, 2004).

vi. Later, the importance of criteria was determined based on their weights. The criterion with the highest weight was more important than other criteria. The main criteria were compared to each other and ranked based on their weight.

3.5 Summary

This chapter explained the research methodology applied in this study. It described the research approach adopted in the study, providing details of the research subjects, the questionnaires and its administration. The data collected then were analyzed using pair-wise comparison or AHP method. Results are explained in Chapter 4.

CHAPTER FOUR

DATA ANALYSIS

In this chapter, the results of the data analysis are presented. The process of analyzing the data is done by using AHP method. The results in this study included on prioritization of criteria on selecting the projects and determine the projects that best meets requirements of the organization.

4.1 The Respondents

There were five respondents, of which three were from top management and two executives. Table 4.1 represents the background of the respondents.

Table 4.1
Background of Respondents

Position	Department	Years of service	Educational qualification	Experience as decision maker	Consideration of selection criteria
Chief Executive Officer	Top management	15 years	PhD	Frequently	Yes
Managing Director	Top management	10 years	PhD	Frequently	Yes
General Manager	Top management	9 years	PhD	Frequently	Yes
Quality Executive	Quality	8 years	PhD	Intermediate	Yes
Purchasing Executive	Purchasing	3 years	Masters	Intermediate	Yes

Table 4.1 shows that the decision makers were primarily top management. The respondents had an average of nine years of service with the company. Of five respondents, three (60%) were frequently involved in decision making and two (40%) were intermediately involved. With regards to educational qualification, majority of the respondents had a doctoral degree, suggesting that they qualified in evaluating and

selecting the most appropriate projects to be prioritized in the company. In addition, all the respondents considered the criteria when selecting of the projects.

4.2 AHP Analysis

The AHP technique was mainly employed to allocate weights to the identified the six selection criteria.

4.2.1 The selection criteria

AHP methods was used to analyze the six selection criteria. These include pair-wise comparison, calculating the relative weights and eigenvector and the consistency ratio.

4.2.1.1 Pair-wise comparison

The establishment of priority among criteria was based on pair-wise comparisons. The data were collected from top management and executives. They tabulated into the pair-wise comparison matrix to assess the criteria. In the pair-wise comparison matrix, the diagonal elements are always equal to one, and the lower triangle elements of the matrix are the reciprocal of the upper triangle elements (Zahedi, 1986).

The following example of calculation is based on the data collected from a decision maker and is used to demonstrate the AHP calculation.

Table 4.2
Pair-wise comparison for criteria – General Manager

Criteria	**FN**	**ST**	**RK**	**UR**	**CA**	**TK**
Financial (FN)	1.000	5.000	3.000	4.000	4.000	5.000
Strategic (ST)	0.200	1.000	2.000	2.000	0.500	2.000
Risk (RK)	0.333	0.500	1.000	3.000	2.000	3.000
Urgency (UR)	0.250	0.500	0.333	1.000	0.500	0.500
Contractor availability (CA)	0.250	2.000	0.500	2.000	1.000	2.000
Technical knowledge (TK)	0.200	0.500	0.333	2.000	0.500	1.000

Table 4.2 shows the data collected from the General Manager. An example, for the first row, he ranked scale of five, means Financial is strongly more important to Strategic criteria. Ranked scale of three, means Financial is moderately more important to Risk criteria and ranked scale of four, means Financial is moderately strongly more important to Urgency. When comparing between the financial and strategic criteria position, it means that the Financial criterion was five times more important that the Strategic criterion. One always enters the whole number in its appropriate position and automatically enters its reciprocal in the transpose position.

Appendix II shows the questionnaire on the selection criteria in the matrix where the respondent did the integer part, while the blank matrix was completed by the researcher.

4.2.1.2 Calculate the relative weights and eigenvector

Next, the normalized matrix was computed from the pair-wise comparison matrix for the selection criteria, followed by calculating the eigenvector.

For matrix normalization, firstly, the column totals were determined based on the data collected in Table 4.2. Table 4.3 demonstrates the computed column totals.

Table 4.3
Pair-wise comparison for criteria – Column Total

Criteria	FN	ST	RK	UR	CA	TK
Financial (FN)	1.000	5.000	3.000	4.000	4.000	5.000
Strategic (ST)	0.200	1.000	2.000	2.000	0.500	2.000
Risk (RK)	0.333	0.500	1.000	3.000	2.000	3.000
Urgency (UR)	0.250	0.500	0.333	1.000	0.500	0.500
Contractor availability (CA)	0.250	2.000	0.500	2.000	1.000	2.000
Technical knowledge (TK)	0.200	0.500	0.333	2.000	0.500	1.000
Column Total	2.233	9.500	7.166	14.000	8.500	13.500

Once the column totals were determined, each number or entry in the matrix was divided by its respective column total to produce the normalized matrix as shown in Table 4.4. Once the matrix is normalized, the numbers in each column will sum up to one.

Table 4.4
Normalized Matrix

Criteria	FN	ST	RK	UR	CA	TK
Financial (FN)	0.447	0.526	0.419	0.286	0.470	0.371
Strategic (ST)	0.090	0.105	0.280	0.143	0.059	0.148
Risk (RK)	0.149	0.053	0.139	0.214	0.235	0.222
Urgency (UR)	0.112	0.053	0.046	0.071	0.059	0.037
Contractor availability (CA)	0.112	0.210	0.070	0.143	0.118	0.148
Technical knowledge (TK)	0.090	0.053	0.046	0.143	0.059	0.074
Total	1.000	1.000	1.000	1.000	1.000	1.000

Subsequently, the averages of the various rows from the matrix of numbers were calculated to determine the eigenvector (priorities), as shown in Table 4.5. For example of Financial criterion, the sum of this row was 2.519. This value was divided by 6 to get the average value of 0.419. Larger values of the eigenvector indicate greater importance of the criteria to the decision maker.

Table 4.5
Eigenvector for the criteria

Criteria	Priority	Ranking
Financial (FN)	0.419	1
Strategic (ST)	0.138	3
Risk (RK)	0.169	2
Urgency (UR)	0.063	6
Contractor availability (CA)	0.133	4
Technical knowledge (TK)	0.077	5

In summary, the General Manager rated financial aspect as the most important criterion in project selection, followed by risk, strategy, contractor availability, technical knowledge and urgency.

4.2.1.3 The consistency ratio

Considering that humans are error-prone and often inconsistent, the AHP allows some degree of errors and inconsistencies in the decision maker's judgments (Min, 1992). The consistency ratio tells us how consistent we are with our ranking. A higher number means we are less consistent, whereas a lower number means that we are more consistent. According to the rule of thumb suggested by Saaty (1980), a consistency ratio (CR) of 0.10 (10%) or less is considered an acceptable margin; otherwise, the decision maker should then reevaluate his/her ranking scores. Figure 4.1 is the formula and calculation of the consistency ratio.

$$CR = \frac{\text{Consistency index (CI)}}{\text{Random index (RI)}}$$

Where

$$CI = \frac{\lambda - n}{n - 1}$$

n = number of decision elements in the consideration

λ = the average value of consistency vector

RI = mean CI of a randomly generated reciprocal matrix from a ratio scale of 1 to 9, as in Table 4.6 (Render & Stair, 2000).

Table 4.6
Random Index

n	Random Index
2	0
3	0.58
4	0.9
5	1.12
6	1.24
7	1.32
8	1.41

Firstly, the weighted sum vector was calculated (Table 4.7), i.e. determine the eigenvector number (Table 4.5) for the first criteria times the first column of the original pair-wise comparison matrix (Table 4.2), second eigenvector number times the second column and so forth, then followed by summing up these values over the rows.

Table 4.7
Weighted Sum Vector

Criteria	FN	ST	RK	UR	CA	TK	Priority	Wt. Sum Vector
Financial (FN)	1.000	5.000	3.000	4.000	4.000	5.000	0.419	2.785
Strategic (ST)	0.200	1.000	2.000	2.000	0.500	2.000	0.138	0.906
Risk (RK)	0.333	0.500	1.000	3.000	2.000	3.000	0.169	1.064
Urgency (UR)	0.250	0.500	0.333	1.000	0.500	0.500	0.063	0.398
Contractor availability (CA)	0.250	2.000	0.500	2.000	1.000	2.000	0.133	0.878
Technical knowledge (TK)	0.200	0.500	0.333	2.000	0.500	1.000	0.077	0.479

Next, the consistency vectors were determined by dividing the weighted sum vector with the respective eigenvectors determined previously (Table 4.8).

Table 4.8
Consistency Vector

Criteria	Priority	Wt. sum vector	Consistency vector
Financial (FN)	0.419	2.785	6.647
Strategic (ST)	0.138	0.906	6.565
Risk (RK)	0.169	1.064	6.295
Urgency (UR)	0.063	0.398	6.317
Contractor availability (CA)	0.133	0.878	6.601
Technical knowledge (TK)	0.077	0.479	6.221

Subsequently, the value of lambda (λ) was computed by taking the average value of the consistency vector, i.e. (6.647 + 6.565 + 6.295 + 6.317 + 6.601 + 6.221) / 6 = 6.441.

Therefore,

$$
\begin{aligned}
CI &= (\lambda - n)/(n-1) \\
&= \frac{(6.441 - 6)}{6 - 1} \\
&= 0.088 \\
CR &= \text{consistency index (CI) / random index (RI)} \\
&= 0.088 / 1.24 \\
&= 0.071
\end{aligned}
$$

In this case, the CR 0.071 shows that pair-wise comparison was deemed consistent within the acceptable random variations for this particular decision maker.

The above steps were repeated for the data collected from all the decision makers and Table 4.9 summarized the relative weights of criteria and rank order of importance of the respective decision makers.

The AHP technique allows decision makers to meaningfully synthesize their priorities in order to derive an overall prioritization and ranking which includes the application of geometric mean (Lai et al., 2002). Thus, the mean weight for each project selection

criteria was obtained by dividing the sum of all the individual weights by five respondents.

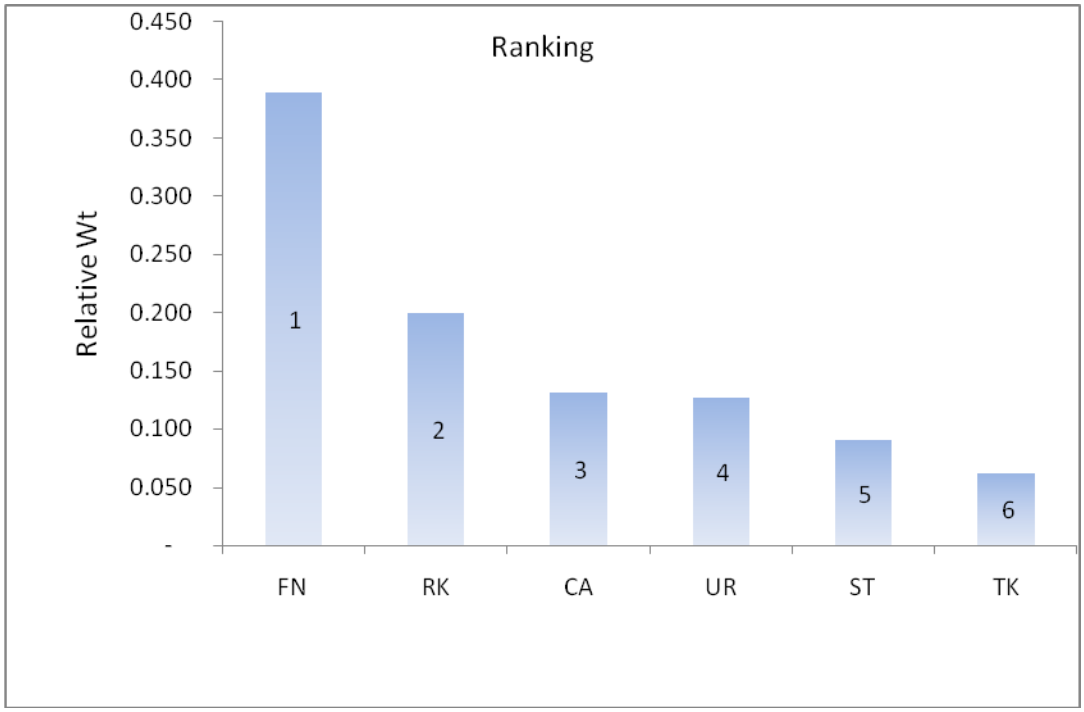
From Table 4.9, based on the geometric mean (Subramaniam, 2010), it can be concluded that the ranking of project selection criteria in the company was Financial, Risk, Contractor Availability, Urgency, Strategy and Technical Knowledge.

Table 4.9
Relative weights of selection criteria

Selection criteria	**Rep. GM**		**Rep. CEO**		**Rep. MD**		**Rep. QE**		**Rep. PE**		**Mean Weight**	
	Wt	**Rank**	**Wt**	**Rank**	**Wt**	**Rank**	**Wt**	**Rank**	**Wt**	**Rank**	**Wt**	**Rank**
Financial (FN)	0.419	1	0.470	1	0.448	1	0.421	1	0.190	3	0.389	1
Strategic (ST)	0.138	3	0.064	4	0.073	6	0.108	4	0.069	5	0.090	5
Risk (RK)	0.169	2	0.220	2	0.137	2	0.261	2	0.214	2	0.200	2
Urgency (UR)	0.063	6	0.061	5	0.095	4	0.044	6	0.372	1	0.127	4
Contractor availability (CA)	0.133	4	0.143	3	0.151	3	0.112	3	0.114	4	0.131	3
Technical knowledge (TK)	0.077	5	0.043	6	0.095	5	0.053	5	0.041	6	0.062	6
Consistency Ratio (CR)	0.071		0.081		0.070		0.092		0.080			

Figure 4.2 shows the mean weight and its correspondent ranking of the project selection criteria.

Figure 4.2
Mean weight and ranking of selection criteria



Throughout the evaluation process, the group members were given the opportunity to discuss and seek clarification on their perspective ranking before they could agree and accept the mean weight calculated and its correspondent ranking.

The Financial aspect was the most important to the group members and three of top management argued on Contractor Availability and Technical Knowledge, because to them, these criteria were related. This means that a contractor must have technical knowledge, too.

In general, all the decision makers were considerably consistent with their choices (Figure 4.3), as the CR values were below the recommended 10% acceptable margin, as suggested by Saaty (1980).

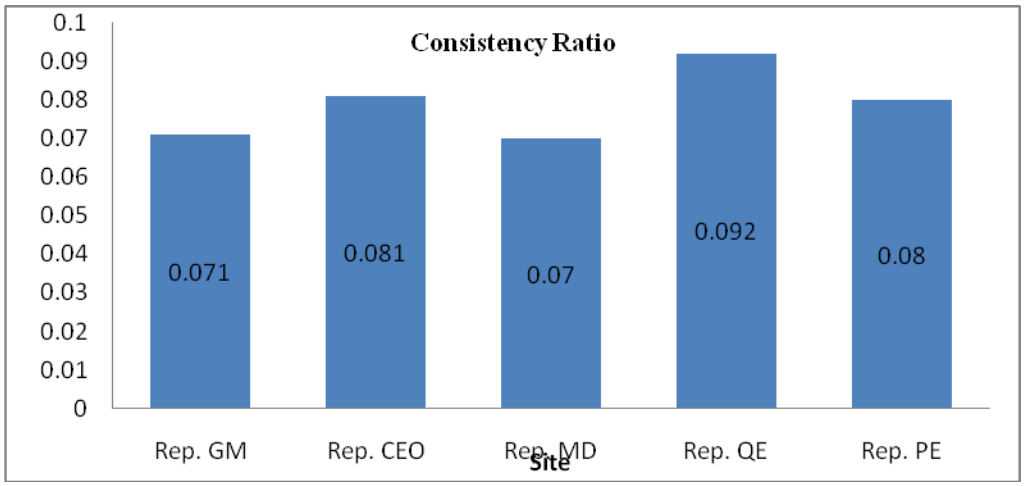


Figure 4.3
Consistency ratio of respective decision makers

4.2.2 The Alternatives

The second part was to compute the normalized matrix from the pair-wise comparison matrix on how the five alternatives (i.e. projects) address each criterion followed by calculating the weight vector. The same method explained earlier was used to compute the five alternatives against each criterion.

Figure 4.4 to Figure 4.8 depict the mean weight and corresponding ranking of the five alternatives addressing respective criteria and Table 4.10 summarizes the results.

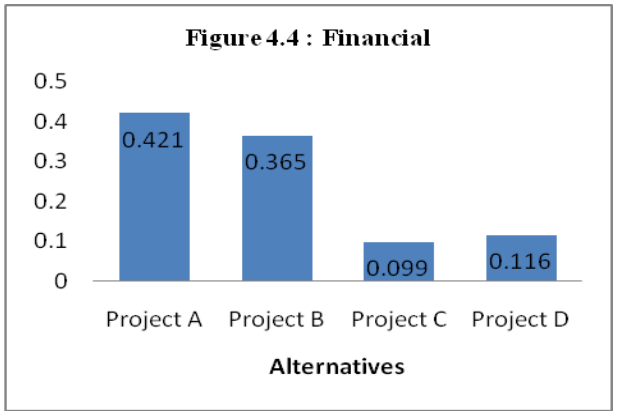


Figure 4.4 : Financial
0.5
0.4
0.3
0.2
0.1
0
0.421
0.365
0.099
0.116
Project A
Project B
Project C
Project D
Alternatives

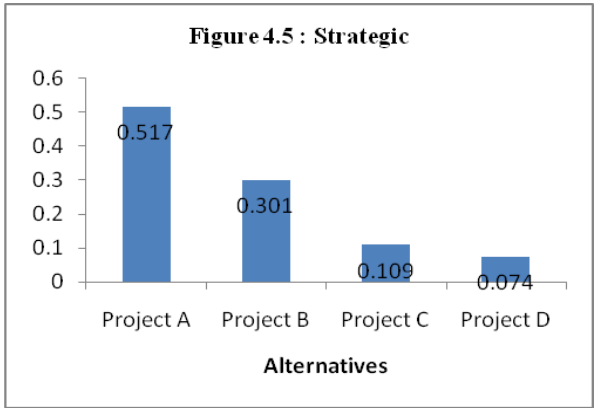


Figure 4.5 : Strategic
0.6
0.5
0.4
0.3
0.2
0.1
0
0.517
0.301
0.109
0.074
Project A
Project B
Project C
Project D
Alternatives

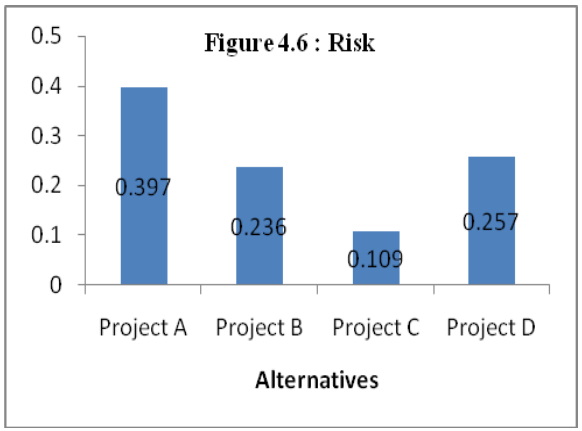


Figure 4.6 : Risk
0.5
0.4
0.3
0.2
0.1
0
0.397
0.236
0.109
0.257
Project A
Project B
Project C
Project D
Alternatives

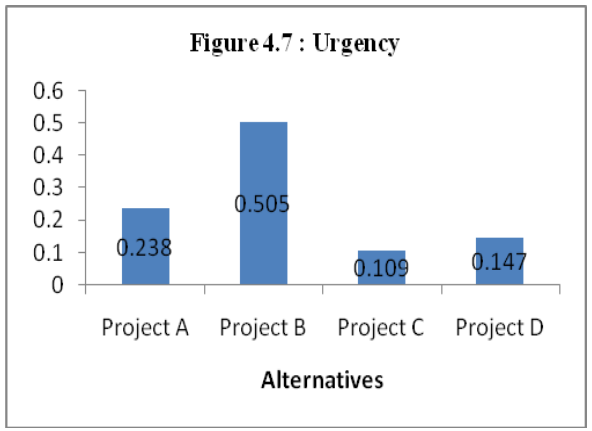
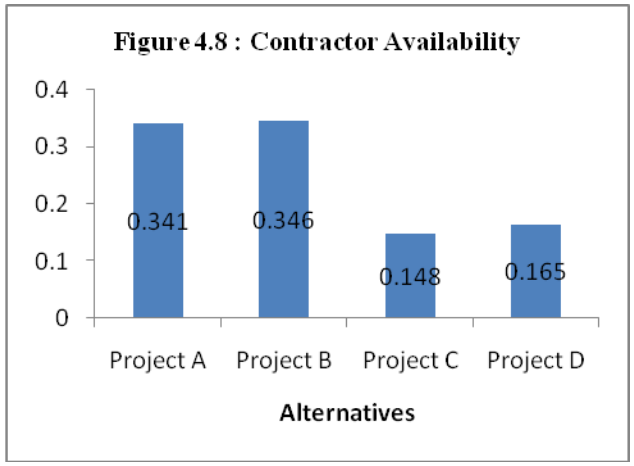


Figure 4.7 : Urgency
0.6
0.5
0.4
0.3
0.2
0.1
0
0.238
0.505
0.109
0.147
Project A
Project B
Project C
Project D
Alternatives



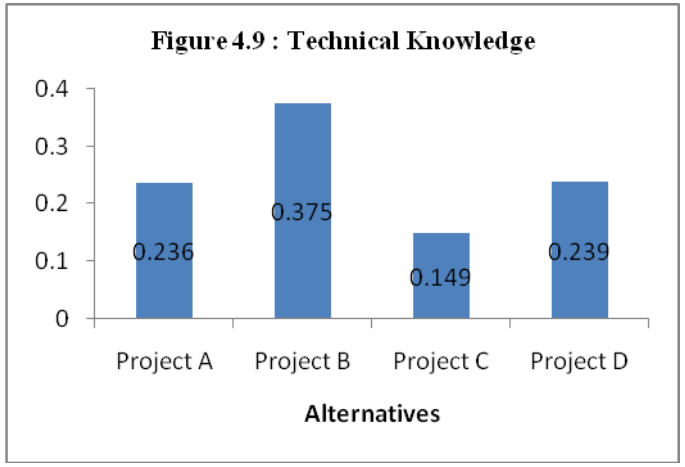


Table 4.10
Mean Weight and Ranking of Alternative against Each Criterion

	FN	Rank	ST	Rank	RK	Rank	UR	Rank	CA	Rank	TK	Rank
Project A	0.421	1	0.517	1	0.397	1	0.238	2	0.341	2	0.236	3
Project B	0.365	2	0.301	2	0.236	3	0.505	1	0.346	1	0.375	1
Project C	0.099	4	0.109	3	0.109	4	0.109	4	0.148	4	0.149	4
Project D	0.116	3	0.074	4	0.257	2	0.147	3	0.165	3	0.239	2

Table 4.10 shows that in terms of financial aspect (FN), Project A (Solar Project) was ranked first as it offered value in terms of cost, profit and return. On the other hand, Project C (Hospitality) was the least preferred as it offered limited value in terms of profit and return and high cost incurred (Figure 4.4).

For strategic (ST) criteria, Project A was ranked first for its alliance with organizational strategic goal and objectives. Due to the company's diversification, Project A (Solar Project) was important to the mission, while Project D (Travel Tours) was ranked the least preferred (Figure 4.5) because its goal did not meet the strategic objectives of the company.

In terms of risk (RK) criteria, Project A (Solar Project) was ranked as having the most acceptable risk, while Project C (Hospitality) was very risky to execute, hence ranked the least preferred (Figure 4.6).

With respect to timing, Project B (University College) was ranked as the most preferred in terms urgency (UR) as this project need to be completed as soon as possible. In terms of financial (FN) and strategic (ST) criteria, this project was the second most preferred because it offered high return and alliance with the company objectives. On the other hand, Project C (Hospitality) was ranked the least preferred in terms of urgency to execute (Figure 4.7).

For contractor availability (CA), Project B (University College) was ranked the most preferred to execute due to availability in terms of contractor equipment, consultant and expert to run this project, while Project C (Hospitality) was ranked the least preferred due to limitation to contractor requirements (Figure 4.8).

For technical knowledge (TK), Project B (University College) was ranked the most preferred because this project required technical knowledge and had high impact on logistic terms. When considered with contractor availability criteria, the contractor must have technical knowledge to run the project. Project C (Hospitality) was ranked the least preferred on the technical knowledge criterion (Figure 4.9).

4.2.3 Aggregate and compute the overall weighted score for each alternative

In this step, the overall weighted score for each project was computed. The ranking for the projects and the selection criteria were combined by multiplying the ranking of the project against each criterion with the ranking of the criteria and then summing the results for each project to achieve an overall ranking of the projects with respect to the criteria (Davis et al., 1994). The respective selection of the group members and the calculated mean weight of the group are illustrated in Table 4.11.

The results from the AHP method shows that General Manager (GM) chose Project B as his first choice with the highest ranking of 0.362, followed by Project D (0.296), Project A (0.234), and Project C (0.108). The same interpretation applied to the rest of the decision makers.

The overall mean weight of the group indicated that Project A was their first choice with the highest mean weight of 0.358, trailed by Project B (0.355), Project D (0.167), and Project C (0.121).

Table 4.11

Summary of Results for AHP Analysis

Selection criteria	**Rep. GM**		**Rep. CEO**		**Rep. MD**		**Rep. QE**		**Rep. PE**		**Mean Weight**	
	Wt	**Rank**	**Wt**	**Rank**	**Wt**	**Rank**	**Wt**	**Rank**	**Wt**	**Rank**	**Wt**	**Rank**
Project A	0.234	3	0.492	1	0.263	2	0.410	1	0.392	1	0.358	1
Project B	0.362	1	0.311	2	0.410	1	0.344	2	0.347	2	0.355	2
Project C	0.108	4	0.132	3	0.109	4	0.165	3	0.089	4	0.121	4
Project D	0.296	2	0.065	4	0.219	3	0.082	4	0.172	3	0.167	3

4.3 Summary

Based on the results from the AHP method and the objectives of the study to identify selection criteria that are the most appropriate and relevant in project selection, financial (FN) criterion showed the highest mean ranking of 0.389. This means that the financial aspect was the most appropriate and relevant in project selection. The group decision makers considered financial aspect as the most important criterion that impacts the organization. On the other hand, technical knowledge (TK) was the least preferred selection criterion.

In determining which projects that best meet the requirements of the organization, Project A, which had the highest mean ranking of 0.358, should be selected. It means that the management must focus on this project in their prioritization of their projects. However, Project B had a mean ranking of 0.355, which was not significantly different from Project A. But in terms of urgency (UR), contractor availability (CA) and technical knowledge (TK) criteria, Project B had shown a high ranking.

CHAPTER FIVE

FINDING AND DISCUSSIONS

This final chapter summarizes the present study by discussing the implications of the application, limitations of the study and recommendations for practice and future work.

5.1 Summary of the Study

Decision making is one of the primary functions of management. Making strategic decisions are important to achieve organizational efficiency and effectiveness. Therefore, the objectives of this study were to identify the selection criteria that are the most appropriate and relevant in project selection and to determine the project that best meets the requirements of the organization. The AHP method was used to identify the project selection in this case study.

This method allows the organization to prioritize its projects based on certain criteria as it is a quantitative decision support tool. This tool d enables the decision makers to justify their choices, as well as generate possible results.

In general, the two objectives set were achieved as follows:

i) From the literature review, six selection criteria were used by this group decision makers and analyzed using AHP method. They were prioritized as follows:

    1. Financial aspect
    2. Risk

3. Contractor availability
4. Urgency
5. Strategic
6. Technical Knowledge

ii) By using the AHP method, Project A (Solar Project) was chosen to be the best among the four projects in meeting the requirements of the organization.

5.2 Contribution of the study

This study contributes as follows:

- Able to present a set of best suitable criteria in making selection. This is suitable and relevant for the benefit of the company.
- Provide a systematic method in selection of a project for the company, instead of human judgment.
- Recommend to use AHP method which considers all the factor and use of pair wise comparison. This AHP method considers both qualitative and quantitative data.

5.3 Limitations

There are some limitations in this study as discussed below and each limitation can be taken as a challenge in future works.

The selection criteria for this case study were based on literature review, so they may be limited and may not be hold true for other companies. For future research, other selection

criteria should be used. Secondly, the decision makers in this company were limited; only top management involved for decision making process. The projects mentioned in this study were known by these respondents since they were confidential

5.4 Recommendations

For group decision making process, the following recommendations are worth being considered:

a. Commitment from decision makers is required to apply the AHP technique in making selection decisions. Supportive top management will enhance its effectiveness.

b. Broaden the usage of AHP to other functions of group decision making in the organization, such as in the selection of supplier for sourcing functions.

c. Training to be provided to potential decision makers in the organization to appreciate the AHP application.

d. Invest in appropriate software to ease computation of AHP such as Expert Choice.

e. Apply AHP to other selection criteria.

5.5 Conclusion

In selection of projects, it necessary for organizations to prioritize their projects due to limited resources. Therefore, the selection of projects that bring value and substantial impact on the organization is very important to ensure that they can compete in the dynamic external environment and meet the goals and objectives.

From the case study, the result suggests that the AHP method can contribute significantly to the identification of sources that need further clarification of attributes and criteria and at the same time providing a systematic analytical tool in making group decision. In conclusion, AHP is the best and efficient method for decision makers to consider all facts, weigh the pluses and minuses, reach, re evaluate and communicate their decision.

REFERENCES

Ang. (2005). *Using AHP in ERP software for group decision making*. Unpublished technical report, Universiti Utara Malaysia, Sintok.

Alexander, L. G., & McKeown, T. J. (1985). Case studies and theories of organizational decision making. *Advances in Information processing in Organizations*, *2*, 2-58.

Al-Subhi, K. M. (2001). Application of the AHP in project management. *International Journal of Project Management, 19,* 19-27.

Andrew, J. C., & Mahmoud, M. Y. (2003). Managing the project management process. *Industrial Management & Data Systems, 103*(1), 39-46.

Asaka, F. O. (2008). Projects selection and management implications in Kenyan local authorities. *Asian Journal of Business and Management Sciences 1*(10), 65-75.

Athawale, M. C. (2009). Supplier selection using multi criteria decision making methods. *Journal of Operations Management, 8,* 41-60.

Bhushan, N., & Rai, K. (2004). *Strategic decision making: Applying the analytic hierarchy process*. New York: Springer.

Burton, C., & Suedel, J. K. (2009). Comparison of the direct scoring method and multi criteria decision analysis for dredged material management decision making.

Charvat, J. (2003). *Project management methodologies: Selecting, implementing, and supporting methodologies and processes for project.* Hoboken, New Jersey: John Wiley & Sons, Inc.

Clifford, F. C., & Larson, W. E. (2003). *Management process* (2nd ed.) New York: McGraw-Hill Ltd.

Colin, O. B. (1985). A linear goal-programming model for public-sector project selection. *The Journal of the Operational Research Society, 36*(1). 13-23.

Costa, H. R., Barros, M. O., & Rocha, A. R. C. (2010). Software project portfolio selection: A modern portfolio theory based technique. *Proceedings of the 22nd Software Engineering and Knowledge Engineering Conference.* San Francisco, EUA.

Eddie W. L. (2002). Analytical hierarchy process: A defective tool when used improperly. *Measuring Business Excellence*, *6*, 33-37.

Kendrick, J. D. (2007). Use of analytic hierarchy process for project selection. *Six Sigma Forum Magazine, 5, 23-25*.

Mahdi, K. A. (2002). Project selection by analytical hierarchy process: Case study--Kuwait's power station air pollution control. *Management Institute, 3,* 67-72.

Mazur, J. L. (2005). Quality infrastructure improvement using QFD to manage project priorities and project management resources. *International Journal of Quality & Reliability Management, 22*, 10-16.

Melone, N. P., & Wharton, T. J. (1984). Strategies for MIS project selection. *Journal of Systems Management, 4,* 26-33.

Morris, W. G., & Pinto, K. J. (2007). *The Wiley guide to project organization and project management competencies.* New Jersey: John Wiley and Sons.

Motta, G. S., & Quintella R. H. (2012). Assessment of non-financial criteria in the selection of investment projects for seed capital funding: The contribution of scientometrics and patentometrics. *Journal of Technology Management & Innovation, 7*(3), 5-7.

Mullins, J. L. (2005). *Management and organizational behavior*. Essex: Pearson Educ. Ltd.

Palcic and Lalic. (2009). Analytical hierarchy process as a tool for selecting and evaluating projects. *Journal of Management, 3,* 45-53.

Pinto, J. (2007). *Project management: Achieving competitive advantage*. UK: Pearson Education.

Pinto, J. K., & Slevin, D.P. (1987). Critical factors in successful project implementation. *IEEE Transactions on Engineering Management, 34*(1), 22-7.

Powers, Ruwanpura, Dolhan, and Chu. (2002). Simulation based project decision analysis tool. Journal of management project, 5, 32-40.

Ricardo, V. V. (2010). Using the analytic hierarchy process (AHP) to select and prioritize projects in a portfolio. *International Journal of Management, 12(2), 321-333.*

Ricardo, V. V. (2011). Urgency: A critical factor in project planning. *International Journal of Management, 14(3),* 231-234.

Rubin, R. E. (1991). *Human resource management in libraries: Theory and practice*. New York: Neal-Schuman.

Sa, S. (2011). Group decision making in multiagent systems with abduction. *Proceedings of Conference on Autonomous Agents and Multiagent SystemsTumer,* 1369-1370.

Saaty, T. L. (1980). *The analytic hierarchy process*. New York: McGraw-Hill.

Saaty, T. L. (2008). Decision making with the analytic hierarchy process. *International Journal of Services Sciences, 1*(1), 83–98.

Subramaniam, Vikneswari. (2010). Competency-based candidate selection model for teacher training program. *Unpublished master thesis,* College of Arts and Sciences, Universiti Utara Malaysia.

Swinscow TD, Campbell MJ. (2003). *Statistics at square one*. 10th ed. New Delhi, India: Viva Books Private Limited.

Triantaphyllou, E. (2002). *Multi-criteria decision making methods: A comparative study.* New York: Springer.

Vries, H. V. (2006). Choosing a quality improvement project using analytical hierarchy process. *International Journal of Quality & Reliability Management, 12,* 409-425.

Zavadskas, E. K., Turskis, Z., Tamošaitienė, J., & Marina, V. (2008). Multicriteria selection of project managers by applying grey criteria. *Technological and Economic Development of Economy, 14*(4), 462–477.