CONTRACTOR SELECTION THROUGH VALUE JUDGMENT METHOD: A CASE STUDY OF A PRIVATE HOSPITAL

By
THANA-ON THEERANON

A Final Report of the Six-Credit Course
SCM 2202 Graduate Project

Submitted in Partial Fulfillment of the Requirements for the Degree of
MASTER OF SCIENCE IN SUPPLY CHAIN MANAGEMENT

Martin de Tours School of Management
Assumption University
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Martin de Tours School of Management
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Bangkok, Thailand

November 2012

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I, Thana-on Theeranon_____

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Contractor selection through value judgment method: A case study of a private hospital

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(A. Thanapat Panthanapratez)

Date 16 NOV 2012

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Thana-on Theeranon
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November 2012

ABSTRACT

The contractor selection process is the critical part of a construction project because the performance of the contractor directly contributes to the success of the project. From data analysis, ABC hospital selected the contractor based on the lowest bid price. This practice led the hospital to award the construction project to an incapable contractor. The review of historical data reveals that the incapability of the contractor was the major cause of delay in this construction project. The delay in construction created huge damage to the hospital including the loss of opportunity in generating revenue of nearly 12 million baht from the construction area if it had been completed on time, and also the loss of customer satisfaction.

Therefore, this research proposes a new contractor selection model for the ABC hospital based on a value judgment method. The model comprises four main steps: capability evaluation by the weighted score model, motivation evaluation by the supplier perception model, combining the result of capability and motivation to see the overall performance, and comparing the performance with the bidding price. Under the proposed model, the hospital selects the contractor who offers the best combination of performance and price. In this research, the model was developed by the construction committee of ABC hospital. Finally, the validation of the proposed model was tested by examining two previous construction projects of ABC hospital.

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CHAPTER I

GENERALITIES OF THE STUDY

Recently, the construction industry in Thailand has become highly competitive since the amount of construction companies are increasing compare with the decreasing investment in the construction business. There are many construction companies in Thailand nowadays, of which the small companies (<20 employees) are the major players in the industry but only have 9.9% of the market share, while big companies (>1,000 employees) have 21.5% (Makulsawatudom, Emsley, & Sinthawanarong, 2004). However, the increasing quantity does not mean high productivity of the company. Day by day, the clients of construction projects are faced with poor performance from contractors.

The contractor plays a vital role in the progress and success of a project; therefore, selecting the contractor is also the important task in which the buyers should make a decision carefully. Traditionally, the buyers usually use a contractor's bid amount as the dominant and important factor to make the decision (Yilmax & Ergonul, 2011) and this is one of the causes resulting in project failure. The outcome of this inefficient practice is that the buyer can get an inadequate contractor who produces poor performance, including cost overrun, delay in meeting the schedule, and unacceptable quality.

As the result of the discussion above, the integration of non-price criteria into the contractor selection process is required. Much research has studied this issue because it can assess the capability of a contractor and this can indicate the success of a project (Clarke, 2007). Moreover, the research also focuses on how these factors should be judged and how they can be integrated into the decision process in order to seek the contractor who offers the best combination of performance and price.

1.1 Background of the Study

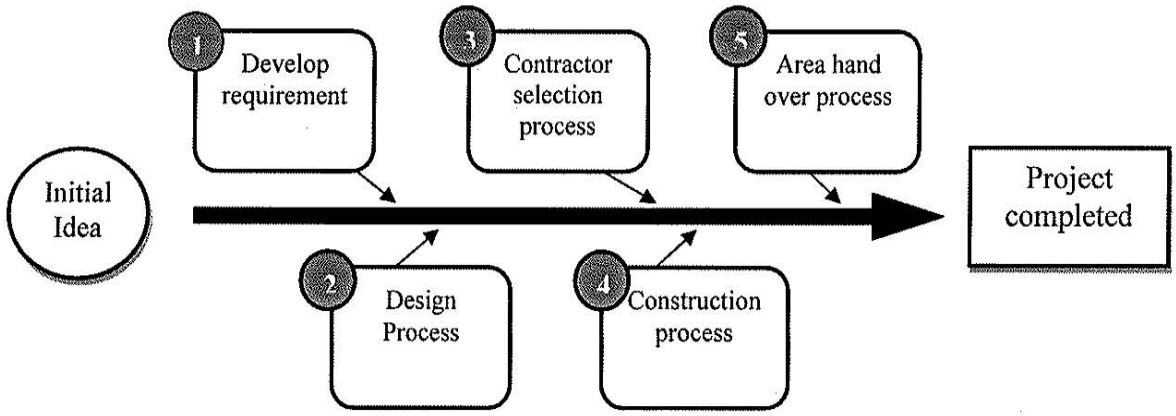
The company in this case study is a private hospital, which hereafter will be called ABC hospital. The hospital was established in 1979 to be a leading provider of medical healthcare services in Thailand and Southeast Asia. With 270 beds, over 400 highly qualified specialists and over 1,200 caretakers, the hospital has long been recognized as a comprehensive facility of choice for locals, foreigners and tourists.

Besides the value of its medical healthcare service, ABC hospital also places importance on creating an environment of healing for the hospital. Money invested in the construction project was 36 million baht in 2010, 72 million baht in 2011, and 212 million baht in 2012 (approximately). The construction projects at ABC hospital can be broken down into two types according to the scope of work. First is **renovation work** which is about improving existing area to be more functional and more aesthetic, the expansion of the existing area to provide more services, and the construction of a new business unit to correspond with the marketing strategy. Second is **mechanical engineering system work** which is about the upgrading or installation of new mechanical systems such as plumbing, elevators, escalators, heating, ventilation and air conditioning. The purpose is to provide the customer with a more comfortable and safer environment.

1.1.1 Construction Project Process

At the beginning of the year, the construction project list which consists of the construction project name, brief details, budget, and timeline of each project, is set and finalized by ABC's executive team. The construction committee, including the project engineer, purchasing staff, accounting staff and the user of each project, is responsible for making design decisions, selecting the contractor, approving the material, following up the construction progress, and handling the area handover process. A brief construction process of ABC hospital is shown in Figure 1.1 and detailed below.

Figure 1.1: Construction Process of ABC Hospital



Source: General Support Division of ABC hospital

Step 1: A Total of Requirement (TOR) is developed by the construction committee. It details all requirements of concept, function, spaces, service, equipment, special finishes and furniture for the completed project. For the technical projects, the hospital hires an outside consultant to prepare the TOR.

Step 2: Design professionals firms, offering both architectural and engineering design, are hired to develop the design. Generally, the hospital uses a regular architecture firm in order to control the perspective of the whole hospital in the same way. The first step of the design process is to develop the schematic design which is a simple diagram describing room sizes, function, layout of the whole area, and single line diagrams of all engineering systems. The design will be reviewed and approved by the construction committee. The second step is to develop the perspective design which allows the project owner to see the colors, patterns, materials, lighting fixtures, other building elements, and a life-like representation of the completed project. After all designs are approved, the architect firm will develop comprehensive construction drawings of architectural and engineering work, specification, and bill of quantity. These construction documents are submitted for review and approval by the construction committee before being used in the tendering process.

Step 3: Contractors who have experience in working for ABC hospital are invited to attend the tendering process. The lowest price bidder is awarded the contract.

Step 4: The awarded contractor performs the construction within the agreed timeline. The project engineer of ABC hospital is the representative of the construction committee who coordinates the work, solves problems, monitors costs and scheduling, and checks the progress of the awarded contractor. The project engineer reports the progress and problems of construction to the construction committee every week.

Step 5: When the construction is complete, the construction committee, housekeeping staff, mechanics and infectious control staff check the construction area. The construction committee checks the overall construction area. The housekeepers check the completion of all furniture. The mechanics test the engineering system including air conditioning, lighting system, telephone line, and nurse call system. The infectious control staff are responsible for checking the cleanliness of the construction area according to the hospital standard. If the construction needs to be corrected, the duration time for correcting all defects will be agreed by both companies.

1.2 Statement of the Problems

A capable contractor is a very important element to contribute to the success of construction projects. In contrast, an inadequate contractor can produce construction delays, cost over-budget costs and poor quality of the completed project, which leads the project client lost money and opportunity.

At ABC hospital in 2011, 8 of the 16 construction projects experienced delays contrary to the schedule. Because of this schedule overrun, ABC hospital lost nearly 12 million baht in generating revenue from the area if it had been completed on time. Moreover, the hospital created dissatisfaction in customers due to unavailability of facilities. From the review of historical data it was found that the major cause of

delayed was generated by the incapability of contractors. The hospital used competitive tendering as the method to procure the construction work. The bidding price was the only criterion of the present practice, as the contractor who offered the lowest price was awarded the project. This purchasing method had been used by ABC hospital generation after generation, because the way to compare only bid prices was easy with fast judgment of the winner of the bidding. Moreover, a more appropriate method had never been suggested to the hospital because the participants in the contractor selection process lacked knowledge and strategy about supplier selection methods. Therefore, "How can ABC hospital develop a value judgment approach as a contractor selection method?" will be studied in this research.

Therefore, the researcher sees the opportunity to improve the practice of selecting the contractor to minimize the consequential damage faced by ABC hospital.

1.3 Research Objectives

This research focuses on identifying the strategy suitable as a contractor selection method for ABC hospital. The objectives of this study are set as the following:

1.3.1 To develop and propose a value judgment method as the contractor selection method for ABC hospital.

1.3.2 To validate the proposed model based on a value judgment method by testing two delayed construction projects at ABC hospital in 2011.

1.4 Scope of the Research

This research is focused on developing a new contractor selection method for ABC hospital. The method is changed from the traditional practice where bidding price is the only criterion to a more efficient practice which covers non-price criteria together with bidding price. The proposed method is 'Value Judgment' which selects the contractor who offers the best combination of performance and price to achieve value

for money. The data was collected from January to December 2011 to analyze the two delayed projects, their cause and effect. The development of the proposed model was conducted by the construction committee of ABC hospital. The validation of the developed model was done by testing the two delayed construction projects of 2011. The proposed model would help ABC hospital in selecting a competent contractor who can deliver success to the construction project.

1.5 Significance of the Research

The outcome of this study is valuable for ABC hospital because it yields a more efficient and systematic contractor selection method. The method can let the hospital see the contractor's capability and motivation apart from the bidding price. The hospital can determine which contractors tend to achieve success in construction projects through good performance of a contract.

1.6 Limitations of the Research

This research focuses on the contractor selection process for construction projects at ABC hospital. The development of the proposed model is conducted by the construction committee of ABC hospital especially to determine the relative important of selection criteria. Therefore, the outcome of this research can be validly applied only to ABC hospital and cannot refer to any other hospital or business area.

1.7 Definition of Terms

Analytical Hierarchy Process (AHP)	It is a decision making method based on multi-criteria decision making methodology (MCDM). It is able to deal with complex, unstructured and multi attribute decision (Zala & Bhatt, 2011).
Contractor selection criteria	The standard used for evaluating candidate contractors in construction project. The appropriate criteria can help the project owner identify the most suitable contractor who trends to produce the best result in terms of cost, time, and quality (Idrus, Sodangi, & Amran, 2011).
Supply positioning model	The model helps an organization in prioritizing the time and effort spent on a purchasing items and guiding an organization in developing the supply (International Trade Center, 2000a)
Time Performance Index (TPI)	The indicator used for measuring the time performance of construction project (Othman, Torrance, & Hamid, 2006)
Value judgment	The offer evaluation method used when the price and non-price criteria are both important when selecting a supplier (International Trade Center, 2000c)

CHAPTER II

REVIEW OF RELATED LITERATURE

The objective of this study is to discuss relevant theories and concepts in order to enhance understanding of contractor selection. The relevant research about contractor selection helped the researcher to find an inappropriate point in the current process. Moreover, it also guided the researcher through the solution that can improve the current situation. The scope of this chapter is the literature, including contractor selection method, selection criteria, Kraljic's model, the value judgment concept, the Analytical Hierarchy Process (AHP) and the Time Performance Index (TPI).

2.1 Contractor Selection Method

Generally, success in a construction project requires many important factors. One of them is to use a capable contractor to execute the work. Many times, construction projects fail in cost, time and quality, directly originating from selecting an inadequate contractor. This is why the contractor selection process is a critical decision to be made by project owners.

According to Yilmaz and Ergonul (2011), companies in today's business have applied various method of contractor selection. The private companies design their own procedure which not systematic and unrestrictive systems. The public companies award the project to the contractor who offers the lowest bid price because they need to explain the reason of their selection and it is easier when the lowest bids is selected. Topcu (2004) stated that in selecting the contractor with the lowest bid price principle, the buyer always get an inadequate contractor, which is a major cause of project problems such as delay in construction, over budget and poor quality of the completed project. Zala and Bhatt (2011) explained three major causes why project owners obtain an inadequate contractor. Firstly, the method used for evaluating the contractor was inappropriate. Secondly, the criteria use to evaluate is not suitable for qualifying

the contractor. Lastly, each criterion is given improper relative importance, with the highest priority always on the bid price. As a result of these causes, we have frequently seen the failure of construction project. Therefore, academics have tried to develop more appropriate selection methods to help the construction industry solve all the problems and maximize project performance. Table 2.1 summarizes the study of contractor selection methods.

Table 2.1: Summary of Contractor Selection Method

Author	Finding
Mahdi, Riley, Fereig, and Alex (2002)	- Contractor selection method should consider other criteria such as experience, past performance and financial strength rather than select the lowest bid price. - Introduced a contractor selection model that could identify the contractor who is suitable for the characteristics of the tendering project.
Sonmez, Yang, and Holt, (2001)	- Using the lowest bid price as the selection principle may produce two disadvantages. First, the project gets problems in cost, time and quality. Second, the contractor offers unrealistic price in order to win the bidding. - Presented Evidential Reasoning (ER) method. The technique used the Degree of Believe (DoB) concept which decision makers draw out the degree of expectation that each contractor achieves in a particular criterion.
Topcu (2004)	- Selecting the contractor based on lowest bid price, buyers always get inadequate contractor who delivers problems such as project delay, cost overrun, and poor quality. Evaluating the contractor against multi-criteria can solve these problems. - Proposed contractor selection model for a construction project in Turkey with pre-qualification concept. The model had two main stages: first was pre-qualify stage in which contractors were evaluated against time and quality dimension. Second stage, the pre-qualified, contractors were evaluated against price.
Yilmaz and Ergonul (2011)	- Selecting the lowest bid price is the major problem because the contractor offers an unrealistic low price in order to stay in the business. - Introduced the contractor selection model which also considered other factors besides price. The model selected the contractor who gave the best value for money. - The model contained three steps. First, contractors were evaluated against non-price criteria with a weight of 30%. Second step was the evaluation of bid price of each contractor with a weight of 70%. Last was to select the winner. The winner was the one who ranked No. 1 for quality even if its offer price was not the lowest.

Source: Author

In Table 2.1, each research studied different method of contractor selection. However, all of them agree to not select the contractor by using a single criterion based on the lowest bid price, but recommend evaluating the contractor against multi-criteria.

2.2 Contractor Selection Criteria

Many researchers have worked on the criteria for contractor selection to evaluate suitable contractors. Hatush and Skitmore (1997) presented seven main criteria for contractor pre-qualification and bid evaluation, including financial soundness, technical ability, management capability, health and safety, and reputation.

Salama, Aziz, Sawah, and Samadony (2006) identified the technical and financial criteria for bid evaluation of construction project in Egypt. Quality control system, adequacy of technical supervision, availability of equipment, method statement, experience of key personnel, and percentage of subcontractor were the criteria used for technical evaluation. While bid price, schedule of payment, consultant or fair estimate and percentage of advanced payment were the financial evaluation factors.

Idrus et al. (2011) investigated the actual contractor selection criteria used by project owners and experts in the construction industry in Malaysia. The research found that top important criteria included track performance, financial capacity, and technical capacity.

The Tasmanian Department of Treasury and Finance (2006) used to adopt lowest bid price method to award government construction projects. However, it always obtained unsuitable contractors. Therefore, this government organization developed an alternative tendering evaluation method with named weighted criteria to procure these construction projects. In this model, seven criteria were recommended for assessing the contractor. Their definition and information required are shown in Table 2.2.

Table 2.2: Contractor Selection Criteria

Criteria	Consider area	Required information
Relative experience	The expertise area of a contractor. A project owner should compare the technical skill of contractor in previous project with the tendered project. Moreover, the scale and the role undertaken in previous project should be considered as well.	List of relevant projects which describe the project detail, role of the tender, project cost and duration time of project.
Past performance	The capability to perform the past projects in sense of quality, time, budget, claims history and project management.	The information of past project includes project name, client's project manager, quality standard, target performance level, tender price, variations, final cost, completion date and extensions of time.
Technical skills	The competency of key personnel that each construction firm proposes to employ for the tender project. It should be assessed in the area of skills and experience in technical area comparing to the tender project.	The detail of proposed key personnel including name, function, technical expertise and curriculum vitae.
Management skill and system	This criteria is assessed the contractor about the management skill of its personnel, and firm management system and method that proposes to use in tender project.	Contractor's quality system, project management tools, program software and environmental management system.
Resource	The equipment proposed to use in tender project including machine, factory, and labor.	The specialist equipment, labor and facilities that each contractor own.
Methodology	The procedure or special methods that the candidate contractor proposed to apply to a tender project in order to achieve satisfied project outcome. The contractor should be able to explain and describe about the methodology of particular approach.	Program of work, key performance indicator, work dividing to sub-contractor, innovative procedure to be used, reporting and recording system and quality plan.
Price	Total cost over the contract period that a project owner is required to pay to a contractor.	It can be considered from fixed capital cost, variable tender costs during the contract period, special adjustments during the contract period, maintenance cost and operating cost.

Source: Tasmanian Department of Treasury and Finance (2006)

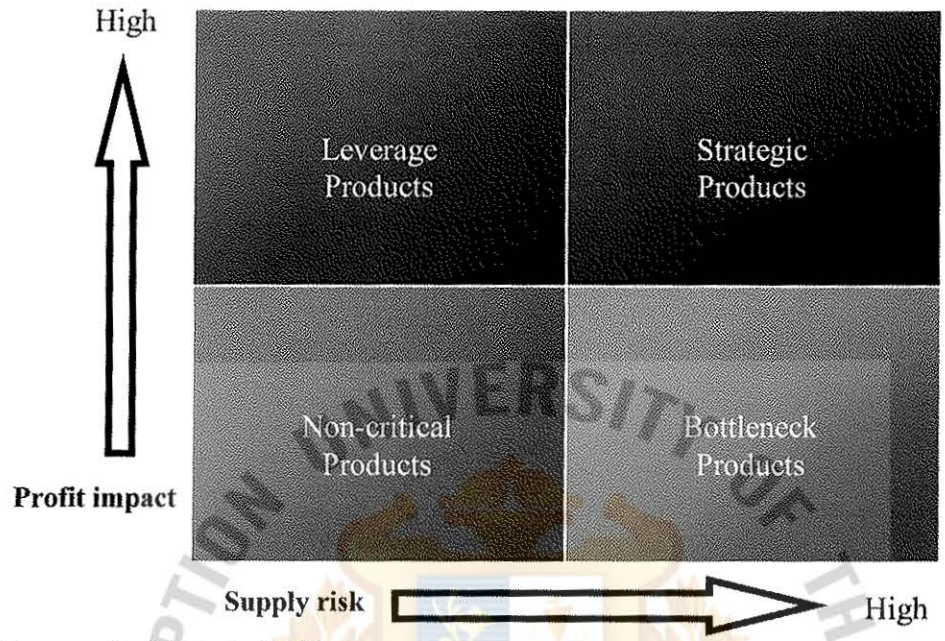
However, the criteria used in the selection process for a particular product should be clearly described by a cross-functional team of the purchasing organization. The member of the team should include a representative who has technical knowledge of that product as well as the personnel from the department who use that product item.

2.3 Kraljic's model

The model was developed by Peter Kraljic and first published as a part of a Harvard Business Review article in 1983. The objective is to classify purchased items based on two dimensions: supply risk and profit impact. It helps purchasers to choose suitable purchasing and supplier strategies for each purchased item (Padhi, Wagner, & Aggarwal, 2012).

The profit impact dimension can be defined in terms of the volume purchased, percentage of total purchase cost, or impact on product quality or business growth. The supply risk dimension is assessed in terms of availability, number of suppliers, competitive demand, make-or-buy opportunities, and storage risks and substitution possibilities. Using these two dimensions, a purchasing company can classify all purchasing items into four categories i.e. strategic, bottleneck, leverage, and non-critical (see Figure 2.1). Due to the possibility of change in demand and supply patterns, a company should update the model regularly in order to use the right strategy (Kraljic, 1983).

Figure 2.1: Kraljic's Model



Source: Padhi et al., 2012

Strategic products show high profit impact and high supply risk. Normally, the products in this category are important for the production process because they are essential parts of the final product. Moreover, since it requires high technology and big purchased volumes, suppliers can customize the product for specific buyers. The buyers should develop long term partnerships with the supplier in order to obtain on-time delivery and reasonable price (Toppari, 2009).

Bottleneck products have low profit impact but high supply risk because only a small number of suppliers provides the items in the market. When the supplier cannot deliver the product, the production line might have to be stopped. Therefore, the buyers are faced with long lead time and lose customer satisfaction. To prevent this situation, buyers should be careful in planning, develop supply-risk analysis, search for alternative suppliers, and look for substitute products (Toppari, 2009)

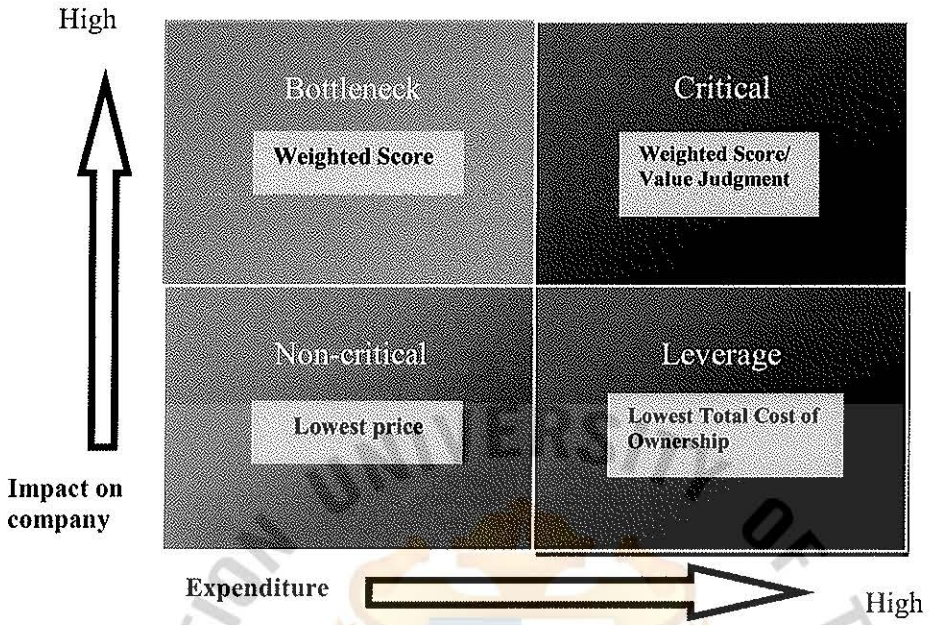
Leverage products represent high profit impact but low supply risk. The suitable purchasing approach is to substitute products or suppliers, and place a high volume of orders in order to have high purchasing power (Mind Tools, n.d.).

Non-critical products are low profit impact and low supply risk. Normally, it is products that have normal standard, small value per unit and are provided by many suppliers. Purchasers should not take much time on the products in this category, so the purchasing process should be as simple as possible. A suitable strategy should be e-procurement, effective internal order delivery, and automatic invoice process. Purchasing companies can authorize the internal users to order (Toppari, 2009).

2.3.1 Offer Evaluation Method of Each Category

A great number of researchers have reviewed variations on the original Krajlic model. However, these models are similar to the Kraljic model with the same dimensions, same product categories and same suggested strategy (Donald, 2006). International Trade Center (2000a) also uses a model similar to Kralji's model classifying purchased items into four categories. The model, called supply positioning model, helps the purchasing company in prioritizing the time and effort spent on purchased items, and guides a suitable supply strategy for each purchasing item. Two dimensions of the model are the percentage of total annual expenditure and the impact on the organization. The impact can be assessed from how the company loses expected sales from its finished products if it cannot meet supply targets. According to International Trade Center (2000c), each category has a different suitable offer evaluation method, as shown in Figure 2.2.

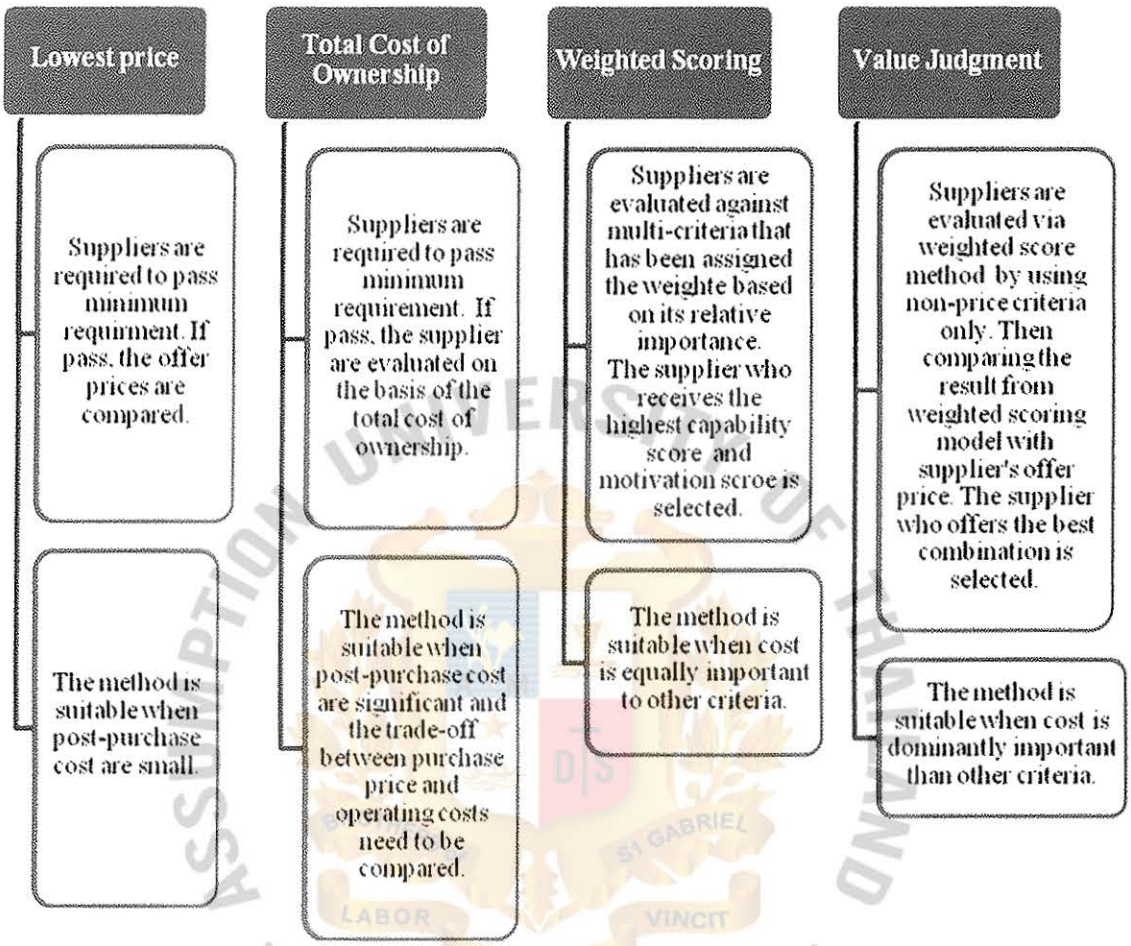
Figure 2.2: Offer Evaluation Method in Supply Positioning Model



Source: International Trade Center (2000c)

The lowest price method is suitable for purchasing items in the non-critical category which has low levels of expenditure and risk. Comparing the price of the supplier passing the minimum requirement is enough for the purchasing items in this quadrant. When the cost goes up, the suitable offer evaluation method is the lowest total cost of ownership in order to determine thoroughly all relevant cost involved in a supplier's offer. The weighted score method is suitable for the purchase items in the bottleneck quadrant to take account of all risks that could happen. For the purchasing items in the critical quadrant which has both cost and risk in high level, the suitable method is value judgment. The detail of each evaluation method is shown in Figure 2.3.

Figure 2.3: Summary of Offer Evaluation Method



Source: International Trade Center (2000c)

2.4 Value Judgment Approach

Wikipedi (n.d.) defines the word value judgment as "a judgment of the rightness or wrongness of something, or of the usefulness of something based on the comparison or other relativity". Byms (1991) defined the phrase 'value for money' as consistent with value judgment, that is the evaluation of product, system or service that is not limited to price but also based on all relevant factors including life cycle cost, available warranties, experience, availability and past performance. He also mentioned that the best value concept was used in daily life by consumers when they considered a trade-off between price and quality. Some consumers preferred to pay a

higher price for better quality, while other consumers considered only a low price. This concept has been used for contractor selection as well but in various terms which are summarized in Table 2.3.

Table 2.3: Value Judgment Concept in Construction Industry

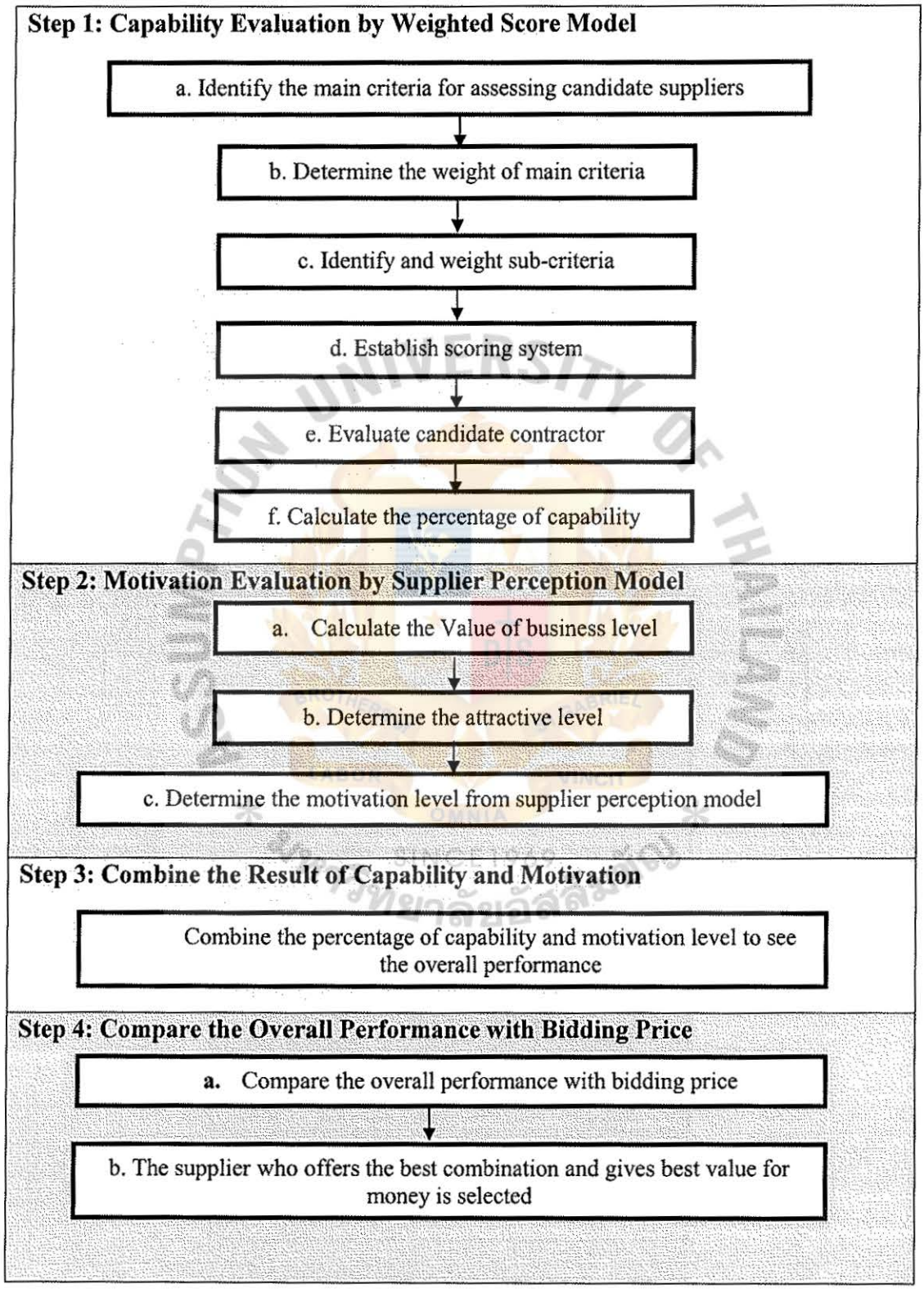
Author	Finding
AGC of America and NASFA (2008)	**Best Value Selection:** The subjective consideration is included in the evaluation, selection, and final award of construction contract not just a low bid price.
Australia Construction Industry Forum (2011)	**Value for money selection**: Not select the lowest bid price contractor when higher price contractor has better performance and lower total cost.
COUNT (n.d.)	**Best Value Contracting (BVC)**: Select the contractor who has superior qualifications, reliable resources and better experience record. Lowest bid approach cannot screen the contractor capability, but qualification of contractor in terms of cost, quality, schedule and previous customer's satisfaction can determine the trend to achieve in the next project.
Clarke (2007)	**Value for money**: Australian Government Department of Defence applies this method for selecting the contractor. The contractors are assessed against non-price criteria. Then the board meeting discusses and considers the bid price of each contractor by give their justification without numerical analysis. The board meeting selects the contractor who gives the best value for money they spent in term of performance and bid price.
International Trade Center (2000a)	**Value judgment method:** The offer evaluation method suitable for product in critical category and when price are dominantly important than other criteria. The supplier is evaluated against non-price criteria first and compared the result with price. Under this method the supplier who did not offer the lowest bid price has a chance to be awarded if their performance is better.
The Scottish Government (n.d.)	**Value for Money (VFM)**: The optimum combination of whole life cost and quality to meet the customer's need. Under this concept, the contractor that offers the lowest bid price does not necessarily to be awarded.
Public Works and Government Services Canada (n.d.)	**Value for money concept:** The contract should be awarded to the bidder whose proposal has the best combination of total life cycle costs, quality and performance that meet the requirement.

Source: Author

From Table 2.3, it can be concluded that the value judgment concept is used for selecting the contractor who offers the best combination between price and other assessed factors. Under this concept, the contractor who offers the lowest bid price may not be selected if it can be shown that the contractor who offers a higher bid price has better capability and performance.

International Trade Center (2000c) wrote the step of developing value judgment method clearly. First, candidate suppliers are assessed on their capability against non-price criteria through a weighted score model. Next, candidate suppliers are evaluated through the supplier perception model to assess their motivation level. Then the capability and motivation results are combined to rate the supplier's performance. Last, the performance is compared with the purchasing price. The buyers judge and select the supplier who gives them the best value for spending money. Figure 2.4 shows the step by step of the value judgment method, and the detail of each step is explained in the following pages.

Figure 2.4: Value Judgment Development Steps



Source: International Trade Center (2000c)

Step 1 Capability Evaluation by Weighted Score Model

Capability of supplier is the ability to deliver according to the buyers' needs. The weighted score model provides the step to assess the capability of suppliers against multi-criteria (International Trade Center, 2000b). The steps to develop this model can be explained in the following paragraphs.

a. Identify the Main Criteria for Assessing Candidate Suppliers.

To prevent the acceptance of the lowest bid price concept, the criteria that will be used to evaluate supplies' capability needs to be identified. In the value judgment method, only non-price criteria are used to evaluate suppliers' capability.

b. Determine the Weight of Main Criteria

The weight of a criterion reflects its relative importance in the purchasing organization's view. The more important criterion is awarded a higher weight. However, the weight of the criteria should be given to the supplier to ensure that they can consider when this when preparing their offer.

c. Identify and Weight Sub-criteria

The sub-criteria may be required in some main criteria in order to scope down the assessing area. The weight of these sub-criteria is also important to identify. The sum total of the sub-criteria weight must equal to the weight of that main criterion.

d. Establish Scoring System

A scoring system is established to be the principle when giving the score to each supplier. To create an effective evaluation process, each decision maker should understand the same interpretation during the scoring step. For example, a 10-point scale where 1-2 = poor, 3 – 4 = weak, 5 – 6 = marginal, 7 – 8 = qualified and 9 – 10 = outstanding. Therefore, the decision maker can give the score to each candidate supplier accurately and without bias. There are two things which need to be determined to establish the scoring system.

First is the score range that will be used in evaluation process. The scoring scale will depend on the company's need (e.g. 0 – 4 or 0 – 10 or 1 - 5) and how the company wants each performance categories to differentiate from another.

Second, what is the possible performance of each score. This can be started at the acceptable level of supplier performance or baseline (score 3, in case the scoring scale 1-5 is applied). Then develop the range of performance above (score 1 and 2) and below (score 4 and 5) the acceptable level.

e. Evaluate Suppliers Directly

When the scoring system has been established, decision makers can start evaluating the supplier based on a supplier's offer and the scoring system that has been set.

f. Calculate the Percentage of Capability

After evaluating the supplier, the score of each sub-criterion is multiplied by the weight of that criterion. This score is called "weighted score". Then all weighted scores of each supplier are summed up to get "the total weighted score". To reach the percentage of capability, the total weighted score is divided by the maximum score possible.

$$\text{Maximum score possible} = \left[\begin{array}{c}\textbf{Sum of weight}\\ \textbf{of all main criteria}\end{array}\right] \times \left[\begin{array}{c}\textbf{Maximum score}\\ \textbf{of score scale}\end{array}\right]$$

$$\text{Percentage of capability} = \frac{\textbf{Total weighted score}}{\textbf{maximum score possible}} \times 100$$

Step 2 Evaluate Suppliers' Motivation by Supplier Perception Model

The potential supplier should not only have the capability but also need to have the motivation to perform the work. The supplier who is highly motivated to work is expected to perform better than one that not interested. The Supplier Perception model can help a purchasing company to assess the motivation level of the suppliers

(International Trade Center, 2000b). The following two elements are considered in this model.

a. Calculate the Value of Business Level

This step assesses the motivation level by comparing the purchase amount to the supplier's sale turnover over a given period (e.g. one year) or the capacity allocated to the supplier compare with its total capacity. The result will show how the supplier values the buyer's business. The more value of a buyer's business to a supplier, the more interested it will be.

$$\text{Value of business} = \frac{Purchase\ amount}{Supplier's\ Turnover}\ x\ 100$$

Then compare the result with Table 2.4 to know the level of how its business is significant in the supplier's view.

Table 2.4: Value of Business Level

Level of value of business	Value of business percentage
High (H)	More that 15%
Moderately high (M)	5% - 15%
Low (L)	0.8% - 5%
Negligible (N)	Less than 0.8%

Source: International Trade Center (2000b)

b. The Level of Attractiveness

The level of attractiveness in a buyer's business is another factor that can be assessed in the supplier motivation. Each supplier gains different experiences from a buyer, so they have different interest in a buyer's business. The buyer can consider the level of attractiveness from the factors shown in Figure 2.5, then applying terms of High, Moderately high, Low or Negligible level of attractiveness.

Figure 2.5: Factors to Evaluate the Level of Attractiveness

Compatibility of Business Strategy
The high degree of strategy compatibility shows the more motivation that a supplier has. The high compatibility can be considered from the purchasing product is in the core business of a supplier, the purchasing product are in a product-line that the supplier is developing, a buyer's business is in the market that a supplier is trying to break into.

Ease of Doing Business
A supplier will feel interested in a buyer business if the process of doing business with a buyer is easy. The ease can be considered from the easy of accessibility to the buyer and the compatibility of two companies about the national culture, the technology information system and the communication system.

Payment Record and Financial Situation
The attractiveness level will be high if the supplier received on-time payment in previous purchasing, the possibility of receiving the advance payment, and the efficiency of a buyer in processing invoice for prompt payment. A new supplier may seek to obtain a credit rating on a buyer company to assess its overall financial health.

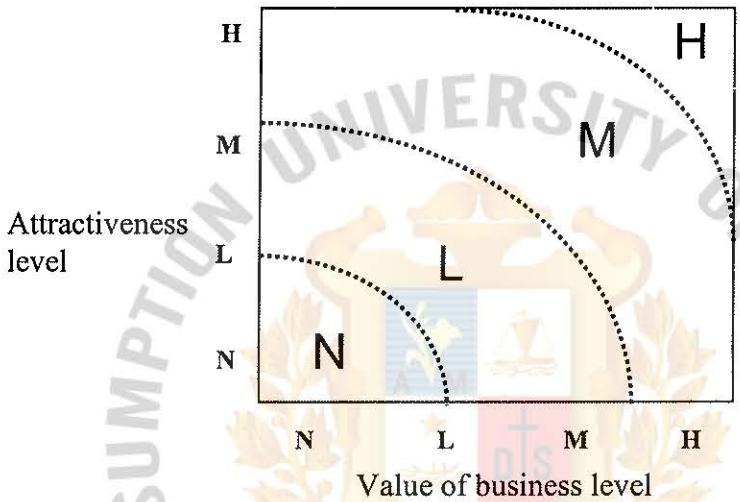
Association with a Respected Client
The reputation and image of a buyer company can be the aspect that assesses the level of attractiveness of a supplier. To be a supplier of a well-know and reliable organization can enhance the credibility of a supplier company. Moreover, a supplier can benefit from persuading other buyers to purchase its products or services.

Possibility to Develop the Business
If the supplier also sells other purchasing items of a buyer company, this can motivate the supplier to do the business with the buyer. Moreover, the buyer can consider from whether its growth potential to expand the future business matches with supplier's business or not. The high possibility of matching shows the high level of attractiveness.

Source: International Trade Center (2000b)

Now the value of business level and the attractiveness level are plotted under the supplier perception model (see Figure 2.6). The level of attractiveness is plotted on the vertical axis and the level of value of business is plotted on the horizontal axis. The level of motivation can be identified in terms of High, Moderately high, Low or Negligible level of attractiveness, according to the zone that each supplier falls into.

Figure 2.6: Supplier Perception Model

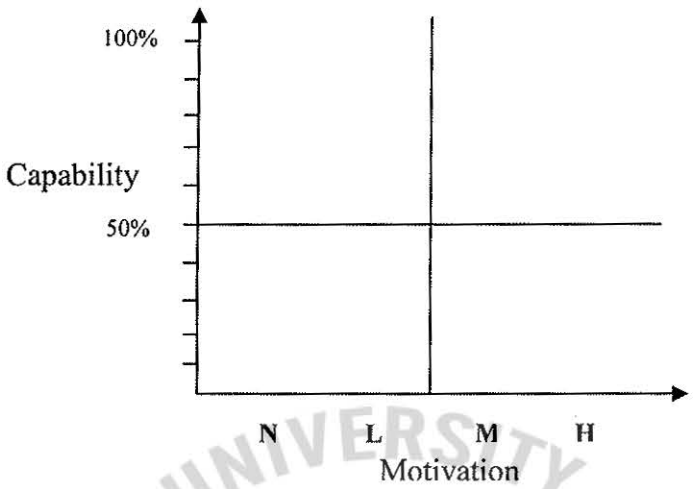


Source: International Trade Center (2000b)

Step 3 Combine the Result of Capability and Motivation

In this step, the capability result and the motivation result are plotted in a single chart (see Figure 2.7). Under this chart, a buyer can see the overall performance of each supplier. The supplier who positions near the right top corner of the chart tends to have great performance (International Trade Center, 2000c).

Figure 2.7: Supplier Performance: Capability and Motivation



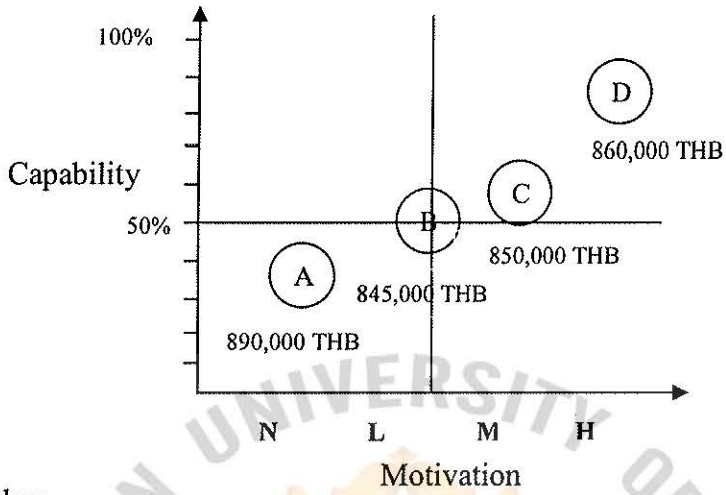
Source: International Trade Center (2000c)

Step 4: Compare the Overall Performance with the Bidding Price

In this step the result from step 3, which is the overall performance of each supplier, is compared with its offer price. Then the purchasing company selects the supplier who offers the best combination of performance and cost. The supplier who offers the higher bid price may be selected if its overall performance is better than the lowest bidder (International Trade Center, 2000c).

Example

Figure 2.8: Supplier Performance and Price



Source: Author

Figure 2.8 shows the last result of the value judgment step which a purchasing company needs to make in a decision by selecting one supplier. Supplier A can be first screened out since it has low capability and motivation while its offer the highest price. Suppliers B and C have nearly overall capability level but supplier C has more motivation and offers 5,000 baht more than supplier B. It will be better if the purchasing company is willing to pay more 10,000 baht, then the firm can get the best overall performance which is supplier D. However, the final selection depends on the judgment of the purchasing team that will select the one who gives the best value for money.

2.5 Analytical Hierarchy Process (AHP)

AHP is one of the well known techniques in the Multi Criteria Decision Making (MCDM) area developed by Thomas L. Saaty in the 1970s. The technique can quantify the relative importance of criteria and alternatives, on a ratio scale based on the judgment, experience and perception of decision makers. The application of AHP can be found as a selection method in various fields such as project procurement system, project management and engineering problem (Zala & Bhatt, 2011).

AHP method was recommended by Topcu (2004) as a suitable method for finding the weight of criteria. The decision makers are asked to compare a preference judgment on each pair of criteria. For example, the question would be; "Of the two criteria, X and Y, which one do you consider more important, and by how many times?" The decision makers given their judgments based on the judgment scale. The judgment is then converted to a numerical value by calculating until reaching the weight of each criterion. The benefit of this method is that it provides a method to check the consistency of the judgment. AHP procedure can be done automatically by Expert Choice Software or manually by the following step (Al – Harbi, 2001);

1. Construct a Pairwise Comparison Matrix

Each pair of criteria is compared in important by giving a score between 1 (equal important) and 9 (Absolutely more important) as indicated in Table 2.5. For example, the decision maker is required to answer the question "How important is criterion 2 relative to criterion 1? If buyers judge that Criterion 2 is moderately more important than Criterion 1, so it is assigned 3; then Criterion 1 must be less important than Criterion 2 and will be assigned 1/3. as in the example in Table 2.6.

Table 2.5: Level of Preference Weight for AHP

Value	Judgment	Explanation
1	Equal	Two criteria show the same level of important
3	Moderate	Experience and judgment slightly favor one criteria over the other
5	Strong	Experience and judgment strongly favor one activity over the other
7	Very strong	Experience and judgment tell that one criteria is much more important that the other
9	Extreme	The difference of important between two criteria is extreme
2,4,6,8	Intermediate values	Used if more precision is needed

Source: Bertolini, Bevilacqua, Braglia, and Frosolni (2004)

Table 2.6: Example of Pairwise Comparison Matrix

	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5
Criteria 1	1	1/3	1/3	1/5	4
Criteria 2	3	1	2	1/2	4
Criteria 3	3	1/2	1	1/4	3
Criteria 4	5	2	4	1	6
Criteria 5	1/4	1/4	1/3	1/6	1
Colum total	12.25	4.08	7.67	2.12	18

**The principal diagonal contains entries of 1

2. Compute the Weight of Criteria

a. Calculating the sum total of each column. For example, the value 12.25 in the table 2.6 is obtained by summing total number in the first column (1+3+3+5+1/4)

b. Dividing each number of the matrix by its column total. For example, the value 0.08 in table 2.7 is obtained by dividing 1 by 12.25 (the sum of the first column in Table 2.6)

c. Finally, the weight of each criterion can be calculated by finding the row averages. For example, the value 0.10 in table 2.7 is calculated by dividing the sum of the rows by the number of criteria [(0.08 + 0.08 + 0.04 + 0.09 + 0.22)/5]

Table 2.7: Example of Synthesized Matrix for the Criteria

	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Weight
Criteria 1	0.08	0.08	0.04	0.09	0.22	**0.10**
Criteria 2	0.24	0.24	0.26	0.24	0.22	**0.24**
Criteria 3	0.24	0.12	0.13	0.12	0.17	**0.16**
Criteria 4	0.41	0.49	0.52	0.47	0.33	**0.45**
Criteria 5	0.02	0.06	0.04	0.08	0.06	**0.05**
Sum of weight						**1.000**

In Table 2.7, it is important to note that sum total of the weight must be equal to 1. To check whether the judgment of determining the criteria weight is acceptable or not, the AHP method provides a method to check back. This can help in eliminating the chance of inconsistency revealed in the criteria.

3. Check the Consistency Level

a) Calculate the λ_{max} (Maximum Eigen value) by multiplying the pair-wise comparison matrix with the acquired priority vector to produce the weight sum matrices (1). Then divide this matrix by the weight of criterion (priority vector) to acquire unit vectors (2). Calculate sequentially the average of the unit vectors to acquire λ_{max} (Maximum Eigen value) (3). The numeric example can be demonstrated as below;

(1) Finding the weight sum matrices

$$0.10\begin{bmatrix}1\\3\\3\\5\\1\\\frac{1}{4}\end{bmatrix} + 0.24\begin{bmatrix}1\\\frac{1}{3}\\1\\1\\\frac{1}{2}\\\frac{1}{4}\end{bmatrix} + 0.16\begin{bmatrix}\frac{1}{3}\\2\\1\\4\\1\\\frac{1}{3}\end{bmatrix} + 0.45\begin{bmatrix}1\\\frac{1}{5}\\1\\\frac{1}{2}\\\frac{1}{4}\\1\\\frac{1}{6}\end{bmatrix} + 0.05\begin{bmatrix}4\\4\\3\\6\\1\end{bmatrix} = \begin{bmatrix}0.523\\1.285\\0.843\\2.370\\0.263\end{bmatrix}$$

(2) Dividing all elements of the weight sum matrices by their priority vector element

$$\frac{0.523}{0.10} = 5.200,\quad \frac{1.285}{0.24} = 5.354,\quad \frac{0.843}{0.16} = 5.266,\quad \frac{2.370}{0.45} = 5.267,\quad \frac{0.263}{0.05} = 5.267$$

(3) Computing the average of the result of (2) to obtain λ_{max}

$$\lambda_{max} = \frac{(5.200+5.354+5.266+5.267+5.267)}{5}$$

$$\lambda_{max} = 5.27$$

b) Computing the consistency index (CI) for each matrix of order n by below equation

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

Example

$$CI = \frac{5.27 - 5}{5 - 1} = 0.067$$

c) Calculating the consistency ratio (CR) by using the equation below

$$CR = \frac{CI}{RI}$$

Example

$$CR = \frac{0.067}{1.12} = 0.06$$

Where the Random Consistency index (RI) depends on the size of the matrix and can be found from Table 2.8.

Table 2.8: Average Random Consistency (RI)

Size of matrix	Random consistency
1	0
2	0
3	0.58
4	0.9
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49

Source: Al – Harbi (2001)

The acceptable range of CR is less than 0.1. If the value of CR is equal to or less than this range, it means that the comparative judgment has a good level of consistency and acceptability. I n contrast, if CR exceeds the acceptable value, it means that inconsistency of judgment has occurred. Having an acceptable consistency can ensure that the decision-making in determining the relative important of criteria is reliable.

2.6 Time Performance Index (TPI)

Time Performance Index (TPI) is an indicator used for measuring the time performance in a construction project (Othman et al., 2006). It has been used broadly in research about construction but with different names such as schedule performance index, time index, duration performance and schedule performance factor. The Time performance index can be calculated by using the equation below:

$$TPI = \frac{Actual\ Contract\ Duration}{Original\ Contract\ Duration}$$

Example **Time Performance Index of Rehabilitation Project** $= \frac{90}{45}$

Where;

TPI > 1, Project exceeded original contract duration which means project are delayed

TPI < 1, Project completed before original contract duration

TPI = 1, Project completion exactly on time

In the equation, the actual contract duration is the real length of time the construction has taken, while the original contract duration means the period of time specified in the contract.

2.7 Summary

The objectives of this literature review are to study the relevant context of contractor selection, and enhance knowledge about related issues. The important finding from the reviewed literature is that the contractor selection method should cover multi criteria, both price and non-price. In addition, other information also supported the researcher in conducting the research. In the next chapter, the researcher brings these findings to identify the inappropriate point of the current process and find the optimal solution for proposing a new model.

CHAPTER III

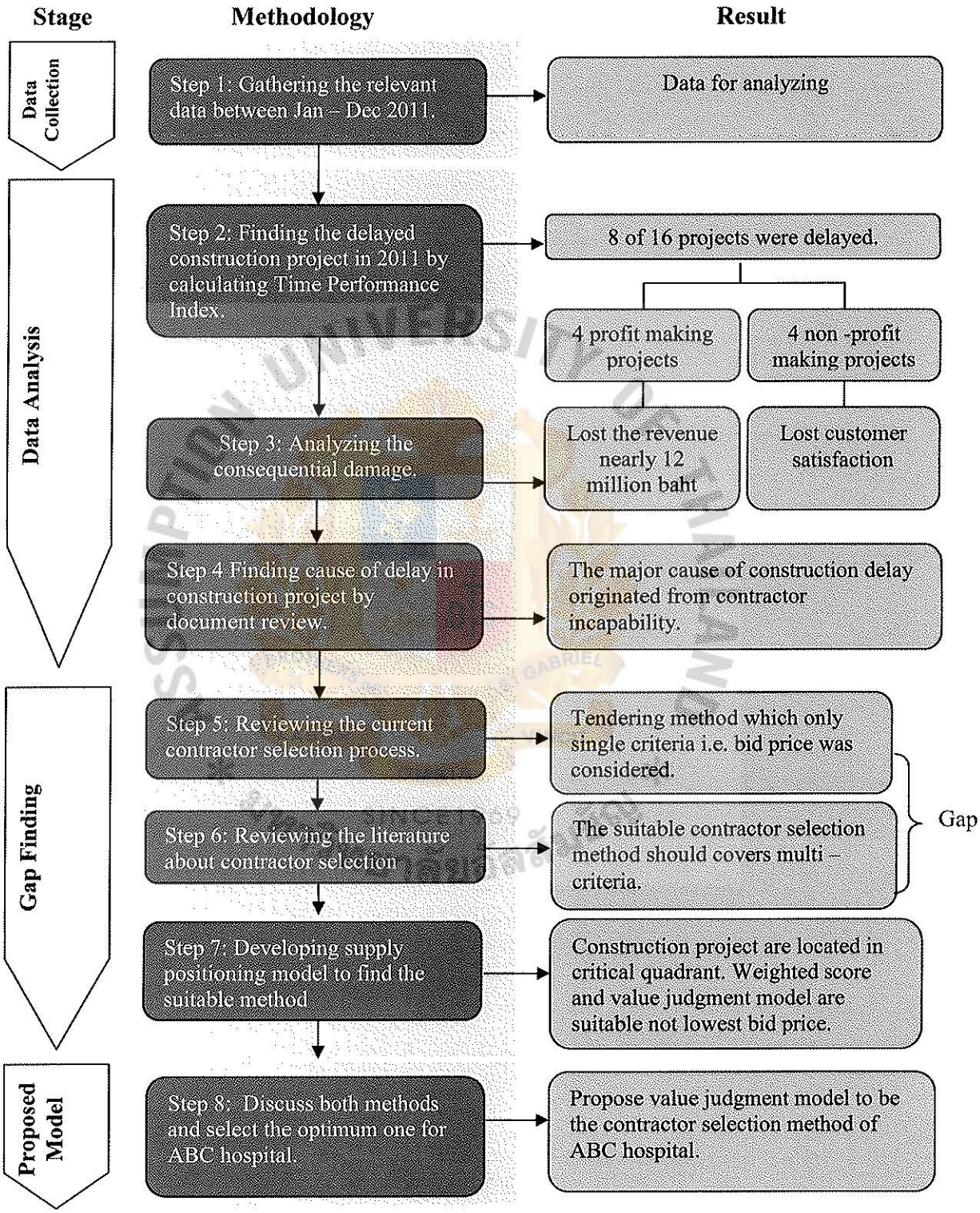
RESEARCH METHODOLOGY

This chapter demonstrates the methodology used for this research. There were five main stages, comprising data collection, data analysis, gap finding, proposed model and summary. First, the data collection stage showed what data was collected by which techniques and for what purpose. Second was the data analysis stage, which began with 8 of 16 construction projects in 2011 which were discovered with delayed schedules by calculating the Time Performance Index (TPI). Then the 8 delayed projects were deeply analyzed to assess how they damaged ABC hospital. The damage was the loss of revenue and customer satisfaction. Next, the cause of the delay was reviewed from the minute of the construction meeting. The researcher found that the major cause of delay was the incapable contractor.

Third, the gap finding stage was to find the difference between the current contractor selection method of ABC hospital and the ideal concept in relevant literature. It found that the current contractor selection method was inappropriate because the literature recommend considering multi-criteria when selecting a contractor, while price was the only factor that was considered in the current process. In this stage the supply positioning model was developed to identify a suitable offer evaluation method. A mismatch was found since the weighted score model or value judgment was more suitable than the lowest price method.

Fourth, in the propose model stage the researcher proposed a value judgment method to be the contractor selection method because ABC hospital focused only on price when selecting the contractor. The last stage was to present the summary of the whole chapter. Figure 3.1 summarizes the algorithm of this research in which the method in each main stage and its result are shown.

Figure 3.1 Research Algorithm



Source: Author

3.1 Data Collection

In this step, the researcher describes the source of data, the method used for collecting the data and the purpose of collecting the data. The data is used for utilizing in the analysis step.

3.1.1 Documentary Review

The historical data since January to December in 2011 was collected by the researcher to review the data from many documents:

- The minutes of weekly construction meetings: to review the cause of delay in each construction project. The data was used to determine the major cause that generated the delay in construction.
- The construction agreement: to collect the starting construction date and the construction duration time that both ABC hospital and the contractor agreed. This data was used to determine the original contract duration which was later used to calculate the Time Performance Index in the data analysis step.
- The project handover document: to review the actual completed date of each construction project. This data was used to determine the actual contract duration which was later used to calculate the Time Performance Index in the data analysis step.
- The monthly revenue of the business unit that was affected by the delays in construction: The data was gathered over two periods of time; first was six months before the area was constructed, and second period was six months after completion of the construction. This data was utilized to calculate how much the hospital lost in revenue that they should have earned during the construction delay.
- The expenditure data: to collect the expenditure of the general support division. The data was used for developing the supply positioning model to identify the quadrants of the construction project.

3.1.2 In-depth interviews

- A face-to-face interview with the project engineer of ABC hospital was conducted to understand how the hospital was affected by the delay of each non-profit making project.
- A face to face interview with the purchasing staff responsible for the construction project was conducted to understand the current contractor selection process.

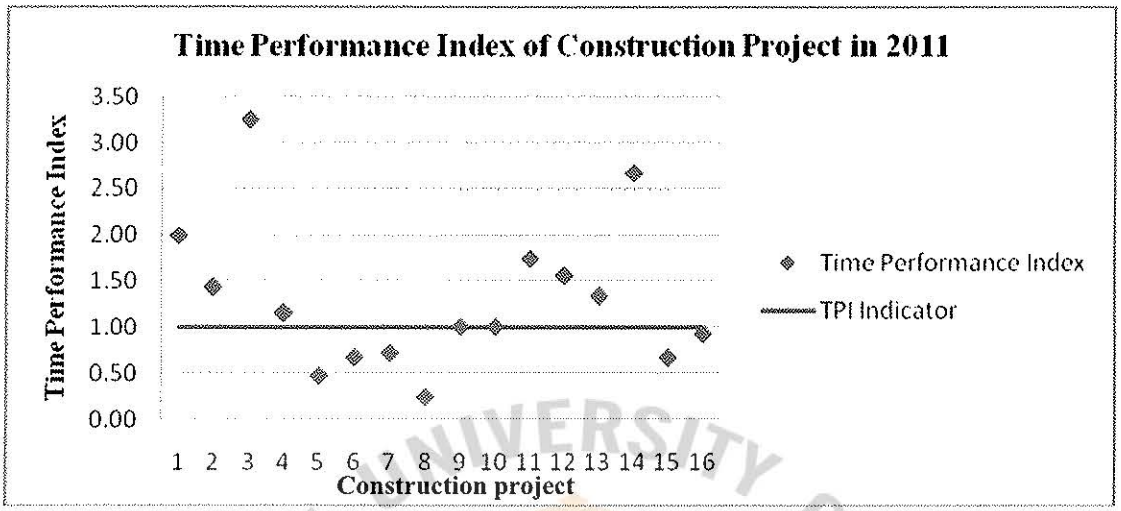
3.2 Data Analysis

In the data analysis stage, the researcher conducted three analysis steps. First, the researcher identified the delayed construction project in 2011 by calculating the Time Performance Index (TPI). Second, the damage to the hospital of the delayed construction projects was determined by reviewing the historical data. Third, the cause of delay was analyzed by reviewing the minutes of construction meetings. Next, the detail of each step was explained.

3.2.1 Identify the Delay Construction Project

At the first step, the researcher found how many construction projects in 2011 were delayed from the schedule, by calculating the Time Performance Index (TPI) of every project (in Appendix A). Regarding the equation, the researcher used the data from Appendix A, the actual contract duration showing the real length of time the construction had taken and the original contract duration where it was the period of time specified in the contract. The results of TPI are demonstrated in Figure 3.2.

Figure 3.2 Time Performance Index of Construction Project in 2011



Source: Author

Any construction project that had a Time Performance Index more than 1 was a delayed project. Therefore, the result in Figure 3.2 showed that from a total 16 construction projects in 2011, there were 8 projects (red dot) delayed from the contract duration time because the TPI was more than 1. The delayed projects were PT Center, Men Beauty Center, Auditorium, Chiller Project Phase II, Heart Center, Cashier Center, Mini-PT Room, and Executive Office.

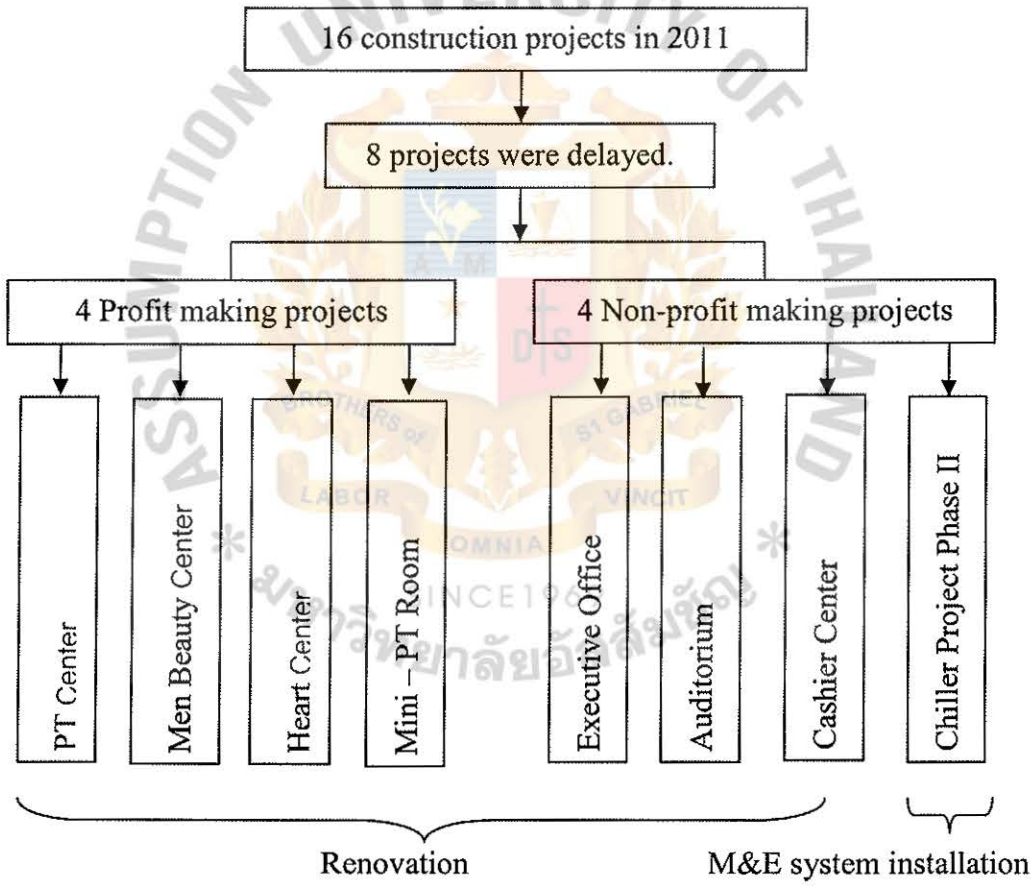
These delayed construction projects could be divided into two types according to the damage to the hospital, as profit making project and non-profit making project. The profit making project was the project from which the hospital could create revenue from the construction area. The purpose of this type of project was not only to build a better environment but also to extend the area in order to generate more revenue. The delayed projects in this group were PT center, Men Beauty Center, Heart Center and Mini-PT Room.

The other type was the non-profit making project. The scope of work of this kind of project included the improving of existing facilities (such as improving the air condition system) or the installation of a new facility (such as the installation of new elevator and escalator), and the renovation in the area which did not generate any

revenue (such as the renovation in the office area). The delayed projects in this group were Chiller project phase II, Auditorium, Cashier Center and Executive Office.

In addition, when considering the scope of work of the delayed projects, the researcher found that 7 of 8 delayed projects were about renovation and the other was about a mechanical engineering (ME) system installation. Figure 3.3 summarizes the classification of construction projects in this research.

Figure 3.3: Classification of Construction Project in 2011



From this section, the delayed construction projects were identified (8 of 16). They were classified according to the damage to the hospital, as four profit making projects and four non-profit making projects. In the next section, the damage to the hospital from the delayed construction projects is analyzed.

3.2.2 Consequential Damage

This section presents the negative effect that the hospital received from the delay of construction projects. The hospital lost money in generating revenue from the area if it had been completed on time as a profit making project. It also lost customer satisfaction and convenience of staff operations from the delay of the non-profit making projects. More detail of the damage from the two kinds of project are described in the following text.

3.2.2.1 Consequential Damage from Profit Making Projects

As mentioned previously, the hospital can make money from the profit making projects after the construction is completed. However, the hospital did not lose all revenue, because during the construction a business unit was moved to operate in a temporary area, so the hospital still generated the revenue. However, once the construction was completed and the business unit moved back to their own area, it can generate more revenue. Therefore, the hospital was faced with losing the opportunity to earn more revenue when the construction was delayed.

ABC hospital calculates the revenue lost during construction delay from the difference of average revenue per day between before and after the construction period, and then multiplying by the number of delay days, as in the equation below. The average revenue per day is calculated from six months (180 days) before and after construction time.

$$\text{Lost revenue} = \left\{\left(\begin{array}{c}\text{Average revenue}\\ \text{per day}\\ \text{before construction}\end{array}\right) - \left(\begin{array}{c}\text{Average revenue}\\ \text{per day}\\ \text{after construction}\end{array}\right)\right\} \times (\text{No .of delay day})$$

Source: ABC's financing and accounting department

Example Lost revenue = {(224,617.01) – (159,332.89)} x 45

= 2,937,785.40 Baht

Table 3.1: Total Revenue Loss from Profit Making Projects.

Project	6 months Ave. revenue before construction (Baht/day)	6 months Ave. revenue after construction (Baht/day)	Dif. Ave. revenue (Baht/day)	Delay days (Days)	Ave. total lost (Baht)
PT Center	159,332.89	224,617.01	65,284.12	45	2,937,785,40
Men Beauty Center	-	178,898.76	-	39	6,977,051.64
Heart Center	296,606.77	341,417.63	44,810.86	45	2,016,488.70
Mini-PT room	-	2,053.19	-	10	20,531.90
Total					**11,951,857.64**

Source: ABC's financial and accounting department

From Table 3.1, the PT Center project was delayed by 45 days from the schedule, leading to the hospital losing 2,937,785.40 baht. The Heart Center project was also delayed 45 days and the hospital lost 2,016,488.70 baht. For the Men Beauty Center and Mini-PT Room, these two projects were the new business units of ABC hospital, therefore the average revenue per day was calculated from the average revenue in the six month after the construction was done. The hospital lost 6,977,051.64 baht and 20,531.90 baht from the delay of the Men Beauty Center and Mini-PT Room projects respectively. In conclusion, the hospital lost revenue totaling 11,951,857.64 baht from the profit making projects.

3.2.2.2 Non-Profit Making Projects

The damage in these projects was that the hospital could not provide the facility to their customers and staffs. This led to customer dissatisfaction and affected the staff's

operation flow. The damage detail in each project was included the interview with the project engineer of ABC hospital, and is described in Table 3.2.

Table 3.2: The Damage from Non-Profit Making Projects

Item	Delay Project	Delay Days (Days)	Consequential Damage
1.	Auditorium	135	During the delay period, the hospital was unable to arrange the important meeting or marketing event as planned.
2.	Cashier Center	25	The customers were not satisfied because the temporary place was not comfortable and not safe.
3.	Chiller project phase II	30	This project was to help the hospital save energy. The delay of the project made the hospital lose money which could have been saved from less energy usage.
4.	Executive office	150	The old area of the executive office was planned to be the new business unit. Therefore, if the executive office could not move out, the area could not start the next construction.

Source: ABC hospital's project engineer.

The total consequential damage showed that ABC hospital suffered monetary effect which was the loss of revenue, and non-monetary effect which were customer satisfaction and convenience of staff operation. This data confirmed that the delay in construction was a serious problem for ABC hospital. Next, the causes of the delay in eight construction projects are revealed.

3.2.3 Finding the Cause of Delay in Construction Projects

In this section, the researcher describes the cause of delay of 8 delayed projects and the source of the delay, by reviewing the minutes of construction meetings as shown in Table 3.3. The finding was the contractor frequently generated the cause of delay.

Table 3.3: The Cause of Delay of Construction Projects

Item	Project	Cause of construction delay	Participant who generate the delay
1.	PT Center	Slow decision making in material approval	Owner
		Additional work was ordered	Owner
		There was a problem in air condition installation because of the sub–contractor lack of technical skill.	Contractor
2.	Men Beauty Center	Many defects needed to be corrected, so the contractor asked for longer time.	Contractor
		Late material delivery	Contractor
		Ordered additional work	Owner
3.	Heart Center	Unacceptable quality of work. Therefore, the contractor needed longer time to re-work.	Contractor
4.	Mini-PT room	Less labor at construction site when project was nearly finished.	Contractor
5.	Executive Office	The contractor could not work to the plan and schedule.	Contractor
		Less labor at construction site when project nearly finished.	Contractor
		Many defects needed to be re-worked.	Contractor
		The design was not clear and some parts were missing.	Architect
		The site work was stopped because it disturbed patients	Other
6.	Auditorium	Problem in installation of air-condition system because of the sub-contractor lack of technical skill.	Contractor
		The contractor did not follow the specification, so they needed to correct many defects.	Contractor
7.	Cashier Center	Ordered additional work	Owner
		Less labor in construction site when the project was near completion.	Contractor
		Poor quality of work, so the contractor needed to correct it.	Contractor
8.	Chiller Project Phase II	Late material delivery	Contractor

Source: Minutes of construction weekly meetings

The result in Table 3.3 showed that the contractors most frequently generated the cause of delay, where every project mentions this (8/8). The poor quality of work, less labor at the construction site, problems from the contractors' lack of technical skill, improper planning, and late material delivery were found as the causes generated by contractors. The causes related to the owner ranked as second. The causes produced by owner were changes in design and additional work (3/8 projects). The third frequently generated cause were the designer by producing unclear design, which only one project mentioned (1/8). The environment at the construction site was also the cause that generated delay, which only one project mentioned. The researcher can summarize from the result in this section that contractors were incapable of performing the construction project, and this was the major cause of delay because they frequently created delays of construction projects.

The result from the data analysis stage showed that 50% (8 of 16) of total construction projects in 2011 were delayed from schedule. The delay affected the hospital in losing revenue, customer satisfaction, and convenience of staff operation. The contractor was found to be the participant who most frequently generated delay of construction. It can be concluded that the contractors' incapability was the major cause of delay. In the next section, the gap that generated these problems is analyzed.

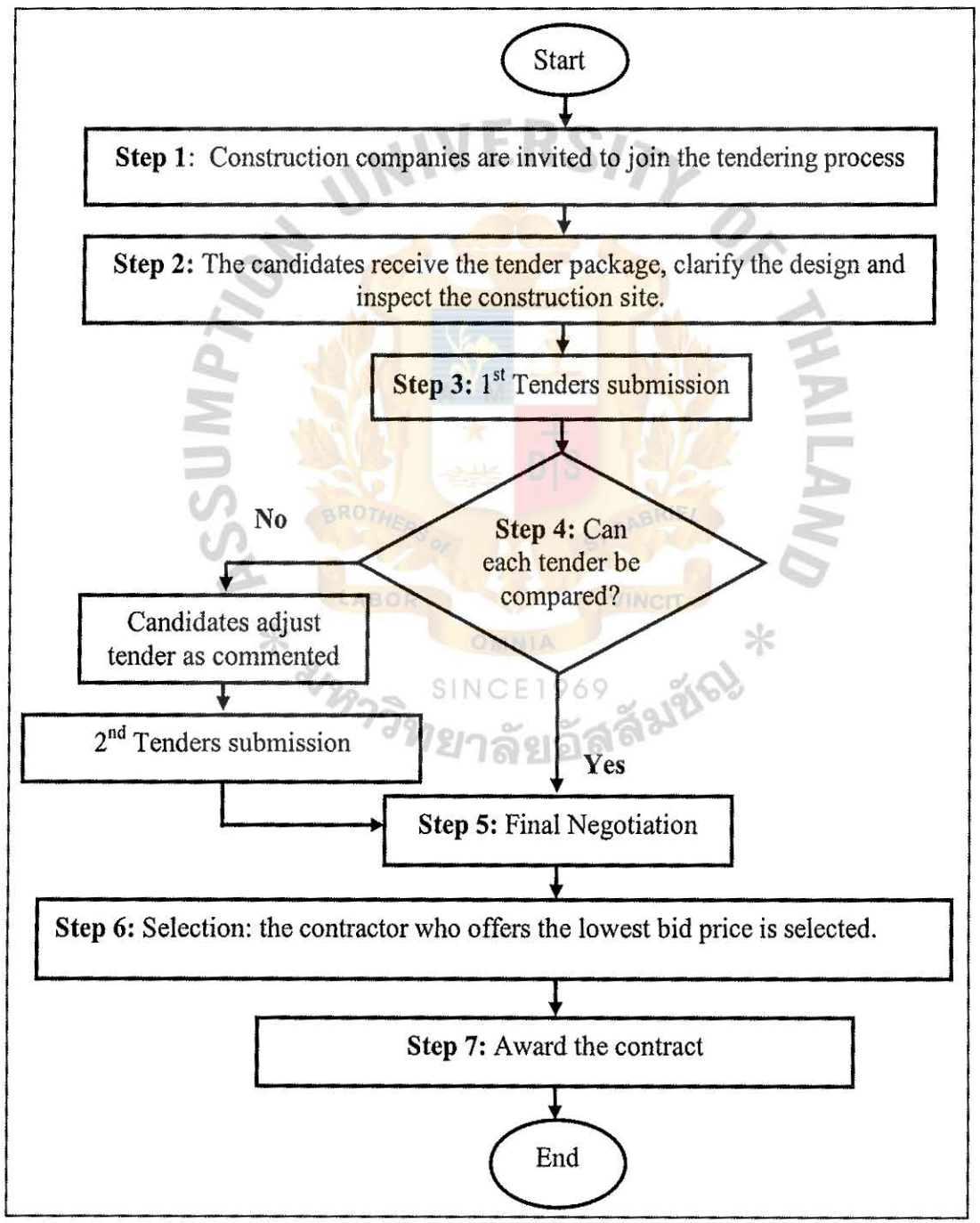
3.3 Gap Finding

In this section, the gap between the current contractor selection process and the findings in the literature was revealed by reviewing the current contractor selection process of ABC hospital. Then, the researcher compared the current process with the findings in literature to discover the gap. A Supplier Positioning model was developed afterwards to find a suitable contractor selection method for ABC hospital.

3.3.1 Reviewing the Current Contractor Selection Process

The old tendering approach had long been adopted as the contractor selection method at ABC hospital. That process of tendering is shown in Figure 3.4 and explained in detail afterwards.

Figure 3.4: The Current Contractor Selection Process



Source: ABC's purchasing department

Step 1: The process starts from inviting the construction firms which regularly work with ABC hospital to participate in the tendering process.

Step 2: All candidates receive the tender package. Then meetings between the hospital, the hired architecture firm and all candidates are held to agree the tender condition and schedule, explain the design and clarify any points not clear. The candidates also have a chance to inspect the actual construction site. The tender package includes the following documents;

- Construction documents i.e. Total of Requirement (TOR), drawings of architectural and engineering work, specification of material, and blank bill of quantity (BOQ).
- Condition of contract such as insurance, cost, and terms of payment etc.
- Tendering schedule

Step 3: Next, all candidates submit tenders on the designated submitting date. The price and bill of quantity (BOQ) must be enclosed in a sealed envelope marked with the candidate's company logo and signature of an authorized person.

Step 4: The tenders are opened by construction committee, without the representatives of candidate contractors. The engineer and hired architect are responsible for reviewing the scope of BOQ between tenders to make sure each of them cover all the things required and can be compared. If the BOQ of each candidate is different, they need to be adjusted and submitted again.

Step 5: After adjusting the scope of BOQ, all candidates are invited to negotiate the final price.

Step 6: The construction committee selects the contractor. The contractor who offers the lowest bid price is selected.

Step 7: After the committee selects the contractor, the award recommendation document is then written to conclude the result. This document is approved by the construction committee and higher executive level. An example of this document is show in Table 3.4. Then the purchasing order process and contract process are started before the contractor starts the construction.

Table 3.4: Award Recommendation Document

Project: PT Center Project		Quotation (Baht) including VAT 7%			
No.	Contractor	1st Quote	2nd Quote	3rd Quote	Final
1	Contractor A	20,500,743	20,123,124	18,500,000	16,150,000
2	Contractor B	22,481,992	19,761,835	17,500,000	16,762,676
3	Contractor C	21,469,471	20,304,853	18,800,000	18,581,192
4	Contractor D	28,473,672	24,830,935	22,500,000	Not submitted

Source: ABC's purchasing department

A review of the current process of contractor selection found that the bid price was the only factor used to compete between candidates. There were no criteria measuring the capability of the contractors. The data in the award recommendation document supported the contractor who offered the lowest bid price and was therefore the winner. From Table 3.4, Contractor A was awarded the PT center project because it offered the lowest bid. The researcher can conclude from these two pieces of evidence that the ABC hospital considered only the bid price as a factor when selecting the contractor for a construction project.

3.3.2 Finding the gap

According to the literature review, many researchers agreed that to select a contractor based only on the lowest tender price was the main factor causing problems in construction projects, including schedule overrun, over budget and poor quality of completed projects (Sonmez et al., 2001; Mahdi et al., 2002; Topcu, 2004; Yilmaz & Ergonul, 2011). The reason was that contractors offered unrealistic prices when faced with a shortage of work in order to stay in business. In addition, all researchers

believed that it was necessary to involve other criteria than the bidding price in the contractor selection method. Those criteria must be able to assess the contractors' competence in order to ensure that the awarded contractor is qualified to undertake the project. The skill, capability and efficiency of a contractor directly lead to the success of construction project performance within budget, on time and with good quality (Al-Harbi, 2001).

When comparing the current contractor selection method of ABC hospital with the findings in the literature, the researcher found that the current method was not appropriate because it was based only on the bidding price. This was the root cause of all problems. From this gap, the researcher saw an opportunity to improve the contractor selection method of ABC hospital by including other criteria able to assess the capability of candidate contractors.

3.3.3 Supply Positioning Model Development

Many contractor selection methods exist in the current literature. International Trade Center (2000c) recommended four valuable evaluation methods which are used in different quadrants of the supply positioning model i.e. lowest price, lowest total cost of ownership, weighted scoring and value judgment. Therefore, to select the appropriate one for construction projects of ABC hospital, the supplier positioning model was developed for matching the right method with what is required.

The model considered the goods or services based on two factors; level of annual expenditure on the item, and impact on the company. The researcher then analyzed these two factors of construction projects of ABC hospital, as in the following;

a. Level of Annual Expenditure

The expenditure was determined on the basis of Pareto's 80/20. The item that accounted for 80% of total expenditure was located on the right side, while the remaining 20% was located on the left side. At ABC hospital, construction projects

were under the responsibility of the general support division. Therefore, the total expenditure of this division was ranked as shown in Table 3.5.

Table 3.5: Expenditure of General Support Division in 2011

Expense Under General Support Division	Annual Expenditure	Percentage	Accumulative Percentage
Construction project	71,735,000.00	93.86 %	93.86 %
Housekeeping service	2,585,800.00	3.38 %	97.24 %
Vehicle service	1,829,000.00	2.39 %	99.64 %
Customer service	144,536.00	0.19 %	99.83 %
Security service	119,000.00	0.16 %	99.99 %
Operator and call center	15,000.00	0.02 %	100.00 %
Total	76,428,336.00	100.00%	

Source: Author

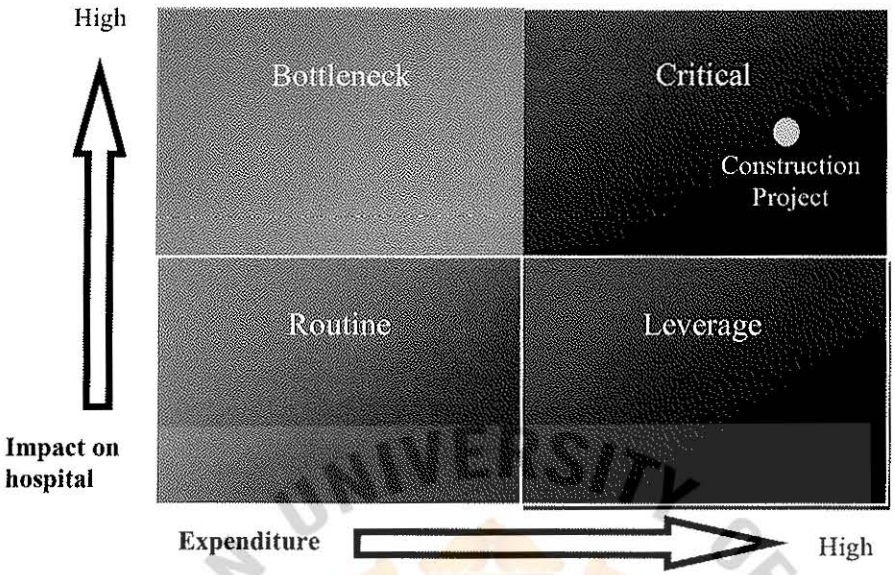
After ranking all expenditures of this division, it was found that construction expenditure was ranked first, which accounts for 93.86% of the general support division's total expenditure in 2011.

b. Impact on the Hospital

This dimension assessed the impact on the hospital if it cannot fully achieve the expected sales of its finished products. The high impact items are located on the top part of the module, while the lesser impact items are plotted on the bottom part. The supply target of a construction project was to complete the project within the timeline. ABC hospital faced delays in construction as a big problem, and it impacted on the hospital's profit (as shown section 3.2.2). This confirmed that the hospital received significant impact to profit from inability to meet the supply target.

Then the analyzed result of the two factors above was plotted on a 2-dimensional matrix (see Figure 3.5). The expenditure was plotted on the horizontal axis and the impact to the hospital was plotted on the vertical axis of the Figure.

Figure 3.5: Supply Positioning Model (Construction Project)



Source: Author

The construction expenditure of ABC hospital accounted for 93.86%, which is more than 80%. Therefore, it was definitely located on the right side of the supply positioning model. The construction project was rated as high level impact to the profit of ABC hospital, so it was positioned at the top part of the Figure.

The researcher firmly concluded from plotting the supply positioning model that the construction project was located in the critical quadrant. According to Figure 2.2, the offer evaluation method for the purchased items in this quadrant could be "Value judgment" or a "Weighted scoring" model. The mismatch had occurred since the current contractor selection method of ABC hospital was the lowest bid price, which is more suitable for the purchase items in the routine quadrant.

In conclusion, currently ABC hospital has a tendering process as the contractor selection method in which the lowest bid price is awarded the contract. When comparing the concept in literature and the current method of ABC hospital, it is found that the hospital should involve other criteria than the bidding price in the selection method. The development of the supply positioning model revealed the

mismatch, and a suitable method should be either the "Value judgment" or "Weighted scoring" model, not lowest bid price method. In the next section, the researcher aims to study which method is more suitable for ABC hospital.

3.4 Proposed Model

From the previous section, the construction project was located in the critical quadrant for which the suitable offer evaluation method could be the "Weighted scoring" or "Value judgment" model. In this section, the researcher discusses the similarity and difference of these two methods, and proposes the value judgment method to be the new contractor selection method of ABC hospital as it fits the situation.

The similarity of weighted score and value judgment was that they provide an assessment method for the criteria related to the supplier capability. However, for the weighted score method, the supplier is scored against a set of criteria of which price is only one of them, while only non-price criteria are used for evaluating suppliers in the value judgment method. Price was compared later with the result of non-price criteria evaluation. The weighted score model is appropriate when price was not more dominant than other criteria, while value judgment considered that price was significantly important.

From the detail of these two methods, the research proposed the value judgment method as the contractor selection method of ABC hospital, for the following reasons.

- The current literatures suggested that the contractor selection method should assess the contractor against multi-criteria. The value judgment method supports this recommendation since it provides the means for evaluating the contractor's capability that covers multi-criteria.
- Value judgment method is appropriate when price is relatively important to buy goods or services. At ABC hospital, bidding price was a highly

important factor of selecting the contractor. Currently, the contractor who offered the lowest bid price was selected.

3.5 Conclusion

The research had gathered the necessary data for the analyzing step, and the result found that there were 8 construction projects which were delayed. The hospital was affected by this problem in losing revenue and losing customer satisfaction. From the document review, the delay was frequently caused by contractors. This confirmed that the contractor was not capable to undertake the construction project. The big gap which generated this problem was the inappropriate contractor selection method which considered only one dimension, i.e. the bidding price.

The value judgment method is proposed in this research since it is suitable for ABC hospital, for two reasons. First, according to the literature, the contractor selection should cover multi-criteria, both price and non-price. The Value judgment concept matches this condition because it provides a method to evaluate the contractor against non-price criteria first, and then compares the result with price before the organization make the decision on selecting a contractor. Second, currently ABC hospital selects the contractor who offers the lowest bid price. This highlights that price is important in ABC's view, and value judgment is appropriate to this condition.

In the next chapter, the proposed contractor selection model based on the value judgment concept was developed by the construction committee of ABC hospital. Moreover, two construction projects in 2011 were tested with the new model to prove that the proposed model worked well at ABC hospital.

CHAPTER IV

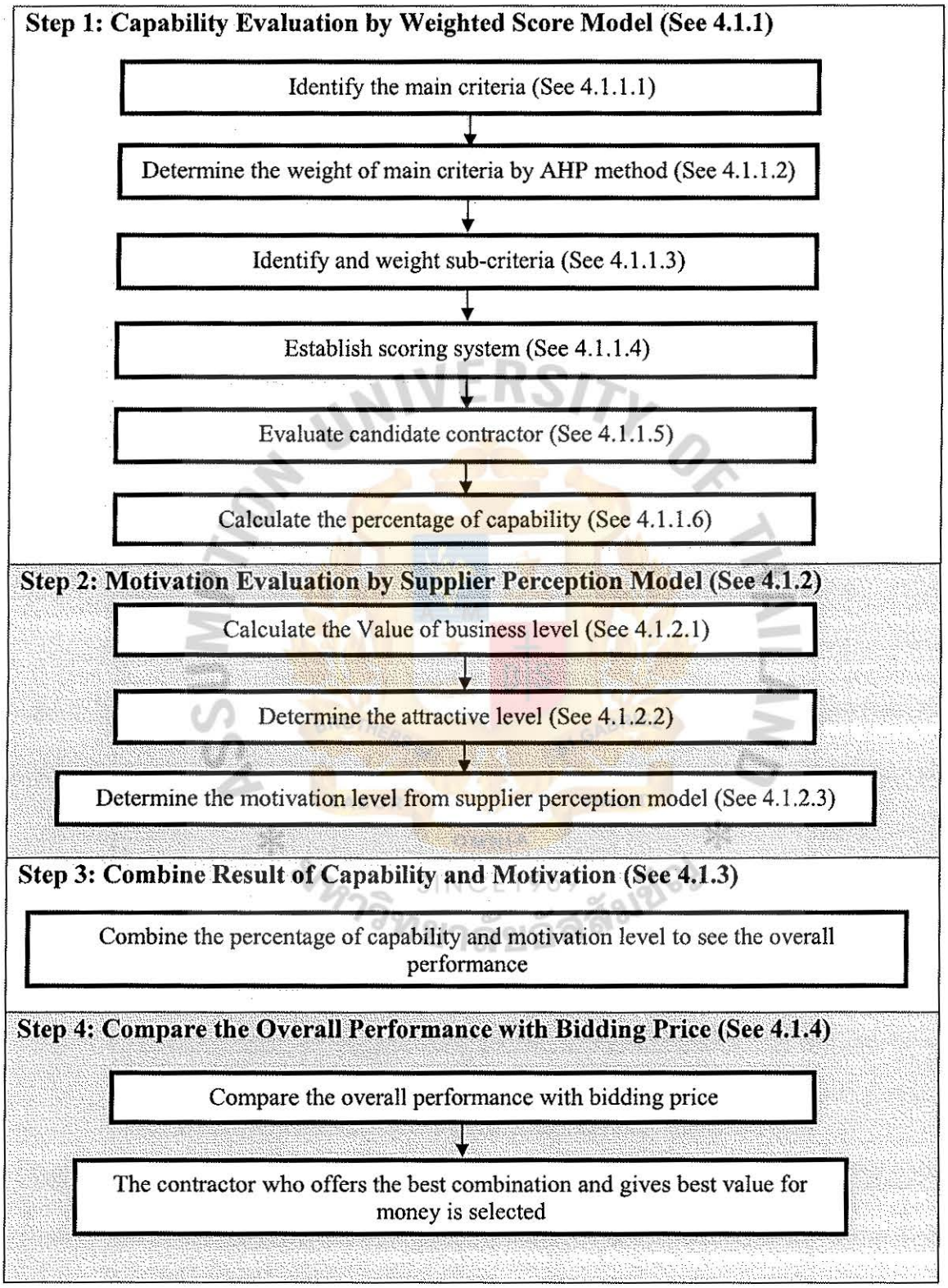
PRESENTATION AND CRITICAL DISCUSSION OF RESULTS

The development of a proposed model based on the value judgment method by the construction committee of ABC hospital is presented in this chapter. The validation of the proposed model was carried out with two previous construction projects of ABC hospital.

4.1 Proposed Model Development

The proposed contractor selection model was developed on the basis of the value judgment method (International Trade Center, 2000c). The construction committee of ABC hospital, including the project engineer, the accounting staff, and the purchasing staff were involved in developing the proposed model for this research. There are four main stages containing several steps (see Figure 4.1): capability evaluation by the weighted score model, motivation evaluation by the supplier perception model, combining the result of capability and motivation, and comparing the overall performance with the bidding price. Then the result of each step is presented.

Figure 4.1: Proposed Model Development Steps



4.1.1 Capability Evaluation by Weighted Score Model

The Weighted Score model is used to assess the contractor's capability since it provides the means to assess the contractor against multi-criteria. ABC's construction committee constructed the weighted score model through the following steps.

4.1.1.1 Identify Main Criteria

Under the value judgment concept, only non-price criteria are used for assessing the contractor capability. The Tasmanian Department of Treasury and Finance (2006) proposed contractor selection criteria that can assess the competence of a contractor to achieve the required project outcome. The construction committee agreed to use six non-price criteria proposed by this organization to be the main criteria of the proposed model. The definition of each main criterion is described in Table 2.2. Table 4.1 presents the main criteria and their abbreviations used in this research.

Table 4.1: Main Criteria

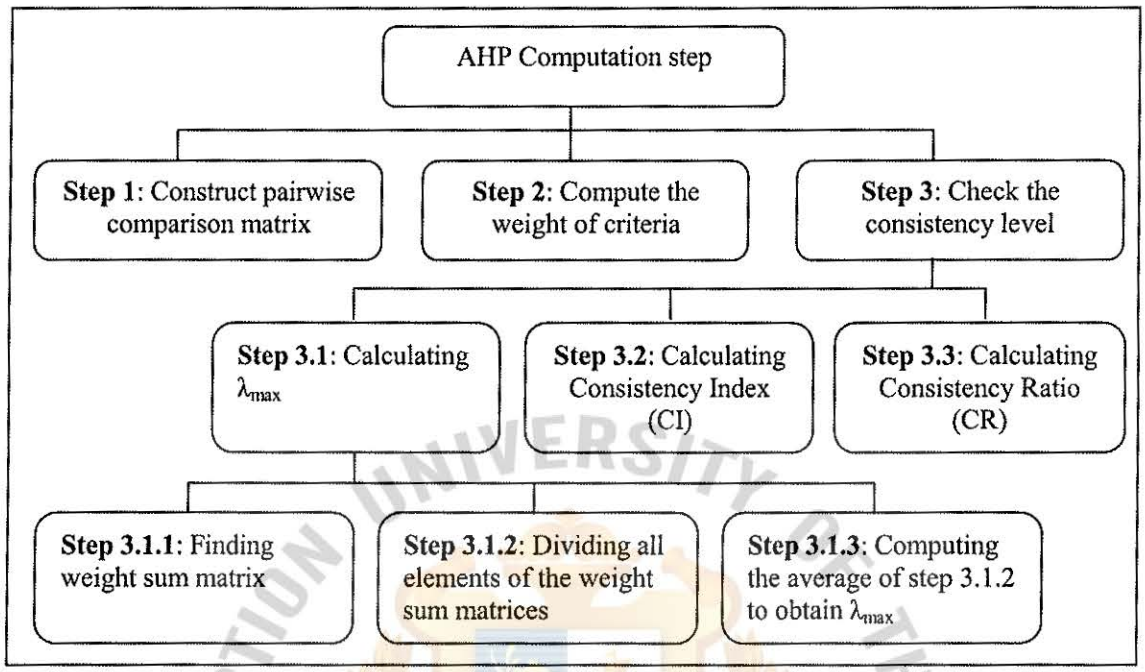
Main Criteria	Abbreviation
Relevant experience	Criteria 1
Past performance	Criteria 2
Technical skill	Criteria 3
Management skill and system	Criteria 4
Resources	Criteria 5
Methodology	Criteria 6

4.1.1.2 Determine the Weight of Main Criteria by AHP Method

Different companies give the relative important of each criterion differently. To know how ABC hospital distinguished the relative important of those main criteria, this study adopted the Analytical Hierarchy Process (AHP). The construction committee determined the weight by following the AHP method of Al-Harbi (2001)

As AHP computation takes many steps and is complicated, to make it easy to understand, Figure 4.2 shows the AHP process diagram.

Figure 4.2: AHP Computation Step



Step 1: Construct the Pairwise Comparison Matrix

The construction committee constructed the pairwise comparison matrix by comparing the importance of each pair of criteria. The scores 1-9 in Table 2.5 were given according to how one criterion was more important over another. The result is shown in Table 4.2.

Table 4.2: Pairwise Comparison Matrix

Criteria	1	2	3	4	5	6
1	1	1/2	1/5	1/7	2	1/6
2	2	1	1/2	1/4	3	1/4
3	5	2	1	1/3	4	1/3
4	7	4	3	1	7	2
5	1/2	1/3	1/4	1/7	1	1/5
6	6	4	3	1/2	5	1
Column Total	21.5000	11.8333	7.9500	2.3690	22.0000	3.9500

Step 2: Compute the Weight of Criteria

Firstly, the construction committee calculated the sum total of each column. Secondly, the construction committee divided each number in the pairwise comparison matrix by its column total; the result is showed in Table 4.3. Afterwards, the weight of each criterion was received from finding the row averages. The weight of criteria is shown in Table 4.3.

Table 4.3 Weight of Criteria

Criteria	1	2	3	4	5	6	Weight
1	0.0465	0.0423	0.0252	0.0603	0.0909	0.0422	**0.0512**
2	0.0930	0.0845	0.0629	0.1055	0.1364	0.0633	**0.0909**
3	0.2326	0.1690	0.1258	0.1407	0.1818	0.0844	**0.1557**
4	0.3256	0.3380	0.3774	0.4221	0.3182	0.5063	**0.3813**
5	0.0233	0.0282	0.0314	0.0603	0.0455	0.0506	**0.0399**
6	0.2791	0.3380	0.3774	0.2111	0.2273	0.2532	**0.2810**
Sum of Weights							**1.0000**

After determining the weight of criteria, management skills and systems were the most important criteria in ABC's view with a weight of 0.3813. Methodology with a weight 0.2810 was ranked second followed by technical skill with weight 0.1557, past performance with weight 0.0909, relevant experience with weight 0.0512, and resource with weight 0.0399. Next, the judgment of ABC's construction committee was checked by the consistency level.

Step 3: Check the Consistency Level

As the pairwise comparison was conducted by human judgment, so the consistency ratio (C.R.) of the comparison judgment was calculated by the construction committee in order to determine the acceptance of the priority weighting. AHP also provides the method of consistency test which aims to eliminate the possible inconsistency reveal in criteria weights. The method can be done in the following step.

Step 3.1: Calculating λ_{max}

Step 3.1.1: Finding weight sum matrix

$$0.0512\begin{bmatrix}1\\2\\5\\7\\\frac{1}{2}\\6\end{bmatrix}+0.0909\begin{bmatrix}\frac{1}{2}\\1\\2\\4\\\frac{1}{3}\\4\end{bmatrix}+0.1557\begin{bmatrix}\frac{1}{5}\\\frac{1}{2}\\1\\3\\\frac{1}{4}\\3\end{bmatrix}+0.3813\begin{bmatrix}\frac{1}{7}\\\frac{1}{4}\\\frac{1}{3}\\1\\\frac{1}{7}\\\frac{1}{2}\end{bmatrix}+0.0399\begin{bmatrix}2\\3\\4\\7\\1\\5\end{bmatrix}+0.2810\begin{bmatrix}\frac{1}{6}\\\frac{1}{4}\\\frac{1}{3}\\\frac{1}{2}\\\frac{1}{5}\\1\end{bmatrix}=\begin{bmatrix}0.3089\\0.5564\\0.9739\\2.4117\\0.2454\\1.8091\end{bmatrix}$$

Step 3.1.2: Dividing all elements of the weight sum matrices by weight of criteria

$$\frac{0.3089}{0.0512}=6.0331$$

$$\frac{0.5564}{0.0909}=6.1213$$

$$\frac{0.9739}{0.1557}=6.2548$$

$$\frac{2.4117}{0.3813}=6.3249$$

$$\frac{0.2454}{0.0399}=6.1503$$

$$\frac{1.8091}{0.2810}=6.4379$$

Step 3.1.3: Computing the average of the result of step 3.1.2 to obtain λ_{max}

$$\lambda_{max} = \frac{(6.0331+6.1213+6.2548+6.3249+6.1503+6.4379)}{6} = 6.2204$$

Step 3.2: Calculating Consistency Index (CI) from CI = $\frac{\lambda max - n}{n-1}$

$$CI = \frac{(6.2204-6)}{(6-1)}$$

$$CI = 0.0441$$

Step 3.3: Calculating Consistency Ration from CR = $\frac{CI}{RI}$

Where RI, Random consistency index (RI), can find from table 2.8

$$CR = \frac{0.0441}{1.24}$$

$$CR = 0.0355$$

As mentioned previously in Chapter 2, a consistency ratio (CR) of 0.1 or less is considered acceptable. The calculation above showed a consistency ratio of 0.0355, therefore the comparative judgment in the pairwise comparison matrix had an acceptable level of consistency. Therefore, the given weight was acceptable.

4.1.1.3 Identify and Weight Sub-criteria

Each main criterion can be broken into its sub-criteria to narrow the assessment area. The construction committee identified the sub-criteria based on six main criteria as the hospital's objectives and needs. Table 4.4 presents the main criteria and their sub-criteria as well as their definitions. After that, the weight of sub-criteria was assigned according to its relative importance. Table 4.5 shows the weight of sub-criteria of which the sum total equals the weight of the main criteria.

Table 4.4: Sub-criteria and Definitions

Main criteria/Sub-criteria	Definition
Relevant experience	
Experience in similar completed project in last three years	The experience of the contractor that performs the construction project similar to the tendering project. The similarity can be defined in terms of scope of work and scale of area. The contractor who has much experience in the same scope with the tendering project seems to be expert in that field. The list of previous similar project performed by the contractor in the last three year is required from the contractor.
Experience in construction industry	The years of experience which the contractor has in the construction industry. The more experience represents the more skill in construction work. The company's Memorandum of Association is required to check how many years the contractor has been in the construction industry.
Past performance	
Time performance	The ability to perform previous construction projects within specific duration time. The Time Performance Index (TPI) of one previous similar project is calculated.
Quality performance	The quality of previous work performed by contractor. The performance of the contractor is checked from the level of past customer satisfaction.
Responsibility performance	The responsibility of contractor during the construction period and warranty period. The performance of the contractor is checked from the previous customer.
Technical skill	
Education level and experience of foreman	The foreman is the head of construction labor. The education level and experience of each foreman is checked since the foreman who has better qualifications trends to have better technique, management skill, problem solving skill, and responsibility.
Experience in hospital of project manager	The project manager has the responsibility to control the whole project to meet the customer's need. Construction in a hospital needs safe, quiet, and clean execution from the contractor. The experience in hospitals of each project manager is checked.
Management skills and systems	
Management skill of project manager	A project manager is responsible for managing and monitoring the overall construction project as well. Therefore, if the construction project is managed by a qualified project manager, the construction can run smoothly and achieve time, quality, and budget. The project manager that each candidate proposed to employ for the tendering project is interviewed and asked questions about construction problems in order to know the level of his management skill.

Source: ABC's construction committee

Table 4.4: Sub-criteria and Definitions (continued)

Main criteria/Sub-criteria	Definitions
Management skills and systems	
Site management	The ability to manage the construction site to be a safe, clean and friendly environment. The site management performance by each contractor is checked from the previous customer's satisfaction.
Resource	
Registered capital	The total money capital that the contractor uses for setting up a company. This amount is stated in Memorandum of Association. In ABC hospital's view, the company which has high registered capital has more reliability to do business with.
The use of sub-contractor	Subcontractor is hired by a general contractor to finish a specific task. The subcontractor is required when the general contractor does not have its own resource to perform the particular task by itself. ABC hospital experiences that when a contractor hire many subcontractors, it is difficult to manage the construction project.
Methodology	
Proposed construction timeline	The timeline that the contractor plans and proposes for the tendering project. It is good for the hospital to ensure a correct schedule. The proposed timeline is assessed by the sequence of activities, the duration of activities, and the existing of each sub-activity. It is beneficial if the contractor can show the date of start and end of each activity.
Proposed methodology	The methodology for the tendering project that a contractor proposes to use. A reasonable and possible method is a good sign that the contractor is likely to succeed in the project. The contractor is asked to describe the methodology.

Source: ABC's construction committee

From Table 4.4, the construction committee identified thirteen sub-criteria based on six main criteria. The sub-criteria were defined according to ABC hospital's needs and objectives. The information on how ABC hospital assessed candidate contractors against each sub-criterion is also described in the Table. Next, the construction committee assigned the weight of each main criterion to their sub-criterion according to their relative importance. The result is shown in Table 4.5 from which we can see that the sum total of sub-criteria's weight is equal to their main criteria's weight, and the sum total of sub-criteria is equal to 1.

Table 4.5: Sub-criteria and Their Weight

Criteria	Weight
1. Relevant experience	**0.0512**
- Experience in similar completed project in last three years (70%)	0.0358
- Experience in construction industry (30%)	0.0154
2. Past performance	**0.0909**
- Time performance (40%)	0.0363
- Quality performance (30%)	0.0273
- Responsibility performance (30%)	0.0273
3. Technical skill	**0.1557**
- Education level and experience of foreman (40%)	0.0623
- Experience in hospital of project manager (60%)	0.0934
4. Management skills and systems	**0.3813**
- Management skills of project manager (60%)	0.2288
- Site management (40%)	0.1525
5. Resources	**0.0399**
- Register capital (70%)	0.0279
- The use of sub-contractor (30%)	0.0120
6. Methodology	**0.2810**
- Proposed construction timeline (50%)	0.1405
- Proposed methodology (50%)	0.1405
Total weight of sub-criteria	**1.0000**

Source: ABC's construction committee

4.1.1.4 Establish a Scoring System

A scoring system was defined in order to be the principal system during the score step. Under the scoring system, the construction committee can agree on the same thing when giving a score to each contractor. In this research, the score scale 1, 2, 3, 4, 5 was used to score the candidate contractors. The definition of each score against each sub-criterion was the possible performance of the contractor. The scoring system established by the construction committee of ABCH hospital is shown in Table 4.6.

Table 4.6: Scoring System

Criteria	Scoring Scale				
	1	2	3	4	5
Relevant experience					
Experience in similar completed project in last three years	≤ 5 similar projects	6 - 10 similar projects	11 – 15 similar projects	16 – 20 similar projects	≥ 21 similar projects
Experience in construction industry	Experience year ≤ 2	>2 Experience year ≥5	>5 Experience year ≥10	>10 Experience year ≥15	Experience year ≥15
Past performance					
Time performance	TPI > 2	2 ≥ TPI > 1.5	1.5 ≥ TPI > 1	TPI = 1, the construction finish within time.	TPI < 1, the construction finish before time.
Quality performance	The previous customer is not satisfied with the quality of previous project of customer and not recommends hiring the contractor.	The previous customer is slightly satisfied with the quality of previous project of customer.	The previous customer is somewhat satisfied with the quality of previous project of customer.	The previous customer is very satisfied with the quality of previous project of customer.	The previous customer is extremely satisfied with the quality of previous project of customer.

Table 4.6: Scoring System (continued)

Criteria	Scoring scale				
	1	2	3	4	5
Responsibility performance	Unable to complete the project and abandon the project.	Able to complete the project but the contractor neglect to repair for the defects during warrantee period.	Able to complete the project but it is difficult to contact the contractor during warrantee period.	Able to complete the project and come to repair the defect promptly when requested.	Able to complete the project and no defect during warranty period
Technical skill					
Education level and experience of foreman	Less than high vocational certificate either has experience or not	High vocational certificate in civil construction or related field without similar project experience	Bachelor of civil engineering without similar project experience	High vocational certificate in civil construction or related field with similar project experience	Bachelor of civil engineering with similar project experience
Experience in hospital of project manager	No working experience in hospital	Experience in other hospital without JCI standard	Experience in ABC hospital	Experience in ABC hospital, and other hospital in the same network.	Experience in ABC hospital, the hospital in same network and , other hospital accredited with JCI standard
Management skill and system					
Management skill of project manager	Poor management skill.	Fair management skill	Good management skill	Very good management skill	Excellent management skill

Table 4.6: Scoring System (continued)

Criteria	Scoring scale				
	1	2	3	4	5
Management skills and systems					
Site management	The previous customer is not satisfied with the site management of the contractor	The previous customer is slightly satisfied with the site management of the contractor	The previous customer is somewhat satisfied with the site management of the contractor	The previous customer is very satisfied with the site management of the contractor	The previous customer is extremely satisfied with the site management of the contractor
Resource					
Registered capital	< 1,000,000 baht	1,000,0000 – 2,000,000 baht	2,000,0001 – 3,000,000 baht	3,000,0001 – 4,000,000 baht	≥ 5,000,000 baht
The use of sub-contractor	The contractor subcontracts for all tasks i.e. interior, architectural, electrical, air conditional, sanitary, and other special task such as LAN system and medical gas system.	• The contractor is respond for architectural task only • Subcontract for interior, electrical, air conditional, sanitary, and other special task such as LAN system and medical gas system.	• The contractor is respond for interior task only • Subcontract for architectural, air conditional, sanitary, and other special tasks such as LAN system and medical gas system.	• The contractor is respond for both interior and architectural task • Subcontract for air conditional, sanitary and other special tasks such as LAN system and medical gas system.	• The contractor is respond for all tasks except special task such as LAN system and medical gas system.

Table 4.6: Scoring System (continued)

Criteria	Scoring scale				
	1	2	3	4	5
Methodology					
Proposed construction timeline	• The activities that will be performed on the project are listed in wrong sequence. • Activity duration is unreasonable.	• Either the contractor can list the activity that will be performed on the project in correct sequence activity or the duration of activity is reasonable	• The contractor can list the activity that will be performed on the project in correct sequence and the duration of activity is reasonable. • The schedule does not shows the sub-activities	• The contractor can list the activity that will be performed on the project in correct sequence and the duration of activity is reasonable. • The schedule shows the sub-activities	• The contractor can list the activity that will be performed on the project in correct sequence and the duration of activity is reasonable. • The schedule shows the sub-activities • The date of start and end of each activity is specified.
Proposed methodology	The purposed method is not likely to make the project success.	The purposed method is general procedure without any special technique. There are some methods that can make the project not success.	The purposed method is general procedure without any special technique. However, it can make the project success.	The contractor proposed special method that can contribute to the better performance.	The contractor proposed special method that contributes to the better performance. The method is practicable with clear steps.

4.1.1.5 Evaluate Candidate Contractors

In this step the construction committee developed a Capability Evaluation form shown in Appendix B by using the main criteria, sub-criteria, and the weight that was identified in previous steps. ABC hospital can use this form to evaluate the capability of candidate contractors against sub-criteria. The score is given to each contractor based on how its offer performs according to scoring system that has been established in step 4.1.1.4.

Referring to the capability evaluation from in appendix B, the weighted score is obtained by multiplying the score of each sub-criterion by its weight. Then it is summed up to reach a total weighted score.

4.1.1.6 Calculate the Percentage of Capability

In this step, the construction committee developed the Percentage of Capability form shown in appendix B for calculating the percentage of capability of each contractor. It is computed by dividing the total weighted score by the total score possible and converting this into percentage.

4.1.2 Motivation Evaluation by Supplier Perception Model

Another dimension used for assessing the candidate contractor is the motivation level. The Supplier Perception model is adopted to identify the motivation of each contractor to work with ABC hospital. In this step, the construction committee designed the form and agreed on the data used for constructing the model.

4.1.2.1 Calculate the Value of Business Level

In this step, the construction committee developed the Value of Business form shown in appendix B. The construction committee agreed to use the estimated value of a tendering project divides by contractor's annual turnover to obtain the percentage of value of business of each contractor. Then the result is compared with the data in Table 2.4 in order to classify the level of value of business.

$$\text{Percentage of Value of Business} = \frac{\textit{Estimated value of tendering project}}{\textit{Contractor's annual turnover}} \times 100$$

4.1.2.2 Determine the Attractiveness Level

The level of attractiveness is assessed to know how each contractor is interested in working with the hospital. To perceive the attractiveness, the construction committee agreed to determine the attractiveness of each contractor following the factor in Figure 2.5 and analyzed into a High, Moderately High, Low, or Negligible level. The Level of Attractiveness form is used to identify the attractiveness level, and is shown in Appendix B.

4.1.2.3 Identify the Motivation Level from the Supplier Perception Model

To identify the motivation level of each contractor, the construction committee brings the result of value of business and attractiveness level to a position in the supplier perception model form shown in Appendix B. The level of motivation can be determined from the curve area into which each contractor falls.

4.1.3 Combining Results of Capability and Motivation

In this step, the construction committee combines the result of capability and motivation evaluation to see the overall performance of each contractor. Both results are plotted into a contractor overall performance form shown in Appendix B.

4.1.4 Comparing the Overall Performance with Bidding Price

In this step, the construction committee developed the contractor performance and price form shown in Appendix B. The form is used for comparing the performance of each contractor compared with its bidding price. After that, the construction committee considers and selects a contractor according to the value judgment concept.

That is the proposed model development constructed by ABC's construction committee. It was apparent that the model was developed based on ABC's objectives and needs. Next, two case studies of ABC's construction project were tested with the

proposed model in order to prove that the model was applicable. The construction committee was asked to make a decision from the proposed model.

4.2 Case Study Application

The validation of the proposed model was carried out using the two delayed construction projects in 2011 that created the highest damage to the hospital; one from a profit making project and another from a non-profit making project. The construction committee used the form in Appendix B, that was developed in the previous section, to evaluate the contractors following the steps of the proposed model.

4.2.1 Application of the Model to a Profit Making Project

Referred to in Table 3.1, Men Beauty Center was the profit making project that created the highest lost revenue per day. Therefore, the faster the project finishes, the more the hospital could generate this revenue. Hence, this project was chosen to examine against the proposed model. The estimated value of this project was 10,000,000 baht. The objective of this project was to renovate the 550 square meters area which was the old office to be the new outpatient department. The scope included demolition, interior decoration, architectural work, mechanical and electrical work, air condition work, sanitary, fire alarm system, LAN system, and medical gas system.

By the current method, the hospital selected the contractor based on the lowest bid price. As can be seen from Table 4.7, five contractors attended the tendering process. AI Company won the tendering process since it offered the lowest price. It underlines the fact that other dimensions of contractor performance were not considered.

Table 4.7: Award Recommendation of Men Beauty Center Project

Project: PT Center Project		Quotation (Baht) including VAT 7%		
No.	Contractor	1st Quote	2nd Quote	Final
1	AA Company	11,926,143	10,673,216	9,500,000
2	OB Company	13,058,730	12,627,121	10,500,000
3	PS Company	11,270,216	11,969,552	10,700,000
4	GM Company	13,753,827	13,154,361	11,000,000
5	SK Company	11,157,793	12,294,769	11,800,000

Source: ABC's Purchasing Department

Next the construction committee validated the proposed model that has been developed in previous section with the Men Beauty Center Project.

4.2.1.1 Capability Evaluation by Weighted Score Model

The construction committee scored each contractor against each sub-criterion based on how the contractor performed. Points were given according to the scoring system that had been established. Table 4.8 presents the result of the capability evaluation of this project.

Table 4.8: Capability Evaluation Result of Men Beauty Center Project

Criteria	Weight	AA Company		OB Company		PS Company		GM Company		SK Company	
		Score	Weighted score	Score	Weighted score	Score	Weighted score	Score	Weighted score	Score	Weighted score
Relevant experience											
- Experience in similar completed project in last three years	0.0358	3	0.1074	3	0.1074	4	0.1432	2	0.0716	2	0.0716
- Experience in construction business	0.0154	3	0.0462	3	0.0462	4	0.0616	2	0.0308	4	0.0616
Past performance											
- Time performance	0.0363	2	0.0726	2	0.0726	3	0.1089	1	0.0363	1	0.0363
- Quality performance	0.0273	3	0.0819	3	0.0819	4	0.1092	2	0.0546	2	0.0546
- Responsibility performance	0.0273	4	0.1092	4	0.1092	4	0.1092	2	0.0546	3	0.0819
Technical skill											
- Education level and experience of foreman	0.0623	3	0.1869	4	0.2492	5	0.3115	2	0.1246	4	0.2492
- Experience in hospital of project manager	0.0934	3	0.2802	4	0.3736	5	0.4670	1	0.0934	3	0.2802
Management skill											
- Management skill of project manager	0.2288	3	0.6864	3	0.6864	4	0.9152	2	0.4576	3	0.6864
- Site management	0.1525	3	0.4575	4	0.6100	4	0.6100	2	0.3050	3	0.4575
Resource											
- Registered capital	0.0279	3	0.0837	3	0.0837	5	0.1395	1	0.0279	4	0.1116
- The use of sub-contractor	0.0120	2	0.0240	3	0.0360	4	0.0480	1	0.0120	3	0.0360
Methodology											
- Proposed timeline	0.1405	3	0.4215	4	0.5620	5	0.7025	2	0.2810	3	0.4215
- Proposed methodology	0.1405	3	0.4215	3	0.4215	3	0.4215	3	0.4215	3	0.4215
Total weighted score			2.9790		3.4397		4.1473		1.9709		2.9699

The total weighted score in Table 4.8 was brought in to calculate the percentage of capability. The result is shown in Table 4.9.

Table 4.9: Percentage of Capability Result of Men Beauty Center Project

Contractor Name	Total weighted score	Total score possible	Percentage of capability
AA Company	2.9790	5.0000	59.58%
OB Company	3.4397	5.0000	68.79%
PS Company	4.1473	5.0000	82.95%
GM Company	1.9709	5.0000	39.42%
SK Company	2.9699	5.0000	59.40%

From Table 4.9, PS Company has the highest percentage of capability at 82.95% followed by OB Company (68.79%), AA Company (59.58%), SK Company (59.40%), and GM Company (39.42%). Next, each contractor was evaluated for their motivation level.

4.2.1.2 Motivation Evaluation by the Supplier Perception Model

The result of the motivation level identified by the construction committee is presented in the following.

4.2.1.2.1 Calculate the Value of Business

To obtain the value of business, the estimated value of this project is divided by the contractor's annual turnover. For this project, the hospital estimated the value of this project at 10,000,000 baht. The annual turnover of each contractor is shown in Table 4.10. The percentage of value of business was compared with Table 2.4 to convert percentage value into the high, moderately high, low, or negligible levels.

Table 4.10 Value of Business Result of Men Beauty Center Project

Contractor name	Estimated value of the tendering project	Contractor's annual turnover	Percentage of Value of business	Level of value of business
AA Company	10,000,000	150,000,000	6.67%	M
OB Company	10,000,000	40,000,000	25%	H
PS Company	10,000,000	100,000,000	10%	M
GM Company	10,000,000	60,000,000	16.67%	H
SK Company	10,000,000	80,000,000	12.50%	M

From the value of business result in Table 4.10, OB Company and GM Company have the high value of business. The other three companies including AA Company, PS Company, and SK Company obtain a moderately high value of business.

4.2.1.2.2 Determine Level of Attractiveness

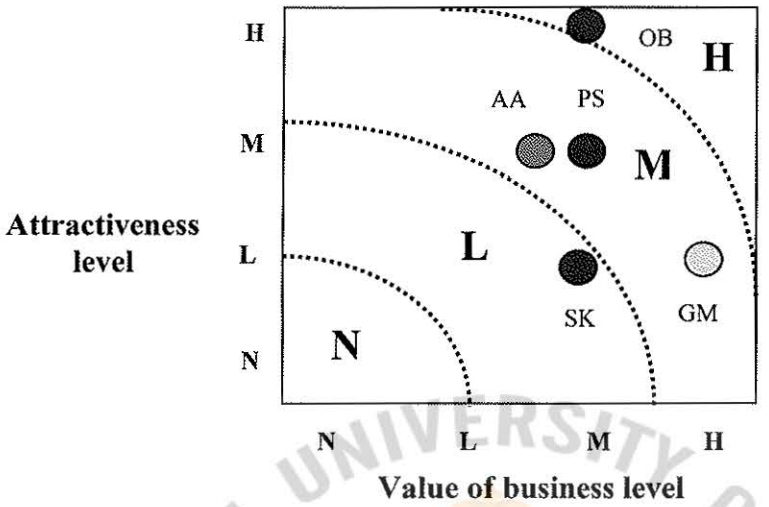
The result of level of attractiveness determined by the construction committee is presented in Table 4.11.

Table 4.11: Level of Attractiveness Result of Men Beauty Center Project

Contractor Name	Attractiveness description	Level
AA Company	The contractor had performed a few projects for ABC hospital. It might want to continue business with the hospital. However, it faced some delay in payment in one previous project.	M
OB Company	The contractor had a long term and good relationship with ABC hospital. It had performed many small projects of ABC hospital. Therefore the tendering project for which the scope was larger might attract the contractor. Moreover, it could improve its reference profile from this project.	H
PS Company	The contractor used to work with ABC hospital in the past. Therefore, it might want to develop business with the hospital again. However, it has many construction projects in hand, so it might not have much attractiveness for this project.	M
GM Company	The contractor had just conducted one previous construction project for ABC hospital but it faced delay in payment. Moreover, there were a lot of problems in that project.	L
SK Company	The contractor had been invited to join the tendering process for many construction projects but had never been awarded one.	L

From Table 4.11, the construction committee determined different levels of attractiveness for different companies. OB Company has a high level of attractiveness, while AA Company and PS Company have the same level of attractiveness at the moderately high level. GM Company and SK Company have a low level of attractiveness. Next, the result of steps 4.2.2.1 and 4.2.2.2 were plotted in Figure 4.3 to identify the level of motivation.

Figure 4.3: Motivation Level Result of Men Beauty Center Project



From Figure 4.3, the construction committee can identify the level of motivation from the area in which each contractor is positioned. OB Company has the high motivation level. AA Company, PS Company, and GM Company have the same motivation level at moderately high level. SK Company is the company that has the lowest motivation level to work with ABC hospital.

4.2.1.3 Combine the Result of Contractor's Capability and Motivation

The construction committee combined the result of capability percentage and motivation level by plotting both results into Figure 4.4 to see the overall performance.

Figure 4.4: Overall Performance Result of Men Beauty Center Project

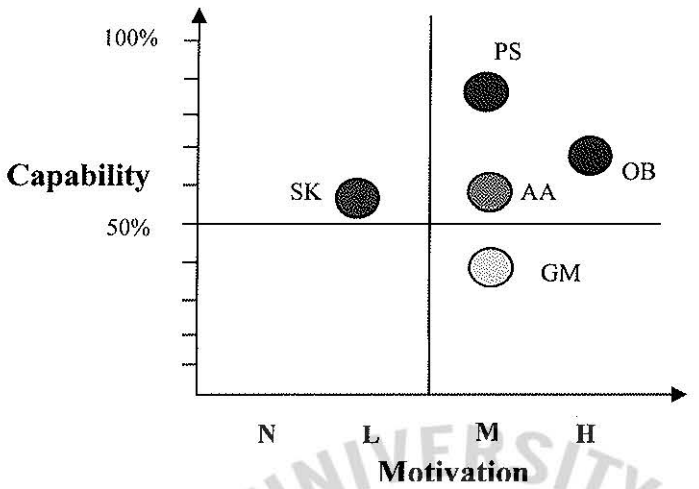
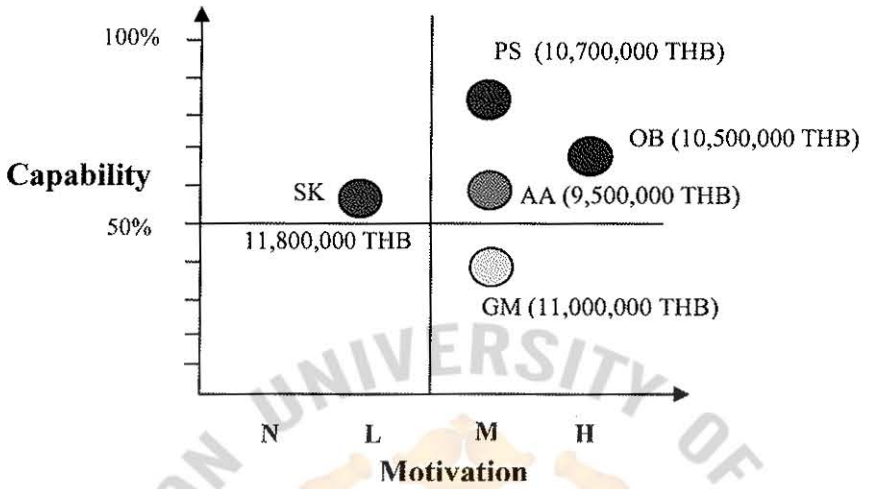


Figure 4.4 shows the performance of each contractor in terms of capability and motivation. PS Company has outstanding capability but its motivation level is moderately high, which is less than OB Company. OB Company is the only contractor which has the high motivation level. However, its capability is a little bit better than AA Company. Next, the overall performance was compared with the bidding price and the construction committee gave their judgment to select one contractor.

4.2.1.4 Compare the Overall Performance with Price

To reach the final selection, the construction committee compared the overall performance from step 4.2.1.3 with the bidding price of each contractor. Figure 4.5 demonstrates the performance position of each contractor with its bidding price.

Figure 4.5: Compare Performance with Bidding Price of Men Beauty Center



The construction committee made a judgment from the performance and bidding price of each contractor from Figure 4.5. The committee agreed that SK Company and GM Company could be dropped from the selection because they offered the high prices but their performance was low. The other three companies which were AA Company, OB Company, and PS Company showed interesting results. This project was the medical service area which patients directly visit, so good quality of work from a good capability contractor was necessary. Therefore, the construction committee agreed to select PS Company who had the best capability to undertake this project.

4.2.2 Application of the Model to a Non-Profit Making Project

Referring to Table 3.2, the Executive Office project was the non-profit making project that created the longest delay. Therefore, the faster the project finished, the quicker the hospital can start the next construction project. Hence, this project was chosen to be examined against the proposed model. The estimated value of this project was 9,000,000 baht. The objective of this project was to renovate the 1,200 square meters area which was the old patient ward to be the new office for the executives. The scope

included demolition, interior decoration, architectural work, mechanical and electrical work, air condition work, sanitary, fire alarm system, and LAN system.

The result from the old current contractor selection method showed that PP Company was awarded the project because it offered the lowest bid price (see Table 4.12).

Table 4.12: Award Recommendation of Executive Office Project

Project: PT Center Project		Quotation (Baht) including VAT 7%		
No.	Contractor	1st Quote	2nd Quote	Final
1	PP Company	9,452,977	9,292,093	8,450,000
2	KK Company	10,775,758	10,229,579	8,500,000
3	ST Company	11,056,710	11,530,547	9,700,000
4	GR Company	11,790,802	11,978,229	11,500,000
5	GS Company	13,562,018	13,562,018	12,700,000

Source: ABC's Purchasing Department

Next, the construction committee validated the proposed model with the Executive office project.

4.2.2.1 Capability Evaluation by Weighted Score Model

The construction committee scored each candidate against each sub-criterion based on how the contractor's performed. Points were given according to the scoring system that had been established. Table 4.13 presents the result of this capability evaluation.

Table 4.13: Capability Evaluation Result of Executive Office Project

Criteria	Weight	PP		KK		ST		GR		GS	
		Score	Weighted score	Score	Weighted score	Score	Weighted score	Score	Weighted score	Score	Weighted score
Relevant experience											
- Experience in similar completed project in last three years	0.0358	1	0.0358	2	0.0716	2	0.0716	1	0.0358	2	0.0716
- Experience in construction business	0.0154	2	0.0308	3	0.0462	4	0.0616	3	0.0462	3	0.0462
Past performance											
- Time performance	0.0363	2	0.0726	3	0.1089	4	0.1452	3	0.1089	2	0.0726
- Quality performance	0.0273	3	0.0819	3	0.0819	4	0.1092	3	0.0819	3	0.0819
- Responsibility performance	0.0273	3	0.0819	4	0.1092	4	0.1092	3	0.0819	3	0.0819
Technical skill											
- Education level and experience of foreman	0.0623	2	0.1246	3	0.1869	4	0.2492	2	0.1246	4	0.2492
- Experience in hospital of project manager	0.0934	3	0.2802	4	0.3736	5	0.4670	3	0.2802	4	0.3736
Management skill											
- Management skill of project manager	0.2288	2	0.4576	3	0.6864	4	0.9152	3	0.6864	2	0.4576
- Site management	0.1525	3	0.4575	3	0.4575	4	0.6100	3	0.4575	4	0.6100
Resource											
- Registered capital	0.0279	2	0.0558	3	0.0837	5	0.1395	2	0.0558	3	0.0837
- The use of sub-contractor	0.0120	1	0.0120	3	0.0360	4	0.0480	2	0.0240	4	0.0480
Methodology											
- Proposed timeline	0.1405	3	0.4215	3	0.4215	4	0.5620	3	0.4215	2	0.2810
- Proposed methodology	0.1405	3	0.4215	4	0.5620	4	0.5620	3	0.4215	3	0.4215
Total weighted score			2.5337		3.2254		4.0497		2.8262		2.8788

The total weighted score in Table 4.13 was used to calculate the percentage of capability by using Table 4.14.

Table 4.14: Percentage of Capability Result of Executive Office Project

Contractor Name	Total weighted score	Total score possible	Percentage of capability
PP	2.5337	5.00	50.67%
KK	3.2254	5.00	64.51%
ST	4.0497	5.00	80.99%
GR	2.8262	5.00	56.52%
GS	2.8788	5.00	57.58%

From Table 4.14, ST Company has the highest percentage of capability at 80.99% followed by KK Company (64.51%), GS Company (57.58%), GR Company (56.52%), and PP (50.67%). Next, each contractor was evaluated for its motivation level.

4.2.2.2 Motivation Evaluation by the Supplier Perception Model

The result of the motivation levels identified by the construction committee is now presented.

4.2.2.2.1 Calculate the Value of Business

To obtain the value of business, the estimated value of this project is divided by the contractor's annual turnover. The hospital estimated the value of this project at 9,000,000 baht. The annual turnover of each contractor is shown in Table 4.15. The percentage of value of business was compared with Table 2.4 to convert percentage values into high, moderately high, low, or negligible levels.

Table 4.15 Value of Business Result of the Executive Office Project

Contractor name	Estimated value of tendering project	Contractor's annual turnover	Percentage of Value of business	Level of value of business
PP	9,000,000	15,000,000	60%	H
KK	9,000,000	40,000,000	22.5%	H
ST	9,000,000	100,000,000	9%	M
GR	9,000,000	70,000,000	12.8%	M
GS	9,000,000	50,000,000	18%	H

From Table 4.15, there are three companies which obtain a high value of business, including PP Company, KK Company, and GS Company. The other two companies, ST Company and GR Company, obtain a moderately high value of business.

4.2.2.2.2 Determine Level of Attractiveness

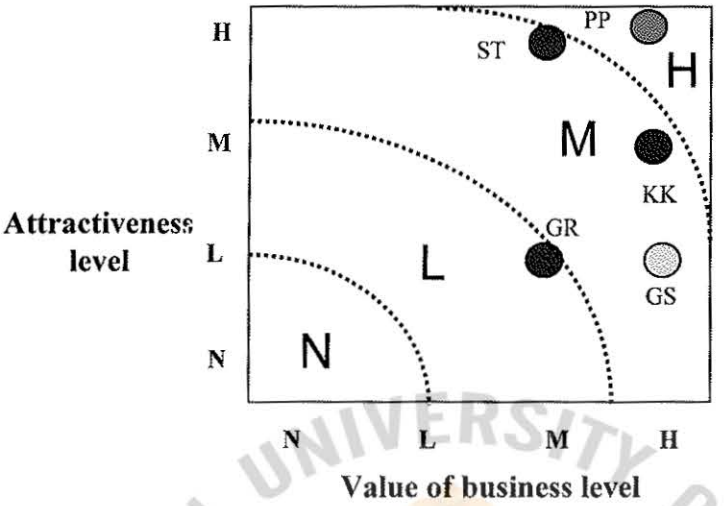
The construction committee defined the level of attractiveness of each contractor based on the factor in Figure 2.5 and other relevant factors. The level of attractiveness of each contractor is shown in Table 4.16.

Table 4.16: Level of Attractiveness Result of Executive Office Project

Contractor Name	Attractiveness description	Level
PP Company	The company had just entered to the business, and they wanted to develop business with ABC hospital. Moreover, it could have a good reference from being ABC's contractor.	H
KK Company	The company had a long term relationship with ABC hospital. It had just finished one project of ABC hospital with smooth working but faced with a little bit of delay in the payment process.	M
ST Company	The company never worked with ABC hospital but had a lot of experience with other hospitals in BDMS group. It was a good opportunity for the contractor to start business with ABC hospital in order to expand its business.	H
GR Company	The company had been invited to the bidding process in many projects but had never been awarded any project because it offered a high price.	L
GS Company	The company had a long relationship with ABC hospital and just finished one small project. It faced the difficulty of area handover process which affected delay in the payment process.	L

From Table 4.16, PP Company and ST Company have been defined as high level of attractiveness since they are new contractors and seem to want to develop business with ABC hospital. KK Company is defined as moderately high level. GR Company and GS Company are defined as low level. Then the result of value of business level and attractiveness level were brought to plot in Figure 4.6 to see the level of motivation.

Figure 4.6: Motivation Level Result of Executive Office Project

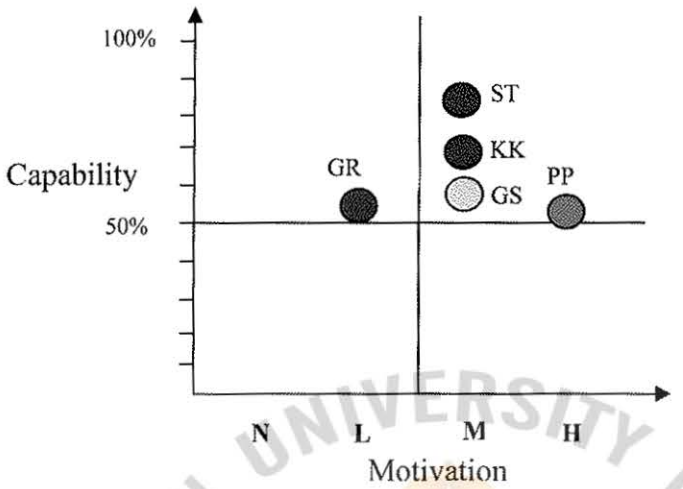


From Figure 4.6, we can see that PP Company has the highest motivation level. ST Company, KK Company, and GS Company have the moderately high level of motivation. GR Company is the only contractor to obtain the low level of motivation. In the next step, the motivation level was combined with the capability level.

4.2.2.3 Combine Results of Capability and Motivation

The construction committee combined the results of capability percentage and motivation level in this step to see the overall performance of each contractor. The result is demonstrated in Figure 4.7.

Figure 4.7: Overall Performance Result of Executive Office Project

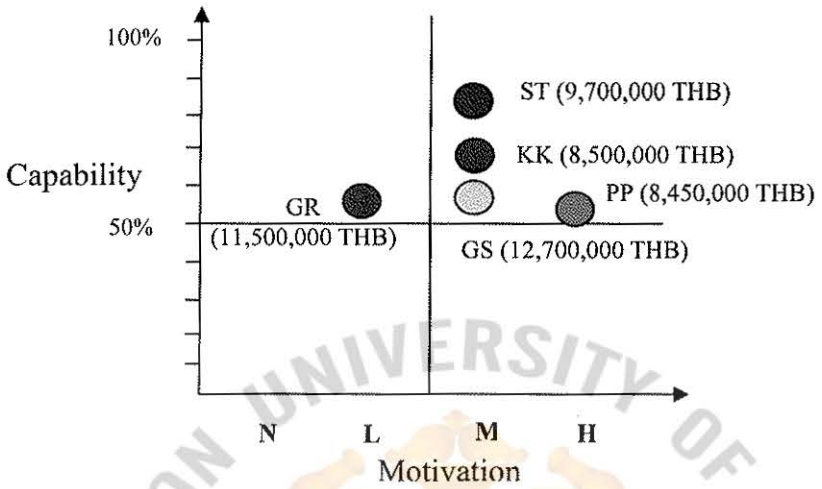


It can be seen from Figure 4.7 that ST Company, KK Company, and GS Company have the same level of motivation at moderately high. The capability of ST Company is extremely good compared to the other two companies, but KK and GS have not much difference in capability. PP is the only contractor which has moderately high level of motivation but it has the lowest capability. GR Company has poor overall performance because it has low level of motivation and its capability is also at low level. Next, the performance is compared with the bidding price that each contractor offered for this project.

4.2.2.4 Compare the Overall Performance with Bidding Price

In this step, the construction committee compared the overall performance from step 4.2.2.3 with the bidding price of each contractor. Figure 4.8 demonstrates the overall performance position of each contractor with its bidding price.

Figure 4.8: Compare Performance with Bidding Price of Executive Office Project



The construction committee made a judgment from Figure 4.8. The construction committee agreed to screen out GR and GS Company because both offered a high bidding price but had quite low performance. PP offered the lowest bid price and had high motivation level, but the result showed that it had lowest capability percentage. Therefore, the construction committee agreed to not select this company. Between ST and KK Company, they had the same level of motivation at moderately high. Their capability was quite different as well as the bidding price. However, this project was the office area, and the scope of work is not complicated. Therefore, the construction committee agreed to select KK since the result showed that it offered suitable capability, motivation, and price to undertake this project.

4.3 Summary

In this chapter, the proposed model based on the value judgment method was developed based on ABC's objectives and needs by the construction committee. Two cases of previous construction projects were tested with the proposed model. It can be seen that the contractor who was awarded the project in real situation was not selected because it had poor capability and low motivation level. The construction committee selected the contractor who has better capability and motivation level, even though

the price is higher. This proves that the proposed model can let the hospital see the contractor in other dimensions including capability and motivation, apart from the bidding price. Therefore, the hospital can obtain the contractor who tends to have enough competencies to perform the construction project and offer value for the money spent.

CHAPTER V

SUMMARY FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This chapter provides a brief overview of the findings in this research. The conclusion of the whole research is presented. Moreover, the theoretical implication and managerial implication are provided. This chapter ends with a discussion about the limitations and the recommendations for future study.

5.1 Summary of the Findings

In accordance with the problem statement, this research developed and proposed a contractor selection model based on the value judgment method for ABC hospital. Every step of the development was conducted by the construction committee of ABC hospital to ensure that the model is in line with ABC's objectives and needs. The contractor selection method of ABC hospital will be changed from the traditional practice in which price is the only factor, to the more strategic practice in which capability and motivation levels are also involved in consideration. This method provides the opportunity to select a suitable contractor who tends to achieve success in construction projects and leads to better contractor performance.

The model validation has proved that this model is applicable. It is interesting to see that the contractor who is the winner in the current method has low capability and motivation level. The contractor who has better capability and motivation is selected in the new system even it offers the higher price.

5.2 Conclusions

Contractors are a significant part in constructions project since their capability directly contributes to the successful completion of those projects. Therefore, selecting a competent contractor increases the chance of a project achieving cost, time, and quality in line with the project owner's goal. Currently, ABC hospital always relies heavily on the bidding price. The contractor who offers the lowest bid price is awarded the project. This method leads to many problems in construction project such as time and cost overrun and poor quality because only one dimension of contractors is assessed.

The contractor selection model through value judgment method can solve these problems. The model involves the multi-dimensional assessment of contractors, including capability, motivation, and bidding price. It helps the hospital to see the overall possible performance of each contractor before selecting the contractor who tends to successfully complete construction projects.

5.3 Theoretical Implications

This research employs mainly three streams of literature. Firstly, the literature related to contractor selection method which can help the researcher find the root cause of the problem. Secondly, the value judgment method which the researcher can propose as the new model based on this theory. Lastly, Analytical Hierarchy Process (AHP) was used for determining the weight of the main criteria.

What can be learnt from contractor selection is that in selecting the contractor based on the lowest bid price, project owners always obtain an incapable contractor who delivers problems in the actual construction project including time overrun, over budget, and poor quality (Sonmez et al., 2001; Mahdi et al., 2002; Topcu, 2004; Yilmaz & Ergonul, 2011). The research suggested that project owners should select

the contractor based on multi-criteria. This can help the researcher find the root cause of the problem.

The second theoretical implication is that the value judgment concept used in the contractor selection method in the construction industry. International Trade Center (2000c) uses this method as the offer evaluation method for products in the critical category. Moreover, this method is suitable when price is more dominantly important than other criteria.

The last theoretical implication is the Analytical Hierarchy Process (AHP). It was recommended by Topcu (2004) as suitable for finding the weight of criteria. Moreover, AHP provides a method to check the consistency level, because the way to determine the weight derives from human judgment.

5.4 Managerial Implications

Apart from the theoretical contributions described in the previous section, this research has provided a new practice of purchasing method for construction projects. To implement the proposed model based on the value judgment method, the managerial implications can be discussed in two categories: the project owners' view and the contractors' view.

Project owners can adopt this model as their contractor selection method. To implement the proposed model, project owners need to change their traditional practice to be more strategic. This means that considering only the bidding price when selecting the contractor must be stopped. Project owners need to assess a contractor against multi-criteria to know the trend of contractor performance since it is important for today's business as the company can enhance its competitiveness from using the right supplier.

From the contractor's view, the result of the assessment provides the contractor an opportunity for improvement in its weak points identified from the capability evaluation result. Competition through performance among contractor industry is the way forward rather than competing only on bidding price.

5.5 Limitations and Recommendations for Future Research

The scope of this research has limitations, which are relevant to future research. The main research objective was to develop a contractor selection model based on the value judgment concept for ABC hospital. Therefore, this model can only be used for the purchasing system for construction projects of ABC hospital. However, for future study, the hospital can use the value judgment concept in developing the supplier selection method by applying it to other purchasing products in the critical quadrant. However, the criteria, sub-criteria, weight, and scoring system needs to be adapted for each particular product.

Another recommendation for future research is the identification of the actual main criteria that related to the contractor selection as experienced by ABC hospital. This research used the main criteria from the literature. To design a complete model for ABC hospital, the main criteria identified by the construction committee should be explored.

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APPENDICES

APPENDIX A

Construction projects of ABC hospital in 2011

The table of actual contract and original contract duration of each project

Projects in 2011			
Item	**Project Name**	**Actual Contract Duration (Day)**	**Original Contract Duration (Day)**
1	PT Center	90	45
2	Men beauty Center	129	90
3	Auditorium	195	60
4	Chiller project Phase II	225	195
5	Improve ceiling of 2F building 2	7	15
6	Medical equipment work shop	20	30
7	Improving the Central Public Address system	10	14
8	Improving the PABX system	7	30
9	Changing the AHU of auditorium room	20	20
10	Changing the AHU of preparation room	20	20
11	Heart center	105	60
12	Cashier center	70	45
13	Mini – PT room	40	30
14	Executive Office Renovation	240	90
15	Changing the AHU of Japanese center	20	30
16	Improving Cap Bank	48	52

APPENDIX B

Contractor Evaluation Form of the Proposed Model

Capability Evaluation Form

Criteria	Weight	Contractor A		Contractor B		Contractor C		Contractor D		Contractor E	
		Score	Weighted score	Score	Weighted score	Score	Weighted score	Score	Weighted score	Score	Weighted score
Relevant experience											
- Experience in similar completed project in last three years	0.0358										
- Experience in construction business	0.0154										
Past performance											
- Time performance	0.0363										
- Quality performance	0.0273										
- Responsibility performance	0.0273										
Technical skill											
- Education level and experience of foreman	0.0623										
- Experience in hospital of project manager	0.0934										
Management skill											
- Management skill of project manager	0.2288										
- Site management	0.1525										
Resource											
- Registered capital	0.0279										
- The use of sub-contractor	0.0120										
Methodology											
- Proposed timeline	0.1405										
- Proposed methodology	0.1405										
Total weighted score											

Percentage of Capability Form

Contractor Name	Total weighted score	Total score possible	Percentage of capability
Contractor A			
Contractor B			
Contractor C			
Contractor D			
Contractor E			

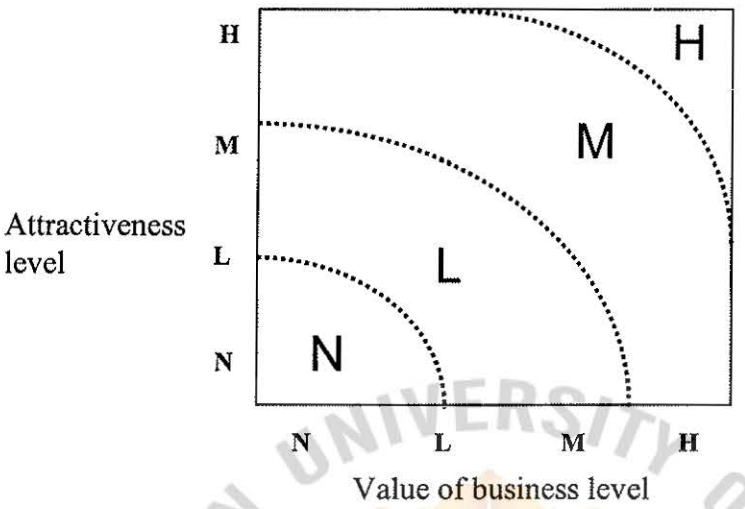
Value of Business Form

Contractor name	Estimated value of tendering project	Contractor's annual turnover	Percentage of Value of business	Level of value of business
Contractor A				
Contractor B				
Contractor C				
Contractor D				
Contractor E				

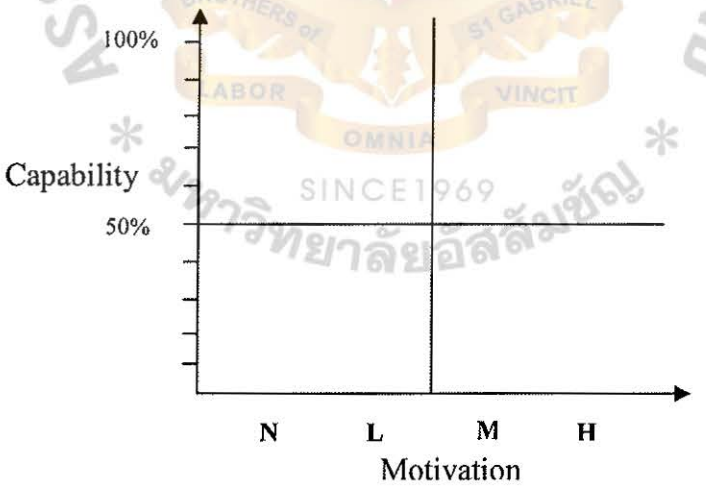
Level of Attractiveness Form

Contractor Name	Attractiveness description	Level
Contractor A		
Contractor B		
Contractor C		
Contractor D		
Contractor E		

Supplier Perception Model Form



Contractor Overall Performance Form



Contractor Performance and Price Form