CONTRACTOR SELECTION BY A HOSPITAL

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Abstract

Contractor selection is the critical part of a construction project. Traditionally, the ABC hospital selection criterion was the lowest bid price, which often turned out to mean an incapable contractor who caused major construction delays which hugely damaged the hospital, including lost revenue opportunities and loss of customer satisfaction. Instead, this research identifies a value judgment selection method. It has four main steps: capability evaluation, motivation evaluation, combining these two results to assess overall performance, and comparing the performance with the bidding price. Thus, the hospital selects the contractor who offers the best combination of performance and price. Validation of the proposed method was tested by examining two previous hospital construction projects.

บทคัดย่อ

การเลือกผู้รับเหมาก่อสร้างเป็นส่วนที่สำคัญของงานก่อสร้าง แต่เดิมโรงพยาบาล ABC ใช้เกณฑ์ในการเลือกจากราคาประมูลที่ต่ำที่สุด ซึ่งมักจะกลายเป็นว่าได้เลือกผู้รับเหมาที่ไม่มีประสิทธิภาพเป็นสาเหตุให้เกิดความล่าช้าในการก่อสร้าง ซึ่งก่อให้เกิดความเสียหายอย่างมากแก่โรงพยาบาล อาทิเช่น สูญเสียโอกาสทางรายได้ และสูญเสียความพึงพอใจจากลูกค้า ดังนั้น งานวิจัยนี้จึงใช้วิธีเลือกผู้รับเหมาแบบ value judgment ซึ่งมี 4 ขั้นตอนหลัก ได้แก่ การประเมินความสามารถ การประเมินแรงจูงใจ การรวมผลจากขั้นตอนทั้งสองเพื่อวิเคราะห์ผลงานโดยรวม และการเปรียบเทียบผลงานกับราคาประมูล ดังนั้น โรงพยาบาลจะเลือกผู้รับเหมา รายที่มีผลงานและราคาที่ดีที่สุด โดยวิธีที่นำเสนอนี้จะมีการทดสอบความน่าเชื่อถือจากจากการใช้โครงการก่อสร้างของโรงพยาบาล จำนวน 2 โครงการก่อนหน้านี้

*This is a greatly condensed version of a research report by Ms Theeranon submitted as part of her MSc degree in supply chain management at Assumption University.

INTRODUCTION

The construction industry in Thailand has great competition between many contractors, although the quantity of contractors does not necessarily mean high quality of work, as there are many examples of poor performance.

Traditionally, the buyers use a contractor's bid amount as the dominant selection decision (Yilmax & Ergonul, 2011), and this often results in project failure, with cost overrun, delay in meeting the schedule, and unacceptable quality. Thus, non-price criteria should be included in selection process, and much research has been done on factors and techniques which combine performance and price for assessing the capability of a contractor, which can be indicative of project success (Clarke, 2007).

The company in this case is a large hospital, 'ABC Hospital' (a pseudonym). It is a leading provider of medical healthcare services in Thailand, used by locals, foreigners and tourists. It regularly improves its facilities with renovation work and engineering work. A construction committee is responsible for making design decisions, selecting the contractor, approving the material, monitoring progress, and the handover process. Assisting the committee are architects and engineers. Drawings, specification, bills of quantity and schedules are approved by the committee to be used in the tendering process.

Contractors who have experience in working for ABC hospital are invited to attend the tendering process. The lowest price bidder is awarded the contract. The hospital's project engineer monitors progress and problems, and reports weekly to the construction committee. When the construction is complete, the construction committee, housekeeping staff, mechanics, and infectious control staff check and test the construction area. If correction is needed, the details will be agreed by both companies.

At this hospital in 2011, 8 of the 16 construction projects experienced delays, contrary to the schedule. The hospital suffered lost financial opportunity by the delay, and there was customer dissatisfaction due to unavailability of facilities. A review of relevant data found that the major cause of delay was due to the incapability of contractors. The hospital thus wanted research into a value judgment approach as a contractor selection method.

REVIEW OF RELATED LITERATURE

Many companies choose the lowest bid price because it is then easier to explain their selection, but Topcu (2004) stated that with this method the buyer always get an inadequate contractor. Zala and Bhatt (2011) explained three major causes of this inadequacy: the selection method is inappropriate; the selection criteria is not suitable; and each cri-

terion is given improper relative importance, the highest priority being the lowest bid. Researchers have developed more appropriate methods, and Table 1 summarizes these, which reveals that all agree: not to use a single criterion based on the lowest bid price, but to use multi-criteria.

Table 1: Summary of Contractor Selection Methods

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 encounters problems in cost, time and quality. Second, the contractor offers unrealistic price in order to win the bidding. - Presented the Evidential Reasoning method. This used the Degree of Belief concept by which decision makers elicit the degree of expectation of each contractor for a particular criterion.
Topcu (2004)	- Selecting the contractor based on lowest bid price, buyers always get an inadequate contractor with problems such as delay, cost overrun, and poor quality. Evaluating the contractor with multi-criteria can solve these problems. - Proposed a contractor selection model for a construction project in Turkey with pre-qualification concept. There were two main stages: pre-qualify stage in which contractors were evaluated against time and quality dimension. The pre-qualified, contractors were then 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 business. - Introduced the contractor selection model which considered other factors besides price, which selected the contractor who gave the best value for money. - The model contained three steps. 1.Contractors were evaluated against non-price criteria with a weight of 30%. 2. Evaluation of bid price of each contractor with a weight of 70%. 3 Select the winner, who was the one who ranked No. 1 for quality even if its offer price was not the lowest.

Source: Author

Many researchers have provided detailed selection criteria. Hatush and Skitmore (1997) presented seven main criteria, including financial soundness, technical ability, management capability, health and safety, and reputation. Salama et al. (2011) investigated contractor selection criteria used by project owners and experts in the construction industry in Malaysia, and found that the most important criteria were track performance, financial capacity, and technical capacity.

The Tasmanian Department of Treasury and Finance (2006) used to adopt the lowest bid price method to award government construction projects, but always obtained unsuitable contractors. Therefore, it developed a tendering evaluation method with seven weighted criteria. Their definition and information required are in Table 2.

Table 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 projects with the tendered project. The scale and the role undertaken in previous projects should also be considered.	List of relevant projects which describes the project detail, role of contractor, project cost and duration time of project.
Past performance	The capability to perform past projects in terms of quality, time, budget, claims history and project management.	Information of past projects includes client's project manager, quality standard, target performance level, tender price, variations, final cost, completion date and any extensions of time.
Technical skill	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 areas compared to the tender project.	Details of proposed key personnel including name, function, technical expertise and curriculum vitae.
Manage-skill and system	This criterion assessed the contractor for the management skill of its personnel, and the firm's management system and method that it proposes to use in the tender project.	Contractor's quality system, project management tools, program software and environmental management tools, and environmental management system.

Criteria	Consider area	Required information
Resource	The equipment proposed to be used in the tender project including machine, factory, and labor.	The specialist equipment, labor and facilities that each contractor has.
Methodology	The procedure or special methods that the contractor proposes to apply to a tender project in order to achieve a satisfactory project outcome. The contractor should be able to explain and describe the methodology of its particular approach.	Program of work, key performance indicator, work allocated to sub-contractors, innovative procedures 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.	Fixed capital cost, variable tender costs and special adjustments during the contract period, maintenance and operating costs.

Source: Tasmanian Department of Treasury and Finance (2006)

Padhi, Wagner, & Aggarwal (2012) used two dimensions, profit impact and supply risk, by which a purchasing company can classify all purchasing items into the four categories of strategic, bottleneck, leverage, and non-critical. The International Trade Center (2000a) uses a similar model. Its supply positioning model prioritizes the time and effort spent on purchased items, and indicates a suitable supply strategy for each item. The two dimensions are the percentage of total annual expenditure and the impact on the organization. Impact can be evaluated from loss of expected sales if the company cannot meet supply targets. Each category has an appropriate offer evaluation method.

The lowest price method is suitable for items in the non-critical category which has low levels of expenditure and risk. When the cost increases, the suitable offer evaluation method is the lowest total cost of ownership in order to determine all relevant cost in a supplier's offer. The weighted score method is suitable for items in the bottleneck quadrant to take account of all risks that could happen. For items in the critical quadrant where both cost and risk are high, the suitable method is value judgment.

Value for money is consistent with value judgment, that is the evaluation of product, system or service that is not limited to price. It is a trade-off between price and quality. This concept has been used for contractor selection, as summarized in Table 3.

Table 3: Value Judgment Concept in the Construction Industry

Author	Finding
AGC of America and NASFA (2008)	**Best Value Selection:** This subjective consideration is included in the evaluation, selection, and final award of a construction contract, not just a low bid price.
Australia Construction Industry Forum (2011)	**Value for money selection:** Do not select the lowest bid price contractor when a 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 a better experience record. Lowest bid approach cannot screen the contractor's capability, but qualification in terms of cost, quality, schedule and previous customers' satisfaction can determine the trend in the next project.
Clarke (2007)	**Value for money:** Australian Department of Defence applies this method. Contractors are assessed against non-price criteria. A Board meeting discusses and considers the bid prices by giving non-numerical justification. The contractor selected gives best value for money, in performance and price.
International Trade Center (2000a)	**Value judgment method:** Suitable for products in the critical category and when price is the most important criterion. The supplier is evaluated against non-price criteria first and then compared with price. A supplier not offering the lowest bid price has a chance if its performance is better.
Scottish Government (n.d.)	**Value for Money (VFM):** The optimum combination of whole-contract cost and quality to meet the customer's need. The contractor that offers the lowest bid price does not necessarily win the contract.
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 requirements.

Source: Author

Thus, 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.

The International Trade Center (2000c) designed clear steps for developing the value judgment method. First, candidate suppliers are assessed on their capability against non-price criteria through a weighted score model. Next, candidates 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 money. This is shown in Table 4, followed by descriptions of some steps.

Table.4: Value Judgment Development Steps

Step 1: Capability Evaluation by Weighted Score Model

- a. Identify the main criteria for assessing candidate suppliers
- b. Determine the weight of main criteria
- c. Identify and weight sub-sriteria
- d. Establish scoring system
- e. Evaluate candidate contractor
- f. Calclate the percentage of capability

Step 2: Motivation Evaluation by Supplier Perception Model

- a. Calculate the Value of Business level
- b. Determine the attractive level
- c. Determine the motivation level from supplier perception model

Step 3: Combine the Result of Capability and Motivation

- Combine the percentage of capability and motivation level to see the overall performance

Step 4: Compare the Overall Performance with Bidding Price

- a. compare the overall performance with bidding price
- b. The supplier who offers the best combination and gives best value for money is selected

Source: International Trade Center (2000c)

Step 2 Evaluate Suppliers' Motivation by Supplier Perception Model

The potential supplier should have capability and motivation. The Supplier Perception model helps a purchasing company to assess motivation level. Motivation is also assessed by comparing the purchase amount to the supplier's sale turnover for one year, or the capacity allocated to the supplier compared with its total capacity, which will show how much the supplier values acquiring this work. Table 5 shows the significance of various percentages.

Table 5: Value of Business Level

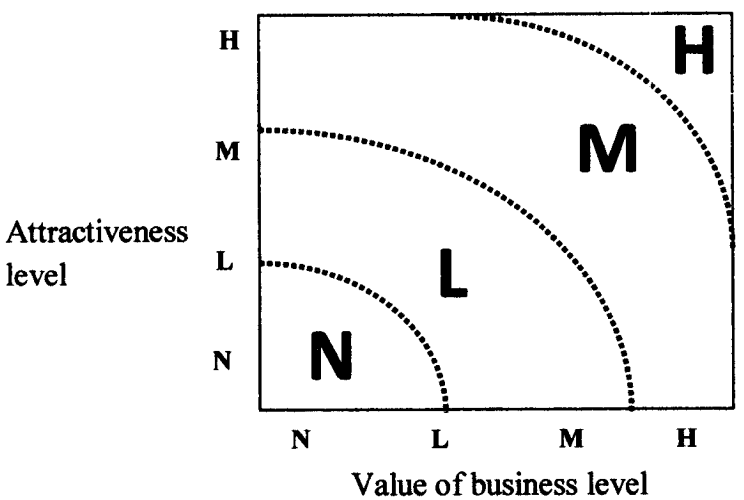
Level of value of business	Value of business percentage
High (H)	More that 15%
Moderately high (M)	5% - 15%
Low (L)	0.8% - 5%
Negligible (N)	Less than 0.8%

Source: International Trade Center (2000b)

The level of attractiveness in a buyer's business is another motivation factor that can be assessed, the factors being: Compatibility of business strategy; Ease of doing business; Payment record and financial situation, Association with a respected client; Possibility to develop the business.

Then the value of business level and the attractiveness level are plotted as two axes in the supplier perception model (see Figure 1). The level of motivation is categorised as High, Moderately high, Low or Negligible level of attractiveness, as below.

Figure 1: Supplier Perception Model

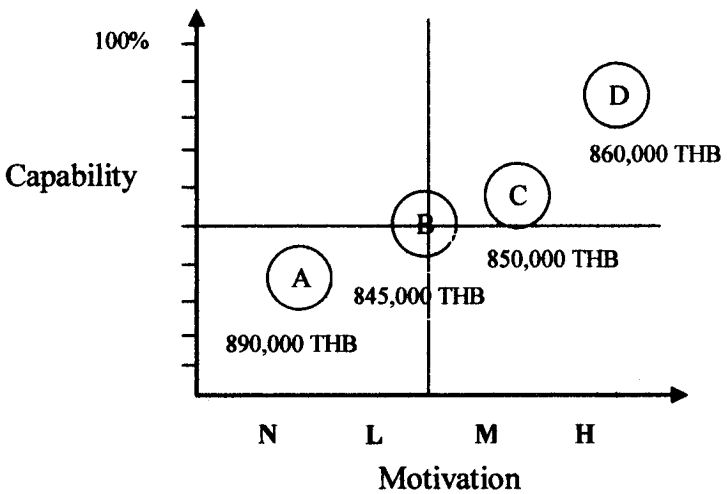


Source: International Trade Center (2000b)

Step 3 Combine the Result of Capability and Motivation
The capability result and the motivation result are plotted in a single chart, from which, a buyer can see the overall performance of each supplier. The supplier whose position is near the right top corner tends to have greater performance.

Step 4: Compare the Overall Performance with the Bidding Price
Finally, the result from step 3 is compared with the offer prices, the purchaser selecting 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. An example is below.

Figure 2: Supplier Performance and Price



Source: Author

From Figure 2, Supplier A can be first screened out since it has low capability and motivation while its offer the highest price. Suppliers B and C are near the overall capability level but C has more motivation and offers 5,000 baht more than B. It would be better for the purchasing company to pay more, to get the best overall performance from D.

Analytical Hierarchy Process (AHP)
AHP is a popular technique in Multi Criteria Decision Making. It can quantify the relative importance of criteria and alternatives, on a ratio scale based on the judgment, experience and perception of decision makers. AHP is a selection method in various fields such as project procurement, project management and engineering problems (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. The decision makers give their judgments based on the judgment scale. The judgment is then converted to a numerical value by calculating the weight of each criterion. Another benefit of this method is that it provides a method to check the consistency of the judgment. The AHP procedure can be performed automatically by Expert Choice Software or manually (Al - Harbi, 2001).

Table 6: Level of Preference Weight for AHP

Value	Judgment	Explanation
1	Equal	Two criteria show the same level of importance
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 importance between two criteria is extreme
2,4,6,8	Intermediate values	Used if more precision is needed

Source: Bertolini et al. (2004)

The weights of the criteria are then computed. The sum total of the weights must be equal to 1. The AHP method provides a method to help in eliminating the chance of inconsistency in the criteria. If the value of the Consistency Ratio is equal to or less than 0.1, it means that the comparative judgment is acceptable.

Time Performance Index (TPI)

The Time Performance Index (TPI) is used for measuring time performance in a construction project (Othman et al., 2006). It can be calculated by using the equation below:

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

Example Time Performance Index of Rehabilitation Project $= \frac{90}{45} = 2$

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

RESEARCH METHODOLOGY

Data was collected. The data analysis was performed on 8 of 16 construction projects in 2011 which suffered from delay, to assess the damage to ABC hospital in terms of loss of revenue and customer dissatisfaction. Next, the cause of the delay was extracted from the minutes of the construction committee. The researcher found that the major cause of delay was contractor incapability.

As the literature review had found the current contractor selection method to be inappropriate, and recommended multi criteria, the supply positioning model was used to identify a suitable offer evaluation method. It was found that the weighted score model (value judgment) was more suitable than the lowest price method. Finally, the researcher proposed a value judgment selection method.

Historical data for the whole of 2011 was collected, including the minutes of weekly construction meetings; the construction agreement; the project handover document; the monthly revenue of the business unit affected by the delays; and expenditure data. Interviews were held with the project engineer and purchasing staff.

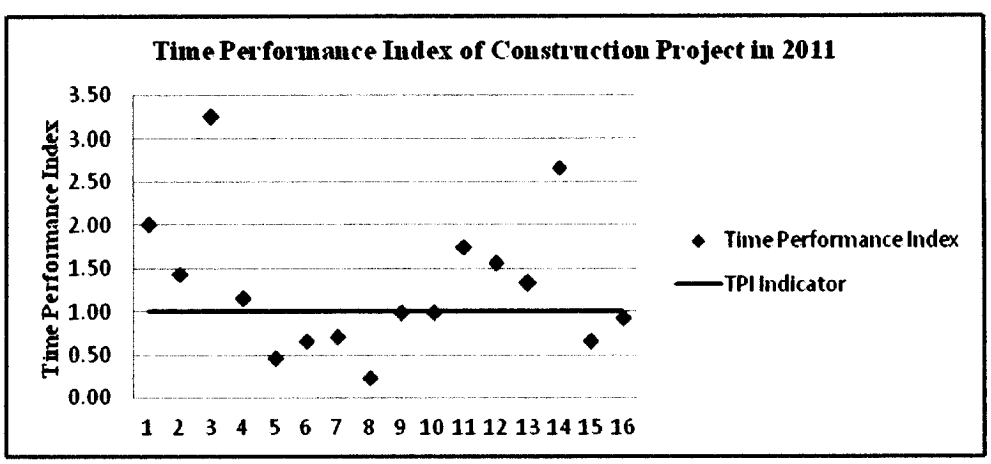
The three data analysis steps were:

*identifying the delayed construction projects in 2011 by calculating the Time Performance Index (TPI)

*determining the damage to the hospital of the delayed construction projects

*analysing causes of delay.

Figure 3: Time Performance Index of Construction Projects in 2011



Source: Author

Any construction project with a Time Performance Index more than 1 was a delayed project. Figure 3 showed that from a total 16 construction projects, 8 were delayed projects (red dot).

These delayed construction projects could be divided into two types of damage to the hospital: profit making projects and non-profit making projects. A profit making project would create revenue, a non-profit making project included improving existing facilities or installing a new facility, and renovation in areas which did not generate revenue and was concerned with customer satisfaction.

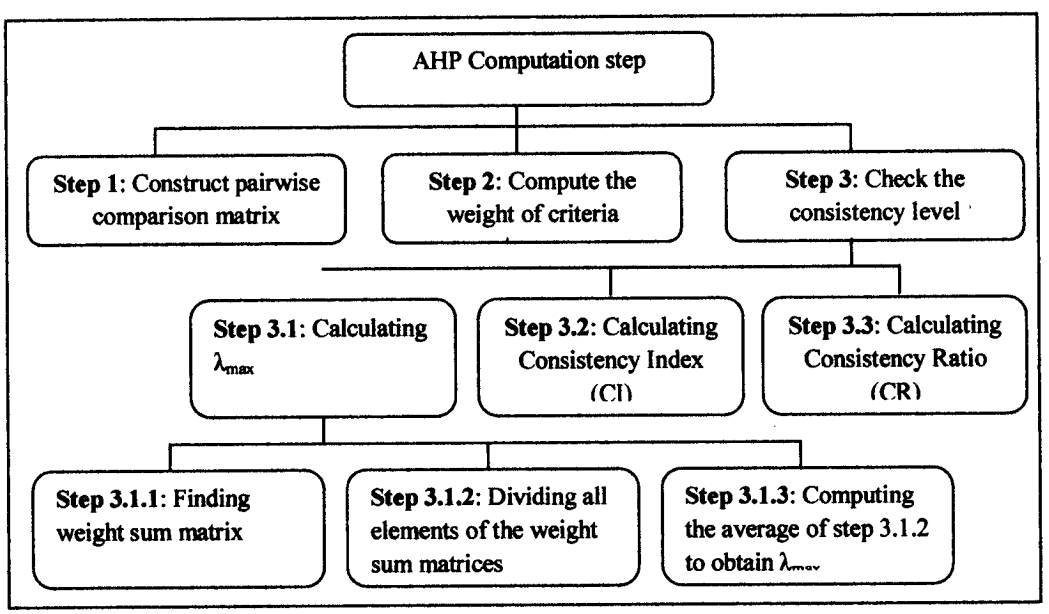
Finding the Cause of Delay in Construction Projects

The result showed that the contractors most frequently generated the cause of delay, and every project mentions this (8/8). There was poor quality of work, insufficient workers at the construction site, contractors' lack of technical skill, improper planning, and late material delivery. Owner-related causes ranked, and included design changes and additional work (3/8 projects).

PRESENTATION OF RESULTS

The Weighted Score model is used to assess the contractor's capability since it provides the means to assess the contractor against multi-criteria. The construction committee determined the weights committee by following the AHP method (Al-Harbi (2001). Figure 4 shows the AHP process.

Figure 4: AHP Computation



The construction committee constructed the pairwise comparison matrix by comparing the importance of each pair of criteria. 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.

As the pairwise comparison was conducted by human judgment, the consistency ratio (C.R.) of the comparison judgment was calculated using the AHP test. The calculation showed a consistency ratio of 0.0355, therefore there was an acceptable level of consistency, being less than 0.1.

The 6 main criteria can be broken into a total of 13 sub-criteria to narrow the assessment area. Table 7 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 8 shows the weight of sub-criteria of which the sum total equals the weight of the main criteria.

Table 7: 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 performed a 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 field as the tendering project seems to be expert in that field. A list of previous similar projects performed by the contractor in the last three years is required.
Experience in construction industry	The years of experience which the contractor has in the construction industry. Greater experience represents 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 a specific time. The Time Performance Index (TPI) of one previous similar project is calculated.

Main criteria/Sub-criteria	Definition
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 a 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 techniques, management skill, problem solving skill and sense of responsibility.
Experience in hospital of project	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. 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. If the construction project is managed by a qualified project manager, the construction can run smoothly and achieve time, quality, and budget. The proposed project manager of each contractor is interviewed about construction problems, to test his management skill.
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. 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, when the general contractor does not have its own resource. When a contractor hires many sub contractors, it is difficult to manage the construction project.

Main criteria/Sub-criteria	Definition
Methodology	
Proposed construction timeline	The schedule the contractor proposes for the project. It is assessed by the sequence of activities, the duration of activities, and the existence of each sub-activity. It is beneficial if the contractor can show the start and end dates of each activity.
Proposed methodology	The methodology for the tendering project. A reasonable possible method is a good sign that the contractor is likely to succeed in the tender project.

Source: ABC's construction committee

The committee assigned the weight of each main criterion to their sub-criteria according to their relative importance. The result is shown in Table 8 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 8: Sub-criteria and Their Weight

Criteria	Weight
1. Relevant experience	**0.0512**
- 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**
- Registered 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

A scoring system was defined in order to be the principal system during the score step. The score scale 1, 2, 3, 4, 5 was used to score the contractors. The definition of each score against each sub-criterion was their possible performance.

Validation of the Case Study Application

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.

Profit Making Project

The DD Beauty Unit was the profit making project that created the highest lost revenue per day. Hence, this project was chosen to test the proposed model. The estimated value of this project was 10 million baht, and the objective was to convert an old office into a new patient department. The scope included demolition, decoration, mechanical and electrical work, air conditioning, and a fire alarm system. The hospital had selected the contractor based on the lowest bid price, from five contractors. Other dimensions of contractor performance were not considered.

In capability evaluation, the construction committee scored each contractor's performance against each sub-criterion. Table 9 presents the result of the capability evaluation of this project. The total weighted score was used to calculate the percentage of capability.

Table 9: Percentage Capability Result of DD Beauty Unit

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%

In this Table, PS Company is the highest with 82.95%, and GM Company the lowest with 39.42%.

Next, the motivation level, using the Supplier Perception model. First, the calculation of the Value of Business, as shown in Table 10.

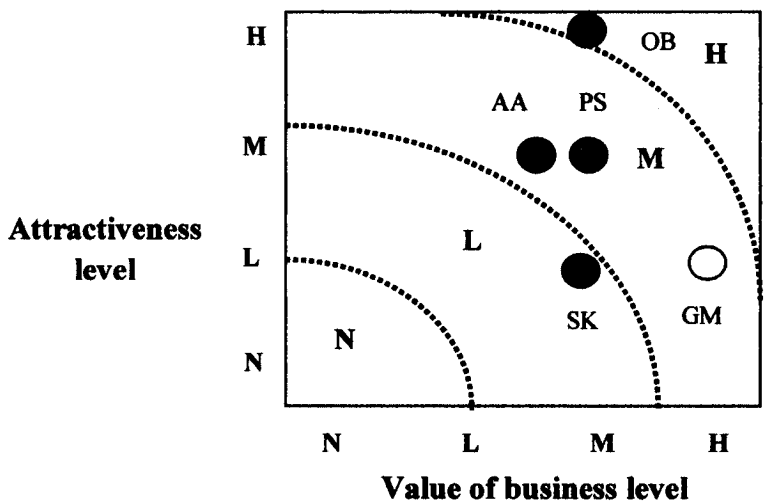
Table 10: Value of Business Result of DD Beauty Unit Project

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%	Moderate
OB Company	10,000,000	40,000,000	25%	High
PS Company	10,000,000	100,000,000	10%	Moderate
GM Company	10,000,000	60,000,000	16.67%	High
SK Company	10,000,000	80,000,000	12.50%	Moderate

OB Company and GM Company have the highest value of business, the other three companies having only a moderate value of business.

The result of level of attractiveness determined by the construction committee is that OB scored highest, AA and PS Moderate, and the other two low. In the motivation assessment, the following chart shows the result.

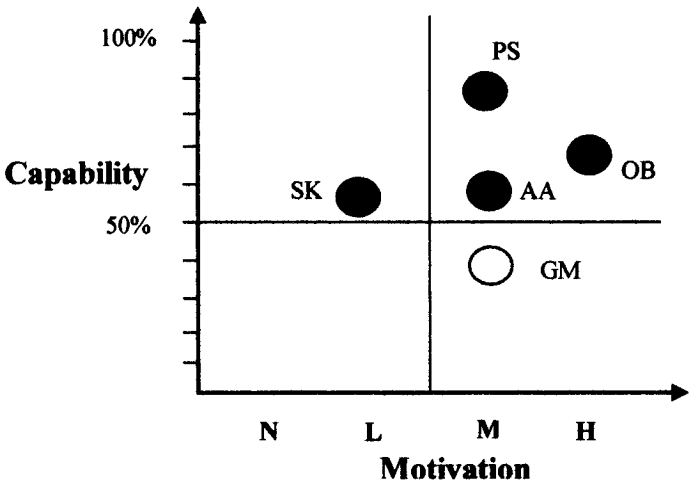
Figure 5: Motivation Level Result of DD Beauty Unit Project



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 has the lowest motivation level to work with ABC hospital.

The construction committee combined the result of capability percentage and motivation level by plotting both results into Figure 6 to see the overall performance.

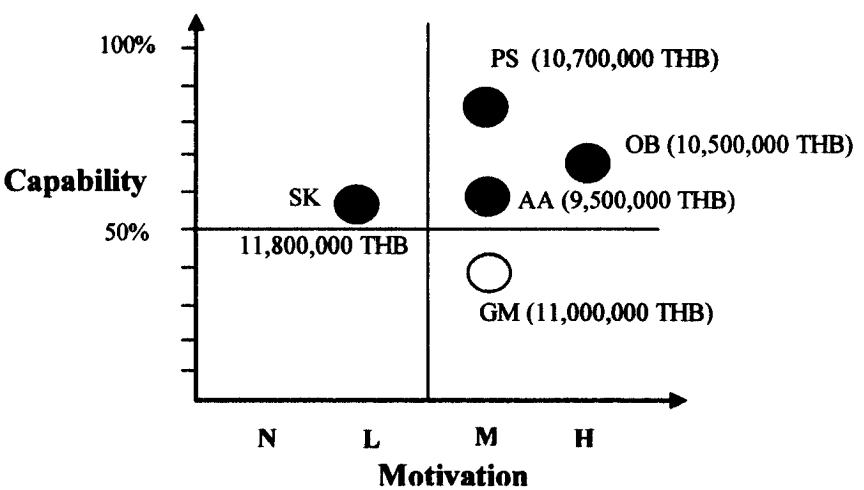
Figure 6: Overall Performance Result of DD Beauty Unit Project



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.

To reach the final selection stage, the construction committee compared the overall performance with the bidding price of each contractor. The next Figure demonstrates the result.

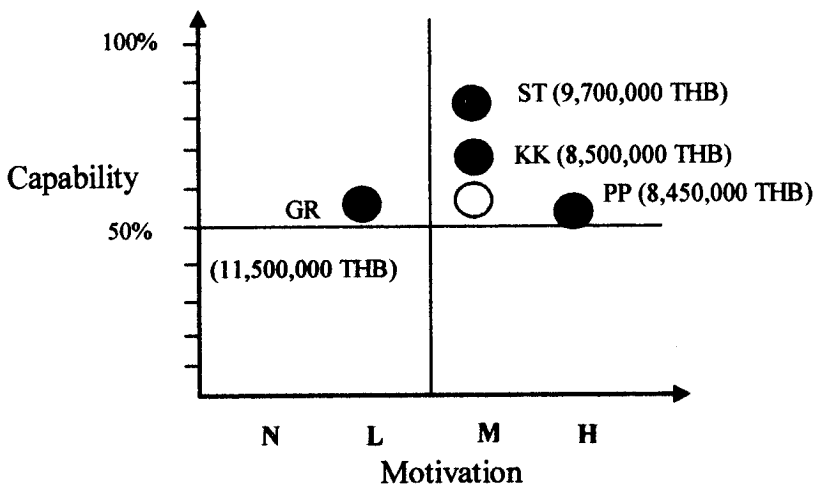
Figure 7: Compare Performance with Bidding Price of DD Beauty Unit



The committee agreed that SK Company and GM Company could be dropped from the selection because they offered high prices but their performance was low. The other three companies showed interesting results. This project was a medical service area which patients visit, so good quality of work from a good capability contractor was necessary. Therefore, the construction committee agreed to select PS Company.

A non-profit making project, office development, that created the longest delay was also subjected to the same assessment procedure, but is not included in this paper (for space reasons) except for the final chart which compares the overall performance with the bidding price of each contractor.

Figure 8: Compare Performance with Bidding Price of Office Project



The 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. ST and KK Companies had the same moderate level of motivation. Their capability was quite different as well as their bidding price. However, this project was an office area, and the scope of work was 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.

CONCLUSION

In both cases studied, the selection of a contractor who has better capability and motivation level, even though the price is higher, proves that the proposed model can allow the hospital to assess other dimensions than price. Therefore, the hospital can obtain the contractor who tends to be competent enough to complete the construction project satisfactorily and offer value for money.

The validation test proved that this model is applicable. The contractor selection model through value judgment method can solve the hospital's construction delay problems. The value judgment concept is useful in the construction industry, as it fits into the 'critical' quadrant, and is suitable when price is a dominant factor. The Analytical Hierarchy Process (AHP) recommended by Topcu (2004) is suitable for finding the weight of criteria, and a check for the consistency level, to guard against human assessment error.

For project owners to implement the proposed model, they need to change their traditional practice to be more strategic. They need to assess a contractor against multi-criteria as it is important for a company to enhance its competitiveness in cost and quality.

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

BIBLIOGRAPHY

AGC of America and NASFA. (2008). *Best Practices for Use of Best Value Selections.* America: AGC of America and NASFA.

Al-Harbi, K. A. (2001). Application of the AHP in project management. *International Journal of Project Management*, 19(1), 19-27.

Australian Construction Industry Forum. (2011, September). Procurement Policy. Retrieved from http://www.acif.com.au/documents/item/32

Bertolini, M., Bevilacqua, M., Braglia, M., & Frosolini, M. (2004). An analytical method for maintenance outsourcing service selection. *International Journal of Quality & Reliability Management*, 21(7), 772-788.

Byms, H. F. (1991). "Best Value" Contracting in the Procurement of Engineering and Technical Services, Master Thesis, Naval Postgraduate School, California, U.S.A.

Clarke, L.E. (2007). Factor in the Selection of Contractors for the Engineering Works, Bachelor Thesis, *University of Southern Queensland*, Australia.

Count. (n.d.). Best Value Contracting. Retrieved from http://www.countprogram.org/bestvalue/bestvalue.htm

Hatush, Z. & Skitmore, M. R. (1997). Criteria for contractor selection. *Construction Management and Economics,* 15(1), 19-38.

International Trade Center (2000a) *Module 3 Analyzing Supply Markets*: International Trade Center.

International Trade Center (2000b) *Module 5 Appraising & Shortlisting Suppliers*: International Trade Center.

International Trade Center (2000c) *Module 6 Obtaining & Selecting Offers*: International Trade Center.

Mahdi, I.M., Riley, M.J., Fereig, S.M., & Alex, A.P. (2002). A multi-criteria approach to contractor selection. *Engineering, Construction and Architectural Management*, 9(1), 29-37.

Othman, A.A., Torrance, J.V., & Hamid, M.A. (2006). Factors influencing the construction time of civil engineering projects in Malaysia. *Engineering, Construction and Architectural Management*, 13(5), 481-501.

Padhi, S.S., Wagner, S.M., & Aggarwal, V. (2012). Positioning of commodities using the Kraljic Portfolio Matrix. *Journal of Purchasing & Supply Management*, 18, 1-8.

Public Works and Government Services Canada. (2012, Feb 24). *Acquisition.* Retrieved from http://www.tpsgc-pwgsc.gc.ca/ecologisation-greening/achats-procurement/directive-guideline/page-3-eng.html

Salama, M., Aziz, A. E., Sawah, H.E., & Samadony, A.E. (2006, September). *Investigating the criteria for contractors' selection and bid evaluation in Egypt.* Paper presented in Proceedings of 22nd Annual ARCOM Conference, UK.

Scottish Government. (2011, Feb 2). *Construction Procurement Manual.* Retrieved from http://www.scothland.gov.uk/Publications

Sonmez, M., Yang, J.B. & Holt, G.D. (2001). Addressing the contractor selection problem using an evidential reasoning approach. *Engineering, Construction and Architectural Management*, 8(3), 198-210.

Tasmanian Department of Treasury and Finance. (2006). *Guidelines on Tender Evaluation using Weighted Criteria for Building Works and Services* (2nd ed.). Tasmania, Australia: Department of Treasury and Finance.

Topcu, Y.I. (2004). A decision model proposal for construction contractor selection in Turkey. *Building and Environment*, 39, 469-481.

Yilmaz, A. & Ergonul, S. (2011). Selection of Contractors for Middle-Sized Projects in Turkey. *Gazi University Journal of Science*, 24(3), 477-485.

Zala, M.I. & Bhatt, R.B. (2011, May). *An Approach of Contractor Selection By Analytical Hierarchy Process.* Paper presented at National Conference on Recent Trends in Engineering & Technology, India.