Supplier Evaluation and Selection for IT Service Group using the Analytic Hierarchy Process

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Abstract: *Good suppliers and suppliers can create a competitive advantage for the IT business, therefore, the issue of evaluation and selection of suppliers from whom you purchase goods, is vitally important. Analytic Hierarchy Process (AHP) is used to evaluate and select the best IT suppliers because all IT products are essential to the overall system performance. In this article, the hierarchical chart was compiled after the calculation of the diagnostic value from the questionnaire with Microsoft Excel. All five were A, B, C, D and E. The results showed that the weight of all the criteria considered D has the highest score of 0.2862, the second is B, 0.2445, the third is A, 0.1686, and the fourth is C, 0.1598, the last is E, the value is 0.1408, respectively. It is considered to be the best supplier and distributor of IT equipment for this case study. From the eight criteria used for evaluation and selection, it can be classified as the most important, the overall quality criterion, cost of IT equipment procurement, delivery, the technical performance, reliability, flexibility, communication, and the least corporate social responsibility. This is the main product of the case study for the four remaining criteria and consisting of two sub-criteria for flexibility consist of ability to procure urgent goods, capability to change order quantity. And the sub-criteria of corporate social responsibility consist of non-hazardous materials and pollution control.This study focuses on Most Quality the results of the study should help suppliers to understand how to develop a product that meets the criteria or requirements of a case study. They can also apply and develop products to work with other products of case studies. It also creates and develops relationships with upstream and downstream areas.*

Keywords: Evaluation and Selection Supplier, AHP

Introduction

Today, information technology is recognized as playing an indispensable role in business operations. It is an essential tool for enhancing organizational performance. In order to be flexible in the management of the system, quickly and to save time, IT is essential. With the evolution of data communications networks through computer systems, work becomes both simple and efficient. These technologies include the internet, video conferencing, remote access. Networking These technologies are also important factors in the development and change of organizations. It also plays a key role in future business competitiveness, in order to create competitive capability by developing purchasing strategies. Procurement is getting more attention because it is not just about cost. It also seeks to build a business alliance that takes advantage of all this technology to create a win-win organization. Throughout the supply chain, this activity is also considered as a key link in the chain. The supply chain affects the overall success of the organization.

However, purchasing must be dedicated in order to evaluate and select suppliers with both qualitative and quantitative criteria. In order to achieve good results for all parties and to look at the whole of the organization, it is necessary to find a decision-making process that

can bring both concrete and abstract factors into consideration. And that is an important aspect of the Analytical Hierarchy Process (AHP) because it has been recognized for solving the problem. It can be applied to multiple decision making. In the context of Thailand, several AHP applications have been applied to decision making. As a result of the assessment of the suppliers in the automotive and electronic industries (Surakrik, 2008), the selection of the suppliers of machine parts to replace the imported ones (Duangkam, 2007). This is a process that imitates the human thinking process (Orapin & Tananya, 2007). It is suitable for use as a tool of decision making.

AHP has been recognized as a process that simplifies the problem and can be expressed in a concrete way. The AHP hierarchy is still one of several decision-making processes, such as assessment and also, we discovered that AHP is likely to be used for continuous assessment and selection of suppliers (Tahr. iri et al., 2008) to find the best decision-making options (Saaty, 1980), because they can be easily understood and manipulated by mimicking human thought processes. In this paper, we propose a hierarchical analysis process for assessing and selecting vendors for IT service providers.

Concept and theory

Analytic Hierarchy Process (AHP) developed by Saaty (1990). AHP transforms quantifiable quantitative uncertainties into quantitative ones by setting standards in the consideration section to provide a rational answer to the purpose, and creating the structure of the problem. Consider a hierarchical chart (Hierarchy), respectively, of the criteria layer from primary to secondary, down to the actual choice. Alternatively, the factors in each level are compared by each factor according to the mathematical process. Let's consider the components of the problem as a whole and compare the problem for every reason. The results of the decision were concise. (Witoon Tanasiri Kongol, 1999).

The AHP method consists of the following important steps (Dyer & Forman, 1992).

1. Problem isolation and hierarchy generation AHP

The AHP method begins with the separation of complex problems into elements of the hierarchy. The highest level (level 1) consists of a criterion about overall purpose submissions that influence decision making are referred to as sub-criteria. The lowest level of the hierarchy is called the choice of decision (see Figure 1). The significance level of the criterion does not depend on the subsets below that threshold (Saaty, 1990).

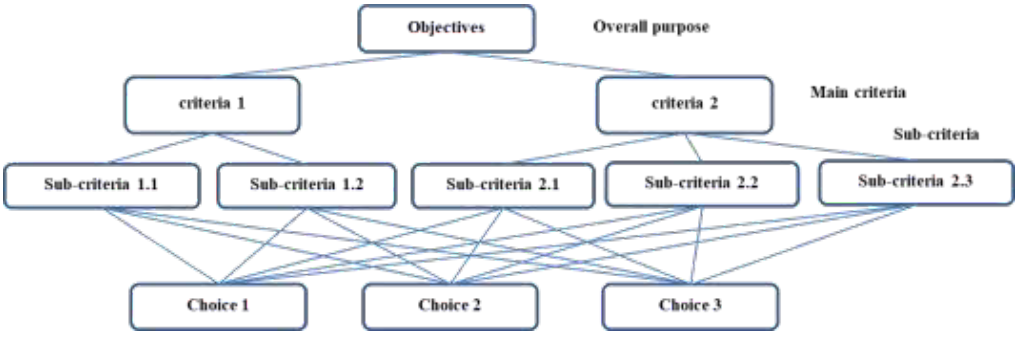

Figure 1: Structure of the process hierarchy AHP

2. Comparative judgment to calculate priorities

Comparative Judgment for Prioritization Step 2 is divided into 3 sub-steps: Pairwise Comparisons, Weight Calculation, and Consistency Check.

2.1 Pairwise Comparisons

When a hierarchy is created, the next step is to compare the pair to find the comparative significance of Subdivisions In each level, the scale used for comparison is the AHP 1-9 baseline (see Table 1). This pairwise comparison or pairing will start from the bottom. (Alternative level) and ends at the second level. (Forman & Selly, 2001) after all subsections have been met. The pairwise comparison is given by scale 1-9, and then the matrix is created.

Table 1: AHP Baseline Scale 1-9 (Saaty, 1996)

Verbal Judgments	criterion
Equal Importance	1
Moderate Importance	3
Strong Importance	5
Very Strongly Importance	7
Extreme Importance	9
Median	2,4,6,8

2.2 Weight calculation

After creating a pairwise comparison matrix the next step is to use a mathematical process to calculate the characteristic vector (Eigenvector) and the Largest Eigenvalue of each matrix vector. The specificity will give priority (weight value). The characteristic value can be used as a gauge to determine the consistency of the calculation method. And specific values can be obtained from Saaty (1990).

2.2 Check the consistency of the discretion.

The AHP method can measure the degree of consistency of each set of judgments. Calculate the Consistency Ratio (C.R.) in each matrix. The consistency ratio, if zero, will mean that the set of discretion is perfectly consistent. If the consistency ratio is one (or 100%) it means that the discrepancy is equivalent to the discretion of the random If the consistency ratio is very high (Critical value is 0.1) the discretion is unreliable. The acceptable range of C.R. depends on the size of the matrix. For example, if a matrix size of 3x3 C.R. should not exceed 0.05 if the 4x4 C.R. matrix should not exceed 0.08 C.R. should not exceed 0.1 (Saaty, 1994). If the valuer's judgment in C.R. exceeds the required level appraisers should review their judgment (Saaty, 1994).

3. Synthesis to obtain significance

By considering all the priorities from the comparison, what choices should be selected for the analysis process of AHP. As shown in equation (1).

3.1 Matrix analysis

$$\begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix} \quad (1)$$

3.2 Geometric Mean Method

Geometric meanings are derived by multiplying the mean of the numbers. Then take the product to root the number. As shown in equation (2).

$$V_i = \left(\prod_{j=1}^{n} a_{ij} \right)^{1/n} \quad (2)$$

When a_i = a numeric value in a matrix table

V_i = geometric mean

n = number of digits to find the mean

3.3 Weight value analysis of alternative formats

The analysis of the weight of each alternative format is based on the synthesis of alternative forms of data, as in Equation (3).

$$W_i = \frac{V_i}{\sum_{i=1}^{n} V_i} \quad (3)$$

When W_i = weight of each criterion

V_i = geometric mean

n = number of digits to find the mean

3.4 Conformity Analysis

How to calculate the consistency of the reason for rating by using a metric comparison, all of the criteria are determined by taking the sum of the diagnostic values for each rule in a row. Each row is multiplied by the sum of the average values in each row and then the resulting multiples. The result is equal to the total number of criteria being compared. This sum is called the maximum eigenvalues (λ max)

$$\lambda \max = \sum_{i=1}^{n} \left[\sum_{j=1}^{n} a_{ij} W_i \right] \quad (4)$$

- If the matrix has a 100%

$\lambda\, max$ = the number of rules to be compared **(**n**)**

- If the matrix is not consistent**.**

$\lambda\, max$ > the number of criteria being compared

Consistency Index (CI)

$$CI = \frac{(\lambda \max - n)}{(n-1)} \quad (5)$$

n = number of criteria

Consistency Ratio (CR)

$$CR = \frac{CI}{RI} \quad (6)$$

CR not exceeding 10%

Random Index (RI) The sample was sampled from a 64,000 matrix. Saaty (1980) Table 2.

Table 2. Consistency index (Saaty, 1980)

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Methodologies

The researcher reviewed the literature and related research. The research process is as shown in Figure 2, with the following details.

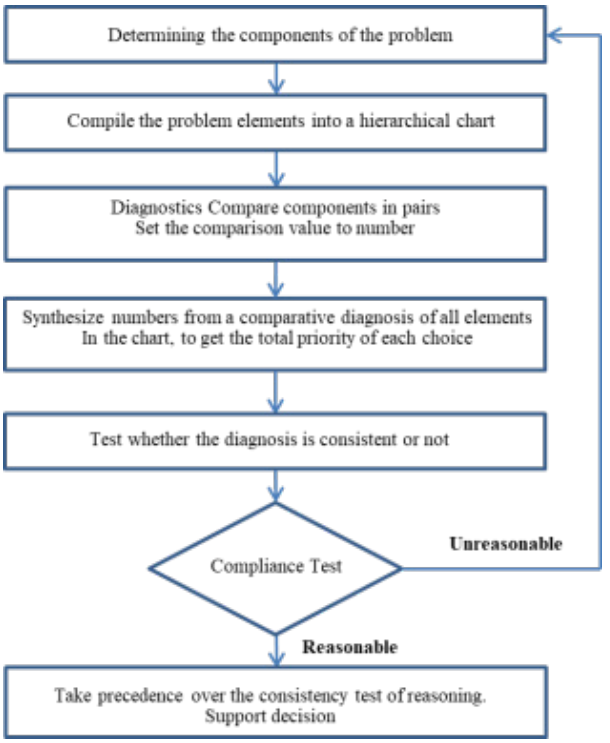

Figure 2: Process step chart AHP (Tonsiri Kongkul, 1999)

1) Analyze and identify problems

Know the basic information and requirements of the case study from the initial coordination. Analyze problems, identify problems and determine solutions. Then offer a case study.

2) Review related papers and research.

It is necessary to browse information involving evaluating and selecting suppliers for the manufacturing industry, the general industry and the IT industry as well as academic articles of research and textbooks related to the implementation of hierarchical analysis. Select criteria for evaluation and selection of suppliers, as well as the evolution of relevant decisions from sources such as libraries, databases, research, etc.

3) Identify criteria for selection and selection of suppliers.

After reviewing the research include all documents related to evaluation and selection of suppliers. Summarize the criteria as a draft for a case study that has been consulted by 5 highly qualified IT professionals who represent the education sector and IT practitioners who provide advice about the appropriate criteria for creating hierarchical charts and query design.

4) Create hierarchical charts

For hierarchical charts for analysis and decision making, this case study has 4 layers (Figure 3).

Layer 1: Goal is to evaluate and select the best fabric supplier for a case study.

Layer 2: There are 8 main criteria, including Overall quality, Delivery, Cost of IT Equipment procurement, Technical performance, Reliability, Flexibility, Communications and Corporate Social Responsibility.

Layer 3: There are 4 Sub-Criteria, including the capability to change order quantity, ability to procure urgent goods, non-hazardous materials and pollution control

Layer 4: Alternative to make decision choice, there are 5 alternatives: A, B, C, D and E.

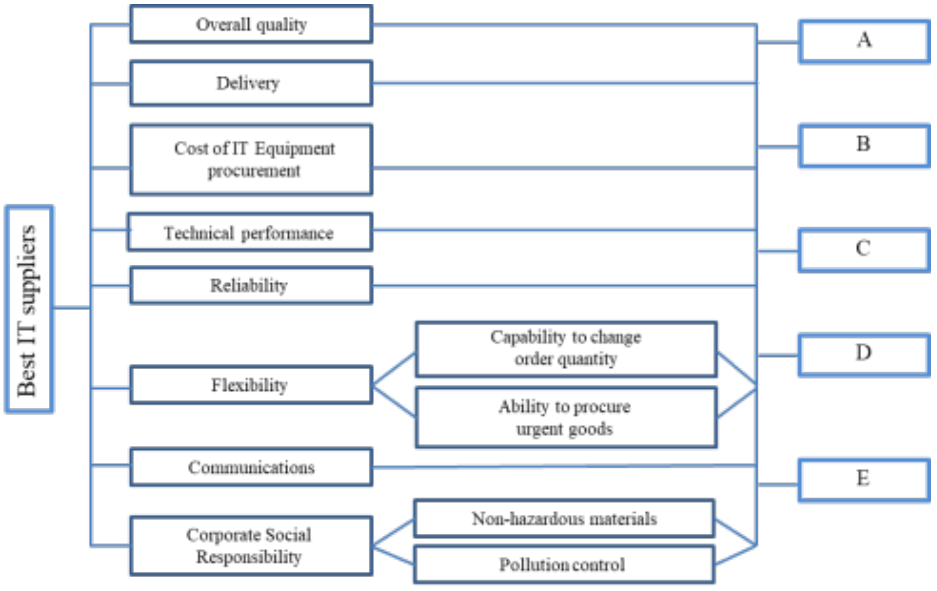

Figure 3. Hierarchical charts for evaluating and selecting suppliers in the IT service business.

5) Prepare a questionnaire

Design of questionnaires and interviews for expert advice in a case study of 4 persons. The questionnaire was used to compare the criteria, sub-criteria and options. There are 130 pairs of comparisons. The AHP Measurement Scale can be divided into 9 levels (Saaty, 1980).

6) Creating Matrix Tables for Matching

Each level of expert judgment in the company. The Pair-wise Comparison (Pair-wise Comparison) from the top to the bottom and the comparison were calculated. The weight of the top layer down to the top until the total score of the choice and use Microsoft Excel as a tool to calculate the results in Table 3.

Table 3: Matrix Criteria Comparison

Main criteria	Overall quality	Delivery	Cost of IT equipment procurement	Technical performance	Reliability	Flexibility	Communi-cations	Corporate Social Responsibility
Overall quality	1.0000	1.4155	1.6540	1.9412	1.6951	2.8823	1.8228	3.1512
Delivery	0.7654	1.0000	1.5251	1.6551	1.5598	1.6551	1.5520	1.4155
Cost of IT equipment procurement	0.6442	0.6228	1.0000	1.6321	1.2151	1.1642	1.5640	1.1212
Technical performance	0.5543	0.6444	0.6784	1.0000	0.8536	1.2565	1.6551	1.1782
Reliability	0.6226	0.4561	1.1451	1.1227	1.0000	0.7888	1.4695	0.8074
Flexibility	0.3551	0.6361	0.7509	0.5524	1.3451	1.0000	0.7551	0.3301
Communications	0.3227	0.5119	0.6228	0.6567	0.6235	1.2392	1.0000	0.8439
Corporate Social Responsibility	0.5195	0.6585	0.9144	0.8709	1.3292	3.4098	1.0892	1.0000
Total	4.7838	5.9453	8.2907	9.4311	9.6214	13.3959	10.9077	9.8475

7) Prioritization

After comparing the criteria one by one the criteria have been set. All criteria are met. Then compare the choices until you can establish the weighting. Then sort the weighting from the most important to the least important value.

8) Test the reasonableness of the data

The results obtained from the consideration of the importance score obtained by pair comparison, according to experts in the company. There is a need to rate it. Sometimes there is an error in the comment. Each person has different opinions according to their knowledge and experience. And that makes the results of the comparison unreasonable. Consistency Index (C.I.)

The calculation of C.I. begins with the sum of the diagnostic values of each vertical rule of each row multiplied by the sum of the mean in the horizontal row of each row. Then multiply the result in each row, which results in the total number of criteria being compared. And this sum is the maximum eigenvalue (λ max) as in equation 4.

If the matrix is consistent, it is 100% perfect. The value of λ max is equal to the number of comparable criteria. (N) But if the matrix is inconsistent then Determine CI as Equation 5.

After obtaining the C.I., the Consistency Ratio (or C.R.) is calculated as follows. When R.I. is a random index, the C.R. value must not exceed 0.1. And the values in the table are derived from the sampling of the table from the 64,000 matrix (Table 2).

Results

After collecting data and analyzing the results with a hierarchical analysis process. The 8 major criteria are listed below. (Figure 4) The overall quality, Delivery, Cost of IT Equipment procurement, Technical performance, Reliability, Flexibility, Communications and Corporate Social Responsibility.

Figure 4. Summarize the weight of the 8 main criteria to evaluate and select suppliers for IT service providers.

When the comparability test was performed, the CR value of 0.0256, which is less than 0.10, can be compared to the corresponding criteria. Further comparisons can be made in the next order for criteria directly related to the distribution of weight. From the main criteria to the direct choice of this case study, there are 10 criteria, called Covering Criteria (Saaty, 2008). The main criteria are the quality criteria, sixth overall procurement costs and delivery fabric 4 threshold is sub-criteria of flexibility, including the ability to change the order. And the sub-criteria of social responsibility consist of non-hazardous materials and pollution control (Figure 5).

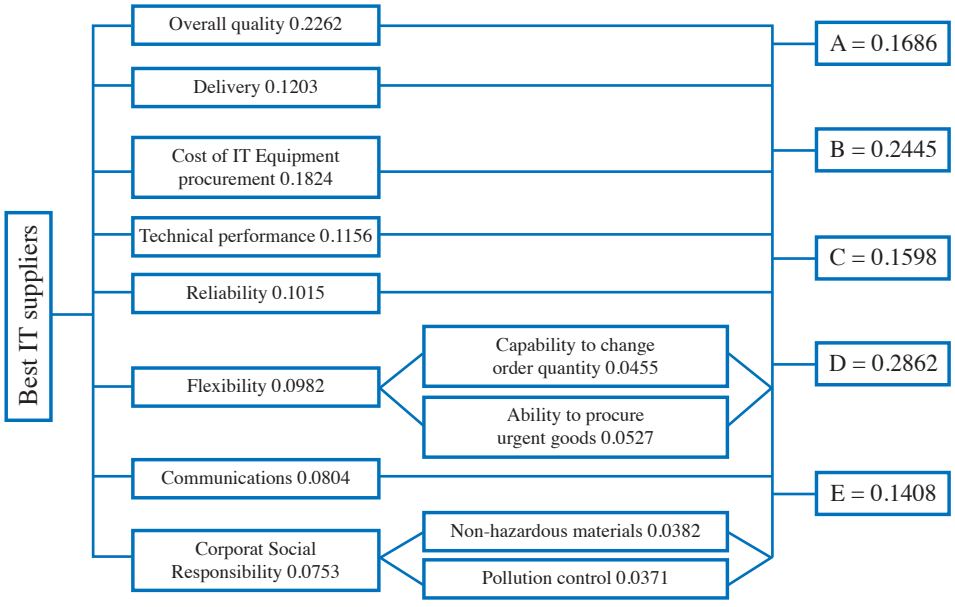

Figure 5: The weight of each supplier under all criteria.

In Figure 5, For Main criteria, the most important main criteria is overall quality criterion (Weight = 0.2662), cost of IT equipment procurement (Weight = 0.1824), delivery (Weight = 0.1203), the technical performance (Weight = 0.1156), reliability (Weight = 0.1015), flexibility (Weight = 0.0982), communication (Weight = 0.0804), and the least corporate social responsibility (Weight = 0.0753)

For Sub-Criteria, there are 2 Sub Criteria of Flexibility are ability to procure urgent goods (Weight = 0.0527), capability to change order quantity (Weight = 0.0455), and 2 Sub Criteria of corporate social responsibility are non-hazardous materials (Weight = 0.0382), pollution control (Weight = 0.0371)

The results show that the weight of all the criteria considered D has the highest score of 0.2862, the second is B, 0.2445, the third is A, 0.1686, and the fourth is C, 0.1598, the last is E, the value is 0.1408.

Conclusions and Discussions

The issues of supplier selection have attracted the interest of researchers in this area. Procurement is one of the key issues for competitive advantage, therefore, the evaluation and selection of suppliers can solve many problems Multi-Criteria Decision-Making Problems (MCDM). Analytic Hierarchy Process (AHP) was used to evaluate and select suppliers for the best IT service providers. IT equipment is key equipment for the installation of information technology. After reviewing the literature and specifying the criteria, a professional questionnaire was developed in the case study and the hierarchical chart was compiled after the calculation of the diagnostic value from the questionnaire with Microsoft Excel. All five were A, B, C, D and E. The results showed that D scored the highest. It is considered to be the best supplier and distributor of IT equipment for this case study. From the eight criteria used for evaluation and selection, it can be classified as the most important, the overall quality criterion, cost of IT equipment procurement, delivery, the technical performance, reliability, flexibility, communication, and the least corporate social responsibility. All the main criteria have similar weight in addition to the scoring of the quality criteria. It is the heaviest criterion. Reflecting that the case study needs to build and maintain customer confidence in the information system, this is the main product of the case study for the four remaining criteria and consisting of two sub-criteria for flexibility consist of ability to procure urgent goods, capability to change order quantity. And the sub-criteria of corporate social responsibility consist of non-hazardous materials and pollution control. It is congruent with Pramolbal, Prasertsiriphan, and Puongklin (2015) who stated that company has little understanding of CSR principles. They just focused on donation or funding only.

This research finding is supported by Tahriri, Osman, Ali, Yusuff, and Esfandiary (2008) who stated that AHP process makes it possible to introduce the optimum order quantities among the selected suppliers. In their work, an AHP-based supplier selection model is formulated and then applied to a real case study for a steel manufacturing company in Malaysia. The use of the proposed model indicated that it can be applied to improve and assist decision making to resolve the supplier selection problem in choosing the optimal supplier combination. The work represents the systematic identification of the important criteria for supplier selection process. In addition, the results exhibit the application of development of a multi-criteria decision model for evaluation and selection of suppliers with proposed AHP model, which by scoring the performance of suppliers is able to reduce the time taken to select a vendor.

As well as, Alsuwehri (2011) pointed out that the AHP model are able to assist decision-makers to examine the strengths and weaknesses of supplier selection by comparing them with appropriate criteria, sub-criteria and sub sub-criteria. Felice, Deldoost, Faizollahi, and Petrillo (2015) summarized that the performance of the supplier is a crucial factor for the

success or failure of any company. Rational and effective decision making in terms of the supplier selection process can help the organization to optimize cost and quality functions. Successful selection can provide competitive advantages in the market including high quality, customer responsiveness and low costs. They conducted the study in Sweden and Iran. The paper shows that AHP can be used as a decision-making tool when it comes to making strategic decisions, e.g., selecting a supplier with which to establish a long term relationship or from which to procure critical material for the company.

Furthermore, Ramlan and Qiang (2014) proposed that an AHP-based supplier selection model applied to improve and assist decision making to resolve the supplier selection problem in choosing the optimal supplier combination.

In summary, this case study can provide a guideline information to help and support suppliers understand how to improve themselves on various aspects to meet its supplier selection criteria based on AHP. It can applies to the selection of equipment and products, and also used to build and develop relationships with upstream businesses.

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