An Analysis of Comparison on Weighted AHP for Improving Supplier Selection in IT Outsourcing

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ABSTRACT

Due to the increase of competency and competitiveness, most organizations are adopting IT outsourcing (ITO) concepts and incorporating them into their main business strategy. ITO offers the benefits that includes cost reduction, improvement in staff ability as well as rapidly accessing and employing new technology. Thus, supplier selection has become a significant process in the organization. However, supplier selection is a complex decision making process which involves evaluation of more than one criterion. Each criterion carries a different weight which are usually defined by the experts. This paper presents the realization of Analytic Hierarchy Process (AHP) to define the priority weight in the supplier selection process. It is operationalized on three datasets which were obtained from the literature. Consequently, a reasonable priority weight vector was chosen to be used in the supplier selection of ITO projects.

Keywords: IT outsourcing, supplier selection problem, Analytic Hierarchy Process.

I. INTRODUCTION

Nowadays, most organizations are facing problems in IT project implementation. These includes inefficient IT staff, difficulty in accessing and maintaining new technology, and also the increasing of project implementation cost (Faisal & Raza, 2016; Thakur & Anbanandam, 2015). Hence, ITO plays an important role in reducing the cost, ensuring time to market and improving the quality of the products. ITO has been described as the process of handing over part or all of an organization's technology/systems-related functions to external service provider(s) (Loh and Venkatraman, 1992; Gottschalk and Solli-Saether, 2005; Kshetri, 2007). Through ITO, the issue of staff inefficiency can be solved as the appointed developed specialized capabilities in managing IT systems at a lower cost (Gonzalez et al., 2005). Hence, according to Kobelsky and Robinson (2010) in ((Faisal & Raza, 2016), ITO is able to improve organizations' IT capabilities and reduce the expenditure on utilizing the latest IT tools. Moreover, ITO projects are also seen as a means of transferring and leveraging the vendors' superior technical, business knowledge, benefiting complementary skills and scarce expertise (Al-Salti & Hackney, 2011).

Despite these benefits, there have been reports on unsuccessful ITO projects as suppliers failed to deliver the expected services or products. This includes where outsourcing has been counted as a high failure rate of one in four projects (Ishizaka & Blakiston, 2012; Landis et al., 2005). This supports prior study (Wang and Yang, 2007) that revealed only 33% of the respondent are satisfied with IT services while 70–80% for non-IT outsourced services. Hence, it is importance to understand how decision was made in selecting the IT suppliers.

Supplier selection is a process of finding a suitable supplier that is able to provide quality products and/or services with the right price, quantity and time (Chamodrakas, Batis, & Martakos, 2010). Making decisions in choosing the right supplier has an important effect on the organizations' profit and success. As highlighted by (Karsak & Dursun, 2016), focusing only on price is not significant in supplier selection. The process should consider other criterias which can be classified into quantitative (tangible) and qualitative (intangible) criteria (Fusiripong, Baharom, & Yusof, 2017). These quantitative and qualitative criteria will influence the decision-making process in the evaluation of supplier through assigning appropriate weight to each criterion (Çakır, 2017; Fusiripong et al., 2017). Consequently, supplier selection problem can be solved using Multi-Criteria Decision-Making (MCDM) method.

The MCDM methods have been widely used in the decision-making process of supplier selection problem. This is supported by (Nazari-Shirkouhi, Miri-Nargesi, & Ansarinejad, 2017; Qiang & Li, 2015), who stated that MCDM methods are able to measure the conflict between quantitative and qualitative criteria, especially the Analytic Hierarchy Process (AHP) method. However, AHP has shortcoming as it relies on the ability of human judgements and experiences to determine the weighting score for the criteria (Bu & Xu, 2009; Mukherjee & Mukherjee, 2015). In addition, human's opinion and experience might take place from individual preference (i.e. individual opinion and experience), which affected the uncertainty and vagueness to the final decision-making process

(Çakır, 2017; Efe, 2016; Zhang, Deng, Chan, Adamatzky, & Mahadevan, 2016). Thus, many studies overcome the human subjective as well as information uncertainty by using Fuzzy Theory Set (FTS) and Group Discussion (GDS) (Deng, Hu, Deng, & Mahadevan, 2014; Mukherjee & Mukherjee, 2015; Yadav & Sharma, 2015; Yang & Huang, 2000). However, the discussion in this paper focuses on the adoption of AHP method in choosing reasonable priority weight vector for supplier selection in ITO projects.

The organization of this paper is as follows. Section 2 presents the review of literature on ITO, supplier selection problem, and the weakness of AHP method. Section 3 presents the adoption of AHP to calculate priority weight in supplier selection problem. Discussion on findings are provided in section 4 while the last section describes the conclusion and future work.

II. LITERATURE REVIEW

This section provides discussion on the ITO, Supplier Selection problem and overview on AHP method.

A. IT Outsourcing

ITO have been widely adopted in many organizations to enhance their competitive advantage through strategic innovation (Hanafizadeh & Zare Ravasan, 2017). Moreover, the trend in adopting ITO have been growing due to the reduction of expenditure, increase in productivity and services, and global business competitiveness (Fallahpour, Udoncy Olugu, Nurmaya Musa, Yew Wong, & Noori, 2017) as well as increase accessibility of new technology (Faisal & Raza, 2016). Although ITO offers some benefits, there are studies reporting on the poor experience of ITO implementation. For example, according to (Hanafizadeh & Zare Ravasan, 2017), IT managers highlighted that the satisfaction rate of the ITO services is only 30 percent as compared to non-ITO services which about 70 - 80 percent satisfaction. This information indicates some negative impact on the wrong decision of the supplier selection process.

B. AHP in Supplier Selection Problem

Supplier selection process is a complex decision making process that offers some benefits such as high-quality products and customer satisfaction (Yadav & Sharma, 2015) and reasonable price (Thakur & Anbanandam, 2015). Supplier selection process commonly involves with many criteria which include organization structure, management strategy, enterprise culture, and organization requirement (Deng et al., 2014). In addition, (Yang & Huang, 2000) determined five criteria for supplier selection in ITO which are management, strategy, technology, economic, and quality. However, in order to improve the decision making process in supplier selection, the process should consider two additional criteria which are resource and risk (Nazari-Shirkouhi et al., 2017).

MCDM has been widely applied in the supplier selection process due to its capability to evaluate more than one criterion. On of the MCDM methods is the AHP which was introduced by Professor Thomas L. Saaty in 1970s (Saaty, 2013). Due to its capability in measuring both quantitative and qualitative criteria (Qiang & Li, 2015) as well as conflict criteria (Nazari-Shirkouhi et al., 2017), AHP has been widely adopted in supplier selection problem for both as individual and integrated methods (Bu & Xu, 2009; Efe, 2016; Mukherjee & Mukherjee, 2015; Nazari-Shirkouhi et al., 2017).

As for the individual approach, (Bu & Xu, 2009; Mukherjee & Mukherjee, 2015; Yang & Huang, 2000) adopt the AHP to calculate the weight for each criterion and the weight was assigned by using group discussion. However, AHP process is complex (Wang & Yang, 2007) as it requires various pairwise comparison which relies on number of choosen criteria (more specifically: $n\frac{(n-1)}{2}$). In addition, the method also suffered from compensation between the good and bad score among criteria due to the use of aggregation (Wang & Yang, 2007). Furthermore, experts subjective opinion on the importance of the criteria also causes uncertainty during the evaluation process (Çakır, 2017; Zhang et al., 2016). Thus, there are various work that try to solve this problem by enhancing AHP with other decision-making methods (Efe, 2016; Nazari-Shirkouhi et al., 2017; Qiang & Li, 2015; Wang, Lin, & Huang, 2008; Wang & Yang, 2007; Yadav & Sharma, 2015).

For example, in (Wang & Yang, 2007), they combined AHP and PROMETHEE to calculate the criteria weight and rank the supplier by avoiding trade-offs process. On the other hand, weight assignment may also rely on the various perspectives of involved stakeholders. Hence, (Wang et al., 2008) highlighted the importance of group discussion to effectively assign weight to each criterion. According to (Yadav & Sharma, 2015), Triangular Fuzzy Number (TFN) was adopted to reduce uncertain ty and vagueness of human judgement in AHP method. Similarly, (Efe, 2016) highlighted AHP capability with TFN and Additive Weighted Aggregation (AWA) operator to calculate overall weight for the supplier selection process. The extensible capability of an individual TFN (Çakır, 2017) leads to the combination of group TFN and AHP method to calculate weight for criteria and its sub-criteria. There is also study that claimed the AHP and D-number combination method, can represent various type of uncertainty in human's subjective judgment, hence increasing the accuracy of supplier selection (Deng et al., 2014).

III. THE ADOPTED AHP

The AHP method has been adopted in this study to determine the priority weight vector for supplier selection in ITO project. Figure 1 presents the hierarchy structure of supplier selection problem in ITO in which each criterion in the structure indicated the suppliers' performance and should reflect with the achievement of the organization's goal.

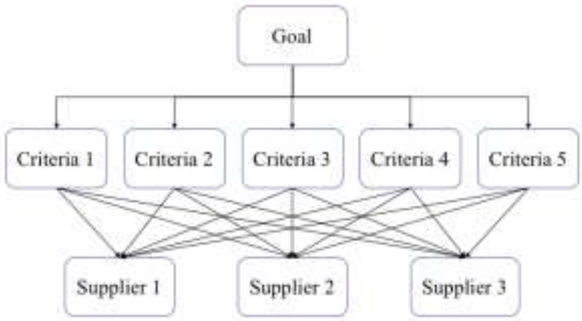

Figure 1. Hierarchy Structure.

In the initial step, this study adopts the Pairwise Comparison Matrix (PCM), which is represented as sub-structure in the hierarchy structure. After that, pair-criteria in a PCM will be assigned with the judgment value based on Saaty's scale. Each pair-criteria may have the same or different judgment value (Fusiripong et al., 2017). The list of Saaty's scale is shown in Table 1.

Table 1. Saaty's Scale (Saaty, 2013).

Saaty's Scale	Verbal definition
1	Equal importance
2	Weak and slight
3	Moderate importance
4	Moderate plus
5	Strong importance
6	Strong plus
7	Very strong or demonstrated importance
8	Very, very strong
9	Extreme importance

The PCM was calculated by using the conceptual of AHP method. The method consisted of four steps to calculate the priority weight vector. In the first step, normalization on each column was performed using equation 1:

$$a'_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \qquad (1)$$

where a'_{ij} *dictated the normalization value of each judgment value in each column while* a_{ij} *dictated the original judgment value.*

After the normalization, the priority weight vector of the PCM will be calculated by following the equation 2:

$$\omega_i = \frac{\sum_{j=1}^{n} a'_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{n} a'_{ij}} \qquad (2)$$

where ω_i *dictated to the each criterion weight.*

To ensure that these criteria weight is consistent, the Consistency Ratio (CR) value must be calculated in order to ensure that the priority weight vector (through PCM) does not exceed 0.1 (Saaty, 2013). Moreover, the CR value depends on the Consistency Index (CI) which comprises of two values that include the Maximum Eigenvalue (λ_{max}) and number of criteria in PCM (n), as following by equation 3 and 4 respectively.

$$CI = \frac{\lambda_{max} - n}{(n-1)} \qquad (3)$$

and

$$CR = \frac{CI}{RI} \qquad (4)$$

where *RI*, the Random Consistency Index, which is defined by (Saaty, 2013) as shown in Table 2.

After PCM has been generated through AHP rule, the study obtained the priority weight vector. In which, it was adopted for considering a suitable supplier selection in ITO.

Table 2. Random Consistency Index (Saaty, 2013).

Number of Criteria (PCM Dimension)	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

IV. RESULT AND DISCUSSION

As mentioned ealier, this study aims to determine the priority weight vector for supplier selection process. The study employs three different dataset with the same criteria and structure obtained from literature. The dataset consists of five criteria which are management (C1), strategy (C2), economic (C3), technology (C4), and quality (C5).

Each dataset has it own judgment value which was assigned for each pair-criterion. In hierarchy structure, AHP method can decompose the structure into several smaller subproblems in the same level. By using the pairwise comparison, this study generates a Pairwise Comparison Matrix (PCM) from a subproblem. Then, the PCM obtained the judgment value for each dataset as shown in Table 3.

Table 3. Judgment Value in Pairwise Matrix of Each Hierarchy Structure

Authors	(Yang & Huang, 2000)						(Bu & Xu, 2009)						(Nazari-Shirkouhi et al., 2017)				
Criteria	C1	C2	C3	C4	C5		C1	C2	C3	C4	C5		C1	C2	C3	C4	C5
C1	1	1	4	5	3		1	1/3	1/5	5	3		1	2	5	6	3
C2	1	1	2	6	3		3	1	1/3	7	5		1/2	1	5	4	4
C3	1/4	1/2	1	3	1		5	3	1	9	7		1/5	1/5	1	3	1/4
C4	1/5	1/6	1/3	1	1/2		1/5	1/7	1/9	1	1/3		1/6	1/4	1/3	1	1/2
C5	1/3	1/3	1	2	1		1/3	1/5	1/7	3	1		1/3	1/4	4	2	1

After building these PCMs, the study adopted equation 1 and 2 to calculate the priority weight vector in each dataset. The results obtained are shown in Table 4. Then, in order to ensure that each priority weight vectors in Table 4 is suitable to be used in the supplier selection process, the study has examined each priority weight vector with the CR value by using equation 3, and 4 respectively.

Table 4. The Priority Weight Vectors

Authors	Criteria	Weight
(Yang & Huang, 2000)	C1	0.364
	C2	0.328
	C3	0.134
	C4	0.057
	C5	0.117
(Bu & Xu, 2009)	C1	0.134
	C2	0.260
	C3	0.503
	C4	0.035
	C5	0.068
(Nazari-Shirkouhi et al., 2017)	C1	0.408
	C2	0.306
	C3	0.085
	C4	0.057
	C5	0.144

Consequently, all priority weight vectors are consistent as the CR values did not exceed 0.1 as shown in Table 5. These findings indicate that all priority weight vectors can be applied in the decision process for the supplier selection of IT project outsourcing. However, since there are three values, this study later identified the most suitable priority weight vector in order to obtain the most effective selection process. Based on literature, if the CR value is close to zero, then it can point to the closely perfect PCM (Saaty, 2013). Additionally, it also can indicate the transparency of the decision makers. Thus, this study selected a priority weight vector, which has the lowest CR value , i.e 0.015. Hence, the most suitable weight for the criteria will include 0.364, 0.328, 0.134, 0.057, and 0.117 respectively.

Table 5. The Consistency Ratio.

Authors	CR Value
(Yang & Huang, 2000)	0.015
(Bu & Xu, 2009)	0.053
(Nazari-Shirkouhi et al., 2017)	0.094

Based on the experience in using AHP for supplier selection, it is learned that the selection of a reasonable priority weight vector still relies on human. Moreover, if the decision structure become more complex the process of performing PCM will be difficult. As a result, it may negatively impact the accuracy of the each weight in each criterion. In addition, the result of decision process is still unclear and imprecise because the weight acquisition relied on the opinion and experience of the individual expert and/or a group of experts where human may make some mistake during the process.

V. CONCLUSION

IT project outsourcing improves organization's competitiveness as the product and/or services is obtained from credible supplier. However, determining the weight for the criterias to be used in supplier selection are still uncertaint and disorientated. Hence, this study demonstrates the employment of Analytic Hierarchy Process (AHP) in determining the weight for three different dataset with five criteria. The method was used to determine the priority weight vector based on consistency ratio reported in the literature. Even though the minimum consistency ratio is adopted, reasonable priority weight vector still relies on the human judgement which might introduce bias in the decision making process. Thus, for future work, the study will improve the quality of decision making in supplier selection of ITO by enhancing the AHP method using optimization technique in artificial intelligence.

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