Criteria for Supplier Selection: An Application of AHP-SCOR Integrated Model (ASIM)

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***Abstract* – Supplier selection has become one important facet in supply chain management. As many conflicting aspects to take into account, supply chain performance is spectacularly elevated due to the enhancement of supplier selection problem in many areas. This paper introduces the new methodology based on integration of analytical hierarchy process. Questionnaire was sent to all stand-alone largest hypermarkets in Selangor, Malaysia to correlate the precedence importance based on 41 criteria in selecting the suppliers. The survey highlights the results that intensify the use of integration of AHP-SCOR model in assisting decision maker to effectively evaluate numerous suppliers. The results amplify the most appropriate decision making method providing the implication of newness development of integrated model.**

Keywords - AHP, AHP-SCOR, Supplier Selection, Decision Making, Criteria

1. Introduction

In current market aggressive and global scattered of supply chain system around the world, the main key elements in gaining competitive advantages by avail the effectiveness of supply chain management. Today's organizations encountered with severe contention, by some means drive them to increasingly consider new applications to improve quality and to reduce production and operation cost. In the modern era of business system, the profound global competitive dynamics forces organization to revolutionize the value chain from suppliers to customers, drive the importance of customer supplier relationship management.
These days, highly aggressive environment is forcing the organizations to establish a short-term and long-term strategic relationship with the supplier. In a way to reduce cost to cost-effective, organizations firm are ought to oversee overall activities along the chain members immense to supply chain network. According to Rajesh & Malliga (2013), the globalization of trade development and the global system using Internet service has widened the purchaser's set of choice. Moreover, ebb and flow of customer preferences require a careful and observant on supplier selection.

Decision making is everyday most routine actions almost for all human life. On a daily basis, people make decision no matter the decision is subject to small or big decision. This decision is depend on the impact of the choices of decision that influence people to give a lot of thought to avoid unnecessary outcomes. Making methodical is challenging largely due to the decision environment's intrinsic complexity. Since the past decade, many studies pertaining to multiple criteria in decision making has been raised. Moreover, many literatures have reviewed the supplier selection problem that discussed the available approaches in selecting the right supplier (Nazim at al., 2015).

2. Decision Making

Decision making is a process of selecting between at least two or more alternatives. The need of decision making in organization is as important as a cognitive process in management. However, decision making in an organization are multi-faced and a complex tasks even a simple matter might have different outcome if misconduct in the process of decision making.

Recent propensity of procurement management is to lessen cost by reducing number of suppliers. To impel the traditional trend in supplier selection, supplier's overall performance must be considered including price, quality, performance history, delivery, reciprocal arrangement and other criteria.

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Nazim et al. (2015) has developed AHP-SCOR Integrated Model (ASIM), a decision making approach to solve supply chain decision-making problem. ASIM compares the scores on different criteria, quantitatively aggregate the criterion scores, and compare the aggregate scores (Nazim et al., 2015; Abdullah, Yahya & Malim, 2013).

In the context factors for decision making process, there are four degree of certainty; certainty, risk, uncertainty and ambiguity. Certainty is describe as all relevant information is known and available to decision maker, and risk is decision maker has the information but there are risk of the outcome of each alternative. Uncertainty is a situation where there is limited information of the alternative and the outcome is unknown, while ambiguity is where alternatives are difficult to specify with unclear goals and objectives.

3. Selecting the Right Supplier

To survive in the intensely competitive global economy, it is often critically important to, not only develop existing suppliers but also to discover new suppliers. The right supplier selection process encompasses different functions, such as purchasing, quality and others within the organizations, and it is a multi objectives problem, encompassing many tangible and intangible factors in a hierarchical manner. A review of academic literature identified that the most popular criteria for selecting and evaluating suppliers is quality, followed by the criteria delivery and cost (Ho et al. 2010). Effective supplier means suppliers who can supply the right amount of materials or services at the right time, at the right price and the right quality (Mwikali and Kavale, 2012). Suppliers can be evaluated across multiple dimensions in order to cover different aspects of the supply to buyers that might include its organization, past performance and many others criteria.

Abdullah, Yahya & Malim (2013) asserted that many conflicting in the analysis and evaluating the supplier specifically correspond with the rank order of the suppliers' criteria. Selecting the right supplier is a distress process, thus having a more simplistic supplier selection process allow emerging business into sustainable margins. A key criterion in choosing the right supplier is value. Value reflects on the criteria where cost is not only the sole determinant, there are others criteria to consider. Nazim et al. (2015) introduces 41 criteria in selecting the right supplier significantly compliance to strengthen the standard in supply chain system.

4. Criteria in Supplier Selection

The sources of criteria in selection decision are crucial and require most complex analysis to take into account. The previous framework involves more than one selection criterions and numerous formal techniques have been developed, based on particular conceptual approaches. This has been supported by Garfamy (2011) study. Guyon and Elisseeff (2003) identified that purchasing decision has indicated similarities in previous research although the supplier evaluation and selection criteria are different products and services. Guyon and Elisseeff (2003) claimed that it is a norm in sub-optimal value if the variables are redundant in selecting the most relevant variables.

Preferences are generally considered to be the function of case-specific evaluations of quality, price, delivery and service. The relative importance of these selection criteria has been examined over various purchasing situations (Zeydan et al., 2011). Weber (1991) noted that the need in further judgemental on the Dickson's criteria is required. This paper proposed framework measurements (figure 1) are grouped into five main categories: cost, quality, organization, service and relationship and 41 criteria that are chosen into this group as sub-category are well supported in the literatures. The added 5 criteria: discount, expertise, resource, experience and knowledge management analyzed the significant relationship to the supplier selection criteria in Malaysia scenario to be tested as newly related criteria for supplier selection. Suppliers were evaluated in the basis of categories dimension and supply chain efficiency can further incorporated into overall supplier's performance. Zhu et al. (2010) recommended that the evaluation of the supplier is based on dimension and sub-variables. The mentioned variables are including cost, quality, organization, service and relationship.

Category	COST	QUALITY	ORGANIZATION	SERVICE	RELATIONSHIP
Sub-Category	Price	Quality	Performance history	Delivery	Desire
	Financial Position	Package ability	Procedural compliance	Warranties	Attitude
	Operating Control	Reliability	Communication System	Technical Capability	Impression
	Inventory Cost	Flexibility	Reputation	Repair Service	Amount of Past Business
	Discount	Consistency	Management & Organization	JIT	Reciprocal Arrangement
		Process improvement	Labor Relation Record	Professionalism	Long-term Relationship
		Product development	Geographical Location	Research	Integrity
		Quality standards	Training Aids	Experience	Culture
		Expertise	Product & Facilities		Knowledge Management
			Resource		

Figure 1: Conceptual Framework – The 41 Criteria

Supplier selection is very important compositions which affect the efficiency of one organizations' supply system. Typically, the improper supplier selection may result in problems, affecting product and services productivity (Benyoucef, 2003). A decision support model as presented in a review of related literatures may be inconsistent. AHP can be employed in the supplier selection decision support model to solve multi criteria decision making. Moreover, selecting the best supplier among alternatives is a decision maker's complex task in order to choose the best out of the best.

Study by Boongasame and Boonjing (2010) clarified that AHP stand alone methods are an optimization decision approaches for which bad score on some criteria can be compensated by excellent scores on other criteria. Therefore, they used the Elimination and Choice Translating Reality III (ELECTRE III) and have been proposed to solve such problem. Nevertheless, the thresholds that were determined and used by identified experts and used in this method may be inconsistent.

SCOR Model is a management tool founded in 1996. The benefits gained by organization, practicing SCOR is supply chain flow will be optimizing and a sustainability of business outcome is derived. Huan et al. (2004) claimed that SCOR model need to strive to improve concerning the use of network modelling tools to support management decision.

Since the integration of AHP with other techniques can be employed to solve complex decision (Hambali et al, 2009), therefore, this paper proposes an integrated approach which employs Supply Chain Operation Reference (SCOR) model and partial concepts of AHP together, name AHP-SCOR Integrated Model (ASIM). In this method, SCOR was used in ranking the criterion or alternatives whereas AHP was used in determining the consistency of the criteria thresholds. In the model, it is found that the values of criteria within ASIM influence the ranking of the alternatives. Specially, the ranking of the ASIM and that of the AHP-ELECTRE III are different.

Shown in proposed AHP-SCOR integrated model in Figure 2, there are four stages in the model: stage 1, stage 2, stage 3 and stage 4. Stage 1 consists of the criteria identification, stage 2 indicates criteria weighted, criteria computation shown in stage 3, and the final stage is the final score measurement. Two major sections in this model are appraisal and selection. Appraisal consists of identifying the criteria and weighted the criteria, along with criteria computation and final score are in selection section.

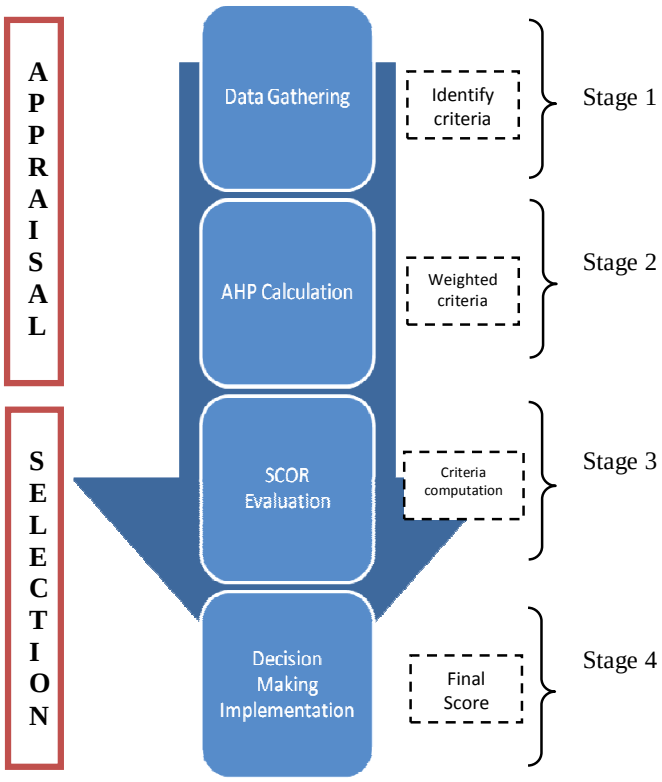

Figure 2: AHP-SCOR Integrated Model (ASIM)

This method proposed to provide a guideline enhancing the support system in supply chain management decision making as a whole. It demonstrates that different decision techniques that have been used may have different results when it is applied to the same problem.

5. Research Methodology

This paper presents a research methodology which implies a process of investigation to obtain information for reliable research results. In order to achieve the objective, this research is focussed on knowledge acquisition by using quantitative research, based on survey research solely on questionnaires survey, and then a comprehensive set of questionnaire was developed. The information then obtained from knowledge acquisition is used to develop a theoretical model, based on Analytic Hierarchy Process (AHP) and SCOR model.

In this paper, Giant hypermarket was selected and selection of supplier is perhaps the most important step in developing supply chain efficiency. With this approach, the researcher chose stand-alone Giant hypermarket located in Selangor and the success rate was 100%.

6. Results

The results from data analysis would provide a clearer picture on the current situation of selection supplier's criteria for choosing of the best supplier with regards to boost in improving the competitiveness in supply chain. It would also increase the understanding on the factors that influence organization and give some ideas on the most appropriate tools to be used in promoting new approach of decision support model and also in increasing both the level and frequency of using the decision support model application for supplier selection in Malaysia.

6.1 Comparison of Supplier Evaluation Criteria between Suppliers

According to the Dickson's (1966) supplier evaluation criteria, the evaluation of extreme important criteria which, correlated with this study

were; quality, performance history and warranties. Table 1 indicates that both Supplier 1 and Supplier 2 criteria for quality were at the first place ranking criteria and were consistent with the Dickson's study in which quality ranked first place. Dickson's third rank was performance history corresponded with the result analysis for supplier 3, whereby performance history was ranked second criteria after price which ranked the most important criteria..

Warranties ranked in the fourth place for Supplier 3, similar to Dickson's finding as extreme important criteria whereas Supplier 2 ranked second criteria and Supplier 1 ranked in fifth place which was in the considerable important criteria. The results from this study evinced with past literature which indicated price and quality ranked at the top of the most important criteria in the supplier selection process.

Table 1: Supplier Evaluation Criteria Comparison

Ranking	SUPPLIER 1	SUPPLIER 2	SUPPLIER 3
1	Quality	Quality	Price
2	Price	Warranties	Performance history
3	Quality Standards	Price	Quality standards
4	Technical capability	Research	Warranties
5	Warranties	Professionalism	Experience
6	Process improvement	Experience	Quality
7	Expertise	Quality standards	Impression
8	Attitude	Knowledge	Flexibility
9	Experience	Performance history	Desire
10	Performance history	Desire	Knowledge

6.2 AHP and ASIM Calculation

In this step, a construction of a pair-wise comparison matrix is a major strength to derive accurate ratio scale priorities. Pair-wise comparisons in this study are based on standardization of nine likert scales (Table 2). Yang (2011) denoted a ranging from 1 – 9 scale preference to pair-wise comparisons where, 1 denoted "equal more importance", 3 represented "moderate more importance", 5 was "strong more importance", 7 denoted "very strong more importance", and 9 "extreme more importance".

Table 2: Comparison Scale

Definition	Intensely of Importance
Equally important	1
Moderately important	3
Strongly more important	5
Very strongly more important	7
Extremely more important	9
Intermediate more important	2, 4, 6, 8

From the proceeding data of the pair-wise comparison, consistency is derived. Consistency ratio (CR) is calculated by dividing Consistency index (CI) to random index (RI); CR=CI/RI. Nevertheless, the consistency ratio should be less than 0.1. Further, factor evaluation and factor weights were multiply and the final score is illustrated in Table 3:

Table 3: Result Summary of Factor Evaluation and Factor Weight

	PLAN	SOURCE	MAKE	DELIVER	RETURN	TOTAL SCORE
SUPPLIER 1	0.274	0.044	0.07	0.035	0.06	0.483
SUPPLIER 2	0.055	0.131	0.07	0.012	0.02	0.288
SUPPLIER 3	0.165	0.044	0.07	0.035	0.02	0.334

The score of factor evaluation and factor weight is applied with the proposed SCOR calculation to evaluate each of the criteria. The weights of SCOR variables are found and these weights are multiplied with the final AHP scores. After the AHP-SCOR methodology is applied, the best supplier is determined.

The final score, resulting from AHP and SCOR metrics evaluation are depicted in the following Table 4. In conclusion, the result will show that supplier C is the best choice of supplier.

Table 4: AHP-SCOR Final Score

	SUPPLIER 1	SUPPLIER 2	SUPPLIER 3
Final Score	0.483	0.288	0.334

The final score will be obtained as an indicator of performance to supplier selection solution. Otherwise, ranking the fuzzy number can be exploited using the integral values ranking method developed by Liou and Wang's model (Aydin and Kahraman, 2012). In this paper, Supplier 1 has been selected as preferred supplier with obtained

high score of 0.483. To conclude, decision making for supplier selection using AHP and ASIM verified that there are significant difference between the two approaches in decision making process. Thus, ASIM ameliorate decision making process to a betterment of organization's supply chain system.

7. Conclusion

Although the popular approaches can deal with multiple and conflicting criteria, they have not taken into consideration the impact of business objectives and requirements of company stakeholders on the evaluating criteria. Integrated approach, combining AHP and SCOR is developed to select suppliers deliberately. 41 criteria by a wide edge is supported in literature and were group into five main categories; cost, quality, organization, service and relationship. These criteria were analyzed to validate the significant relationship on supplier selection process. AHP-SCOR integrated model (ASIM) is a method simplified supplier selection process using new decision support model. The values acquired from supplier's single evaluation on the criteria were evaluated in hierarchy. Subsequently, the comparison matrix was calculated with pair-wise comparison to obtained scores. Substantially, decision maker grant exceptional benefits and attain competitive edge through the credible of newly develop decision making method.

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