Supplier Selection Decision Support System: A Case Study in Malaysian Hypermarket

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Abstract - **This paper attempt to classify the criteria in supplier selection, and to provide the decision maker with a systematic decision support system, based on a combination of multi criteria and application of modified Analytic Hierarchy Process (AHP) with Supply Chain Operations Reference (SCOR) integrated model. A modified AHP used for measuring supply chain efficiency and structured in four stages. In the first stage, data are gathered and used to construct a hierarchical model for supplier selection represented by the AHP. This is followed by determining the criteria to be used in evaluation and weighted for each criterion. The third stage specifies SCOR evaluation and finally the implementation of decision making is provided. Supplier selection is being practiced in organizations' supply chain managements with the need to modernize in the decision support system to fit the nature of selection processes. The results amplify the most appropriate decision-making providing the implication of novelty development of new integrated approach. Finally, this paper provide practitioners at personal or professional setting to achieve a success of the holistic approach in future decision support system.**

Index terms – Supply chain, AHP, SCOR, Decision Making, Supplier selection, Decision Support System, Criteria, Hypermarket

I. INTRODUCTION

Interest in supply chain decision has been highly outlined in the context of supply chain efficiency. Local and global organization supply chain member entails on making choices among alternative courses of actions and rapid improvement in supply chain performance. Many literatures have reviewed on the supplier selection problem that discussed on multi criteria decision making method. In contrast, selecting supplier is imperative important practice in industry including manufacturers, distributors, retailers, and service providers.

This paper is divided into five sections - Section 1: introduction, Section 2: AHP, Section 3: SCOR, Section 4: AHP-SCOR integrated approach, Section 5: Stages in proposed model, the last section demonstrate the conclusion.

II. AHP

Literature reveals that there have different views on the measurement of supplier criterion. Many studies have relatively presented criterion in supplier selection. According to Giuseppe (2009), many conflicting in the analysis and measuring the supplier, based on the rank order of the supplier's criteria. He added the most utilized methodology is the Analytic Hierarchy Process (AHP). Supplier selection is regarded as a multi criteria decision making (MCDM) because it's incorporate to solve a decision problem involving many goals and objectives. Despite that, there are four types of MCDM methods to solve decision problem and AHP, developed by Saaty (1980), is a tool for decision making process continuously be the extensively decision making theory to be employ. AHP is a general theory to set priorities to a qualitative and quantitative decision making. AHP has been widely applied in solving decision problems. As evidence in Wan Khadijah and Lazim Abdullah (2012) study, environmental performance index was applied to the AHP principles to illustrate the world most countries' environment performance.

As AHP is recognized as the most practical method to evaluating and selecting different alternatives, AHP is based on three main principles, including structuring the problem, comparative judgement, and synthesize of the priorities. Pair-wise comparison metrics using 9 likert scales helps decision maker to compare different alternative. The values or scales can be modified depending on the relevant (Sahar, 2006).

Boongasame and Boonjing (2010) in their study clarify that AHP stand alone methods are compensatory optimization approaches for which bad score on some criteria can be compensated by excellent scores on other criteria. Supply Chain Operation Reference (SCOR) model is a management

tools founded in 1996 (Huan, 2004). Organizations practicing SCOR gained benefits by optimized the supply chain flow and a sustainability of business outcome is derived. Huan (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, 2008), this paper proposes an integrated approach which employs SCOR model and partial concepts of AHP together, named the AHP-SCOR Integrated Model. In this method, SCOR will be used in ranking the criterion or alternatives whereas AHP is used in determining the consistency of the criteria thresholds. In this model, it is found that the values of criteria within SCOR influence the ranking of the alternatives.

Study by Boongasame and Boonjing (2010) clarifies that AHP stand alone methods are compensate optimization approaches for which bad score on some criteria can be compensated by excellent scores on other criteria. So, they used the Elimination and Choice Translating Reality III (ELECTRE III) and have been proposed to solve such problem. However, the score values outcome from the ranks of the alternatives may be inconsistent.

AHP stands alone model needs to improve in its model and Bruno (2009) in his study has emphasize 51 out of 201 papers used AHP combined with other approaches for decision making process.

III. SUPPLY CHAIN OPERATIONS REFERENCE (SCOR) MODEL

The SCOR was established in 1996 founded by the Supply-Chain Council (SCC). According to Elgazzar (2010), SCOR model is a business process reengineering, benchmarking, process measurement, and best practice analysis to be exercised in supply chain as an integrated modelling. The principle of SCOR allows organizations to align supply chain management practice as well as filling the gaps in chain performance.

The configuration of a supply chain in SCOR model is driven by:

a. Plan - levels of aggregation and information sources
b. Source - locations and products
c. Make - production sites and methods
d. Deliver - channels, inventory deployment and products
e. Return - locations and methods

To assist organizations in solving supply chain problems, SCOR demonstrates four distinct processes: source, make, deliver, and plan (Huan, 2004). In 2011, Elgazzar (2010) and Supply Chain Council (www.supply-chain.org) extended one variable in SCOR process reference that is returned with the purpose of attaining competitive advantage. SCOR model-based supply chain infrastructure exploited by Huan (2004) and, Elgazzar (2010), SCC (2010) is shown in a Figure 1.

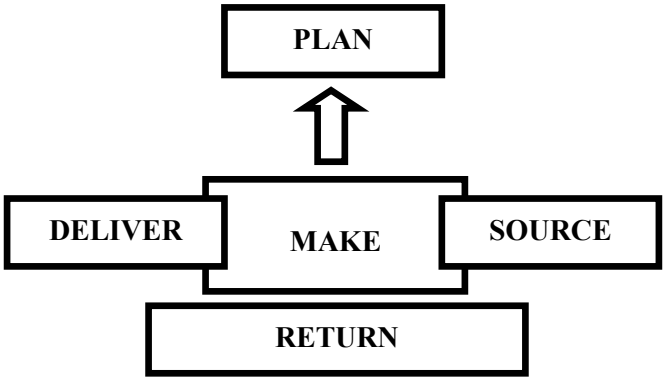

Figure 1: The SCOR model-based supply chain infrastructure

IV. AHP-SCOR INTEGRATED APPROACH

AHP-SCOR integrated approach is newly developed decision model to solve supply chain decision-makings. In this paper, one tool that is used to support the decision-making is a modified AHP model by comparing the scores on the different criteria and employed SCOR model to quantitatively aggregate the criterion scores and comparing the aggregate scores. Subsequently, ranking reversals are applied, based on ELECTRE III methods. The construction of this outranking is to finalize the ranking of the SCOR model multiplying between criteria scores to determine which supplier is preferred. The combination of AHP, ELECTRE III and SCOR are illustrated in Figure 2.

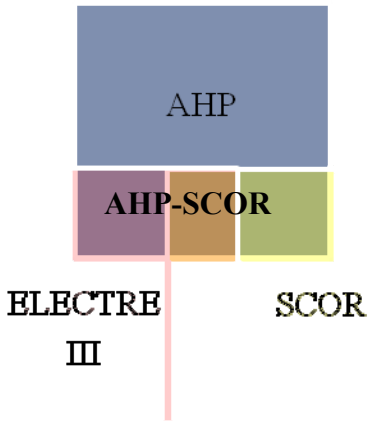

Figure 2: AHP, ELECTRE III and SCOR Combined Theory

Shown in proposed AHP-SCOR integrated model in Figure 3, 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.

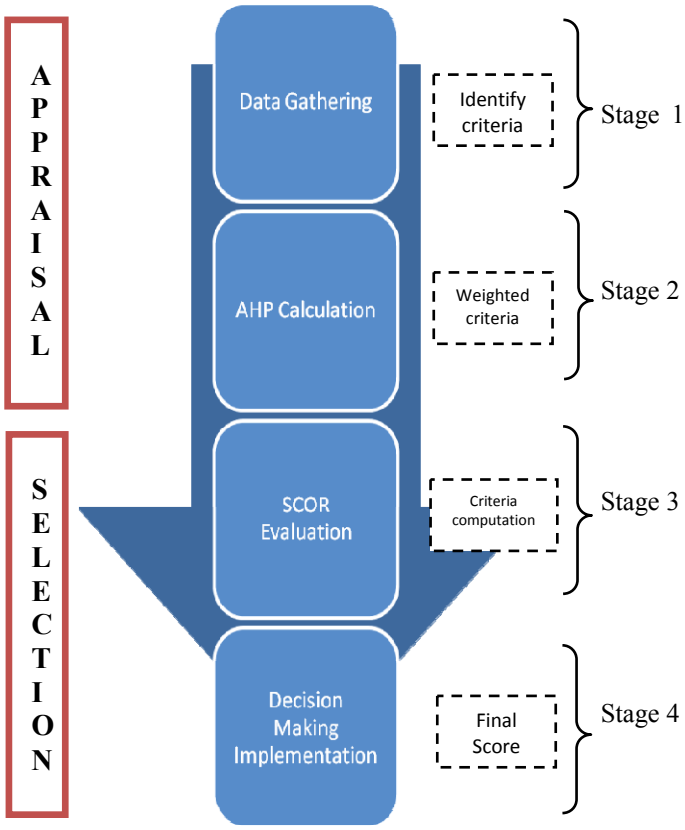

Figure 3: AHP-SCOR Integrated Model

This approach 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.

Finally, the proposed integrated model will be applied to Giant hypermarket as sampling for verification purposes. Then the listed suppliers of this Giant hypermarket are ranked by the means of computation AHP-SCOR method.

The schematic methods for selection process are as follows:

i. Gathering the data to structure the model. The best criteria will be selected. (details process in Section 4: Stages in Proposed Model)
ii. Criteria will be calculated and weighted with AHP. Step 1 and step 2 are appraisal stages.
iii. In selection stage, criteria AHP-SCOR will be computed.
iv. Lastly, final score is analyzed and decision on the best supplier will be implemented.

V. STAGES IN PROPOSED MODEL

Stage 1: Data Gathering

The first stage denoted the identification of criteria. The criterion was based on the past literature (Cheraghi, 2004) from the 36 criteria presented in the theoretical framework. Applying the AHP in supplier selection can be considered as hypothetic problem. Thus, due to competitive advantage in the industry, organizations must able to choose the right supplier to meet supply chain goals. The criteria will then be developed in a hierarchy model. The study analysis is narrowed further as below:

Criteria	
Criteria 1	Cost
Criteria 2	Quality
Criteria 3	Organization
Criteria 4	Service
Criteria 5	Relationship

Supplier:
Supplier A
Supplier B
Supplier C

A schematic of the decision hierarchy for measuring supplier criteria is presented below and **Appendix-1** showed a developed hierarchy model:

Level 1: BEST SUPPLIER FOR HYPERMARKET

Level 2: CRITERIA: 1, 2, 3, 4, 5

Level 3: SUB-CRITERIA

Level 4: ALTERNATIVES: Supplier A, B, C

Level 1

The top element of the hierarchy is the overall goal of the decision-making. Thus in this study, level 1 indicates the best supplier for hypermarket.

Level 2

The second level, which is known as the cluster that are grouped, represents the main criteria which classified into five aspects; cost, quality, organization, service, and relationship. General criteria usually will impact the goal directly.

Level 3

Level 3 are sub-criteria for the 5 main criteria specify in level 2. There are 36 sub-criterion affecting business performance measurements.

Level 4

Alternative of the supplier A, B, and C are shown in level 4.

Stage 2: AHP Calculation

In the next 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 1). 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 1: 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 will be 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 will be multiply and the final score is illustrated in Table 4:

Table 2: Result Summary of Factor Evaluation and Factor Weight

Criteria	A	B	C
Cost	0.06666	0.08888	0.04444
Quality	0.06666	0.08888	0.04444
Organization	0.06666	0.08888	0.04444
Service	0.06666	0.08888	0.04444
Relationship	0.06666	0.08888	0.04444
TOTAL	0.3333	0.4444*	0.2222

Stage 3: SCOR Evaluation

The score of factor evaluation and factor weight will be 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 as illustrated in Figure 3.

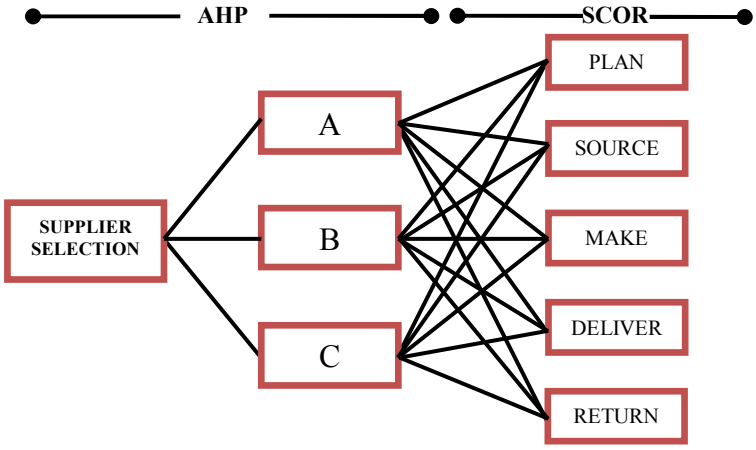

Figure 3: AHP and SCOR Metrics Evaluation

The final score, resulting from AHP and SCOR metrics evaluation are depicted in the following Table 3. In conclusion, the result will show that supplier C is the best choice of supplier.

Table 3: AHP-SCOR Final Score

	A	B	C
Final Score	10	20	30

Stage 4: Decision Making Implementation

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, 2011).

VI. CONCLUSION

Recently literatures are correspond with reference to solving supplier selection problem by mean to the utilization to improve performance evaluation decision. Criteria's in supplier selection of criterion involves both qualitative and qualitative factors. As such, AHP is a widely used decision-making process, involving supplier evaluation process. Literature has supported the determination of supplier selection criterion to appraise suppliers. MCDM is deemed as significant in this research paper that involve complex decision-making, therefore, a theoretical model is developed to represent AHP methodology. 36 criteria are well supported in literature are group into five categories. These criteria were analysed to verify significant relationship to the supplier selection criteria in Malaysia scenario. Supplier will be evaluated in the basis of categories dimension and supply chain efficiency can further incorporated into overall supplier's performance. The value acquired from supplier's personal evaluation on the criteria

evaluated in the hierarchy. Subsequently, the comparison matrix is calculated with pair-wise comparison matrix to obtained scores. The AHP-SCOR integrated approach is simplified in supplier selection using new decision support system. The final score of each supplier will be reckoned and the most score will be selected as the best supplier. This study discussed AHP model together with integrated SCOR approach to select hypermarket's best suppliers applied in Malaysia scenario. Essentially, based on the research findings, suppliers in Malaysia would gain benefits and acquire competitive edge through the sustainability of new decision support system.

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Appendix-1 A Developed Hierarchy Model