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# Enhancing Decision Making Process using AHP-SCOR Integrated Model (ASIM)

**Raja Nazim Abdullah[a], Saadiah Yahya[b], Muhammad Rozi Malim[c], Mohamaed Nor Azhari Azman[d], Ganefri[e],** [a]Faculty of Technical and Vocational, Universiti Pendidikan Sultan Idris, 35900 Tanjong Malim, Perak, Malaysia, [b,c,d] Faculty of Computer & Mathematical Sciences, Universiti Teknologi MARA, 42300 Shah Alam, Selangor, Malaysia [e] Faculty of Engineering, Universitas Negeri Padang, Jl. Prof. Dr. Hamka, Air Tawar Bar., Kec. Padang Utara, Kota Padang, Sumatera Barat 25132, Indonesia,

**Purpose** - Supplier selection is the most crucial element in a hypermarket's supply chain system. This paper verifies the past research framework of supplier selection criteria by developing a supplier selection decision support model based on the modified Analytical Hierarchy Process (AHP) with the integrated Supply Chain Operation Reference (SCOR) model. **Methodology** - This paper presents a methodology to develop a theoretical model and literature analysis is executed in the area of supplier selection decision support model. Stratified sampling was chosen as sampling technique in this study to select hypermarket located in Selangor, Malaysia. All stand-alone Giant hypermarkets were selected. A combined theory model for the supplier selection employed the typical stages of the supplier selection process: data gathering, AHP calculation, SCOR evaluation, and the implementation of decision making. **Findings** - An increase in the market's competitive edge, this paper highlights the current hypermarket situation and the selection criteria for choosing of the best supplier, especially with regards to improving the competitiveness of the whole supply chain system. **Practical Implication** - The results amplify the most appropriate decision-making approach, providing the implication of novelty development of the new integrated decision-making approach. **Originality/value** - This new model attempts to provide practitioners in a personal or professional setting with the skills to achieve the success of the holistic approach in the future decision support system.

**Key words:** *Supply chain management, ASIM, Decision Making, Supplier selection, Decision Support model, Criteria.*

## Introduction

The current market competitiveness and interest in supply chain decisions has been highly outlined in the context of supply chain efficiency. Today's fast changing pace of supply chain management has made organisations change their performance to survive in a global market. Most organizations are forced to gain the goals of low cost and high-quality services to maintain a competitive structure. While manufacturers and organizations focus on the continuous improvement of supply chain integration, there is still a lack in internal supply chain optimization, such as customer order position, order priority and order process planners. The area that can be improved are sales management, production management, order management and others related supply chain system's functions. This area may also involve decision-making processes which underline purchasing strategies in order to gain an advantage. Suppliers, manufacturers and distributors attain significant success in supply chain optimization even if they are facing some difficulties in planning, organizing and implementing a norm supply chain system.

The evolution of supply chain interaction underlines that suppliers are required to have an adequate set of competencies to be part of a supply system that is capable of facing market competition (Villanueva-Ponce, Avelar-Sosa, Alvarado-Iniesta & Cruz-Sánchez (2015); Esposito and Passaro, 2009). To this effect, organizations have to be consistent in various actions and strategies, particularly with the assessment processes that are assumed a crucial importance. Assessment of suppliers depends on several criteria with undertaking consideration on customer's requirement.

## Supplier Selection

In the contemporary selection process, the decision-maker plays an important role in thedecision-making stage. The stages include gathering information, identifying decisions, identifying alternative decisions, assessing the decision, and taking action, until a final review of the decision is undertaken. In a traditional way, decision-makers rely on their past experience to decide on the best suppliers. This is not a reliable approach since the nature of the selection process involves a multi criteria decision skill that has become an even more complex process. Therefore, supplier selection is a very complicated task. In Malaysia, supplier selection is an intense complex decision problem, involving qualitative and quantitative factors that are indecisive in dealing with the trade-off between tangible and intangible suppliers' criteria (Farzad, Rasid, Aidy, Rosnah and Alireza, 2008). Typically, in the supplier selection processes, the supplier with the lowest price bid often wins the tender. Price is not the only criteria consumers use when choosing the supplier, whereas many of the decision-makers are unaware with the availability of the decision support model for selecting

the best supplier (Nazim & Yaacob, 2017; Nazim, Yahya & Malim, 2015; Abdullah, Yahya & Malim, 2013). According to Yazdani, Chatterjee, Zavadskas & Zolfani (2017), choosing the right supplier may reduce material purchasing costs, increases flexibility and increases product quality. As a result, inefficient supply chain process will affect the entire organization's supply chain performance (Enyinda, Emeka and Fesseha, 2010).

Many conflictions in the analysis involve identifying, assessing, evaluating and choosing the supplier specifically to correspond with the ranking order of the supplier's criteria (Nazim & Yaacob, 2017; Nazim, Yahya & Malim, 2015; Abdullah, Yahya & Malim, 2013). A traditional supplier selection method was fundamentally based on financial measures. Recently, more emphasis on supplier selection has been devoted to other aspects, bringing multiple criteria into the evaluation process. Weber (1991), discusses Dickson's 23 criteria for suppliers' selection, based on a questionnaire sent to 273 procurement managers as shown in Table 1. Table 1 summarizes the findings of Dickson's study with regards to the importance of the 23 criteria. The factors, which are referring to the supplier's criteria are quality, delivery and performance history, are considered, in its respective order, as the three most important criteria. In summary, Weber's (1991) studies show that in selecting suppliers, quality is the highest rank evaluated as extreme importance with 3.508 means rating followed by delivery and performance, 2.417 and 2.998 mean respectively. Meanwhile, price falls in 6th rank evaluated as considerable important supplier criteria.

**Table 1:** Dickson's vendor selection criteria a Rank Factor Mean Evaluation rating

| Rank | Factor | Mean Rating | Evaluation |
|---|---|---|---|
| 1 | Quality | 3.508 | Extreme importance |
| 2 | Delivery | 3.417 | |
| 3 | Performance history | 2.998 | |
| 4 | Warranties and claim policies | 2.849 | |
| 5 | Production facilities and capacity | 2.775 | Considerable importance |
| 6 | Price | 2.758 | |
| 7 | Technical capability | 2.545 | |
| 8 | Financial position | 2.514 | |
| 9 | Procedural compliance | 2.488 | |
| 10 | Communication system | 2.426 | |
| 11 | Reputation and positioning industry | 2.412 | |
| 12 | Desire for business | 2.256 | |
| 13 | Management and organization | 2.216 | |
| 14 | Operating controls | 2.211 | Average importance |
| 15 | Repair service | 2.187 | |
| 16 | Attitude | 2.120 | |

| | | | |
|---|---|---|---|
| 17 | Impression | 2.054 | |
| 18 | Packaging ability | 2.009 | |
| 19 | Labor relations record | 2.003 | |
| 20 | Geographical location | 1.872 | |
| 21 | Amount of past business | 0.597 | |
| 22 | Training aids | 1.537 | |
| 23 | Reciprocal arrangements | 0.610 | Slight importance |

Ha and Krishnan (2008), add to the 23 criteria from Dickson's vendor selection criteria, a set of attributes to 30 criteria as shown in Table 2. They provide a prerequisite to the difficulty of the problem as many conflicting factors should be taken into consideration. While some of these attributes can be easily measured by qualitative or quantitative concepts, it will result to a delicate problem for the aggregation of these attributes in a last measurement such as out of 30 criteria the most common important criteria among supplier preference are price, quality and delivery.

**Table 2:** Supplier selection attributes framework

| | | |
|---|---|---|
| After sales service | Geographical location | Product appearance |
| Amount of past business | Impression | Production facilities and capacity |
| Attitude | JIT capability | Quality |
| Catalogue technology | Labour relations | Reciprocal arrangements |
| Communication system | Maintainability | Reputation and position in the industry |
| Delivery | Management and Organization | Response to the customer's request |
| Ease-of-use | Operational controls | Technical capability |
| E-commerce capability | Packaging ability | Technical support |
| Environmentally friendly products | Performance history | Training aids |
| Financial position | Price | Warranties and claims |

**Table 3:** 41 Supplier's Criteria

| | | |
|---|---|---|
| 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 | Labour Relation Record |
| Professionalism | Long-term Relationship | Product development |
| Geographical Location | Research | Integrity |
| Quality standards | Training Aids | Experience |
| Culture | Expertise | Product & Facilities |
| Knowledge Management | Resource | |

Dickson (1966), identifies 23 criteria for the supplier selection criteria as seen in the publication of academic articles from 1966 to 1990 (Weber, 1991), whereas from 1992 to 2003, about 49 related articles were published (Zhang, 2004). Moreover, Cheraghi (2004) discovered 36 criteria with an additional 13 criteria from the origin of Dickson's 23 criteria. Due to the highly competitive global market environment, Nazim and Yaacob (2017) introduce 41 criteria (Table 3), that are consistent with the brink of the industrial revolution 4.0 (IR 4.0) that change the whole supply chain system. Therefore, this paper considered 41 criteria as the independent variables in the Malaysian hypermarket's supplier selection study.

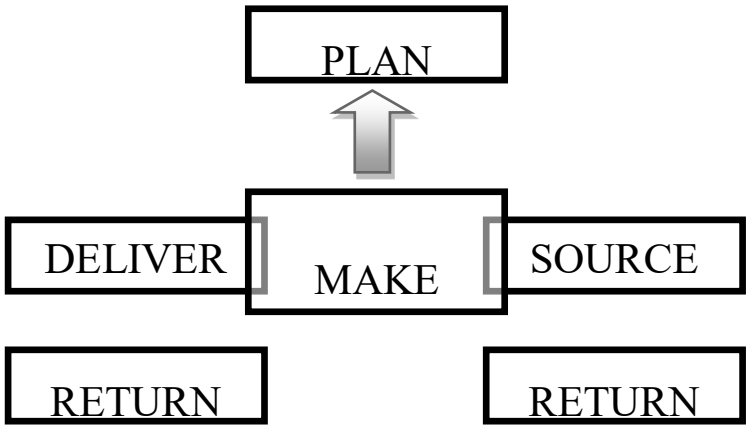
**Decision Support Model**

Literature proves that there are different views in the measurement of supplier criteria. Many studies have presented various criteria in supplier selection. Giuseppe et al. (2009), discussed that there are many conflictions in the analysis and measurement of the supplier, based on the rank order of the supplier's criteria. He added that the most utilized methodology is the Analytic Hierarchy Process (AHP). Supplier selection is regarded as a part of the multi criteria decision making (MCDM), because it is incorporated to solve a decision making problem that involves many different goals and objectives. There are four types of MCDM methods that can be used to solve the decision-making problem. AHP, developed by Saaty (1980), is one of the MCDM methods. AHP is a tool for decision-making processes that continues to be an important decision-making approach to be utilised.

AHP is a general theory of setting priorities to both qualitative and quantitative decision making. AHP has been widely exercised in many government and private sectors in solving decision problems. This has been found in a study by Khadijah and Lazim Abdullah's (2012), where the environmental performance index was applied to the AHP principles to illustrate various countries' environment performance. Thus, the AHP stand alone model needs timprovement, and Bruno et al. (2009), have emphasized that 51 out of 201 papers had used AHP combined with other theories or approaches.

The supply chain reference operation (SCOR) model was established in 1996 by the Supply-Chain Council (SCC). According to Elgazzar et al. (2010), the SCOR model is a business process that focuses on reengineering, benchmarking, process measurement, and the best practice analysis to be exercised in the supply chain as integrated modelling. Wang et al. (2004), claim that the SCOR model needs to strive to improve in regards to the use of network modelling tools to support management's decisions. The principle of SCOR allows organizations to align their supply chain management practices as well as fill in the gaps in the chain's performance. The SCOR model-based supply chain infrastructure by Wang et al. (2004) and Elgazzar (2010), SCC (2010) is shown in a Figure 1.

**Figure 1.** The SCOR model-based supply chain infrastructure




MCDM proposed an alternative performance in which each of the criteria are outranked and compared in pairs. The study by Boongasame and Boonjing (2010), clarifies that AHP stand-alone methods are compensate optimization approaches, for which a 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 proposed ways to solve such problem. However, the score values outcome from the ranks of the alternatives may be inconsistent. In response to the need for a robust supplier selection system, this paper is justified to develop a theoretical model, the Analytic Hierarchy Process combined theory with the SCOR model for the selection of supplier. This proposed research will be referred as AHP-SCOR Integrated Model (ASIM).

**AHP-Scor Integrated Model (Asim)**

The AHP-SCOR integrated model (ASIM) is a newly developed decision-making approach to solve the issues that arise in the supply chain decision making process. The tools that were used to improve the decision-making process is a modified AHP model that compares the scores on the different criteria and the SCOR model is employed to quantitatively aggregate

the criterion scores and compare the aggregate scores. Subsequently, ranking reversals are applied. 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 and SCOR.

Shown in ASIM, there are four stages in the model: stage 1, stage 2, stage 3 and stage 4 (Nazim, Yahya, & Malim, 2015). 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 scores are in the selection section.

This approach proposed to provide a guideline to enhance the support system in supply chain management decision-making as a whole. It demonstrates that the different decision techniques that have been used may have different results when they are applied to the same problem. Finally, the proposed integrated model will be applied to the Giant Hypermarket as a sampling for verification purposes. 48 'stand-alone' Giant hypermarkets were chosen as the sample for data collection method. 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 the appraisal stages.
iii. In the selection stage, criteria AHP-SCOR will be computed.
iv. Lastly, the final score is analysed and decision on the best supplier will be implemented.

***Stage 1: Data Gathering***

The first stage is the identification of the criteria. Applying the AHP in supplier selection can be considered as a hypothetic problem. Thus, due to the competitive advantage in the industry, organizations must be able to choose the right supplier to meet the supply chain goals. The criteria will then be developed in a hierarchy model. The study analysis is narrowed further as 41 criteria are categorized into five categories: cost, quality, organization, service, and relationship. The best three suppliers were chosen based on their overall performance: Supplier A, Supplier B, and Supplier C. Supplier A, B and C are ranked

according to the preference of the decision-maker (procurement manager), in which supplier A is the most preferable and supplier C is least preferable.

***Stage 2: AHP Calculation***

In the second stage, a construction of a pair-wise comparison matrix was used to derive the accurate ratio scale priorities. Pair-wise comparisons in this study are based on the standardization of nine likert scales (Table 3). Yang et al. (2011), denoted a scale ranging from 1 - 9 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 4:** 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 |

AHP steps are illustrated as follows (Saaty, 1980):

Step 1: Decomposition phase - defining the problem.
Step 2: Hierarchy is established by containing criteria and sub-criteria. Usually the top element is the goals of the decision.
Step 3: Comparative judgement phase - criterion of one level of hierarchy are compared with the construction of a pair-wise comparison matrix using 9 likert scales (Table 4).
Step 4: Develop n(n-1) judgement. Example of resulting priorities of alternative A and B as follow:
Step 5: Hierarchical synthesis used by calculating the eigenvalue and eigenvector.
Step 6: Consistency is determined by CI = (Imax-n) / (n-1), where CI is consistency index, CR is consistency ratio, RI is random index, Imax is the largest eigenvalue, and n is the matrix size. CR is acceptable when CR<0.1. Table 5 shows a recommended RI values (Yang et al, 2011).

**Table 5:** Random Index

| N | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| **RI** | 0 | 0.52 | 0.89 | 1.11 | 1.25 | 1.35 | 1.40 | 1.45 | 1.49 |

Step 7: Repeat step 4-6 for all level in hierarchy.

From the proceeding data of the pair-wise comparison, consistency will be derived. Consistency ratio (CR) is calculated by dividing the 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 multiplied and the final score is illustrated in Table 6:

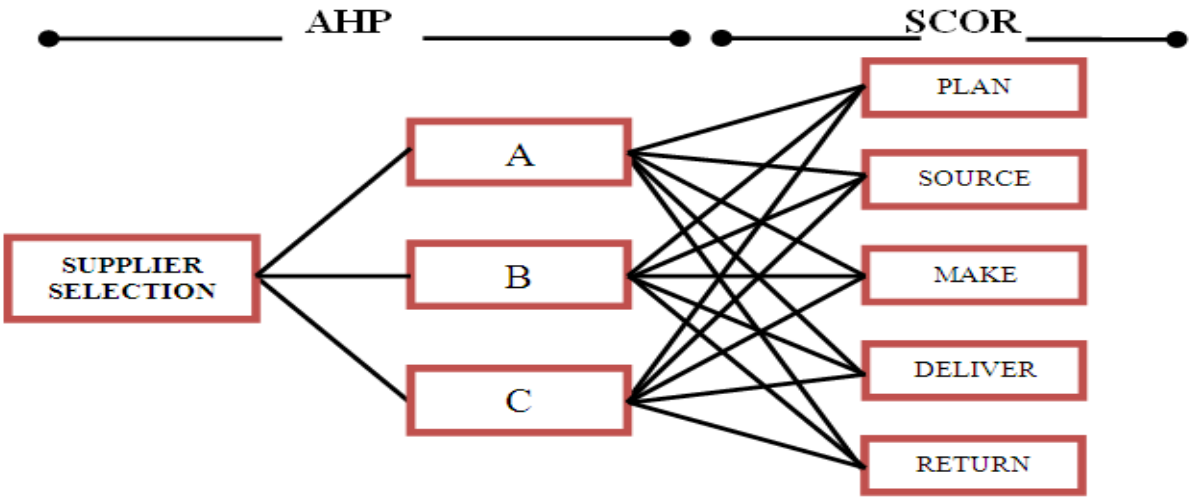
**Table 6:** The Result Summary of Factor Evaluation and Factor Weight

| Criteria | A | B | C |
|---|---|---|---|
| **Cost** | 0.166 | 0.166 | 0.055 |
| **Quality** | 0.077 | 0.077 | 0.081 |
| **Organization** | 0.061 | 0.051 | 0.061 |
| **Service** | 0.057 | 0.057 | 0.012 |
| **Relationship** | 0.018 | 0.055 | 0.018 |
| **TOTAL** | 0.379 | 0.416* | 0.227 |

***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 2.

**Figure 2.** 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 A is the best choice of supplier.

**Table 7:** AHP-SCOR Final Score

| | **A** | **B** | **C** |
|---|---|---|---|
| **Final Score** | 0.483* | 0.288 | 0.334 |

***Stage 4: Decision Making Implementation***

The final score will be obtained as an indicator of thr performance to the 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).

**Conclusion**

Both qualitative and qualitative factors are involved in the supplier selections' criterion. The value acquired from the supplier's personal evaluation on the criteria evaluated in the hierarchy was from the most importance to the least importance. As the findings indicate, supplier selection is crucial in the decision-making process where salient issues in supplier's criteria are resolved. The findings suggest that the Supplier B will be chosen as the best supplier as compared to Supplier A and Supplier C using the AHP calculation. Subsequently, the comparison matrix is calculated with pair-wise comparison matrix to obtain scores and

the scores are multiplied with the SCOR score. ASIM verified that there is a significant difference between the two approaches in the decision making process towards the advancement of supply chain efficiency. A comprehensive overview of the determination of supplier selection criterion to appraise suppliers is deemed as significant in this study that involves a complex decision-making process. From the decision-maker's perspective, supplier's criteria have a significant influence on the final score of assessed suppliers and they will receive benefits and gain competitive edge through the sustainability of a new decision support model.

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