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TOPSIS-AHP Based Approach for Selection of Reverse Logistics Service Provider: A Case Study of Mobile Phone Industry

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Abstract

Reverse supply chain logistics, means mobility of goods from end consumers towards core manufacturer in the channel of product distribution. In the turbulent business environment, the companies must promote alternative uses of resources that may be cost-effective and ecology friendly by extending products' routine life cycles. Reveres logistics activities i.e. storing, transporting and handling of used products poses a great challenge to reverse logistics managers as there is always chances of uncertainty in terms of quantity, quality and timing of return of EOL products in case of reverse supply chains. Business organizations including those of white/electronics goods manufacturing industries would like to focus on their core competency areas and there is need of making outsourcing decisions of their reverse logistics process to Third-Party reverse Logistics Providers (3PRLPs). Thus, most important strategic issue for top management is the evaluation and selection of third party logistics service provider who can effectively provide reverse logistics operation services to the firms. The objective of this work is to develop decision support system to assist the top management of the company in selection and evaluation of different 3PRL service providers by hybrid approach using Analytical Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method. A real life case study of a mobile phone manufacturing company is presented to demonstrate the steps of the decision support system. Present study also enables the logistics managers to better understand the complex relationships of the key attributes in the decision making environment and subsequently improve the reliability of the decision making process.

Keywords: Technique for order preference by similarity to ideal solution; Mobile industry; Analytical hierarchical process; reverse logistics operation.

1. Introduction

Supply chain management systems have seen a dynamic change in operational style since last two decades. In earlier business practices, supply chain flow happens in the forward direction only. In current business environment industries are facing the problem of return flow of the products in the supply chain for a variety of reasons like product recalls, warranty failure, service failure, commercial returns, manufacturing returns, end-of-life (EOL) and end-of-use returns. Reverse logistics is the process of return product handling mechanism in forward supply chain. The industries may have earned more benefits during the process of reuse recycle and remanufacturing of the used products. In general, the producer collects their used products from consumers and then again sells to new customers as new ones after reprocessing or remanufacturing process. Closed loop supply chain mainly focuses on how to take back the used products and recover the useful components efficiently and economically in eco-friendly manners. It is beneficial to save environment, natural resource, increase financial benefits, enhance enterprises competition, for the industries to implement reverse logistics activities in their supply chain. However, reverse logistics activities collection, inspection/testing, transporting and handling of used products/components poses a great challenge to reverse logistics supervisors as there is very high level uncertainty involves in terms of quantity, quality and timing of return of end-of life products in case of close loop supply chains. Diversion of electronics and white goods products from landfills is important issue, because they contain substances various hazardous elements like cadmium, lead, and mercury which may have ill effects on human health if dispose off in appropriately manner. Day by day increasing volume and rapid rates of obsolescence of these used products only serves to enhance the problem. PCs alone contribute 300 million pounds of lead to the waste stream each year (V. Ravi, 2012).

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The productive utilization of 3PLS providers for reverse logistics activities may lead to enhancement of profit margin and effective integrated supply chain network for organizations. An efficient collection & processing used products is important for maintaining sustainability. Therefore, a very important strategic issue for company management is the evaluation and selection of 3PL logistics service providers who can efficiently provide reverse logistics services to organization. In this paper, a hybrid approach (a combination of TOPSIS and AHP) has been used for making strategic decision in multi-attribute decision environment for selection of 3PL service providers for collection of end-of-life (EOL) mobile phones. This paper organized as follows. In Section 2, AHP-TOPSIS approach for decision making is presented. Subsequently, section 3 presents a case study of mobile industry. In the section 4, proposed decision support system steps are explained. The section 5 evaluates 3PL service providers. In the section 6, managerial implications of the model discussed. Finally, section 7 discusses conclusion & future research directions.

2. TOPSIS-AHP Method

The foundation of the Analytic Hierarchy Process (AHP) is a set of axioms that carefully delimits the scope of the problem environment (Saaty, 1988). It is based on the well- defined mathematical structure of consistent matrices and their associated eigenvector's ability to generate true or approximate weights (V. Ravi, 2012). The analytic hierarchy process compares criteria, or alternatives with respect to a criterion, in a natural, pair wise mode. The analytic hierarchy process uses a fundamental scale of absolute numbers that has been proven in practice and validated by physical and decision problem experiments. The fundamental scale has been shown to be a scale that captures individual preferences with respect to qualitative and quantitative attributes just as well or better than other scales (Saaty1980, 1994). It converts individual preferences into ratio scale weights that can be combined into a linear additive weight for each alternative. The resultant can be used to compare and rank the alternatives and, hence, assist the decision maker in sound decision making. (Saaty1980, 1994). In year 1981 Yoon and Hwang developed TOPSIS method that simultaneously considers the distance to the ideal solution and negative-ideal solution regarding each alternative and selecting the closest relative to the ideal solution as the best alternative. One of the unique features of AHP is that it provides a powerful procedure to determine the relative importance of different attributes with respect to the objective. A hybrid MADM approach using TOPSIS and AHP has been used in this research for selection of 3PL service providers for collection of used mobile/end-of-life cell phones. The MCDM approach based on AHP-TOPSIS is explained in the following steps:

Step 1: TOPSIS method begins with decision matrix having 'n' criteria/attributes and 'm' alternatives and decision matrix can be represented as:

$$D = \begin{pmatrix} X_{11} & X_{12} & X_{13} & \ldots & \ldots & X_{1n} \\ X_{21} & X_{22} & X_{23} & \ldots & \ldots & X_{2n} \\ X_{31} & X_{32} & X_{33} & \ldots & \ldots & X_{3n} \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ X_{m1} & X_{m2} & X_{m3} & \ldots & \ldots & X_{mn} \end{pmatrix} \quad (1)$$

Where, x_{ij} is the performance of the i^{th} alternative with respect to j^{th} attribute.

Step 2: The normalized decision matrix is obtained, which is given herewith:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad \text{Where } j = 1, 2, 3 \ldots\ldots\ldots m \quad (2)$$

Step 3: In this step, relative importance of different attributes with respect to the overall objective is determined, and weights for attributes are given according to their importance. A nine-point preference scale of Saaty (1980) has been used for construction of pair-wise comparison matrices. One of the salient properties of this scale is reflexive property between the relatedness of two criteria being compared. For example, if a criterion 'B' is 7 times more important compared to another criterion 'C', then 'C' will be 1/7 times as important as 'B'.