A METHODOLOGY FOR THE SELECTION OF CHANNELS OF OPERATION IN REVERSE LOGISTICS

Dr. C. Thirumal Azhagan* & K. K. Chockalingom**
*Assistant Professor, Department of Management Studies, Anna University, BIT Campus, Trichy.
*Student, Department of Management Studies, Anna University, BIT Campus, Trichy.

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ABSTRACT *The Tactical problem is theeffective management of product returns. These days, the expectation of the customer from the manufacturer is to develop a reverse logistics system by which the returned products can be recovered. It is very important to select the channels of operations in Reverse logistics, With the development and advancement of reverse logistics practice. In this paper, based on Analytical Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) under fuzzy environment, Analytical Network Process (ANP), Decision-Making Trial and Evaluation Laboratory (DEMATEL), the selection and evaluation of reverse logistics operating channels are discussed.*

Keywords: *Reverse Logistics, TOPSIS Method,AHP Method, Managing Product Return*

1.INTRODUCTION

1.1. Reverse Logistics

Reverse Logistics (RL) is the process of planning, implementing and controlling the efficient, cost effective flow of raw materials, in process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value, or proper disposal. The studyof reverse logistics is in exploration stage. Cost reduction is possible in reverse logistics. A reverse logistics defines a supply chain that is redesigned to efficient manage the flow of products or parts designed for remanufacturing, recycling or disposal and to effectively utilize resources. The various functions executed through RL activities include gatekeeping, compacting disposition cycle times, remanufacturing and refurbishment, asset recovery, negotiation, outsourcing and customer service.In addition to disposition and transportation, value added services such as JIT, quick response and program solutions are also important functions in reverse logistics.

Recovery of products for remanufacturing, repair and recycling can create profitable business opportunities. For managing the returns, the companies can reuse them, resell or destroy them. Retailers may return the goods due to seasonality, expiry or because of transit damage.

Customers may return the goods due to poor quality. Managing the product returns increases the customer service level and retention level.Each activity from procurement to distribution generates waste and reduction of this waste is a major goal of environmentally conscious business practices. Manufactures see reverse logistics as a process of recovering defective products or reusable containers back from the user.

In the e-commerce since buyers need assurance for refund, reverse logistics is an important issue. A distribution system which uses a combination of manufacturing and remanufacturing was proposed and the models were compared with respect to the various prices. But AHP and Fuzzy TOPSIS has not been used by any researcher for selection of RL operating channels selection.

The companies can choose three operating channels for performing the RL activitiesa) Manufacturer collecting the used products-Manufacturer Operation(MO). The manufacturer should control human resources, information systems and related equipment.b)Retailer will collect the used products- Joint Operation (JO). c) Outsourcing to third party-Third Party Operation (TPO).

Remanufacturing costs may be reduced by third party. Evaluating and selecting reverse logistics channels is regarded as Multi criteria decision making (MCDM) process in which a decision maker chooses the best option among the existing alternatives.

1.2. Problem in the Selection

Reverse Logistics can be applied to wide variety of industries. In automobile, electronicmanufacturingcompanies the recovery of the end of life auto parts and Electronic products that contain hazardous materials are disposed. Reverse Logistics may take place through Manufacturer Operation (MO),Third Party Operation(TPO), or Joint Operation (JO). Decision makers find the problem of assessing the variety of alternatives and then selecting the best one using a set of criteria.

Multiple criteria decision making methods (MCDM) are discrete with a restricted number of alternatives. A decision matrix in MCDM consists of three main parts a) Alternativesb) Criteria c) Weights of Relative importance.The criteria for theselection of RL operating channels areEconomy Factors(E), Reverse Logistics, Functions(RL), Management(M), Time(T), Flexibility(F),IT applications(IT).

1.3. Statement of the Problem

An Efficient management of product returns is a strategic issue. There is a difficulty in selecting the channel of operation for recovering the products and to meet the requirements of the customers. Since financial and operational attributes are involved, the implementation of reverse logistics may be an unsafe task for the industry, but it is very important to be implemented in-order to achieve more efficiency in the production and to survive in the competition filled world markets.

1.4. Objective of the Study

1) To manage the product return and recovery efficiently using the hierarchy model.
2) To study the customer's requirements and to make them retaining through ReverseLogistics Operations.
3) To propose a methodology based on AHP and TOPSIS methods for the selection of Reverse Logistics Operating Channels.
4) To reduce the cost of production, and to effectively utilize the resources in reverse logistics.

1.5. Need of the Study

With the development and advancement of reverse logistics practice, the selection of reverse logistics operating channels becomes more important. The one among the three operating channels is to be chosen and they are Manufacturer Operation, Third Party Operation, Joint-Operation.

Companies are compelled to adopt and integrate reverse logistics for the following key reasons: Companies can't afford to produce products only to be tossed up in landfills in a few years. Huge costs involved in manufacturing and technology transfer. Economic scenario rendering cost saving initiatives lucrative.

Growing recognition of recapturable value from returned merchandize Increased customer-responsiveness. Increased returns ranging from 10% to 40%, Legal requirements, Improved Information- processing software for reverse logistics.

1.6. Scope of the Study

Identification of key constituents and stages of reverse supply chain activity for the reverse logistics network by studying multi-criteria decision making methods and through the surveys. Determination of principle business objectives associated with reverse logistics networks. Further, exploring alternative methods exercised by industries for carrying out activities at each stage of reverse logistics, and establishing explicit preferences amongst these alternatives by different industry sectors through extensive industry feedback.

2. ANALYTICAL METHODS

From the various studies, the reverse logistics has traditional approach and strategic approach in the product returns. The Traditional approach to returns involves: aggregation, sorting, consolidation and it may take several weeks. However, the strategic approach leverages and infrastructure to provide complete data visibility and may be finished in days.In this paper, a hybrid methodology based on Analytical Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) under fuzzy environment, Analytical Network Process (ANP), Decision Making Trail and Evaluation Laboratory (DEMATEL)is presented. The weights of criteria are calculated by applying the AHP method. The Fuzzy TOPSIS method is applied to get the final ranking results.

2.1. Analytic Hierarchy Process (AHP)

AHP method is developed by Prof. Thomas L. Saaty. AHP divides a complex problem into a hierarchy of interrelated decision elements. AHP can deal with objective as well as non-tangible subjective attributes.

The procedure of AHP is as follows

- Model the problem as a hierarchy.
- Construct a pairwise comparison matrix.
- Test the Consistency by calculating the Eigen Vectors.

The relative normalized weight of each attribute is determined by calculating the geometric mean of the row and then normalizing the geometric means of rows in comparison matrix. Determine the consistency index (CI).$CI = \frac{(\lambda_{max} - M)}{(M-1)}$

Where,λ_{max} = Maximum Eigen Value

M = Size of the Matrix.

Consistency Ratio.

CR = CI / RI.

A consistency ratio of 0.1 or less is considered as acceptable for matrices $M \geq 5$. If a consistency ratio is more than the acceptable value, inconsistency occurs, and the judgements are untrustworthy, the evaluation process needs to be improved. Consistency ratio helps to ensure decision maker reliability in determining the priorities for the criteria.

Criteria	E	RL	M	T	F	IT	Weights
Economy Factors(E)	1	6	5	3	7	6	0.488
Reverse Logistics Functions(RL)	1/6	1	1/4	2	2	3	0.107
Management(M)	1/5	4	1	2	5	4	0.215
Time(T)	1/3	1/2	1/2	1	2	3	0.103
Flexibility(F)	1/5	1/2	1/5	½	1	2	0.048
IT applications(IT)	1/6	1/3	1/4	1/3	½	1	0.043

Table1: Pairwise Comparison matrix.

Table 2:values.

Maximum. Eigen Value (λ_{max})	6.460
Consistency Index(CI)	0.092
Random Index(RI)	1.24
Consistency Ratio(CR)	0.074

2.2. Analytical Network Process (ANP)

Analytical Network Process (ANP) method is introduced by Thomas L. Saaty on 1980.ANP is a generalization of Analytical Hierarchy Process (AHP). The main difference between ANP and AHP is ANP method consider the relationship between criteria, while AHP considers as a hierarchy.

There are several steps to conduct ANP method.

1. Defining problem/criteria.
2. Defining criteria and sub criteria relationship.
3. Conducting Pairwise Comparison
4. Calculating Unweighted Super matrix.
5. Calculating Limit Super matrix
6. Determining Weight
7. Calculating Inconsistency Ratio.

Criteria	**Inconsistency Ratio**
Economic	0.004
Environmental	0.018
Social	0.014
Customer Relationship Management	0.014
Innovation and learning	0.014
Process flow management	0.016

Table 3: Inconsistency Ratio.

2.3. Fuzzy DEMATEL

DEMATEL Method

The DEMATEL method was developed by the Geneva Research Centre of the Battelle Memorial Institute, which was developed to study the structural relationships in a complicated cluster of problems. The DEMATEL method can be used to indicate the degree of influence between factors and visualize the causal relationship among the factors through a cause-effect diagram. The method uses directed graphs to demonstrate the directed relationship among these factors. Suppose there is a set of n factors in the decision-making problem,$F = \{F1, F2, \ldots, FN\}$.

The procedure of the Fuzzy DEMATEL method isexplained below.

Step 1: Identifying the goal for decision-making and extracting the evaluation criteria. In decision-making problems, the first step must be identifying the decision goal. Second, it is necessary to develop a set of key criteriafor evaluation;

For example, forming a committee is aneffective way to gather group knowledge to extract the evaluation criteria of the goal and design the questionnaire using the set of criteria.

Step 2: Acquiring and aggregating the opinions of thedecision makers. This step generates a survey to obtain the opinions of the decision makers. For dealing with the ambiguities of human thought, fuzzy set theory is incorporated with the DEMATEL method. Decision makers assign the linguistic variables to the pairwise comparison between criteria, and these linguistic variables will be converted into TFN. Using the Centroid method, these fuzzy assessments are aggregated and defuzzified as a crisp value. After deffizification, an average direct relationshipmatrix will be obtained, and the matrix can be used in the rest of the DEMATEL method.

Step 3: Computing the total relationship matrix. Basedon the average direct relationship matrix, the normalized direct relationship matrix can be obtained through definition 3, and the total relationship matrix can be acquired.

Step 4: Obtaining and analysing the cause-effectdiagram. According to definition 5, the sum of row "Ri"and the sum of column "Ci" can be obtained, and the dataset for each factor can be calculated.

The cause-effect diagram can be drawn with the horizontal axis "$R + C$" and the vertical axis "$R - C$". Hence, the cause-effect diagram can be used to illustrate the complicated interrelationship of factors. Finally, the cause-effect diagram can be analysed, and its managerial implications can be interpreted by decision makers.

Factors	R	C	Total effect (R+C)	Net effect (R-C)
F1	2.471	1.144	3.855	1.567
F2	2.593	1.300	3.893	1.293
F3	1.999	1.659	3.659	0.340
F4	1.608	1.007	2.615	0.601
F5	2.044	1.981	4.025	0.063
F6	1.625	2.052	3.677	-0.428

Table 4: The sum of the effects given and received for each factor.

2.4. Fuzzy TOPSIS Method

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was first established by Hwang &Yoon.The best alternative would be the one that is nearest to the positive ideal solution (the solution that maximizes the benefit criteria and minimizes the cost criteria) and farthest away from the negative ideal solution.

In the traditional TOPSIS method, the weights of the criteria are known precisely and crisp values are used in the evaluation procedure.Fuzzy set theory allows the decision maker to incorporate unquantifiable information, incomplete information and non-obtainable information and partially ignorant facts into the decision model.

The linguistic variables that are applied in the model can be expressed in triangular fuzzy Numbers for each criterion. Some basic definitions of fuzzy sets are given.Based on the fuzzy theory concepts, Onut&Soner indicated the various steps in the Fuzzy TOPSIS method.

Step 1: Choose the linguistic values$j$for alternatives with respect to criteria. The fuzzy linguistic rating x preserves the property that the range of normalized triangular fuzzy numbers belonging to 0.1 thus three is no need for normalization

Step 2: Calculate the weighed normalized fuzzy matrix. The weighed normalized value is calculated using equation.

Step 3: Identify positive ideal and negative ideal solutions using the equations.

$$A^{+} = \{v_1^{+}, v_2^{+}, \dots \dots, v_i^{+}\} = \{(\max v_{ij} / i \in I'') \quad \times (\min v_{ij} \ / i \in I'')\} \quad i = 1, 2, \dots \dots n$$
$$j = 1, 2, \dots \dots, j$$

$$A^{-} = \{v_1^{-}, v_2^{-}, \dots \dots, v_i^{-}\} = \{(\min v_{ij} / i \in I'') \quad \times (\max v_{ij} \ / i \in I'')\} \quad i = 1, 2, \dots \dots n$$
$$j = 1, 2, \dots \dots, j$$

Step 4: Calculate the distance of each alternative using the equations.

$$D_j^{+} = \sum_{j=1}^{n} d(v_{ij}, v_i^{+}) \quad j = 1, 2, \dots j$$

$$D_j^{-} = \sum_{j=1}^{n} d(v_{ij}, v_i^{-}) \quad j = 1, 2, \dots j$$

Step 5: Calculate the Closeness Coefficient and rank each CC of alternative in descending order.

$$CC_j = \frac{D_j^{+}}{(D_j^{-} + D_j^{+})} \quad j = 1, 2, \dots \dots j$$

Alternatives	D_j^{+}	D_j^{-}	CC_j
MO	4.98	1.21	0.198
TPO	3.65	1.17	0.203
JO	3.82	1.02	0.162

Table 5: Distances to Ideal solution

Alternatives	CC_j	Rank
MO	0.203	II
TPO	0.213	I
JO	0.171	III

Table 6: overall Final values

The order of rating among the alternatives is TPO>JO>MO. The higher the closeness coefficient the better is the rank. The TPO is preferred more than MO and JO. Hence the result is obtained and most of the responses and the ratings greatly favours the third party operations.

3. PROPOSED METHODOLOGY

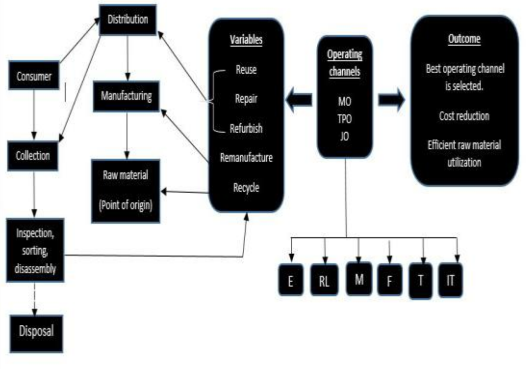

Figure 1: Proposed framework.

Criteria in the channels of operations.

- Economy Factors (E),
- Reverse Logistics Functions(RL)

- Management (M),
- Time (T),
- Flexibility (F),
- IT applications (IT).

Channels of operations

- Manufacturer Operation (MO).
- Third party Operation (TPO).
- Joint Operation (JO).

4. FINDINGS

From the study, some of the results are revealed and these findings are helpful for making suggestions.

1). Responses from Survey

The responses from the respondents are taken for analysis. More number of responses are from manufacturers and the distributors.

2). Reason for Returns

The most frequently given reasons by customer are, not functioning and damaged.

The other reasons are, Need of scheduled services, order cancellation, collection, Exchange new product with old product for upgrade / product replacement Expired Products, Taking back defective materials against credit ,Customer operates the product improperly so is returned as not functioning, Stock Return / Consignment Return/Consigned inventory return, Multiple Orders for the same item, Overstock Distributor Stock returns.

70 % of retail returns are no defect found, defective returns are usually hardware failures.

3). RL(In-house Vs Outsourcing)

The statistics shows that majority of respondent companies prefer outsourcing 5 out of 8 reverselogistics activities than managing them in-house. The activities that have higher percentage in outsourcing compared with in-house are:Collection/sorting/testing, transportation/distribution, warehousing and storage, recycling/full disposal, redistribution/resell.

4). Ranking of Factors of 3PLP

The final results shows that the Third Party Logistics providers are more suitable for collecting the returned products and thus factors of 3PLP are evaluated and ranked. Expertise of third party service provider, service charges, and types of services offered are the factors, which are primarily evaluated by companies.

5. RECOMMENDATIONS

According to thecurrent situation in the industrial markets, the reverse logistics is still difficult be done in-house. So it is suggested that the reverse logistics has to be handled by the third party operations so that the regular business activities are greatly focused.

With the help of third parties the returned products are collected more-faster than the other channels of operations, thereby reducing the cost of production.

From the data we can say that currently companies are managing following activities in-house than outsourcing them to a third party service provider.

Currently many companies are handling returns using forward logistics processes and thus it is getting difficult to separate the data and analyse each process separately.

A Study can be done on integration of forward logistics and reverse logistics to handle forward and reverse flow of products and material to increase the efficiency of closed loop supply chain.

Turnaround time, quality, cost of repair (per unit), and flexibility were major performance measuring parameters practiced by most of the respondents. The trend in future will be to outsource RL activities.

Survey also shows that companies are looking for RL management software to track all data which can be used for analysis to track real time information on return and thus to improve the return process management.

From survey response we can see that remanufacturing/refurbishing and recycling/full disposal will preferably be managed in-house by respondents whereas outsourcing of following activities will be increased by over one to two percentage in next two years.

Asset management & extended service contracts, return authorization management, IT management, and collection/testing/sorting.

5. CONCLUSION

Reverse logistics is still in its infancy stage and have not received much attention yet.

Reverse Logistics Executive Council and Reverse Logistics Trends, Inc. are the organizations making an effort to educate industries and are conducting and promoting researches in reverse logistics.

The survey was primarilyconducted using online survey email distribution, by providing URL of the survey to contacts, and by studying existing literature on reverse logistics.

From survey response, we can see that the reverse logistics activities will preferably be managed in-house whereas outsourcing of following activities will be increased by over one to two percentage in next two years; Asset management & extended service contracts, return authorization management, IT management, and collection/testing/sorting. Since financial and operational attributes are involved, the implementation of reverse logistics may be an unsafe task for the industry.

However growing environmental concerns have forced the industries to opt for reverse logistics.Thus by combining the two Multiple Criteria Decision making Methods the better among the channels of operations can be selected and the model for the channel selection is created.

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Success is not the key to happiness. Happiness is the key to success.

If you love what you are doing, you'll be a success.

~ Albert Schweitzer