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Prioritizing of Reverse Logistic Implementation Factor A Case Study on Walton Hi-tech Industries

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Abstract-: *The reverse logistics (RL) try to discover to assist the return of consumer supplies or its ingredient materials in the production phase*. Nowadays reversed *logistics have been* achieved more attention *in supply chain management. Political, economic, green image and social responsibility etc.* influence *firms to develop strategies to their current systems because, substitute uses of resources must be promoted that may be cost-effective and ecology friendly by extending products' routine life cycles in the turbulent business environment. Reverse 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 end of life (EOL) products. This approach intends to investigate the going-over dynamics of reversed logistics implementation based on survey opinion polls for Walton electronics industry by a real life case study. Fuzzy Analytic Hierarchy Process (FAHP) was select*ed for identify *the vital gauges from different companies' professionals of confirmation and electronics firms* to do the *related eco-friendly management work. The pri*rotization *of each factor* has been *obtained.* T*he overall weights and performance ranking of the evaluation criteria* have been shown by the result of this study *with respect to the reverse logistics implementation.*

Keywords: Reverse logistics, Electronics Industry, EOL, Fuzzy TOPSIS process

1. INTRODUCTION

Electronics industry is introduced in Bangladesh during the post liberalization era. Due to extension of information technology, many Bangladeshi companies start to produce electronics goods and Walton is the first local electronics industry in Bangladesh. Electronics waste or e-waste is the result of this. . E-waste can be made profitable and useful by establishing RL system. Reverse logistics means the reuse of products and materials. In reverse logistics system, the source goes at least one step back in the supply chain. Normally in supply chain products move manufacturers to distributors or customers. Any process or management which maintain or continue after the sale of the product called reverse logistics. Defective product can be returned by customer. The manufacturing firm would then have to organize shipping of the defective product, testing the product, dismantling, repairing, recycling or disposing the product. The product would move in reverse through the supply chain network in order to retain any use from the defective product. The logistics for such matters is reverse logistics [4] found that effective RL focuses on the back-ward flow of materials to maximize value from returned items and guarantee their proper disposal [1, 5, 6]. However, many companies are not yet ready to implement RL including Walton. Walton Hi-Tech Industries Ltd. has been selected for the study because it has a high consumption volume, and major source of waste generation. Also, this is one of the few sectors which come under e-waste regulations [1, 5, 6].A thorough study of CSFs and their ordered implementation is essential for successful RL implementation. The major intention of this study is to understand various CSFs for RL implementation in Walton Hi-Tech Industries Ltd. The identification and prioritization of these factors will help the researchers and the managers in strategic decision making for RL implementation. After review of literature on RL and the opinion of experts, 11 CSFs factors of RL implementation were identified. The experts were asked to rate each of these 11 factors in terms of their importance. A decision matrix was developed from these responses which are used in the application of fuzzy-TOPSIS methodology for prioritizing CSFs [1, 5, 6].

2. METHODOLOGY

Fuzzy TOPSIS algorithm is used for Prioritizing Reverse Logistics Implementation Factors .This algorithm consists of 8 steps. These steps are presented in detain as follows:

Step 1: Collecting the required data containing linguistics terms. A proper scale must be chosen to represent the data. Respondents must be asked to choose the best alternative among the linguistics terms for a given question. Fuzzy numbers for the selected linguistics terms are presented in Table 1.

Table 1: Linguistic terms and corresponding Fuzzy number

Linguistic term	Fuzzy number
Low	(0.0,0.1,0.3)
Fairly low	(0.1,0.3,0.5)
Medium	(0.3,0.5,0.7)
Fairly high	(0.5,0.7,0.9)
High	(0.7,0.9,1.0)

Step 2 The TOPSIS method evaluates the following fuzzy decision matrix.

$$D=\begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1j} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2j} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ x_{i1} & x_{i2} & \cdots & x_{ij} & \cdots & x_{in} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mj} & \cdots & x_{mn} \end{bmatrix} \quad \cdots\cdots(1)$$

Where is a fuzzy number corresponding to the linguistic term assigned by the I the Decision Maker (DM) to the j th factor. i=1, 2,….,m are the number of DMs and j = 1, 2, …, n are the number of factors (CSFs).
Step 3 This step includes neutralizing the weight of decision matrix and generating fuzzy un-weighted matrix (R).
To generate R, following relationship can be applied.

$$R = [r_{ij}]_{m*n}, \quad r_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right) \quad \cdots\cdots(2)$$

Where $c_j^*=\max_i c_{ij}$
Step 4 Calculate the weighted normalized decision matrix

$$V = [v_{ij}]_{m*n} \quad i = 1, 2, 3 \ldots m \text{ and } j= 1, 2 \ldots n \quad \cdots\cdots(3)$$

The weighted normalized value v_{ij} is calculated as

$$\text{Where } [v_{ij}] = r_{ij} * w_j \quad \cdots\cdots(4)$$

Where w_j is the weight given to each decision maker. w_i= (1, 1, 1, 1, 1)$\forall j \in n$, because all the DMs are considered to have same weight for this study.
Step 5 Determine the ideal and negative-ideal solution for the CSFs

$$A^* = (v_1^*, v_2^*, \ldots, v_n^*) \quad \cdots\cdots(5)$$

$$A^- = (v_1^-, v_2^-, \ldots, v_n^-) \quad \cdots\cdots(6)$$

Since the positive and negative ideas introduced by Chen (1997) are used for the research. The following terms are used for ideal and negative ideal solution.

$$v_j^* = (1, 1, 1) \quad \cdots\cdots(7)$$

$$v_j^- = (0, 0, 0) \quad \cdots\cdots(8)$$

Step 6 Calculate the sum of distances from positive and negative ideal solution for each factor.

$$D_j^* = \frac{\sum_{i=1}^{m} d(v_{ij}-v_i^*)}{m}, \text{ j= 1, 2, ………, n} \quad \cdots\cdots(9)$$

D $(v_{ij} - v_i^*)$ is the distance between two fuzzy numbers which can be calculated using the vector algebra. For example distance between two numbers A1 (a_1, b_1, c_1)and A2(a_1, b_1, c_1)can be calculated as

$$d\,(A1 - A2) = \sqrt{\frac{1}{3}\left[\left(a_2 - a_1\right)^2 + (b_2 - b_1)^2 + (c_2 - c)^2\right]} \cdots(10)$$

Similarly, the separation from the negative ideal solution is given as

$$D_j^- = \frac{\sum_{i=1}^{m} d(v_{ij}-v_i^-)}{m}, \text{ j= 1, 2, …, n} \quad \cdots\cdots(11)$$

Step 7 Calculate the relative closeness to the ideal solution. The relative closeness with respect to A^* is defined as

$$CC_j = \frac{D_j^-}{D_j^* + D_j^-}, \text{ i=1,2…, m} \quad \cdots\cdots(12)$$

Step 8 Prioritize the preference order based on the order of the values of C_j.

3. Numerical Analysis

3.1 Analysis of Critical Factors:

Many CSFs are common to all of these studies and these factors can be utilized as base for discussion with expert from Walton Hi-tech Industries ltd. Eleven CSFs were identified after pertinent literature review including studies discussed in ‘‘Introduction’’ and discussion with the number of experts from the Walton Hi-tech Industries ltd. These factors are Total manufacturing cost (C1), Recycling (C2), Environment concern (C3), Recycled volume (C4),
Economic Need (C5), Pressure with stakeholders (C6), Reverse logistics management information system(C7), Top management awareness(C8), capabilities & skilled workers(C9),
Increase of sales volume for new product (C10), Consumer awareness & Social acceptability (C11).

3.2 Decision Maker Choosing:

The fuzzy TOPSIS methodology, presented in this research paper has been evaluated in context of Walton electronics industry. Four experts from electronic companies participated in this study. Profile of the decision makers and their respective organization is given as follows and their respective organization is given as follows:

First decision maker (DM1) is a supply chain manager in Walton electronic industry. Second decision maker (DM2) is a logistics manager in Walton electronic industry. Third decision maker (DM3) is a logistics manager in Walton electronic industry. Fourth decision maker (DM4) is vice president of operations management of same industry.

3.3 Data Analysis:

Table 2: Decision matrix using linguistic variable

Factor	Decision Maker			
	D1	D2	D3	D4
Total manufacturing cost (C1)	FH	M	FL	M
Recycling cost (C2)	FH	M	M	FH
Environment concern(C3)	M	FH	H	M
Recycled volume (C4)	FH	FH	FH	M
Economic Need(C5)	FH	FH	M	H
Pressure with stakeholders (C6)	L	M	L	FL
Reverse logistics management information system(C7)	M	L	M	FH
Top management awareness(C8)	H	H	FH	FH
Process capabilities & skilled workers(C9)	FL	FL	L	FL
Increase of sales volume for new product (C10)	M	M	FL	L
Consumer awareness & Social acceptability (C11)	M	H	M	M

Table 3: Aggregate fuzzy weights for criteria

	Decision Makers			
	D1	D2	D3	D4
C1	(.5,.7,.9)	(.5,.7,.9)	(.1,.3,.5)	(.3,.5,.7)
C2	(.5,.7,.9)	(.3,.5,.7)	(.3,.5,.7)	(.5,.7,.9)
C3	(.5,.7,.9)	(.5,.7,.9)	(.7,.9,1)	(.3,.5,.7)
C4	(.5,.7,.9)	(.5,.7,.9)	(.5,.7,.9)	(.3,.5,.7)
C5	(.5,.7,.9)	(.5,.7,.9)	(.3,.5,.7)	(.7,.9,1)
C6	(0,.1,.3)	(.3,.5,.7)	(0,.1,.3)	(.1,.3,.5)
C7	(.3,.5,.7)	(0,.1,.3)	(.3,.5,.7)	(.5,.7,.9)
C8	(.7,.9,1)	(.7,.9,1)	(.5,.7,.9)	(.5,.7,.9)
C9	(.1,.3,.5)	(.1,.3,.5)	(0,.1,.3)	(.1,.3,.5)
C10	(.3,.5,.7)	(.3,.5,.7)	(.1,.3,.5)	(0,.1,.3)
C11	(.3,.5,.7)	(.7,.9,1)	(.3,.5,.7)	(.3,.5,.7)

Here all decision maker weight is 1 and $A^*$is (1, 1, 1) and A^- is (0, 0, 0). So the table for Normalized fuzzy decision matrix for criteria and weighted normalized alternatives, FPIS and FNIS are same as table 2.

Table 4: Distance D_j^* for criteria

Factors	Decision Maker				
	D1	D2	D3	D4	Average
C1	.342	.525	.719	.525	.528
C2	.342	.525	.525	.342	.434
C3	.525	.342	.183	.525	.394
C4	.342	.342	.342	.525	.388
C5	.342	.342	.525	.183	.348
C6	.876	.525	.876	.719	.749
C7	.525	.876	.525	.342	.567
C8	.183	.183	.342	.342	.262
C9	.719	.719	.876	.719	.758
C10	.525	.525	.719	.876	.661
C11	.525	.183	.525	.525	.440

Table 5: Distance D_j^- for criteria

Factors	Decision Maker				
	D1	D2	D3	D4	Average
C1	.719	.526	.342	.526	.528
C2	.719	.526	.526	.719	.622
C3	.526	.719	.879	.526	.662
C4	.719	.719	.719	.526	.670
C5	.719	.719	.526	.879	.710
C6	.183	.526	.183	.342	.309
C7	.526	.183	.526	.719	.89
C8	.879	.879	.719	.719	.796
C9	.342	.342	.183	.342	.302
C10	.526	.526	.342	.183	.397
C11	.526	.879	.526	.526	.614

Table 6: Closeness coefficients (CCi) of the three alternatives

S No	Factor	D^*	D^-	C	Priority
1	Total manufacturing cost (C1)	.528	.528	.500	7
2	Recycling cost (C2)	.434	.622	.590	5
3	Environment concern(C3)	.394	.662	.627	4
4	Recycled volume (C4)	.388	.6708	.634	3
5	Economic Need(C5)	.348	.710	.716	2
6	Pressure with stakeholders (C6)	.749	.309	.292	10
7	Reverse logistics management information system(C7)	.567	.489	.463	8
8	Top management awareness(C8)	.2623	.796	.752	1
9	Process capabilities & skilled workers(C9)	.758	.302	.284	11
10	Increase of sales volume for new product (C10)	.661	.394	.373	9
11	Consumer awareness & Social acceptability (C11)	.440	.614	.582	6

5. RESULT AND DISCUSSION

To prioritize the CSFs for RL implementation in Walton Electronic industry, 11 factor legislation, Total manufacturing cost (C1), Recycling cost (C2), Environment concern (C3), Recycled volume (C4), Economic Need (C5), Pressure with stakeholders (C6), Reverse logistics management information system (C7), Top management awareness (C8), Process capabilities & skilled workers (C9), Increase of sales volume for new product (C10), Consumer awareness &Social acceptability (C11), identified in section ‘‘Identification of CSFs for RL implementation’’ are considered for the prioritization. Four decision makers DM1, DM2, DM3, and DM4 were asked to rate the importance of the above mentioned each CSF on a 5-point scale having the linguistic terms low (L), fairly low (FL), medium (M), fairly high (FH), and high (H). The decision makers used the linguistic variables shown in table 2 to assess the importance of the CSFs. A decision matrix was prepared based on the responses received from the DMs shown in table 3. As mentioned in the fuzzy-TOPSIS methodology step 1, triangular fuzzy numbers were used to convert linguistics variable into the fuzzy numbers. By converting the fuzzy linguistic variables into triangular fuzzy numbers using table 1, the fuzzy decision matrix D was obtained. In the next step un-weighted fuzzy decision matrix R was enumerated. Further steps were followed to obtain the weighted fuzzy normalized decision matrix, to find the ideal and negative-ideal solutions for the CSFs. The distance D^- and D^* of each CSF is derived, respectively, by using Eqs. (7), (8), (9), and (10). The D^- and D^* closeness coefficient C for each CSF is obtained by using Eq. (11). Values of and closeness coefficient C for each CSF are shown in table 6. The prioritization of CSFs was obtained and is shown in table 6. The most important CSF among the 11 CSFs is top management awareness and the least important CSF is process capabilities and skilled workers.

The overall prioritization of CSFs is

CSF8> CSF5> CSF4> CSF3> CSF2> CSF11> CSF1> CSF7> CSF10> CSF6> CSF9

6. CONCLUSION:

RL is in focus worldwide because of its inherent advantages of reducing the impact of hazard materials on human life and environment. Reuse/recycle of materials is important because of rising costs of materials, limited resources and growing environmental concerns. RL is relatively new for Bangladesh industry and limited studies are available for RL practices. This research paper provides the valuable information on RL implementation for Bangladesh electronics industry. The research identified 12 CSFs for RL implementation in Bangladesh electronics industry. The identified factors are somewhat similar to those identified by various researchers all over the world. Analysis of the findings shows that top four prioritized factors top management awareness, economic need, recycled volume, and environment concern are the most important among all 12 factors. Briefly, the contributions of this study are summarized as follows:

(a) The study provides the insight into previous research on RL implementation.

(b) Identifies the CSFs based on past literature review and experts opinion for successful reverse logistics implementation.

(c) The research work proposes a framework for evaluating and prioritizing the CSFs by using Fuzzy-TOPSIS methodology for RL implementation.

(d) The study will help the managers and practitioners implementation of RL. It will enable the managers in identifying the factorswhich they need to work out for successful implementation.

The findings of the research will help the managers and academicians in the development of RL strategies and practices in Bangladesh electronics industry. These CSFs can also be used for RL implementation in other sectors of Bangladesh industry. Like other studies, this study also has some limitations. This study is conducted using for experts from the Walton electronic industry. Future studies may consider larger sample size to assess the methodology and the effectiveness of the proposed solution to enable generalization. Furthermore, the wider rating of the 7 or 11-point linguistic scale could be used instead of using a 5-point linguistics scale. Researchers may utilize other methodologies including other MCDM methodologies and may compare the results. Future studies may be carried out to identify company-specific or product-specific identification of CSFs for RL implementation.

7. REFERENCES

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8. NOMENCLATURE

Symbol	Meaning
D	fuzzy decision matrix
R	fuzzy un-weighted matrix
V	weighted normalized decision matrix
$A*$	Fuzzy positive ideal solution
A^-	Fuzzy negative ideal solution
D_j^*	distances from positive ideal solution
D_j^-	distances from negative ideal solution
CC_j	Closeness Coefficient
i	Number of Decision Maker
j	Number of CSF