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An Evaluation of Barriers to Implement Reverse Logistics: A Case Study of Indian Fastener Industry

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Abstract**—**Reverse logistics (RL) is supposed to be a systematic procedure that helps in improving the environmental hazards and maintain business sustainability for industries. Industries in Indian are now opting for adoption of RL techniques in business. But, RL practices are not popular in Indian industries because of many barriers for its successful implementation. Therefore, need arises to identify and evaluate the barriers to implement RL practices by taking an Indian industries perspective. Literature review approach and case study approach have been adapted to identify relevant barriers to implement RL practices. Further, Fuzzy Decision Making Trial and Evaluation Laboratory methodology has been brought into use for evaluating causal relationships among the barriers to implement RL practices. Seven barriers out of ten barriers have been categorized into the cause group and remaining into effect group. This research will help Indian industries to manage these barriers towards effective implementing RL practices.

Keywords**—**Barriers, decision making trial and evaluation laboratory, fuzzy set theory, Indian industries, reverse logistics.

I. Introduction

IN recent years, managers, and practitioners have started considering environment protection as the most important area of concern around the globe. Also, customers have become increasingly aware about the environmental impacts. Thus, to attain business sustainability, the industries must start adopting green processes [1]-[4]. RL is a method that consists of reusing of products, work in process and materials. In recent years, due to reductions in cost, environmental laws, and increased consumers concern for environment, an increased focus towards RL has resulted. RL was presented by RevLog, a European RL initiative [5].

RL is defined as a term used to refer to the role of logistics in recycling, product returns, materials substitution, waste disposal, source reduction, reuse of materials and refurbishing, repair, and remanufacturing [6]. RL programs are receiving higher attention because of enforced legislation, corporate citizenship, and industrial ecology, but presence of barriers makes RL implementation difficult and hence reduces the success rate [7]. India is well endowed with both technology and human resources. Indian large manufacturers have started RL practices due to the increased awareness environmental issues among society. Despite this, the concept of RL is yet not widely accepted in Indian industries because of many barriers for its successful implementation [8]. In this context, need arises to identify the barriers that obstruct the implication of RL practices. Because of increasing awareness of customer's towards growing ecology and due to presence of constraints in natural resources, industries have to go through great pressures to include eco-friendly measures in supply chain system. Industries in India are encouraged towards adopting RL practices in their businesses, but they also face difficulties such as insufficient knowledge and resources regarding RL implementation [9]. Therefore, the objectives of the research are:

(i) Identification of barriers for implementing RL practices in Indian context.
(ii) Analyzing barriers to implement the RL practices, which will assist in categorizing these identified barriers towards their removal to the effective implementation of RL practices in Indian industries.

Literature review approach has been adapted for identifying relevant barriers to implement the RL practices in Indian industries. A literature review is an essential part of any research to recognize the theoretical content of the research field and provides direction towards theory building [10]. Fuzzy DEMATEL methodology has been utilized for analyzing the identified barriers to implement RL practices. Fuzzy DEMATEL methodology is applied for identifying the relationships in terms of interdependencies as well as the intensity of interdependence between complex components of a system under uncertain environment [11].

Section II deals with the identification of important barriers to implement the RL practices from literature review and discussions with experts from a case organization. The adapted methodology has been explained in Section III. Section IV deals with results and discussions of the adapted approach. In the last section, concluding remarks are given along with study limitations and future research.

II. Literature Review: Identification of Barriers to Implement RL Practices

Initially, barriers to implement the RL practices are determined from reviewing of literature using various databases like Google Scholar and Scopus etc. Ten barriers to implement RL practices are identified and tabulated as shown in Table I.

In the next step, for validating the barriers identified for implementing the RL practices, a case study has been used. In the present research, a leading fastener manufacturing firm

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located in northern part of India has been selected. The case firm is much busy with the manufacturing of cold forged high tensile fasteners of around 7000 varieties. It is a supplier for a vast range of industries like automobile, textile, agriculture, and so on. It has been continuously dealing with the problem of RL practices implementation and therefore, determines towards identifying and analyzing various driving barriers for successful implementation of RL practices. Consequently, a decision team consisting of three professionals was developed (including one purchasing member, one production head, and one production planning and control department head) from the case organization. After the decision team was finalized, data collection was done. A brainstorming session was organized for validating the identified barriers. On the basis of the interactive group discussion conducted, all identified barriers were validated for the RL practices implementation.

TABLE I
IDENTIFIED BARRIERS TO IMPLEMENT RL PRACTICES

S. No.	Barriers to implement RL practices	References
B1	Regulatory barriers	[2], [12]-[16]
B2	Financial constraints	[5], [8], [9], [15], [17]
B3	Technological barriers	[7], [18]-[21]
B4	Management barriers	[8], [15], [22]-[24]
B5	Human resource and organizational barriers	[25]-[29]
B6	Market barriers	[16], [27], [30]-[32]
B7	Strategic barriers	[7], [8], [15], [25], [30]
B8	Benchmarking related issues	[8], [28], [33], [34]
B9	Behavioral issues	[25], [35]-[37]
B10	Societal issues	[1], [14], [38], [39]

III. METHODOLOGY

In past few years, DEMATEL method has gained much importance as it can visualize the structure of complicated causal relationships [40]. The Science and Human Affairs Program of the Battelle Memorial Institute of Geneva developed the DEMATEL approach somewhat around 1972 to 1976 [41]. This approach helps in understanding and resolving complex decision problems [42]. DEMATEL assists in computing the relationships and strength among criteria. It is based on digraphs that are used for categorizing identified barriers to implement RL practices into cause and effect group. But it is not capable to deal with human subjectivity and vagueness in the data. Thus, fuzzy DEMATEL is suggested in that situation [11], [43]. Fuzzy DEMATEL methodology consists of the following stages as described below:

Stage 1. To define expert panel/decision group and assessment criteria

In this stage, the identified ten barriers to implement the RL practices are finalized as assessment criteria.

Stage 2. To construct fuzzy pair-wise comparison matrix

In this stage, pair-wise comparisons have been made to develop the initial direct relation matrix by using the scale provided in Table II, according to decision group's opinions from case organization. Considering this, a relation matrix for evaluation criteria is developed from experts' judgments. To capture the fuzziness in the judgments, the positive TFN is used and fuzzy linguistic scale used in present research [44] is shown in Table II.

TABLE II
FUZZY LINGUISTIC SCALE USED IN PRESENT RESEARCH

Description of linguistic variable	Equivalent TFNs
No influence (No)	(0,0,0.25)
Very low influence (VL)	(0,0.25,0.5)
Low influence (L)	(0.25,0.5,0.75)
High influence (H)	(0.5,0.75,1.0)
Very high influence (VH)	(0.75,1.0,1.0)

Stage 3. To obtain fuzzy initial direct relation matrix (A)

TFN is indicated by a triplet, i.e. $(e_{ij}, fb_{ij}, g_{ij})$. Suppose $x_{ij}^k = e_{ij}^k, f_{ij}^k, g_{ij}^k$ where $1 \le k \le K$, to be the fuzzy evaluation that the m^{th} expert in decision panel gives about the degree to which barrier i has influence on barrier j. Fuzzy numbers are not appropriate for operations of matrix. In order to conduct further operations, for changing fuzzy numbers to a crisp number, process of defuzzification is required. From the weighted average method, defuzzification of fuzzy direct relation matrix is done by using (1):

$$I_T = \frac{1}{6}(e + 4f + g) \quad (1)$$

Stage 4. To obtain the normalized initial direct relation matrix (D) by means of subsequent (2) and (3).

$$m = \min\left[\frac{1}{\max\sum_{j=1}^{n}|a_{ij}|}, \frac{1}{\max\sum_{i=1}^{n}|a_{ij}|}\right] \quad (2)$$

$$D = m \times A \quad (3)$$

In this stage, the normalized initial direct relation matrix has been computed by using above said equations.

Stage 5. To construct the total-relation matrix by using (4) as:

$$T = (I - D)^{-1} \quad (4)$$

where, I indicates Identity matrix; T indicates total relation matrix

$$T = \left[t_{ij}\right]_{n\times n}$$

Stage 6. Calculating sum of rows (R) and sum of column (C) by using (5) and (6) as:

$$R = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1} \quad (5)$$

$$C = \left[\sum_{i=1}^{n} t_{ij}\right]_{1\times n} \quad (6)$$

R stands for the overall effects of one barrier say (i) on the other barrier (j) and C represent the overall effects experienced by barrier (j) from the other barrier (i).

Stage 7. Drawing cause and effect graph through mapping dataset of (R+C; R-C)

The dataset (R+C) i.e. 'Prominence' indicates the measure of importance of barriers to implement RL practices, whereas (R-C) i.e. 'Relation or influence' indicates the entire effect of barriers to implement RL practices. If (R-C) is positive, that barrier comes in the cause group, and if (R-C) comes out to be negative, then the corresponding barrier relates to the effect group [11], [43].

IV. Data Analysis and Results

To test the utility of this study, an example of a leading fastener manufacturing organization located in northern part of India is taken into account. It is desired to identify and evaluate the barriers in order to implement the RL practices. To achieve this, the proposed fuzzy DEMATEL method has been used, and the detail of applying the projected methods is given as:

In the first step, a brainstorming session was made with the same panel of experts (explained in Section II) to make pair-wise comparisons between barriers to implement the RL practices using scale provided in Table II. The fuzzy assessment provided data by the decision group have been shown in Table III.

TABLE III
Fuzzy Assessment Data Provided by Decision Team

Barriers to RL practices	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
B1	No	H	VH	H	H	H	VH	VH	VH	H
B2	H	No	H	L	H	L	VH	VH	VH	VH
B3	H	H	No	L	H	H	H	H	H	L
B4	H	H	H	No	H	H	VH	VH	VH	H
B5	VL	L	VH	L	No	H	H	H	H	H
B6	L	L	H	L	H	No	VH	H	H	H
B7	L	L	VL	L	VL	L	No	H	VH	H
B8	L	L	L	H	VL	H	L	No	H	L
B9	L	L	L	L	H	L	H	H	No	L
B10	L	L	H	H	H	L	VH	VH	VH	No

Further, to develop the initial direct relation matrix, transformation of fuzzy numbers to crisp numbers is done by the defuzzification process as suggested in Step 3 of fuzzy DEMATEL methodology. Fuzzy initial direct relation matrix of barriers for implementing RL practices is given in Table IV.

TABLE IV
Fuzzy Initial Direct Relationship Matrix of Barriers for Implementing RL Practices

Barriers to RL practices	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
B1	0.04	0.75	0.96	0.75	0.75	0.75	0.96	0.96	0.96	0.75
B2	0.75	0.04	0.75	0.5	0.75	0.5	0.96	0.96	0.96	0.96
B3	0.75	0.75	0.04	0.5	0.75	0.75	0.75	0.75	0.75	0.5
B4	0.75	0.75	0.75	0.04	0.75	0.75	0.96	0.96	0.96	0.75
B5	0.25	0.5	0.96	0.5	0.04	0.75	0.75	0.75	0.75	0.75
B6	0.5	0.5	0.75	0.5	0.75	0.04	0.96	0.75	0.75	0.75
B7	0.5	0.5	0.25	0.5	0.25	0.5	0.04	0.75	0.96	0.75
B8	0.5	0.5	0.5	0.75	0.25	0.75	0.25	0.04	0.75	0.5
B9	0.5	0.5	0.5	0.5	0.75	0.5	0.75	0.75	0.04	0.5
B10	0.5	0.5	0.75	0.75	0.75	0.5	0.96	0.96	0.96	0.04

In the next step, the fuzzy normalized direct relation matrix of CFs has been attained by (2) and (3). Fuzzy normalized initial direct relation matrix of barriers for implementing RL practices. Further, the total direct relation matrix of barriers for implementing RL practices has been obtained by using (4) and presented in Table V.

TABLE V
Fuzzy Total Direct Relationship Matrix of Barriers for Implementing RL Practices

Barriers to RL practices	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
B1	0.29	0.39	0.45	0.39	0.41	0.42	0.51	0.54	0.55	0.44
B2	0.36	0.29	0.41	0.35	0.39	0.37	0.49	0.51	0.52	0.44
B3	0.33	0.34	0.29	0.32	0.36	0.37	0.43	0.44	0.45	0.36
B4	0.37	0.38	0.42	0.30	0.40	0.41	0.50	0.52	0.54	0.43
B5	0.26	0.30	0.38	0.30	0.26	0.35	0.41	0.42	0.43	0.36
B6	0.30	0.31	0.37	0.31	0.35	0.28	0.44	0.44	0.45	0.38
B7	0.25	0.26	0.26	0.27	0.25	0.28	0.28	0.37	0.41	0.32
B8	0.25	0.26	0.29	0.29	0.25	0.31	0.30	0.29	0.38	0.29
B9	0.26	0.27	0.30	0.28	0.32	0.29	0.37	0.39	0.31	0.31
B10	0.31	0.32	0.39	0.35	0.37	0.35	0.46	0.48	0.49	0.31

In the next step, sum of rows (R) and sum of columns (C) of barriers to implement RL practices have been calculated by using (5) and (6). After that, datasets (R+C) and (R−C) datasets of barriers to implement RL practices have been calculated and shown in Table VI.

TABLE VI
Calculation of (R+C) and (R-C) Datasets of Barriers for Implementing RL Practices

Barriers to RL practices	R	C	R+C	R-C	Relation
B1	4.40	2.99	7.39	1.40	Cause
B2	4.11	3.12	7.23	0.99	Cause
B3	3.69	3.57	7.26	0.12	Cause
B4	4.28	3.16	7.44	1.12	Cause
B5	3.48	3.37	6.85	0.12	Cause
B6	3.62	3.42	7.04	0.21	Cause
B7	2.95	4.19	7.15	-1.24	Effect
B8	2.91	4.40	7.31	-1.49	Effect
B9	3.11	4.53	7.64	-1.42	Effect
B10	3.84	3.63	7.47	0.20	Cause

In the last step, (R+ C) and (R−C) datasets have been developed to deduce the cause and effect diagram (presented in Fig. 1).

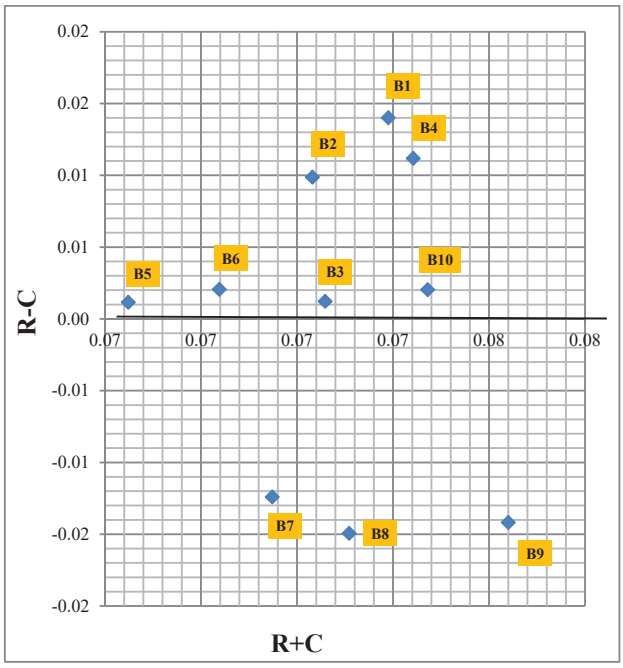

Fig. 1 The cause and effect diagram of barriers to implement RL practices

From Fig. 1, seven barriers (B1, B2, B3, B4, B5, B6, and B10) have been categorized into the cause group barriers, and three barriers (B7, B8 and B9) have been categorized into the effect group.

V. Discussions and Concluding Remarks

RL is supposed to be a systematic procedure that helps in improving the environmental hazards and maintain business sustainability for industries [9]. This paper provides identification and evaluation of barriers to implement the RL practices in Indian industries context. A comprehensive literature review was conducted for the identification of barriers to implement the RL practices in Indian industries context. Most relevant ten barriers to implement RL practices have been identified and validated through the chosen case organization's experts. Further, an application of fuzzy DEMATEL approach has been done for distinguishing if a barrier comes within cause or effect group. The cause group indicates the influencing barriers, whereas the effect group denotes the influenced barriers. Cause group barriers are very critical as they have a direct influence on the system. Also, focusing on the barriers of cause group in the beginning is important as they cause a significant influence on the effect group barriers. Regulatory barriers (B1); Management barriers (B4) and Financial constraints (B2) have been reported as three key barriers to implement the RL practices in Indian industries context.

This study may provide a great help in understanding of various barriers to implement the RL practices in Indian industries context. Evaluation of these barriers will help to understand their causal relationships and priorities in implementing RL practices for Indian industries context.

Pair comparisons in DEMATEL are all made based on opinions of experts' selected from case organization. Opinions of experts may be different. Experts are not randomly selected. Further, other multi-criteria decision making (MCDM) techniques can also be used for solving this problem and the results accordingly can be used for comparison with the present study's results. In future, research may be focused on empirical study of Indian industries for analyzing barriers to implement RL practices.

References

[1] J. Sarkis, M. M. Helms and A. A. Hervani, "Reverse logistics and social sustainability", *Corporate Social Responsibility and Environmental Management*, vol. 17, no6, pp. 337-354, 2010.

[2] S. Luthra, V. Kumar, S. Kumar and A. Haleem, "Barriers to implement green supply chain management in automobile industry using interpretive structural modeling technique: An Indian perspective", *Journal of Industrial Engineering and Management*, vol. 4, no2, pp. 231-257, 2011.

[3] S. Mangla, J. Madaan and F. T. Chan, "Analysis of flexible decision strategies for sustainability-focused green product recovery system", *International Journal of Production Research*, vol. 51, no11, pp. 3428-3442, 2013.

[4] K. Govindan, H. Soleimani and D. Kannan, "Reverse logistics and closed-loop supply chain: A comprehensive review to explore the future", *European Journal of Operational Research*, vol. 240, no3, pp. 603-626, 2015.

[5] G. Ji, "Market-motivated value systems, reverse logistics and the evaluation model for the third party reverse logistics providers", *International Logistics and Trade*, vol. 4, no1, pp. 53-92, 2006.

[6] N. Dheeraj and N. Vishal, "An overview of green supply chain management in India", *Research Journal of Recent Sciences*, vol. 1, no6, pp. 77-82, 2012.

[7] C. Prakash and M. K. Barua, "Integration of AHP-TOPSIS method for prioritizing the solutions of reverse logistics adoption to overcome its barriers under fuzzy environment", *Journal of Manufacturing Systems*, vol. 37, pp. 599-615, 2015.

[8] S. K. Sharma, B. N. Panda, S. S. Mahapatra and S. Sahu, "Analysis of barriers for reverse logistics: An Indian perspective", *International Journal of Modeling and Optimization*, vol. 1, no2, pp. 101-106, 2011.

[9] S. K. Mangla, K. Govindan and S. Luthra, "Critical success factors for reverse logistics in Indian industries: a structural model", *Journal of Cleaner Production*, 2016.

[10] S. Luthra, D. Garg and A. Haleem, "Green supply chain management: Implementation and performance–a literature review and some issues", *Journal of Advances in Management Research*, vol. 11, no1, pp. 20-46, 2014.

[11] R. J. Lin, "Using fuzzy DEMATEL to evaluate the green supply chain management practices", *Journal of Cleaner Production*, vol. 40, pp. 32-39, 2013.

[12] R. K. Mudgal, R. Shankar, P. Talib, and T. Raj, "Modelling the barriers of green supply chain practices: An Indian perspective", *International Journal of Logistics Systems and Management*, vol. 7, no1, pp. 81-107, 2010.

[13] Wooi, G. C. and Zailani, S. (2010). Green supply chain initiatives: investigation on the barriers in the context of SMEs in Malaysia. *International Business Management*, vol. 4, no1, pp. 20-27, 2010.

[14] K. H. Lai, S. J. Wu and C. W. Wong, "Did reverse logistics practices hit the triple bottom line of Chinese manufacturers?", *International Journal of Production Economics*, vol. 146, no1, pp. 106-117, 2013.

[15] M. D. Abdulrahman, A. Gunasekaran and N. Subramanian, "Critical barriers in implementing reverse logistics in the Chinese manufacturing sectors", *International Journal of Production Economics*, vol. 147, pp. 460-471, 2014.

[16] M. Bouzon, K. Govindan, C. M. T. Rodriguez, and L. M. Campos, "Identification and analysis of reverse logistics barriers using fuzzy Delphi method and AHP", *Resources, Conservation and Recycling,* 2016.
[17] V. Ravi, and R. Shankar, "Survey of reverse logistics practices in manufacturing industries: An Indian context", *Benchmarking: An International Journal*, vol. 22, no5, pp. 874-899, 2015.
[18] K. H. Lau and Y. Wang, "Reverse logistics in the electronic industry of China: a case study", *Supply Chain Management: An International Journal*, vol. 14, no6, pp. 447-465, 2009.
[19] K. Mukherjee, and S. Mondal, "Analysis of issues relating to remanufacturing technology–a case of an Indian company", *Technology Analysis & Strategic Management*, vol. 21, no5, pp. 639-652, 2009.
[20] A. J., Chaghooshi and N. Zereshki, "Barrier Analysis in GSCM Implementation in Auto Component Manufacturing in Iran", *Global Journal of Management Studies and Researches*, vol. 1, no1, pp. 21-36, 2014.
[21] M. Bouzon, K. Govindan and C. M. T. Rodriguez, "Reducing the extraction of minerals: Reverse logistics in the machinery manufacturing industry sector in Brazil using ISM approach", *Resources Policy*, vol. 46, pp. 27-36, 2015.
[22] G. T. S. Ho, K. L. Choy, C. H. Y. Lam and D. W. Wong, "Factors influencing implementation of reverse logistics: a survey among Hong Kong businesses", *Measuring Business Excellence*, vol. 16, no3, pp. 29-46, 2012.
[23] K. Rashmi and T. Z. Quazi, "Reverse logistics a key to green world", *International Journal of Mechanical Engineering and Information Technology,* vol. 9, no12, pp. 939-945, 2014.
[24] M. R., Shaharudin, S. Zailani and K. C. Tan, "Barriers to product returns and recovery management in a developing country: investigation using multiple methods", *Journal of Cleaner Production*, vol. 96, pp. 220-232, 2015.
[25] V. Ravi and R. Shankar, "Analysis of interactions among the barriers of reverse logistics", *Technological Forecasting and Social Change*, vol. 72, no8, pp. 1011-1029, 2005.
[26] D. Grundey and K. Rimienė, "Logistics centre concept through evolution and definition", *Engineering Economics*, vol. 54, no4, pp. 87-956, 2007.
[27] A. Coşkun, "Barriers to reverse logistics practices in SMEs: An empirical research", In *International Entrepreneurship Congress,* University of Economics, Nevşehir, pp. 1-13, 2011.
[28] R. Kaynak, I. Koçoğlu, and A. E. Akgün, "The role of reverse logistics in the concept of logistics centers", *Procedia-Social and Behavioral Sciences*, vol. 109, pp. 438-442, 2014.
[29] N. Subramanian and A. Gunasekaran, "Cleaner supply-chain management practices for twenty-first-century organizational competitiveness: Practice-performance framework and research propositions", *International Journal of Production Economics*, vol. 164, pp. 216-233, 2015.
[30] D. S. Rogers and R. Tibben-Lembke, "An examination of reverse logistics practices", *Journal of business logistics*, vol. 22, no2, pp. 129-148, 2001.
[31] S. Pumpinyo and V. Nitivattananon, "Investigation of barriers and factors affecting the reverse logistics of waste management practice: A case study in Thailand", *Sustainability*, vol. 6, no10, pp. 7048-7062, 2014.
[32] V. G. Venkatesh, S. Bhattacharya, M. Sethi, and S. Dua, "Performance measurement of sustainable third party reverse logistics provider by data envelopment analysis: a case study of an Indian apparel manufacturing group", *International Journal of Automation and Logistics*, vol. 1, no3, pp. 273-293, 2015.
[33] R. G. Richey Jr, H. Chen, R. Upreti, S. E. Fawcett and F. G. Adams, "The moderating role of barriers on the relationship between drivers to supply chain integration and firm performance", *International Journal of Physical Distribution & Logistics Management*, vol. 39, no10, pp. 826-840, 2009.
[34] V. Ravi and R. Shankar, "Reverse logistics: insights from sectoral analysis of Indian manufacturing industries", *International Journal of Logistics Systems and Management*, vol. 17, no2, pp. 234-259, 2014.
[35] M. J. Álvarez-Gil, P. Berrone, F. J. Husillos, and N. Lado, "Reverse logistics, stakeholders' influence, organizational slack, and managers' posture", *Journal of Business Research*, vol. 60, no5, pp. 463-473, 2007.
[36] F. Ye, X. Zhao, C. Prahinski and Y. Li, "The impact of institutional pressures, top managers' posture and reverse logistics on performance—Evidence from China", *International Journal of Production Economics*, vol. 143, no1, pp. 132-143, 2013.
[37] C. Gonul Kochan, S. Pourreza, H. Tran and V. R. Prybutok, "Determinants and logistics of e-waste recycling", *The International Journal of Logistics Management*, vol. 27, no1, pp. 52-70, 2016.
[38] S. K. Srivastava and R. K. Srivastava, "Managing product returns for reverse logistics", *International Journal of Physical Distribution & Logistics Management*, vol. 36, no7, pp. 524-546, 2006.
[39] D. Dhouib, "An extension of MACBETH method for a fuzzy environment to analyze alternatives in reverse logistics for automobile tire wastes", *Omega*, vol. 42, no1, pp. 25-32, 2014.
[40] K. Govindan, R. Khodaverdi and A. Vafadarnikjoo, "A grey DEMATEL approach to develop third-party logistics provider selection criteria", *Industrial Management & Data Systems*, vol. 116, no4, pp. 690-722, 2016.
[41] A. Gabus and E. Fontela, "World problems, an invitation to further thought within the framework of DEMATEL", *BATTELLE Institute, Geneva Research Centre,* Geneva, Switzerland, 1972.
[42] S. Gandhi, S. K. Mangla, P. Kumar, and D. Kumar, "Evaluating factors in implementation of successful green supply chain management using DEMATEL: A case study", *International Strategic Management Review*, vol. 3, no1, pp. 96-109, 2015.
[43] S. K. Patil and R. Kant, "A hybrid approach based on fuzzy DEMATEL and FMCDM to predict success of knowledge management adoption in supply chain", Applied *Soft Computing*, vol. 8, pp. 126-135, 2014.
[44] W. W. Wu, "Segmenting critical factors for successful knowledge management implementation using the fuzzy DEMATEL method", Applied *Soft Computing*, vol. 12, no1, pp. 527-535, 2012.

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