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Sustainable Reverse Logistics Practices And Performance Evaluation of Indian Textile Retailers with Grey Topsis Method

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Abstract:- Reverse Logistics (RL) involves the transfer of products from customers back to manufacturers, playing a crucial role in operations like remanufacturing and refurbishment. This research focuses on the RL processes employed by retailers in India, emphasizing its benefits for cost reduction, heightened customer satisfaction, and increased sustainability. The research work aims to raise awareness among retailers regarding RL frameworks, addressing concerns on cost management. Using the GREY-TOPSIS approach in Multiple Criteria Decision Analysis (MCDA), the study analyzes data from 14 identified retailers based on 12 RL parameters. This comprehensive analysis identifies the most and least effective RL practitioners, offering insights for improvement and setting benchmarks for an efficient RL approach among retailers. The ultimate goal is to maximize the potential of RL for sustainability and operational excellence in the retail sector.

Keywords*: Reverse Logistics (RL), GREY- TOPSIS, Indian Textile Retailers, Retailing*

1.Introduction

The textile industry, ranking third in pollution after compost, plastic, and paper, generates a significant daily fabric waste of up to 46,000 meters in major textile hubs in India. The global textile market is expanding rapidly, with clothing becoming a disposable commodity in the nation. Predictions indicate that by 2025, global clothing demand will reach 130 million tonnes, growing at an average annual rate of 4.3%. Recycling clothing is crucial for optimal material utilization, reducing the need for new material production and conserving energy. Reverse logistics (RL), a method involving the return of products for repair, resale, reuse, recycling, refurbishment, or proper disposal, plays a key role in clothing recycling [1][2]. Recognizing its strategic importance, businesses are exploring RL to enhance social standing and economic growth [3][4][5]. To evaluate sustainable RL performance among merchants, we developed a form based on 12 identified RL parameters, and through linguistic phrases, 14 retailers rated their RL practices. Using the GREY-TOPSIS approach, the retailers were analyzed and ranked based on evaluations provided by decision makers through Google forms.

Literature Rerview

Organized retailing is rapidly expanding in India, marked by significant growth in chain stores, supermarkets, and hypermarkets, partially fueled by foreign investments. To stay competitive, businesses must prioritize customer service, operational improvements, and environmentally friendly practices such as Recycling for the Environment (RL) [6][7]. The stringent environmental regulations in India are driving industries like textiles, steel, automotive, and electronics assembly to adopt green initiatives [8][9]. Challenges to RL process development include inadequate infrastructure, lack of top management involvement, and insufficient understanding [10][11][12]. Customer connection is vital in retail RL processes, necessitating effective management of returns and ensuring timely responses for enhanced customer satisfaction [13][14][15]. Collaborative efforts among retail organizations are crucial to establishing a seamless flow of commodities in the RL process [16][17][18].

Implementing effective RL practices presents a win-win model for retailing in underdeveloped countries like India [19][20][21].

Research Methodlogy Identification of RL Parameters

Forward Logistics pertains to the movement of goods from the manufacturer to the customer, whereas Reverse Logistics (RL) involves the reverse journey—from the customer back to the manufacturer. This process is triggered when a delivered product is flawed, requires replacement, or has reached the end of its cycle. In the retail sector, RL typically commences at the distribution centre (DC) and is directed to central return centres (CRC) for processing returns from retail establishments. CRCs sort and route returns for further inspection. Upon a customer's return, the retailer assesses the product and forwards it to the CRC for detailed examination based on criteria like remanufacturing, refurbishment, or scrap disposal. If the returned product aligns with predefined parameters, it undergoes remanufacturing or refurbishment; otherwise, it is environmentally responsibly disposed of in the scrap category. The proposed RL practices model is depicted in Figure 1.

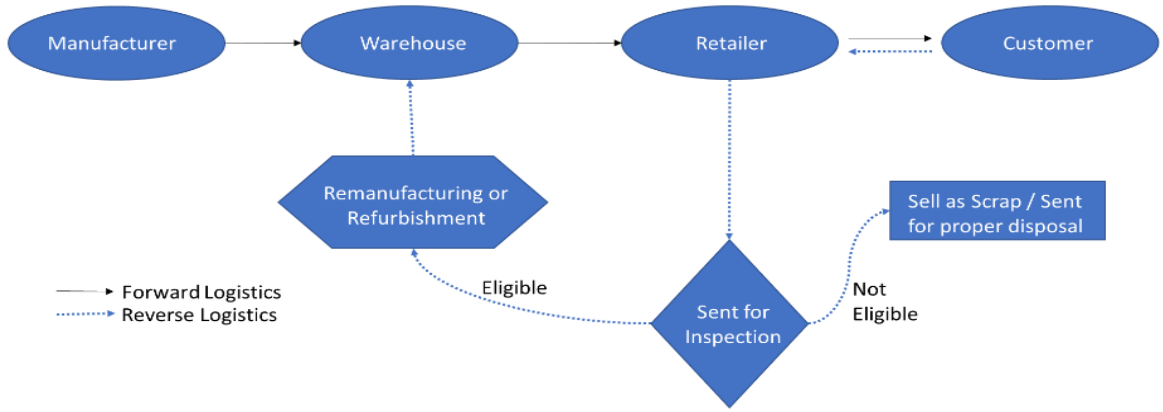

Fig. 1. Basic model of the RL practices

In the RL process the retailers are playing an important role in order to recuperate the value of the returned product. After having discussions with them and reading of many journals, online articles etc. We identified and framed 12 RL parameters to evaluate and to find how efficiently the retailers are following RL practices. The 12 RL parameters that have been identified from the various sources of literatures are mentioned below in Table 1

Table 1: Identified 12-RL Parameters and Its Description

S. NO	IDENTIFIED PARAMETER	DESCRIPTION	REFERENCE
1	Go Green Ambition	Managing of poly bags and following of green initiative practices in the company	[22]
2	Awareness of RL	Awareness of Reverse Logistics among retailers.	[23]
3	Product Returns	Approach towards the return of products from the customer.	[24]
4	Examine of Product return	Doing a thorough Examination of the Returned Product.	[25]
5	Return via Third Parties	Collection of product return through third parties by companies.	[26]
6	Customer Encouragement	Encouraging customers for product return.	[27]
7	Separate Department For RL	Company having a Separate Department for Reverse Logistics Process.	[28]
8	Cost Effective	Cost Effectiveness of Company from retailer’s point of view.	[29]
9	Government Guidelines	The retailers adhere to the government's regulations for RL.	[30]

10	Organized Layout	A Systematic Plan for the Recovery and Disposal of Returned Products.	[28]
11	Customer Order Cycle Time	Assuring of customer service through the maintenance of order cycle time reliability.	[31]
12	Customer Relationship	Maintaining a good relationship with the customers.	[27]

Data Collection

After formulating 12 Reverse Logistics (RL) parameters, we engaged with over 30 prominent textile retailers across India to conduct comprehensive discussions on their store history, customer interactions, and RL practices. The selected retailers possess a distinguished retail supply chain in India, recognized for their expertise and leadership in the retail industry within their respective zones. Despite brand name considerations, company policies, and personal views, 14 retailers accepted our request for discussion sessions, providing valuable insights. Through our designed "Retailers Performance Evaluation Form by Students," we gathered data in the form of linguistic responses on framed parameters, each featuring a five-point scale. The collated forms and recorded feedback were then submitted to decision-makers for evaluating each retailer. The form used for data collection is illustrated in Figure 2.

Approach Towards Decision Makers

The evaluation of our identified 12 RL parameters and the performance of the 14 retailers were carried out by 4 decision makers who have extensive knowledge and experience in the field of supply chain. For this we personally approached and requested more than 10 decision makers via social media and finally we got up with the best 4 decision makers who shown keen interest towards our project and accepted our request proposal to do the evaluations for our project. After deciding of decision makers we sent our own created Google forms and retailer consolidated data's to them. Firstly, they evaluated our selected 12-RL parameters by responding to the respective assigned linguistic terms. Then evaluated each retailer by considering 12 RL parameters and the responses collected from the retailers. They have also assigned the overall ratings for the retailers, and shared their comments regarding the RL process and about our study work.

Evaluation of the Final Data

After receiving the final data from the decision makers, we arranged and structured those data in a proper manner for the further data analysis and calculation part. Our study has incorporated GREY-TOPSIS method on selecting the best RL practitioner among 14 retailers. We chose that method because many supply chain analysts have recommended this is the best method which can be used among the Multi-Criteria Decision Analysis (MCDA) to get the realistic result.

Grey TOPSIS Aproach Methodlogy

Grey TOPSIS approach consists of 9 steps in order to evaluate retailer's performance and those steps are presented in detail as follows.

Step 1: Selection of RL Parameters for the evaluation process
Step 2: The weighting of selected parameters and the rating of retailers
Step 3: Aggregate grey weight calculation for selected parameter and rating for retailers. Determining of Decision matrix.
Step 4: Calculation of weighted normalized matrix
Step 5: Determining of best and worst alternative for each parameter.
Step 6: Euclidean distance calculation between the target alternative and the best and worst alternative respectively:
Step 7: Calculating the degree of similarity (Ri) to the worst alternative for each value of Best (B) and Worst (W) distances. The discovered outcomes are our TOPSIS scores
Step 8: Ranking the retailers.

Step 9: Sensitivity analysis is executed, to find out the impact of parameter weights have on the data evaluation process.

Data Analysis and Result

Each of the 4 Decision Makers (DM1, DM2, DM3, and DM4) evaluates 14 retailers and assists in selecting the best retailers to improve performance based on RL practises. From diverse sources of literature, 12 RL practices-related parameters have been extracted. In addition, these 12 parameters were measured by considering the linguistic terms listed in Tables 2(a) and 2(b), and then the Grey Topsis method was used to develop a model to rank the retailers. The execution of this model, including results and discussion, is provided in the following section. In Table 2(a) and Table 2(b), the types of linguistic terms and their corresponding Grey numbers are also depicted.

Table 2 Linguistic terms for a) RL parameters ratings and b) Textile Retailers Ratings

a)

Linguistic term	Id	Membership Function
NOT IMPORTANT	NI	(0,0.1)
SOMEWHAT IMPORTANT	SI	(0.1,0.3)
IMPORTANT	IM	(0.3,0.5)
VERY IMPORTANT	VI	(0.5,0.7)
EXTREMELY IMPORTANT	EI	(0.7,0.9)

b)

Linguistic Term	Id	Membership Function
POOR	P	(0,1)
FAIR	F	(1,3)
AVERAGE	A	(3,5)
GOOD	G	(5,7)
EXCELLENT	E	(7,9)

To protect the privacy of retailer-related information, retailers are being considered as R1 to R14 while parameters as P1 to P12. This implementation of the Grey Topsis method is expressed as a series of the steps listed below. The linguistic terms are used to create a comparison matrix in the Grey form, and the decision makers' aggregate and final weight for RL parameters have been calculated in Table 3 and Table 4. Ranking of values according to the **TOPSIS** score by descending order was carried out, is shown below in Table 5.

Table 3: Linguistic Terms for the RL Parameters Ratings by Decision Makers

Id (Parameters)	D1	D2	D3	D4
P1	EI	VI	VI	EI
P2	EI	EI	EI	EI
P3	IM	EI	VI	VI
P4	IM	EI	EI	EI
P5	SI	IM	IM	SI
P6	IM	IM	EI	VI
P7	IM	EI	VI	EI
P8	EI	EI	IM	EI
P9	EI	EI	VI	EI
P10	VI	EI	VI	EI
P11	VI	EI	EI	VI
P12	EI	EI	EI	EI

Table 4: Display the ratings of RL parameters for all retailers (alternatives) converted using linguistic terms.

Parameters/ Retailers	R1				R2				R3				R4				R5				R6				R7			
	D1	D2	D3	D4	D1	D2	D3	D4	D1	D2	D3	D4	D1	D2	D3	D4	D1	D2	D3	D4	D1	D2	D3	D4	D1	D2	D3	D4
P1	E	G	G	G	G	G	G	A	E	G	G	G	E	G	E	G	G	A	G	G	G	G	G	A	G	A	G	G
P2	G	A	G	A	A	F	A	A	E	G	E	G	G	A	G	A	G	A	G	G	E	G	E	G	A	F	A	F
P3	E	G	E	G	G	A	A	G	E	E	E	G	E	G	G	G	G	A	E	G	G	A	G	G	F	P	F	F
P4	E	G	G	A	G	A	E	G	G	A	A	G	G	A	A	A	G	A	A	G	G	A	A	G	F	P	G	F
P5	A	F	A	A	P	P	F	P	P	P	F	F	P	P	P	F	P	P	P	P	P	P	P	F	F	P	P	F
P6	G	G	A	G	G	A	A	A	E	G	E	G	P	P	P	F	G	A	F	G	F	F	A	F	P	P	A	P
P7	F	F	F	F	P	P	F	F	A	F	F	A	A	F	A	A	E	G	A	G	A	A	F	A	G	A	F	A
P8	P	P	F	P	P	P	F	F	F	P	P	A	F	P	F	F	F	F	F	F	P	P	F	P	P	P	F	F
P9	F	P	A	A	G	F	A	A	G	G	G	G	G	A	G	A	G	A	G	G	E	G	G	G	P	P	A	F
P10	A	F	A	G	A	P	G	F	G	G	G	G	A	F	G	A	G	G	G	G	A	A	A	A	F	F	F	P
P11	E	G	E	G	E	G	G	G	E	E	G	E	E	G	E	G	E	G	E	G	E	G	E	G	E	G	G	G
P12	E	G	G	G	E	G	E	G	E	E	G	E	E	G	G	G	E	G	G	G	E	G	G	G	E	G	E	G
Parameters/ Retailers	**R8**				**R9**				**R10**				**R11**				**R12**				**R13**				**R14**			
	D1	D2	D3	D4	D1	D2	D3	D4	D1	D2	D3	D4	D1	D2	D3	D4	D1	D2	D3	D4	D1	D2	D3	D4	D1	D2	D3	D4
P1	G	A	G	G	G	A	G	G	G	G	E	G	G	G	E	G	G	G	G	A	G	A	G	G	E	G	E	G
P2	G	G	G	G	G	G	E	G	F	A	A	A	G	A	G	G	A	A	G	A	A	G	G	G	G	G	G	G
P3	E	G	E	G	G	G	A	F	E	G	G	G	G	G	A	G	A	A	A	A	G	G	G	G	E	A	G	G
P4	G	A	A	A	G	G	G	G	E	A	A	A	E	G	G	G	G	A	G	A	G	A	A	G	E	A	G	G
P5	F	F	P	F	G	A	A	F	G	A	F	A	P	P	P	F	P	P	P	F	P	F	F	F	F	P	P	A
P6	F	P	A	F	F	P	F	A	A	G	A	A	A	F	A	A	A	F	F	P	G	G	A	G	F	P	P	A
P7	P	P	F	F	G	G	G	G	A	A	F	A	E	G	G	G	E	A	A	A	G	A	F	G	G	F	G	G
P8	A	F	A	A	F	A	F	P	F	F	F	P	G	G	A	G	F	F	P	A	F	F	P	A	G	A	A	A
P9	G	A	G	A	G	G	G	G	G	A	G	G	E	G	E	G	G	A	G	G	G	G	G	G	G	G	E	G
P10	G	F	G	A	E	G	E	G	E	G	G	A	E	A	G	G	G	A	A	A	G	G	A	G	E	A	A	G
P11	A	A	E	G	G	G	G	G	G	G	E	G	E	G	G	G	E	G	E	G	E	E	E	G	E	G	E	G
P12	G	G	G	G	G	E	E	G	E	G	E	G	E	G	E	G	E	G	G	G	E	G	E	G	E	G	E	G

Table 5: Ranking of values according to the TOPSIS score.

Retailers (Id)	R_i	Ranked in Descending order		
		Rank	Retailers (Id)	R_i
R1	0.4606	**1**	**R9**	**0.6115**
R2	0.3680	2	R11	0.5239
R3	0.4736	3	R5	0.5000
R4	0.4273	4	R14	0.4823
R5	0.5000	5	R3	0.4736
R6	0.4210	6	R13	0.4679
R7	**0.3001**	7	R1	0.4606
R8	0.4470	8	R8	0.4470
R9	**0.6115**	9	R12	0.4322
R10	0.4137	10	R4	0.4273
R11	0.5239	11	R6	0.4210
R12	0.4322	12	R10	0.4137
R13	0.4679	13	R2	0.3680
R14	0.4823	**14**	**R7**	**0.3001**
R7 is the worst performing and **R9** is the best performing				

17 Experiments were executed to check the reliableness of this method and the assigned weight. Table 6 show the result of sensitivity analysis. After the execution of 17 experiments, retailer 9 ranked as 1st for 13/17 times and retailer 7 ranked as 14th for 7/17 times. It appears to be that the reliableness of this method is 70.59%.

Table 6: Sensitivity Analysis

Exp. No	Definition	Grey possibility						
		R_1	R_2	R_3	R_4	R_5	R_6	R_7
1	**P_1- P_{12} = (0, 0.1)**	0	0	0	0	0	0	0
2	**P_1- P_{12} = (0.1,0.3)**	0.50	0.42	0.54	0.46	0.55	0.48	0.32
3	**P_1- P_{12} = (0.3, 0.5)**	0.5	0.42	0.54	0.46	0.55	0.48	0.32
4	**P_1- P_{12} = (0.5, 0.7)**	1.22	0.42	0.85	0.46	0.55	0.48	0.32
5	**P_1- P_{12} = (0.7, 0.9)**	1.22	0.42	0.85	0.46	0.55	0.48	0.32
6	**P_1 = (0.7, 0.9), P_2- P_{12} = (0, 0.1)**	0.16	0.15	0.16	0.16	0.15	0.15	0.15
7	**P_2 = (0.7, 0.9), P_1, P_3- P_{12} = (0, 0.1)**	0.15	0.13	0.16	0.15	0.15	0.16	0.12
8	**P_3 = (0.7, 0.9), P_1, P_2, - P_{12} = (0, 0.1)**	0.16	0.15	0.16	0.16	0.16	0.15	0.8
9	**P_4 = (0.7, 0.9), P_1-P_3, P_5- P_{12} = (0, 0.1)**	0.15	0.15	0.11	0.24	0.15	0.15	0.12
10	**P_5 = (0.7, 0.9), P_1-P_4, P_6- P_{12} = (0, 0.1)**	0.13	0.06	0.09	0.06	0	0.06	0.07
11	**P_6 = (0.7, 0.9), P_1-P_5, P_7- P_{10} = (0, 0.1)**	0.15	0.14	0.16	0.06	0.15	0.11	0.10
12	**P_7 = (0.7, 0.9), P_1-P_6, P_8- P_{10} = (0, 0.1)**	0.09	0.07	0.13	0.13	0.16	0.13	0.13
13	**P_8 = (0.7, 0.9), P_1-P_7, P_9- P_{10} = (0, 0.1)**	0.06	0.07	0.12	0.09	0.09	0.06	0.07
14	**P_9 = (0.7, 0.9), P_1-P_8, P_{10} = (0, 0.1)**	0.13	0.14	0.16	0.15	0.15	0.16	0.10
15	**P_{10} = (0.7, 0.9), P_1- P_9, P_{11}- P_{12} = (0,0.1)**	0.14	0.13	0.16	0.14	0.16	0.14	0.08
16	**P_{11} = (0.7, 0.9), P_1- P_{10}, P_{12} = (0, 0.1)**	0.16	0.16	0.16	0.16	0.16	0.16	0.15
17	**P_{12} = (0.7, 0.9), P_1- P_{11}= (0, 0.1)**	0.16	0.16	0.16	0.16	0.16	0.16	0.16

From the above attained Sensitivity analysis calculations of 17 experiments on retailers we have ranked them accordingly fixing the highest achieved value to be in the 1st rank and the lowest achieved value to be in the 14th rank, which is shown below in Table 7.

Table 7: Sensitivity Analysis Ranking

Exp.No	Definition	Grey possibility Ranking of the Retailers
1	P_1- P_{12} = (0, 0.1)	R1=R2=R3=R4=R5=R6=R7=R8=R10=R11=R12=R13=R14<R9
2	P_1- P_{12} = (0.1,0.3)	R8<R10=R7<R11=R13=R14<R2<R12<R4<R6<R1<R3<R5<R9
3	P_1- P_{12} = (0.3, 0.5)	R10<R8=R14<R13<R11<R12<R7<R9<R2<R4<R6<R1<R3<R5
4	P_1- P_{12} = (0.5, 0.7)	R7<R11<R2<R8<R4<R6<R10<R5<R12=R14<R9<R13<R3<R1
5	P_1- P_{12} = (0.7, 0.9)	R7<R2<R8<R4<R6<R10<R5<R11=R12=R13=R14<R9<R3<R1
6	P_1 = (0.7, 0.9), P_2- P_{12} = (0, 0.1)	R2=R8=R6=R5=R7<R1=R4=R10=R3=R11=R12=R14<R9<R13
7	P_2 = (0.7, 0.9), P_1,P_3- P_{12} = (0, 0.1)	R7<R2=R10<R4=R1=R5=R8<R6=R3<R11=R12=R13=R14<R9
8	P_3 = (0.7, 0.9), P_1,P_2,P_4- P_{12} = (0, 0.1)	R7<R2=R6<R5=R4=R10=R8=R1=R11=R12=R13=R14=R3<R9
9	P_4 = (0.7, 0.9), P_1-P_3,P_5- P_{12} =(0, 0.1)	R3<R7<R8<R6=R10=R5=R2=R1<R11=R12=R13=R14<R4<R9
10	P_5 = (0.7, 0.9), P_1-P_4,P_6- P_{12} =(0, 0.1)	R5<R2=R4=R6<R7<R8=R3<R1=R11=R12=R13=R14<R10<R9
11	P_6 = (0.7, 0.9), P_1-P_5,P_7- P_{10} =(0, 0.1)	R4<R7<R6<R2<R5=R1<R3<R8<R10<R11=R12=R13=R14<R9
12	P_7 = (0.7, 0.9), P_1-P_6,P_8- P_{10} =(0, 0.1)	R2<R8<R1<R3=R4=R6=R10=R7<R5=R11=R12=R12=R14<R9
13	P_8 = (0.7, 0.9), P_1-P_7,P_9- P_{10} =(0, 0.1)	R6=R1<R7=R2<R4=R10=R5<R3<R8<R11=R12=R13=R14<R9
14	P_9 = (0.7, 0.9), P_1-P_8,P_{10} = (0, 0.1)	R7<R1<R2<R4=R5<R3=R6<R8<R10<R11=R12=R13=R14<R9
15	P_{10} = (0.7, 0.9), P_1- P_9, P_{11}- P_{12} =(0,0.1)	R7<R2<R4=R6=R1<R5=R3<R8<R10<R11=R12=R13=R14<R9
16	P_{11} = (0.7, 0.9), P_1- P_{10}, P_{12} = (0, 0.1)	R7<R2=R4=R6=R51=R5=R3<R8<R10<R11=R12=R13=R14<R9
17	P_{12} = (0.7, 0.9), P_1- P_{11}= (0, 0.1)	R8<R7=R4=R6=R2=R1=R5=R10=R3<R11=R12=R13=R14<R9

Discussion of Findings

Grey TOPSIS Approach have successfully carried out and got the results after doing the calculations with almost care. After the doing of calculations and the sensitivity analysis of 17 experiments we attained the results as Retailer 9 to be the best RL practitioner and Retailer 7 to be the worst RL practitioner. The graphical representation of the obtained retailers rank is shown in fig 3 and in details is shown below in Table 8.

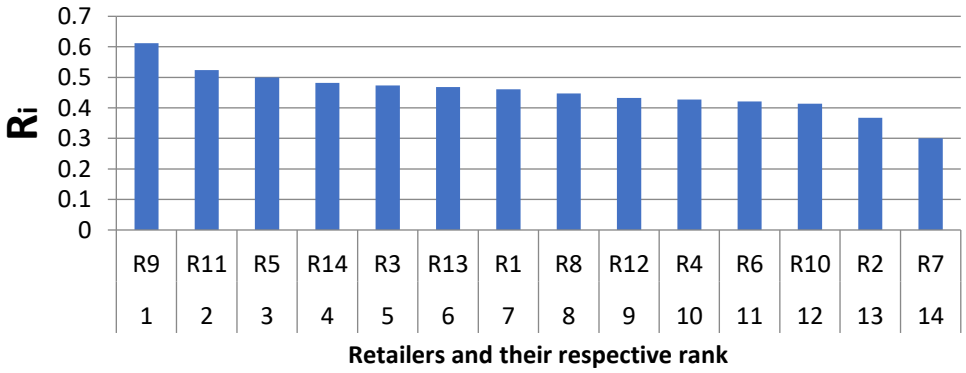

Fig 3: The Graphical Representation of the Retailers ranking according to their obtained TOPSIS score

Table 8: Ranking of values according to the TOPSIS score

Rank	Retailers (Id)	R_i
1	**R9**	**0.6115**
2	R11	0.5239
3	R5	0.5000
4	R14	0.4823
5	R3	0.4736
6	R13	0.4679
7	R1	0.4606
8	R8	0.4470
9	R12	0.4322
10	R4	0.4273
11	R6	0.4210
12	R10	0.4137
13	R2	0.3680
14	**R7**	**0.3001**

Conclusion

Utilizing the GREY-TOPSIS approach, this research assessed and ranked the proficiency of Reverse Logistics (RL) practices among a sample of retailers. Findings identified Retailer 9 as the most adept RL practitioner and Retailer 7 as less proficient. Twelve RL characteristics were selected based on their relevance, spanning green practices, product return procedures, RL awareness, customer-related factors, cost-effectiveness, and adherence to RL regulations. Decision-makers assigned weights to each criterion and employed the GREY-TOPSIS approach to rank stores by their TOPSIS scores. A sensitivity analysis gauged the impact of weights on decision-making. The study underscores the underutilization of RL methods in the Indian business sector, advocating government support through awareness campaigns, RL legislation, and collaboration with suppliers. The retail sector in India stands to benefit significantly by prioritizing RL for enhanced productivity and customer satisfaction, emphasizing the vital role of government assistance in fostering sustainable business practices. Future research could explore larger sample sizes and additional variables influencing RL practices.

Refrences

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