REVERSE LOGISTICS IN PLASTIC RECYCLING IN KERALA

BRIJ BHAN SINGH[1],

RESEARCH SCHOLAR, DEPARTMENT OF AERONAUTICAL ENGINEERING, SSSUTMS SEHORE[1].

Abstract

Taking the context of Kerala into account, this study investigates motivations and barriers for RL adoption as well benefits in plastic recycling units (PRU). Through different statistical analysis, the study finds that economic factors are more determinants of urban recycling units while environmental and social concerns drive rural units. There are differences by region in the barriers to RL adoption, with urban units experiencing HR and organizational challenges, while rural units face technological obstacles. RL practices result in a variety of benefits; urban units achieved improvements in relationship with stake holders, cost effectiveness and social advantages while environmental gains for rural beneficiaries. The results highlight the heterogeneity of RL practices in Kerala and this could serve as a fundamental stepping-stone for shaping policy environment, directing future investments even promotional activities on recycling towards addressing requisite needs of rural/urban cycles so that comprehensive solution may be tailored with reference to tackling grinding waste management woes from across the state.

Keywords: *Rural Recycling Units[1], Adoption Barriers[2], Reverse Logistics[3], Plastic Recycling[4], Kerala[5].*

1. Introduction

Reverse Logistics (RL) practices are more and more seen as a key to reduce waste, guaranteeing the environmental sustainability within plastic recycling. This study examines how RL activities become operational in plastic recycling units distributed across the diverse geographical and socio-economic landscape of Kerala – a typical Indian southern state. It is concerned with identifying the incentives for such practices as well as challenges faced and achievements made by recycling units—both in urban and rural communities. The current drivers for urban recycling units in Kerala are mostly economic with an objective driven by the need to reduce costs, improve efficiency and relationships with stakeholders. In general, rural units pay more attention to the environmental and social contexts wishing tackle local ecological problems as well as community impacts. According to the study, barriers for RL adoption vary according to region as urban units are grappling with HR and organizational issues while rural ones struggle with serious technological impediments. The value of RL practices are differently judged by region as well. Urban units show significant cost savings and social benefits with a slight reduction in environmental upside, while rural units receive large-and-in-charge increases to their green thumb bushido ways. We found contrasting patterns of RL adoption across Kerala, suggesting a unique aspect to the dynamics that may be useful for both policymakers and industry stakeholders. Strategic planning for RL and improving plastic recycling in the state can be benefited by considering needs of both urban as well as rural level units respectively.

2. Literature Survey

Gobena and Azene (2022) analyzed the response of converse plans for plastic waste reusing in Ethiopia, which characterizes key achievement factors required for its fruitful usage. In their review, they reiterated the importance of institutional support, public awareness and technological infrastructure to help facilitate successful reverse coordinated entries practices. They emphasized that turn around arranged operations systems are probably not going to completely understand their capability in reducing plastic waste without these components.

Nabavi-Pelesaraei et al. (2022) prepared an environmentally beneficial life-cycle assessment (LCA) on the natural impacts of clinical waste amid Coronavirus. The survey stressed the job of LCA in helping reasonable improvement objectives by offering a comprehensive understanding into nature's turf results to waste management rehearses. Although their study primarily focused on clinical waste, the principles discussed are highly relevant to plastic waste management where LCA can help identify most eco-friendly disposal methods. The relation between plastics and animals was already described here as an environmental issue but now extended by insights from medical sector observers: Waste generation boom during pandemicThe arrival of COVID-19 treatment regimens has given rise to a tremendous increase in...

Hossain et al. (2022) considered reasons for the difficulties being experienced in overseeing wastes such as infrastructure, public knowledge and economic constraints. An audit set out a way to the roundabout economy and included making merchandise more straightforward to fix, further developing assortments of waste frameworks and expanding reusing practices.

Sun et al. (2022) examined the economic aspects of plastic waste management based on China's roadmap for tackling plastic waste. In their study, they highlighted the dire economic costs of mismanaged waste and called for government intervention to encourage recycling and curb plastic use. According to them, monetary incentives and regulatory measures are necessary for the sustainable management of plastic waste.

Lahane and Kant (2022) investigated how round economy practices help in attaining the sustainable development goals. A recent review of theirs showed that implementing a circular economy regulations for instance recycling and re-use could make significant contribution to several SDGs. This 'Living Product Benchmarks 2020' for the first time set out to measure both a product performance based on environmental, social and economic benefits as well including cycled Nutrient which is essential criterias towards going circular in economy.

Zatrochová et al. (2021) conducted a review of the principles for contrary tasks in waste administration, which proposed an all-encompassing outline on how transferral methodologies could be incorporated into current waste system. So they outlined the importance of efficient operations process, proper waste disposal and role of technology in optimising reverse logistics. They contended the principles were crucial in order to improve waste recovery rates and diminish environmental effect.

Vargas et al. (2021) examined switch strategies of building construction solid waste. They observed that construction waste poses unique issues due to the scale and diversity of development waste. Their study demonstrated how opposing coordinated factors could be exploited to reclaim valuable materials from construction debris, ultimately reducing landfill consumption and promoting material recycling. They argued converse engineered activities might play a critical role in enabling more sustainable development practices.

Brandão et al. Foster (2021) extended this dialogue by exploring the policy execution equipment that animate opposed strategies in construction. They offer a conceptual typology that categorizes different systems—administrative structures, monetary incentives, public-private partnerships etc. Among the key discoveries of their investigation were that government-related help is indispensable for making a domain helpful for revere design contribution, particularly in ventures, as development where waste administration can be difficult and asset escalated.

U-Dominic et al. (2021) for damping the application of reverse strategies using a hybrid model based on IF-DEMATEL—EDAS. There were a few major causes as noted in their review, such as high costs and no structure among others. They suggested that overcoming these barriers will require a coordinated effort by companies, government agencies and the public to ensure anti-poaching policies can be successfully integrated into established supply chains.

Wang et al. (2021) The debasement of antibiotic medication by iron-stacked graphitic carbon from microplastics was obtained, is discussed to yield a different conclusion (2021). Although their focus was on the reactant performance and degradation pathway, these findings contributes to a wider discource in plastic waste management through advanced materials and technologies for recovery upcycling as well.

Plakas et al. (2020) provided a solution by employing Advanced Web of Things (IoT) and Low Power Wide Area Network fill technology. Their review highlighted the potential of digital advances to improving reverse logistics operations, thus it is easy enough to track and manage plastic waste through its lifecycle. They argued that these are a critical piece of tackling the growing problem with plastic waste in industries that use large quantities of single-use plastics.

Fikru (2020) taking a gander at organizations like Top Water, Water Addis Soda Bottle Labels Can Restore Slengthss ad Coke. His research provided much-needed practical insights into the operational troubles being faced by such firms including logistical bottlenecks and a demand for more efficient recycling facilities. Crutzen emphasized the need for beefing up proper reverse operations systems to ensure that plastic bottles are properly recycled and do not end up polluting nature.

3. Research Gap

Even though reverse logistics best practices has been a topic of research from a decade, and while numerous amount of papers have discussed the importance, applicability or feasibility on this concept especially pertaining to waste management and recycling there is still fewer studies reported among plastic recycling units in Kerala. Reverse logistics practices have been studied in different contexts of recycling but no research exists that primarly focussed on how these is carried out among the plastics registered under Suchitwa Mission, Govt. This study aims to address this gap by investigating the reverse coordinated operations practices in these units, providing insights that are crucial to improving plastic waste management in the region.

4. Objectives of the Study

- Reasons for adopting Reverse Logisitics.
- To study problems in the execution of reverse logistics.
- Benefits of Reverse Logistics adoption.

5. Research Methodology

This study employs an analytical and descriptive research design, using a telephonic survey and an interview schedule to gather data from plastic recycling units in Kerala, with the research conducted from December 2020 to February 2021. The sample consists of 81 units, selected through simple random sampling from those registered in the Kerala Suchitwa Mission Portal. Primary data is obtained directly from these units, while secondary data is sourced from research journals and the Suchitwa Mission's website. Data analysis is carried out using SPSS Adaptation 25, applying the Mann-Whitney U test, various discriminant investigations, and Levene's Test to ensure statistical rigor and balance in assessing the recycling units' operations and effectiveness.

6. Analysis and Interpretation

Tests used in the study objectives related to Reverse Logistics in Plastic Recycling in Kerala SPSS was used for analytical and interpretational purpose, carried out using significant statistical tests. The analysis and audios were recorded in terms of these objectives.

Objective 1: Identify motives for adopting reverse logistics

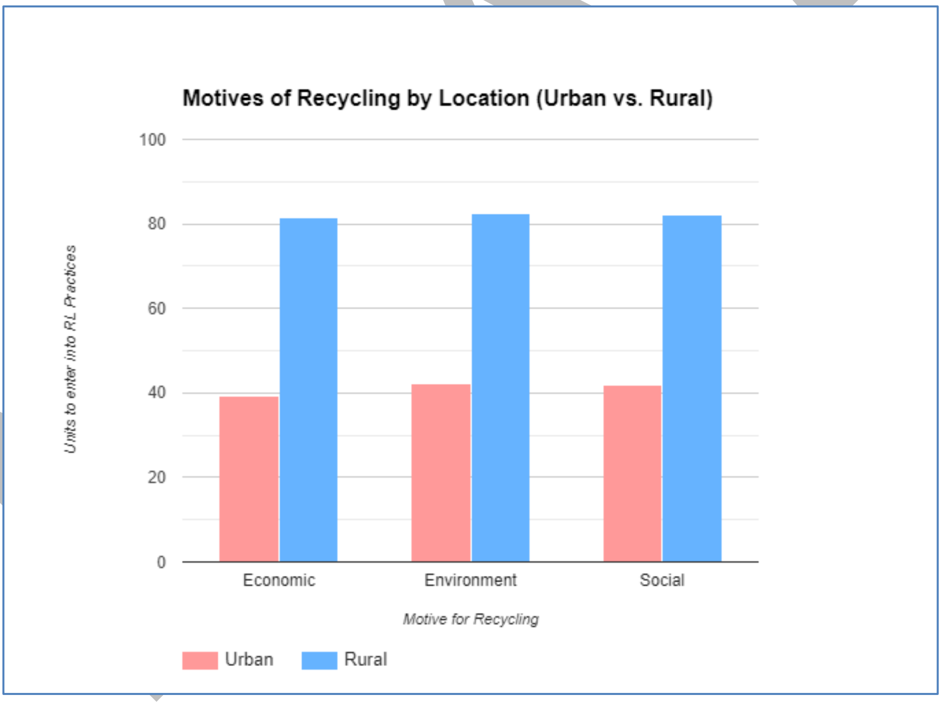
This question tries to solve the reason why recycling units in rural or urban locality of Kerala, opt for Reverse Logistics mechanism.

Test Used: Whitney U test to calculate this.

Table 1 Motives of Recycling Units to enter into RL Practices

Motive	Location		Test Statistic	
	Urban	Rural	Z	Sig
Economic	**39.13**	42.22	-.637	.524
Environment	42.31	**40.14**	-.451	.652
Social	41.83	**40.46**	-.282	.778

Source: Computed using SPSS



Graph 1 Motives of Recycling Units to Enter into RL Practices

The factors that motivate recycling units to adopt Reverse Logistics practices are described in Table 1. The finding through statistical analysis is that economic factors are the main motive for Reverse Logistics in urban units, and on their part rural too need to be more environment-sensitive / social responsible. A measure of importance the reason moving it demonstrates there is no critical distinction between urban and rustic thought processes yet regardless they are diverse with regards to Switch Planned operations in plastic reusing Kerala.

Objective 2 limitations in reverse logistics practices

The fourth objective is the difficulties of plastic recycling, specifically after widespread implementation of Reverse Logistics practices has taken place.

Table 2 Eigen Values

Eigen Values				
Function	Eigen value	% of Variance	Cumulative %	Canonical Correlation
1	.085[a]	100	100	.280

a. **First 1 canonical discriminant functions were used in the analysis**

Table 3 Wilks' Lambda

Wilk's Lambda				
Test of Function	Wilk's Lambda	Chi Square	df	Significance
1	.922	6.061	9	.000

b. Wilk's Lambda was utilized to test significance.

The sanctioned connection coefficient, 0.280 or all the fluctuation in this event equals 100 percent at Pv £05 level with a Wilk's Lambda value of.0922 and Chi-Square X^2=6.061. This indicates that the capacity identifying recycling units in urban and rural areas is statistically significant which justifies more examination on Turn around Integrated factors to plastic recycling with regards to Kerala.

Table 4 Functions at Group Centroids

Location	Function
Urban	-.356
Rural	.232

Standardized Canonical Discriminant Functions Evaluated at Group Means

The table shows a group centroid of 0.232 for rural units, which are located to the right in the space; and −10.356 (urban units), since these ones are positioned more on left side than those from rural areas. Cutoff point:−0.062 Accordingly, variables with values greater than this cutoff will be important to rural units whereas those less than are for urban continuum. Table 7 gives us the coefficients of canonical discriminant function in Reverse Logistics on plastic recycling in Kerala.

Table 5 Standardized Canonical Discriminant Function Coefficients

Regulatory Barriers	.474
Financial Constraints	.201
Technological Barriers	.493
Management Barriers	-.089
HR and Organisational Barriers	-.623
Strategic Barriers	.301
Benchmarking issues	-.080
Behavioural issues from personnel	-.257
Societal issues	.013

Source: Primary Data

Based on the results in Table 6, it can be concluded that Management and HR & Organizational Barriers; Benchmarking Issues pertaining to Businesses or Industries involving Recycling Units are mostly pertinent to

Urban recycling units. All other barriers are more applicable to recycling units in rural areas, whereas on the contrary. Some of the discriminating variables used to identify this Discriminant Function have been structured in Table 3 according to their total correlation with Standardized Canonical Discriminant functions based on Reverse Logistics carried out for Plastic Recycling in Kerala.

Table 6 Structure Matrix

	Function
Technological Barriers	**.580**
HR and Organisational Barriers	**-.577**
Regulatory Barriers	.398
Strategic Barriers	.222
Management Barriers	-.214
Financial Constraints	.182
Behavioural Issues from Personnel	-.150
Benchmarking issues	-.068
Societal Issues	-.046

Canonical discriminant functions are presented in pooled within-clump relationships segregating factors and normalized standard discriminant capabilities

Factors are ordered by their strength of connection with the power. From the lattice it can be found that mechanical constraints have biggest effect on reusing units in rustic ranges and reused to a littler,degree likewise influenced by Aliquots, while HR and Hagans Natural Boundaries has greatest impact for reuse unit where as HR is most minimized all things considered..Transactional Limits was ranked first under opposite strategies The pallet of Hierarchical boundaries put Transactional limits firstly followed by Physical Barriers respectively - Table-17.

iii) Objective 3: Examine benefits of reverse logistics adoption

This is the main objective of this stage since it intended to show a brief view about the most important benefits achieved in recycle centers by adopting Reverse Logistics practices.

Test Used: Levene Test for Homogeneity of Variance

Table 7 Benefits of entering into Reverse Logistics Practices

Benefits	Mean		Significance
	Urban	Rural	
Relationship withStakeholders	**2.72**	2.43	.358
Environmental Benefit	2.69	**2.88**	.489
Cost and Profit Benefit	**3.19**	2.65	.044
Social Benefit	**2.78**	2.69	.762

Source: Primary Data

Table 7: Mean Scores and Significance levels of Various Benefits of Reverse Logistics in Urban vs Rural areas The "Cost and Profit Benefit" shows significant difference (p =. 044), with urban areas (mean = 3.19) perceiving greater benefits than rural areas… The three variables, “Relationship with Stakeholders” (p =. Environmental Benefit (p =.358), 489), and Model D (p =. 762), revealing similar interpretations of these advantages in both contexts.

7. Conclusion

Reverse Logistics in Plastic Recycling Reuse with Statistical Studies: A Case Study of Kerala. The first objective to emerge was the existence for urban recycling units, economic aspects are predominant whereas environmental and social aspects determine attitudes in rural areas. Nevertheless, there were no differences found between urban and rural areas with respect to these reasons. However, Objective 2 has some important difficulties: the more urban unit reports problems related to management/Human Resouces/organizational aspects and the rural units with technological issues. These differences are brought out very sharply in the canonical discriminant analysis. Under Objective 3, urban areas perceive cost and profit benefits from reverse logistics practices as stronger compared to rural geography (significantly), while stakeholder relationships and environmental impacts do not show significant differences. This highlights the importance of differentiated strategies according to certain barriers and benefits that may be experienced in various environments.

Scope of Future Research:

1. Investigate the impact of reverse logistics practices on the financial performance of recycling units.
2. Explore the effectiveness of targeted interventions to overcome specific barriers identified in urban and rural areas.
3. Examine the long-term sustainability and scalability of reverse logistics practices in different regional contexts.

Suggestion:

- Conduct Region-Specific Studies
- Explore Motivational Factors
- Analyze Barriers
- Assess Benefits
- Develop Targeted Policies

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