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Critical Barriers to Implementation of Reverse Logistics in the Manufacturing Industry: A Case Study of a Developing Country

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Abstract: Globalization policies are encouraging manufacturing companies to produce environment-friendly products that offer a sustainable competitive advantage. Currently, product recovery and zero-waste supply chains have caught the attention of manufacturers and professionals. Reverse logistics (RL) is considered as the most significant part of supply chain management in developed countries; unfortunately, its implementation in developing countries is in the initial stages due to certain barriers. This study aims to identify and verify the barriers to implementation of reverse logistics using a two-stage methodology: the Delphi Method and Structural Equation Modeling. A comprehensive literature review was considered to identify a primary set of barriers. Using the Delphi Method, a team of experts screened out barriers after performing three iterations. A survey-based questionnaire was then sent out to supply chain and logistics employees in the manufacturing industry and relevant government authorities. Five hundred and forty-seven useful responses were analyzed in the Statistical Package for the Social Science (SPSS) & AMOS 21 softwares using Structural Equation Modeling to verify barriers, and ranked according to their severity. The most critical barriers with respect to each category are: high cost of reverse logistics adoption (finance and economics), lack of skilled professionals (knowledge and experience), lack of government supportive policies (law and regulation), poor organizational culture (management), lack of human resources (infrastructure and technology), lack of environmental law awareness (environment), lack of community pressure (market) and company policies (reverse logistics in policy). Overall, the top five barriers found in this study include lack of initial capital, lack of skilled professional in RL, companies' policies against RL, lack of new technologies and information systems, and lack of community pressure. Knowledge about barriers to reverse logistics allows manufacturing companies to prepare a priority list of actions for better implementation of the reverse logistics system.

Keywords: reverse logistics; sustainability; supply chain management; manufacturing industry; waste management; product recovery

1. Introduction

With the rapid increase in population across the globe and booming technology development, the production and consumption of products that have short lifecycles have increased. Massive production has resulted in more raw materials being consumed, thus contributing to an increase in and filling up of landfills [1]. Thus, it has become necessary for companies to incorporate strategies that efficiently and effectively deal with sustainability issues in their supply chain management (SCM) activities [2]. Globalization policies have encouraged manufacturing companies to produce environmentally-friendly products by adopting reengineering and innovative technology. A company's reaction toward the adoption of new technology is becoming its main driver. Product recovery and zero waste supply chains have caught the attention of manufacturers, professionals, and researchers over the last two decades [3–8].

Reverse logistics is any activity that is directly or indirectly associated with the recovery, collection, or disposal of used products. According to the American Reverse Logistics Executive Council [9], "Reverse logistics 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 recapturing value or proper disposal." RL issues are becoming significant and need to be resolved; they could be due to different factors such as product recall, remanufacturing, warranty return, disposal, service return, EOL (end of life) return, and (EOU) end of use return [8,10–12]. RL is a process of managing regressive flow and recycling used products from the consumer to the supplier with the aim of value creation, cost minimization, and environmental protection [13,14]. According to the Department of Energy and Environment in Australia, the depletion of resources are increasing landfill costs and significant return policies for vendors are stressing on the importance of RL for manufacturers and other stakeholders [15].

The adaption of reverse logistics practices can help producers minimize pollution by decreasing the burden of load of end-of-life products (EOL) on the environment [16–19]. However, there are several reasons why organizations decide to implement or refrain from RL practices. Researchers have highlighted different barriers to implementation of reverse logistics in developed countries. They include high processing costs, high warehousing and transportation costs, poor waste management, inadequate time commitment, lack of integrated corporate supply chain strategies toward reverse logistics, low awareness about reverse logistics operations, and lack of interest by top management toward RL activities and functional priorities [20–22]. These barriers and their severity vary from firm to firm. Even within a firm, the same barrier might need different treatment methods and may vary in the priority and importance given due to a variation in organizational resources, strategies, and capabilities. Despite the presence of these barriers, several organizations have shown a desire to effectively and efficiently adopt reverse logistics practices. Therefore, it is necessary to rank these barriers and propose possible solutions on priority. According to the literature, less attention is paid to the barriers and drivers of RL implementation in developing countries like Pakistan [18,21,23–28].

Manufacturing companies and government authorities in Pakistan should give importance to reverse logistics activities due to the following factors: execution of environmental policy (Policy and Regulations-Solid Waste Management Pakistan 2010); Waste and Hazardous Substances Rules, 2016 under Sections 13 and 14 of Pakistan Environmental Protection Act, 1997; Hazardous Substances Rules (2003); economic issues; improvement of green marketing; social conditions, and problems in recovery of used products. Pakistan is the 6th most populous country in the world, with more than 201 million people [29]. Approximately, 20 million tons of solid waste annually (an annual growth rate of 2.4%) is dumped on open land without any practical treatment solution. Pakistan's solid waste management needs a serious look at because more than 5 million people die every year in the country due to untreated waste [30]. On the other hand, Pakistan's manufacturing and logistics companies are facing hurdles in their operations due to deficiencies in logistics infrastructure [31,32]. Therefore, this burning issue must be investigated by researchers in order to identify and verify barriers to reverse logistics thorough scientific research.

Different countries have established different practices to promote reverse logistics practices and foster sustainable development. Due to the difference in economic growth, the approaches to implement reverse logistics are different in developed nations and developing nations. However, RL implementation is in its initial stages in developing nations. Therefore, valuable lessons can be learned from developed nations. The authors of [8,18,28] investigated barriers to implementation of RL in Brazil, China, and India, respectively. However, due to differences in rules and regulations, company size, operation systems, and maturity level of RL practices, the findings of research in Brazil and the two-largest developing nations of China and India cannot be generalized for other developing countries. Therefore, considering the lack of quantitative and qualitative research in developing nations [33], this study aims to identify and verify the most critical barriers affecting the development of RL in Pakistan and evaluate their significance in the manufacturing industry. This study proposes to use the Delphi Method (DM) and Structural Equation Modeling (SEM) for the same.

This study is structured as follows: Section 2 describes the literature review. Section 3 presents the research methodology. Sections 4 and 5 describe results and discussion, respectively. Section 6 eloborates the concluding remarks. Finally, Section 7 describes the practical implications, limitations, and future research direction.

2. Literature Review

This segment presents the literature in the Pakistani context, reverse logistics barriers, the use of Structural Equation Modeling (SEM) and Delphi Method in RL, and supply chain field and gap analysis.

2.1. Reverse Logistics and Pakistani Context

According to the Council of Logistics Management, logistics professionals have been publishing studies since the early nineties. Reverse logistics is considered a significant part of society and business [34] as it deals with the reverse flow of used products from the point of consumption to the point of production. Research on barriers and drivers to implementation of reverse logistics has concentrated on developed nations rather than developing nations [28]. RL is in its infancy stage in developing nations, particularly Pakistan. However, researchers have pointed out that the lack of research in developing countries is hardly surprising, although RL is considered a significant component of the supply chain.

Pakistan is a developing country, positioned at number six in the world population with 201 million inhabitants. In 2016, it was the second-largest economy in South Asia with a GDP of $988.2 billion and growth rate of 4.7% [29]. According to statistics provided by the government and NGOs, environmental degradation is a critical issue in Pakistan. The country ranks seventh in a list of countries most affected by global warming, an alarming situation for the Pakistan Environmental Protection Agency (PAK-EPA). A significant part of the environmental degradation is due to the generation of 20 million tons of solid waste yearly, with an annual growth rate of 2.4%. Unfortunately, RL is still unexplored in Pakistan, and environmental degradation remains an urgent global problem.

Pakistan is a country with low environmental protection standards. Firms generally perceive RL as an underestimated part of SCM [28]. Awareness about drivers, barriers, and opportunities in Pakistan is truly limited, and there is no literature review on it. However, RL has been gaining attention in the country owing to awareness of the "Draft Hazardous Waste and Hazardous Substances Rules" (DHWHSE), 2016, in Sections 13 and 14 of Pakistan Environmental Protection Act, 1997 Hazardous Substances Rules (2003); green marketing, economic issues, implementation of a new environmental policy, recovery of valued used products, and improving social conditions.

Although the policies mentioned above are significant drivers for RL in Pakistan, an effective processing system should be developed in order to achieve the objective of sustainable SCM for a variety of consumer-used products, such as lubricants, pesticide packing, batteries, lights, bulb, tires and electronics equipment, which are not properly disposed of. There must exist a system in Pakistan that has the capacity to return these solid waste items into the original production supply chain [35]. However, companies' knowledge of barriers to RL is limited and poorly addressed in developing countries. Unfortunately, there is no literature available related in Pakistan that could serve as the basis for problem identification.

2.2. Manufacturing Industry in Pakistan

According to the International Monetary Fund (IMF), Pakistan is the world's third-fastest growing economy among the top 25 economies. The China-Pakistan economic corridor (CPEC) is helping to accelerate the current growth with rising investments in infrastructure and energy projects. The consumption of natural resources has increased due to heavy industrialization. Pakistan's steel production and consumption rose by 39.3% with 5 million tons in 2017, a remarkable growth in the international steel industry. Pakistan's iron and steel industry is considered the backbone of the economy and sustains its growth. However, the heavy iron and steel waste generation due to modernization requires effective recycling and reusing of this waste [36]. The plastic and paper industry has employed more than one million workers and generated a value of total export of more than US$135 million [37]. Every year, 55 billion plastic bags are produced and consumed in the country. Pakistan's garments, textile, and footwear (GTF) industry employs 4.2 million workers and earned total export of nearly US$13.6 billion in 2015. The Pakistan automobile industry has a workforce of 2.5 million direct and indirect members, projected to increase to 4 million by 2021. In 2017–2018, 2.5 million motorcycles and 0.249 million vehicles were manufactured [38].

The next section discusses and present the barriers to RL based on earlier studies.

2.3. Barriers to RL

Over the past few decades, several studies in SCM have discussed the barriers of RL. Ravi and Shankar [3] found lack of top management commitment and low awareness about RL practices as the significant barriers to implementation of RL. Walker et al. [39] found the following four main barriers to research: high cost, lack of legitimacy, poor supplier commitment, and lack of rules and regulation. Meehan and Muir [40] compiled five barriers to SCM: lack of employee skill, lack of improvement and experience, low trust in 3rd party logistics, and lack of interest from top management. Dashore and Sohani [41] identified seven main barriers in his study: lack of advancement in new technology, lack of commitment from top management, lack of customers awareness, lack of knowledge training and experience, low integration with information and technology systems, lack of skilled professionals, and lack of waste management and energy management. Manzouri et al. [42] attempted to highlight the major barriers to implementation of SCM in the manufacturing industry in Iran and Malaysia; they include low awareness about SCM practices, lack of logistics executives, lack of information, and low awareness about new technology. According to Mudgal et al. [43], lack of CSR and lack of commitment from top management are the most significant barriers to implementation of RL. Sharma, Panda, Mahapatra and Sahu [10] examined management negligence, lack of initial capital, lack of SCM performance, lack of improved management systems and company strategies, and administrative issues as barriers that have both strong dependence and driving power. Legal issues, low awareness of RL and financial constraints were found to be independent barriers to a strong driving power. Giunipero et al. [44] identified four major barriers in his study: lack of rules and regulation and sustainability standards, lack of coordination at the CEO level, high cost of sustainability, and non-alignment of short and long-run strategic goals.

Al Zaabi et al. [45] addressed five main barriers in his paper: lack of top management commitment, improper alignment of a long run and a short run of strategic goals, lack of appropriate standards for sustainability, lack of facilities to adopt RL practices, and lack of evaluation measures for sustainability. Govindan et al. [46] found in his study lack of new technology, financial constraints, knowledge-related barriers and involvement, and support barriers as main obstacles to green SCM implementation in the manufacturing industry. Abdulrahman, Gunasekaran and Subramanian [28] highlighted five most critical barriers in RL: scarcity of capital and funds to monitor an RL system, lack of enforceable laws and government policies that support the economy and, low commitment by RL experts and lack of a system for return monitoring. It is necessary for both a company's ownership and top management to have the capability to differentiate between the similarities and differences among the RL barriers. Jayant and Azhar [47] highlighted six major influential barriers in his article: lack of ISO certification, high cost of disposal hazardous products, market competition, lack of a government support system, and waste and pollution of industries. Chileshe et al. [48] addressed the following six significant barriers of RL: lack of regulation restrictions, lack of incorporation of salvaged material, higher costs, longer time association, and potential legal liabilities in RL of the construction industry. Prakash and Barua [18] included 38 barriers in his study; the following are the important ones that make implementation of RL difficult: lack of rules and regulations for end of EOL products, lack of consumer awareness about RL, lack of top management commitment, lack of initial capital and operating cost, low forecasting and planning, and lack of new technology and information system.

Shaharudin et al. [49] identified seven major barriers to RL, including lower adaption rate of RL practices, limited usage of material, costly operations, lack of rules and regulations, inadequate support, lack of customers operation performance and customers perception. Bouzon, Govindan, Rodriguez and Campos [8] found four main barriers: financial burden of tax, limited forecasting and planning for product recovery, lack of top management commitment, and uncertainty related to economic issues in the Brazilian EEE industry sector. Lack of pressure to adapt green supply chain management practices, lack of training and monitoring, and lack of customers awareness are the key barriers found by Wang et al. [50] in an empirical study. Bouzon et al. [51] identified five key barriers from the organizational prospects of RL, which include limited forecasting and planning, difficulties with supply chain members, company policies against RL, less involvement of top management and strategic planning, and low importance to RL issues. Company policies against RL was at the top of the list.

The next section presents the studies used Structural Equation Modeling (SEM) and the Delphi Method (DM) in supply chain management

2.4. Structural Equation Modeling and Delphi Method in Supply Chain Management

DM and SEM have been proposed for identification and verification of RL barriers in this study. SEM has entered its fourth decade of use and can provide an insight into existing research, and endeavor to predict findings for the near future. SEM is a major research technique that measures significant relationships between different variables of a model. It has been widely used in social and management science because of the realistic results it offers in measuring structural analysis [52]. The blind use of SEM has been criticized as it generates ambiguous results [53,54]. However, it continues to be one of the most widely used research techniques in the field of supply chain management and reverse logistics [55,56]. With the help of SEM, researchers can estimate a model and draw a path diagram; raw data can also be reviewed using this diversified program. SEM offers easy drawing of path diagrams (using drawing tools) without complex commands and equations [57].

This study suggests a two-stage methodology for the identification and verification of barriers to RL, including SEM and DM. DM assists by getting a consistent flow of information about RL barriers with the help of a questionnaire. It has been widely used in supply chain management studies; Auramo et al. [58] utilized DM to determine professional opinions toward electric business logistics companies. Akkermans et al. [59] incorporated DM to check the impact of enterprise resources planning on SCM. Ogden et al. [60] used DM for the development of important strategies in SCM for future forecasting. Seuring and Müller [61] used DM to determine the sustainability of the supply chain by evaluating the most critical barriers. To form a set of sustainability criteria, Lee et al. [62] utilized DM to determine green suppliers for the high-tech industry. Heiko and Darkow [63] used DM for the development of a comprehensive model for long-term planning of RL in the service industry. Jayaram and Avittathur [64] utilized DM for the development of green supply chain management strategies in an emerging economy with the help of company sustainable strategies.

Rao and Holt [65] used SEM to evaluate the potential connection between the GSCM initiative (as an environmental improvement step) and economic performance among South Asia firms. Min et al. [66] utilized SEM to understand the relationship between market orientation and supply chain orientation in SCM. Juga et al. [67] incorporated SEM to investigate service quality influence on third-party logistics provider and shipper satisfaction. Jun and Shengrong [68] checked the competitiveness of logistics companies with the help of SEM. Hazen et al. [69] used SEM to understand behavior toward adaptation of green logistics practices. Lin and Sheu [70] determined adaptation of green practices among firms from the perspective of institutional theory using SEM. Kye et al. [71] utilized SEM to identify indicators to check the impact of logistics packaging on freight transport efficiency. Chin et al. [72] used SEM to explore the motivation of Malaysian manufacturers to adopt GSCM activities to protect the environment. To the best of the author's knowledge and as per a review of the literature, no study has used a hybrid (DM and SEM) approach to identify and verify barriers to implementation of reverse logistics in developing countries.

Table 1 describes different studies using SEM, DM SCM, and logistics research.

Table 1. SEM and DM studies in supply chain management.

Research Objectives	Author	Analysis Method
Understanding the customer's behavior toward adaptation of green logistics practices	[69]	SEM
Obtaining initial indicators to check the impact of logistics packaging on transportation efficiency freight	[71]	SEM
Evaluating most critical and core problems in sustainable supply chain management (SCM)	[61]	DM
Evaluation of competitiveness of logistics companies using Structural Equation Modeling	[68]	SEM
Comprehensive long-term planning for logistics service industry, a Delphi method analysis for 2025	[63]	DM
Purpose of this study was to check the relationship between market orientation, supply chain orientation, and supply chain management	[66]	SEM
Development of most important strategies in supply chain management for future forecasting with the help of the Delphi technique	[60]	DM
Purpose of this study was to evaluate the selection of a green supplier for the high-tech industry	[62]	DM
The main purpose of this paper was to evaluate three strategies: market strategy, process strategy, and information strategy of logistics with the help of Structural Equation Modeling	[73]	SEM
The objective of this paper was to check the impact of enterprise resource planning on SCM with the help of the Delphi Method	[59]	DM
The objective of this study was to investigate the service quality that influences third-party logistics provider relationship and shipper satisfaction	[67]	SEM
The aim of this study observes the relationship between 3PL, customer relation and logistics firm improvement	[74]	SEM
A Delphi Method based study to identify the factors affecting location decision in international operations	[75]	DM
The purpose of this study was to evaluate the potential connection between green SCM initiative as an environmental improvement option, competitiveness, and economic performance among South Asian firms	[65]	SEM
The purpose of this paper was to motivate Malaysian manufacturing companies to adopt GSCM activities to protect the environment	[72]	SEM
Identification of most critical issues in reverse logistics faced by professionals in time management activities	[76]	DM
Influence of institutional theory on adoption of green supply chain practices in the manufacturing industry	[70]	SEM
The development of a comprehensive model-based decision for GSCM using SEM and securing better understanding among managers on internal and external factors	[77]	SEM
Professionals opinions toward electronics business logistics companies	[58]	DM
The aim of this study was to fill the gap by provision of empirical evidence to manufacturing companies for implementation of green supply chain management to protect the environment	[78]	SEM
Development of green supply chain management strategies from companies' sustainable strategies and emerging economy perspective	[64]	DM

2.5. Research Gap

Through comprehensive literature review, it has been noted that companies share almost the same barriers in the time management and implementation of RL activities. Moreover, a country's current situation (i.e., green business policy, environmental laws, poor logistics network, government priority and socio-economic condition, etc.) might affect the severity of different RL barriers, as well as prioritization of the most critical ones. More specifically, literature review shows that both professionals and experts are interested in exploring the critical barriers for RL; the need of the hour is mitigation of these constraints for successful implementation. With the help of the previous section, this study highlights the following research gap:

- Lack of qualitative and quantitate studies focusing on identification and verification of RL barriers in developing countries
- The need to address the research gap on developing RL infrastructure in the Pakistani context due to the following factors: implementation of the new environmental policy (National Policy on Solid Waste Management 2016), green marketing, social issues, economic issues, environmental standards, and new rules of Pakistan Environmental Protection Agency (PAK-EPA). On the other hand, deficiencies in logistics infrastructure is a big challenge for Pakistani manufacturing companies.
- More specifically, companies perceive RL as an unexplored part of supply chain management and one of the most difficult and significant initiatives to implement in the green supply chain management field.
- There is wide applicability of SEM and DM in the supply chain management field. According to previous literature review, several studies have focused on exploring the barriers in developed countries and supplier selection. To the best of our knowledge, no one has used the combined methodologies of SEM and DM for RL barriers analysis.

3. Research Methodology

This study aims to identify and verify the most critical barriers to RL and recognize hurdles to its development. This research suggests a two-step method to identify study objectives. In the first step, international peer-reviewed publications on the barriers to RL were extensively and comprehensively reviewed, enabling the authors to design a questionnaire and facilitate data collection. A team of experts (financial experts, managerial experts, environmental scientists and sustainable standards developers), including from the RL field, was hired from different universities of Pakistan to respond to the questionnaire. In the second step, empirical research was conducted involving employees working in supply chain and logistics departments of Pakistani manufacturing companies and PAK-EPA to check the authenticity of these barriers in the Pakistani RL context. The step-by-step study approach is shown in Figure 1. Further sections provide a detailed explanation of each step.

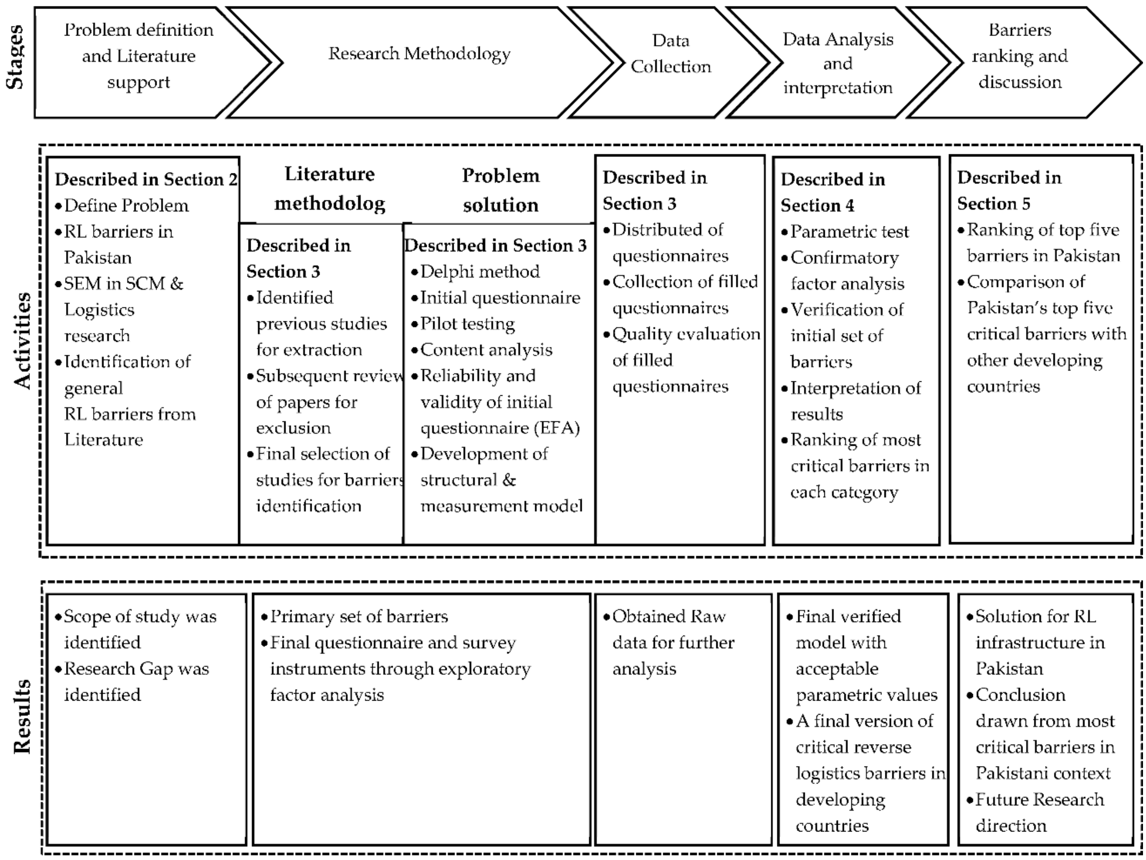

Figure 1. Study framework to identify and verify RL barriers in the manufacturing industry of Pakistan, including different stages, activities, and results.

3.1. Problem Description

RL is in the early stages in almost every industry in developing countries [26]. While in developed countries, products are being reused and recycled, products in developing countries are continuously being sent to landfill because of a lack of logistics infrastructure and technology, thus causing huge damage to the environment [79]. According to literature review, a majority of the existing research on RL barriers and drivers and their successful implementation is concentrated on developed nations; less attention is being paid to developing ones [26,28]. Interestingly, RL, which is a main driver for green supply chain management initiatives, is still unexplored in emerging economies [80]. It is, thus, the responsibility of researchers to conduct more research on barrier identification, analysis, and successful implementation in a developing country like Pakistan.

3.2. Barrier Identification

Existing studies have explored the barriers to implementation of RL internationally. By means of comprehensive and general literature review, 47 critical barriers have been identified. They are listed with their source reference in Table 2.

The identified barriers were selected and grouped into eight categories on the basis of their meaning and similarities:

- Financial and economic-related barriers (FERB): this category offers information about financial and economic-related barriers; for example, those related to investments, loans, adaptation costs and return and funding, among others.

- Knowledge and experience-related barriers (KERB): this group contains information about barriers related to professional skills, training, and experience of employees; responsibilities of professionals, and RL awareness among companies.
- Law and regulation-related barriers (LRRB): this category includes the barriers related to laws and regulations concerning the reverse flow of products, political commitment, and government policies.
- Management-related barriers (MRB): in this category, barriers related to management, such as the manager's importance to RL is compared with other organizational issues and top management commitment to RL logistics activities.
- Infrastructure and technology-related barriers (ITRB): this category includes issues related to infrastructure and technology, such as lack of logistics infrastructure, issues related to lack of technical human skill and lack of technology, and information system for the improvement of RL within the country.
- Environment-related barriers (ERB): this category refers to issues related to environmental protection and sustainable development within the country.
- Market-related barriers (MB): this category deal with barriers related to market competition and uncertainty, undeveloped recovery marketplaces, and lack of community pressure on manufacturers to protect the environment.
- Policy-related barriers (PRB): this category contains information about barriers that are related to policies, such as lack of corporate, social and ethical responsibilities; lack of clarity regarding sustainability, and company policies against RL.

Table 2 describes the different barriers to reverse logistics, identified through comprehensive literature review, and categorized on the basis of their meaning and similarities.

Table 2. Barriers to RL.

Code	Barriers	References
FERB	**1 Financial & Economical Related Barriers**	
FERB1	Lack of initial capital	[13,28,43,44,51,81–83]
FERB2	Non-availability of bank loans to encourage green products/processes	[26]
FERB3	Higher costs of adopting RL	[21,28,48,84,85]
FERB4	Lack of funds for product return monitoring systems	[28,86]
FERB5	High investments and less return-on-investments	[26,86]
FERB6	Expenditure on collecting used products	[18,26]
KERB	**2 Knowledge & Experience Related Barriers**	
KERB1	Lack of skilled professionals in RL	[28,46,82,87–89]
KERB2	Lack of knowledge, training and experience in RL	[45,46,87,90,91]
KERB3	Lack of awareness about RL practices	[10,26,43,48,82,84,92]
KERB4	Immaturity and low investment in knowledge management and information systems	[8,48,83,93,94]
KERB5	Wrong forecasting	[49,95,96]
KERB6	Lack of responsiveness about RL	[97–101]
LRRB	**3 Law & Regulation Related Barriers**	
LRRB1	Lack of government supportive policies for RL	[86,102]
LRRB2	Changing regulations due to changing political climate	[103]
LRRB3	Lack of regulatory restrictions	[26,104,105]
LRRB4	Lack of enforceable laws on products' return of end-of-life	[18,28]
LRRB5	Customers are not informed to returned use products	[3,18]
LRRB6	Lack of political commitment	[106]
MRB	**4 Management Related Barriers**	
MRB1	Lack of commitment from top management	[41,44,47–49,87,97,107–109]
MRB2	Lack of management initiatives	[41,82]
MRB3	Lack of cooperation with RL professionals	[28,87]

Table 2. *Cont.*

Code	Barriers	References
MRB4	Lack of coordination with 3PL providers	[18,26]
MRB5	Lack of waste management practices	[8,28,110]
MRB6	Poor organizational culture	[41,47,97,109,111]
MRB7	Resistance to change	[97,112–114]
ITRB	**5 Infrastructure & Technology Related barriers**	
ITRB1	Lack of new technology and information systems	[41,46,84,87,105]
ITRB2	Lack of logistics infrastructure facilities	[104]
ITRB3	Lack of human resources	[3,46,48,105,115,116]
ITRB4	Lack of technology for waste management and recycling	[22,28,45,87,117]
ITRB5	Deficiency of road conditions	[104]
ITRB6	Poor service quality of local 3PL provider	[104]
ERB	**6 Environmental Related Barriers**	
ERB1	Lack of environmental law awareness	[46,51,118]
ERB2	Complexity in measuring and monitoring suppliers' environmental practices	[46]
ERB3	Lack of effective environmental measure	[46,65]
ERB4	Difficulty in identifying environmental opportunities	[46,119]
ERB5	Lack of international or U.S environmental standards	[28,44,51]
ERB6	No specific environmental goals	[26,119]
MB	**7 Market-Related Barriers**	
MB1	Market competition and uncertainty	[26,43]
MB2	Lack of community pressure	[40,103,120]
MB3	Marketing of remanufactured product	[26,86,120,121]
MB4	Uncertain quality and quantity of return	[21,26,40,86,120]
MB5	Uncertain return and demand	[86,121,122]
MB6	Undeveloped recovery marketplaces	[51,102,123]
PRB	**8 Policy Related Barriers**	
PRB1	Lack of corporate social responsibility and ethical standards	[26,43,51,87]
PRB2	Companies policies against RL	[51,90,102]
PRB3	Lack of clarity regarding sustainability	[45,86]
PRB4	Limited forecasting and planning in RL	[18,28,51]

3.3. Literature Review Methodology (Steps 1 and 2)

In order to identify a research gap, systematic research was performed to find publications in English journals that had RL articles (Step 1). Several bibliographic databases were searched, which included Google Scholar, Science Direct, Emerald Insight, ISI Web of Science, Springer, Taylor & Francis, Willey, and Scopus. This search concluded that no study has focused on the identification and verification of the most critical barriers of RL in the Pakistani context. This led us to a strong study gap.

After identification of the study gap, the next step was to find comprehensive literature review on RL barriers. This literature review focused on articles published only in English journals. In this step, the most important decision that had to be taken was the description and delimitation of material and description of unit analysis [124]. Bibliographic databases were searched using the same procedure as in Step 1. To look for research articles, the main keywords of the study—reverse logistics and barriers—were used in the title, abstracts, and keywords. This whole procedure resulted in the selection of more than 185 publications from over 100 journals. The next step was to sort the articles according to research scope by eliminating duplicity with the help of title and abstract analyzation. Finally, 57 papers from 45 journals, five conference proceedings, and one book were utilized to identify critical barriers to RL in the Pakistani context. Here are the names of some top journals and the numbers of research articles in each: *International Journal of Production Economics* (3 papers), *The International Journal of Advanced Manufacturing Technology* (1 paper), *Journal of Cleaner Production* (4 papers), *Journal of Business Logistics* (1 paper), *Resource Conversation and Recycling* (3 papers), *International Journal of Operations & Production Management* (2 papers), *Supply Chain Management: An International Journal* (2 paper), *Purchasing and Supply Chain Management* (2 paper), *Reviewable Sustainable Energy Reviews*

(1 paper), *Journal of Manufacturing System* (2 papers), and *International Journal of Logistics System and Management* (2 papers).

RL is considered the most important part of SCM and sustainable environmental logistics practices. This comprehensive study included all recent and relevant publications on barriers in the field of GSCM to cover extensive literature on RL barriers. These studies highlighted as few as five and as many as 45 barriers in each. Finally, through an extensive literature review, a primary set of 47 barriers were identified and classified into eight categories, based on their meaning and similarities.

3.4. Developing the Survey Questionnaire

Based on the literature review mentioned above, a comprehensive questionnaire was developed by identifying 47 most critical barriers, grouped into eight constructs—financial & economic; knowledge & experience; law & regulation; management; infrastructure & technology; environmental; market; and policy-related barriers. A five-point Likert scale (1 = strongly disagree and 5 = strongly agree) was adopted to judge the importance of each barrier. The questionnaire was evaluated by a team of experts using DM. A meeting with the experts was first conducted, based on a procedure set by the DM [125] to identify the important barriers to RL.

However, DM has some weaknesses, one of which is its poor application [125,126]; for example, easy selection of experts, lack of evolution and no concern for failure, poor formulation of barriers and questions, and insufficient analysis of findings. Real-time DM was thus introduced to overcome the weakness of the Delphi method, which included complex tasks for facilitators, lack of presentation of real-time findings, and complications in tracking over-time progress. Real-time DM is an advanced computer-based version of the Delphi method, which increases the authenticity of the process.

To proceed to real-time DM, the board of experts (supply chain managers, supply chain supervisors, reverse logistics professionals, environmental scientists, financial experts, social scientists, and managerial experts) was invited to participate in a group decision-making process. Each of them had more than 10 years' experience in the field of logistics and supply chain management. They were requested to consider the Pakistani manufacturing industry and the background of barriers at the time of identifying critical barriers to RL and assess if all the potential barriers were covered in the questionnaire or if any barrier needed to be added to or deleted from the list. The experts provided remarkable advice. The following questions were asked:

Q1. Which barriers would need to be resolved on priority in order to implement RL in your industry?
Q2. Follow up questions were asked about the addition and deletion of selected barriers.
Q3. Please highlight barriers faced by your company that are not in the list.

Firstly, the facilitator asked the experts to fill the predefined survey independently to the best of their knowledge. The pre-defined survey data was then collected by the facilitator. Based on their responses, the author prepared anonymous summary results, which was then sent again to the experts for further modification and opinions. Once, three iterations were completed, and consensus among all professional experts was achieved, screening of the final set of barriers affecting RL program in Pakistan was easy.

Based on the DM results, the board decided to reduce the number of barriers from 47 to 38 by removing the following barriers because of ambiguity and repetition: FERB2, KERB3, KERB4, LRRB6, MRB2, MRB4, ERB2, MB3, and MB5. In addition, the experts suggested that two potential barriers—lack of stakeholder pressure and complexity in reverse logistics implementation—which were omitted from the initial barrier list should be considered. Later, considering the Pakistani manufacturing situation, the experts modified these barriers to "lack of community pressure" and "complexity in measuring and monitoring supplier environmental practices" and included them in the final version of the questionnaire. Finally, these 38 barriers were selected to define an eight-factor model of RL barriers.

After identifying barriers through literature review and DM, a questionnaire including the screened 38 barriers was developed for a survey and to verify the most critical barriers using structural equation modeling. The questionnaire also included background information of the respondents, which included their professional capabilities and working experience within organizations. More details about the eligibility of respondents are given below. Saunders and Lewis [127] suggested a formula to calculate a sample size when population size is unknown. It helps calculate an accurate sample size for research:

$$\text{sample size} = [(\text{minimum sample size required} \times 100) \div (\text{Average percentage response rate expected})]$$

It is recommended to have a minimum sample size of 200 for any SEM analysis [128]. The response rate in previous relevant studies on logistics is comparatively low, e.g., 37% in a study by Abdulrahman, Gunasekaran and Subramanian [28]. Based on these values, the estimated sample size can be calculated as: $[(200 \times 100) \div 37] = 540$. In this survey, 1000 questionnaires were distributed to supply chain supervisors, directors, and managers of the manufacturing industry and government employees of relevant institutes in Pakistan from January to August 2017. Data was collected from the employees of Environmental Protection Agency (PAK-EPA) and Sustainable Development Policy Institute (SDPI) in Pakistan, as these government institutes are vital for successful implementation of New Policy on Solid Waste (NPSW) in the country.

The following procedure was adopted for selection of respondents from the manufacturing industry, service industry, customers, and education field, based on the capability and professionalism of the respondents and to enhance the quality and reliability of data:

(1) The company should be operating in Pakistan.
(2) The company should be large, facing the described barriers, and have available resources.
(3) An RL program should be implemented or available for implementation within the company.
(4) The company should agree to participate in this research and answer all the questions in the questionnaire.

Table 3 describes the details of respondents, including their gender, age, education, industry and work status.

Table 3. Details of respondents.

Demographic	Count	Percentage
Gender		
Male	454	83
Female	93	17
Age group		
20–35 years	197	36
36–50 years	279	51
>50 years	73	13
Education		
Bachelor	317	58
Master	211	39
Ph.D.	19	3
Industry category		
Textile mills	73	13
Food industry	59	11
Plastic bags manufacturing	41	7

Table 3. *Cont.*

Demographic	Count	Percentage
Apparel mills	25	5
Beverage companies	82	15
Paper manufacturing	27	5
Rubber and plastics mills	34	6
Coal and petroleum companies	28	5
Electronic products manufacturing	49	9
Lubricants companies	58	11
Fertilizer companies	50	9
Government Employees (PAK-EPA, SDPI)	21	4
Work status		
Top level	46	8
Middle level	322	59
Low level	179	33
Total	547	100

4. Results

The study found 547 questionnaire responses to be usable. The instrument's reliability and validity were initially analyzed using Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). With Cronbach's Alpha results, the internal consistency was measured. The values of Cronbach's Alpha ranged between 0.731–0.867, which show that the internal consistency of all eight categories was greater than 0.70, as recommended by the author of [129]. The values of Cronbach's Alpha prove that the developed scale is reliable. EFA was then applied to eight constructs, including 38 items, to uncover latent factors. The main purpose of EFA is to check whether a link between the observed and latent variables is uncertain or unknown. Factor analysis is a significant and widely used technique to observe reliability of constructs [130]. Principle component analysis using varimax rotation was employed to perform EFA on the 38 items. EFA starts by judging the appropriateness of the data to perform it. The Kaiser-Meyer-Olkin (KMO) and Bartlett test judges the sampling adequacy to perform EFA. KMO value should be 0.60 or more to perform a good factor analysis [131]. KMO value was 0.859 and Bartlett test X^2 = 32,054.324, $p > 0.000$, which is significant, showing adequate inter-correlation and adequate sample size to perform factor analysis. According to the criteria, all factor loadings should be greater than >0.40 Costello and Osborne [132], communalities <0.30 and cross-loadings >0.40 [133]. The findings of EFA show that the eigenvalues of all eight factors are greater than 1, following the criteria recommended by Kaiser [134], with 73.64% total variance. One item (lack of clarity regarding sustainability) was deleted from policy-related barriers due to low commonality (0.214) and factor loading (0.297) values. After the deletion, the communalities values ranged from 0.516 to 0.793, and factor loading values from 0.50 to 0.87, which matches the above-mentioned recommended criteria. Finally, 37 barriers were extracted to perform the Confirmatory Factor Analysis (CFA).

Table 4 describes the results of EFA, including factor loadings of barriers identified through literature review and Delphi method.

Table 4. Results of Exploratory Factor Analysis.

Factors	Reliability	1	2	3	4	5	6	7	8
FERB1	0.875	0.876							
FERB3		0.822							
FERB4		0.650							
FERB5		0.802							
FERB6		0.729							
KERB1	0.751		0.872						
KERB2			0.742						
KERB5			0.837						
KERB6			0.591						
LRRB1	0.834			0.856					
LRRB2				0.638					
LRRB3				0.683					
LRRB4				0.801					
LRRB5				0.848					
MRB1	0.764				0.825				
MRB3					0.788				
MRB5					0.674				
MRB6					0.863				
MRB7					0.502				
ITRB1	0.837					0.855			
ITRB2						0.729			
ITRB3						0.866			
ITRB4						0.710			
ITRB5						0.696			
ITRB6						0.830			
ERB1	0.712						0.832		
ERB2							0.783		
ERB3							0.670		
ERB4							0.598		
ERB5							0.580		
ERB6							0.709		
MB1	0.845							0.641	
MB2								0.865	
MB4								0.780	
MB6								0.804	
PRB1	0.796								0.829
PRB2									0.867
PRB3									0.297
PRB4									0.785

CFA was applied using AMOS 21.0 software (demo version) to check for model validity of the statistical analysis for Structural Equation Modeling (SEM). The CFA technique is considered a significant research technique in logistics and SCM research, utilized to identify covariance structure [135] and linear structural relationship model [136]. Researchers prefer to use this multivariate research technique when they have limited information about the latent structure.

The eight-factor confirmatory model was explored with 37 items using different model fitness indices. The results indicated that squared multiple correlation (SMCs) values ranged between 0.342 to 0.712 and modification indices had smaller values, except for one high value. Therefore, one item from the management-related category was deleted on observing domain representativeness [137]. The item 'resistance to change' was removed due to tapping with 'lack of commitment to top management'. This procedure was repeated more than three times; no more barriers were deleted.

Finally, the confirmatory model presented 36 items under eight categories. According to the findings, the 36 item eight-factor model had good indices, as x^2 = 144.2; p = 0.000; x^2/df = 1.173; NFI = 0.96; NNFI = 0.95; CFI = 0.96; GFI = 0.94; AGFI = 0.92; RMSEA = 0.054; SRMR = 0.049. SMCs values ranged from 0.489 to 0.724, and the range of all modification indices was low, from 0 to 10. The confirmatory factor model with 36 items in eight categories is shown in Figure 2. In the next step, convergent, discriminant and unidimensional validity were checked. Unidimensional validity confirmed that for each item, there was only one related construct [136]. Cronbach Alpha value ranged from 0.712 to 0.875, as shown in Table 4, and composite reliability values ranged from 0.76 to 0.90 (shown in Table 5).

The values of the findings were greater than the recommended value of 0.70, which indicates good reliability with high internal consistency [54]. With the help of factor loadings, convergent validity was assessed. The values of NFI should be higher than 0.90 to present strong convergent validity [138]. All factor loadings of CFA were greater than 0.70, proving data suitability. Average variance extracted (AVE) for all eight factors was greater than the recommended value of 0.5 [139] and ranged from 0.60 to 0.65. The composite reliability (CR) of all factors, meeting the criteria recommended by the author of [133], was also above 0.70, proving convergent validity. Discriminant validity was judged by making a comparison of AVEs of specific measures with shared variances in between measures [54]. The results are described in Table 5.

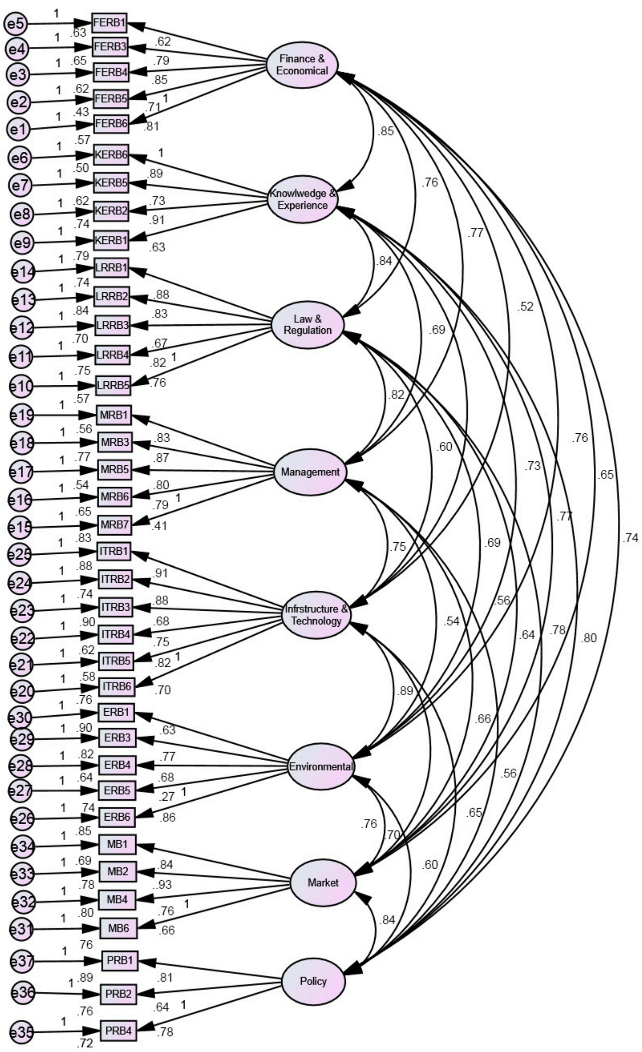

Figure 2. Schematic representation of the structural model drawn in Amos to verify barriers to RL in the manufacturing industry in Pakistan.

Table 5. Constructs validity and model-fit indices.

Variables	Composite Reliability [1]	Average Variance Extracted [2]	Fit Indices [3,4,5]	Statistics	Recommended Criteria
Financial & Economical	0.85	0.654	NFI	0.96	>0.90
Knowledge & Experience	0.89	0.601	NNFI	0.94	>0.90
Law & Regulation	0.78	0.587	CFI	0.96	>0.90
Management	0.80	0.642	GFI	0.94	>0.90
Infrastructure & Technology	0.86	0.596	AGFI	0.92	>0.90
Environmental	0.87	0.548	RMSEA	0.054	>0.08
Market	0.76	0.662	SRMR	0.049	>0.08
Policy	.082	0.648			

[1] [54]; [2] [139]; [3] [138]; [4] [140]; [5] [141].

Finally, 36-barriers were verified through structural equation modeling. It can be concluded that 36 barriers were verified out of a primary set of 47 barriers. These are the most critical barriers to implementation of RL in the manufacturing industry in Pakistan.

5. Discussions

This discussion is divided into two sections: the first section is related to barrier verification through factor analysis and the second section consists of a comparison of RL in Pakistan with others developing countries. In this section, a comprehensive overview of our study is presented and a clear overview of the barriers to RL is provided. However, it is difficult to identify which barriers are most critical for RL. Therefore, a ranking of the barriers was carried out to offer more consistency and rationality to decision-making by relevant authorities. According to the results of our study, the implementation of RL is in its early stages in Pakistan. In this study, the ranking of described financial & economic barriers sub-criteria are: FERB1 > FERB3 > FERB5 > FERB6 > FERB4 (Table 4). The general results show that the prominent financial and economic barriers to RL implementation in Pakistan are lack of initial capital, higher costs of adopting RL, and high investments and less return on investments. These findings are similar to that of previous research [28]. Correspondingly, knowledge & experience-related barriers' sub criteria rankings are: KERB1 > KERB5 > KERB2 > KERB6. In this category, the most critical barriers to RL implementation are lack of skilled professionals in RL and wrong forecasting, and lack of knowledge. The results of this category agree with previous research results [18,28]. This shows that law & regulation barriers is a prominent category standing in the way of RL implementation.

Laws & regulation barriers are ranked as: LRRB1 > LRRB5 > LRRB4 > LRRB3 > LRRB2, shown in Table 4. Most influencing barriers in this category are: lack of government supportive policies to RL, lack of enforceable laws on products return of EOL, and customers not being informed to return used products. In management-related barriers, sub-criteria ranking is as follows: MRB6 > MRB1 > MRB3 > MRB5 > MRB7; in this construct, poor organization culture, lack of commitment from top management and lack of cooperation with RL professionals are the dominating and top barriers, respectively. Lack of human resources, lack of new technology and information systems are the highest priority barriers, and deficiencies in road condition is the lowest priority barrier in infrastructure & technology-related barriers. Rest of the barriers rankings are: ITRB3 > ITRB1 > ITRB6 > ITRB2 > ITRB4 > ITRB5, in descending order. Similarly, ranking of environmental-related barriers are: ERB1 > ERB6 > ERB3 > ERB4 > ERB5, as shown in Table 4. Lack of environmental law awareness and no environmental specific goals are the highest weight barriers in this category. In market-related barriers, lack of community pressure and undeveloped recovery marketplaces are the dominant barriers to RL implementation. Other barriers' ranking are as follows: MB2 > MB6 > MB4 > BM5, in a descending order. The ranking of policy-related barriers is described in descending order: PRB2 > PRB1 > PRB4. Lack of corporate social responsibility and ethical standards are the highest-ranking barriers in this category.

Comparison of Findings with Brazil, China, and India

Most of the barriers used in this study were adopted from earlier studies (presented in Table 2), which explored the barriers to RL implementation in developing countries like Brazil, China, and India. Therefore, comparing the findings of this study with select developing counties might assist in understanding and highlighting differences among the barriers in Pakistan and the select countries. This will be beneficial for the concerned authorities and policymakers to advocate worldwide. The top five barriers identified in this study are compared to the top barriers of other developing countries like Brazil, China, and India. This type of comparison has attracted the attention of academia in the field of logistics and SCM. For instance, the author of [142] compared his results on strategies to promote the adoption of green building technologies in Ghana with results of the U.S., while the author of [143] tried to compare his findings on the UK with the factors affecting the successful implementation of public-private partnership in China. In addition, the author of [144] compared his finding with a study conducted in Hong Kong on schedule delay causes in mega construction projects. This study, however, is the first to compare the top five barriers to implementation of RL in Pakistan to RL in others developing countries. In the future, this research can be expanded and improved by comparing the results with other developing or developed countries.

Table 6 presents the top five barriers of the select developing countries; and Table 7 presents a comparison of the topmost critical barriers to RL in Pakistan with Brazil, China, and India. As presented in Table 7 the top five barriers to RL for each country are marked with a $\surd$ symbol; however, the rest of the barriers are marked with this a – symbol. Table 7 also contains the individual ranking of each barrier for all countries. According to our results, only one barrier—lack of initial capital—is in the top five for three countries: Pakistan, China and India with rank 1, rank 1 and rank 5, respectively; in Brazil, it was at rank – 12. The comparative results show that "lack of initial capital" has been identified as the most critical barrier in Pakistan, China and India. In Brazil, it is identified as comparatively less important, ranked at – 12. Interestingly, the rest of the four top barriers to RL in Pakistan—lack of skilled professionals in RL, company policies against RL, lack of new technology and information system, and lack of community pressure—does not appear in the list of top five barriers in Brazil, China and India; they are ranked as (– 11, – 10, – 7), (rejected in Brazil, – 7, – 37), (– 22, – 8, – 6) and (NL) not available in Brazil, – 15, – 22), respectively. These results may be due to different economic conditions in Pakistan, as the government does not provide enough financial support for the building of reverse logistics infrastructure.

Table 6. Top five barriers of select developing countries.

Brazil [a]	China [b]	India [c]
The financial burden of tax	Lack of initial capital	Limited forecasting & planning
Limited forecasting and planning	Low commitment	Customer perception about RL
Uncertainty related to economic issues	Lack of enforceable laws and directives on take-back of end-of-life	Lack of organization personnel resources
Complexity in operation	Lack of coordination with 3PL providers	Lack of top management commitment
Lack of taxation knowledge on returned products	Lack of funds for return monitoring systems	Lack of a system to monitor returns

[a] [8]; [b] [28]; [c] [18].

Table 7. Occurrence of Pakistan's top five barriers to RL implementation in Brazil, China, and India.

Top Five Barriers to RL Implementation in Pakistan's Manufacturing Industry	Current Study	Brazil [a]	China [b]	India [c]
Lack of initial capital	√ (rank 1)	– (rank 12)	√ (rank 1)	√ (rank 5)
Lack of skilled professionals in RL	√ (rank 2)	– (rank 11)	– (rank 10)	– (rank 7)
Company policies against RL	√ (rank 3)	REJ *	– (rank 7)	– (rank 37)
Lack of new technology and information system	√ (rank 4)	– (rank 22)	– (rank 8)	– (rank 6)
Lack of community pressure	√ (rank 5)	NL **	– (rank 15)	– (rank 22)

Not listed (NL **), Rejected at the initial stage (REJ *). [a] [8]; [b] [28]; [c] [18].

Findings of a comparison between Pakistan, Brazil, China, and India identified the top five barriers to implementation of RL in the Pakistani manufacturing industry; there are four barriers that are absent from the top five barriers for Brazil, China, and India. According to our results, the most critical barriers to implementation of RL in Pakistan's manufacturing industry vary in the selected countries. Due to different economic conditions, rules, and regulations, distinctive treatment methods are required for specific barriers in different economies. However, the current study recommends that regardless of different economic conditions and geographic location, lack of initial capital highly restricts the successful implementation of RL in the Pakistani manufacturing industry. The remaining four barriers are, however, still identified as the most critical ones. Concerned authorities and policymakers should, therefore, pay more attention to the top five barriers in a bid to ensure successful implementation of RL in the country.

6. Conclusions

Change in climate, societal pressure, scarcity of resources, competitive situations, and customer awareness has helped increase the significance of reverse logistics worldwide. For environmental protection and to capture market shares, competitive industries often implement RL strategies, engage in recycling, and reuse their products to meet the expectations of their target customers. The implementation of reverse logistics is difficult in developing countries, especially in Pakistan, due to the existence of barriers. Therefore, it is necessary to provide solutions to these barriers for successful implementation of RL. This requires strong coordination among all level of employees in an organization—from a low level to top management. It is impossible to implement all solutions at the same time in the same organization; thus, there is the need to prioritize solutions to overcome the desired barriers. This study presents a significant and comprehensive framework to eradicate complicated barriers and support managerial policy on the return of used products, from the point of consumption to the point of production. By integrating DM and SEM, this study screened out a primary set of 47 barriers under eight categories to 37 barriers with the help of DM. After rigorous analysis using SEM, 35 critical barriers were extracted under eight categories.

The results of the Structural Equation Modeling identify infrastructure & technology (ITRB) as the dominant barrier category. Because Pakistan is a developing country and lacks proper infrastructure and new technology, proper implementation of RL is difficult. Local and multinational enterprises should, thus, invest in R&D to devise innovative strategies for the RL program. Moreover, outsourcing can also be helpful to deal with this barrier category. Secondly, law & regulation-related barriers category was identified as critical barriers. When compared to developed countries, inadequate laws and regulations are a major restraint in developing countries. It is the responsibility of the government to introduce new laws and regulations related to waste management. The hierarchy of severity of other barriers is as follows: financial & economic, knowledge & experience, management, environmental, market, and policy-related barriers.

The top five barriers were finally identified for Pakistan; they include lack of initial capital, lack of skilled professionals in RL, companies' policies against RL, lack of new technology and information systems and lack of community pressure. However, it is impossible to eradicate or tackle all the identified barriers in the initial stage. It is the responsibility of relevant authorities to identify barriers that pose a major hurdle to RL implementation.

7. Practical Implications and Future Research Direction

Global waste problems are alarming for the environment. With time, these issues will become more serious and require special attention. A major percentage of waste comes from EOL products, which are enough to cover landfills and pollute the environment. Thus, RL processes and operations must be implemented within organizations to reduce the impact of waste and ensure proper disposal. Enterprises and governments in Pakistan must work together for the proper implementation of proposed solutions against the critical barriers. Therefore, a broader understanding is required to understand these complicated barriers. PAK-EPA is only responsible for devising rules and regulations on environmental issues. The implementation of an RL system requires strong collaboration between political and law enforcement institutions, in a bid to take strong measures against enterprises lacking them. Pakistan is going to become a manufacturing hub because of the China-Pakistan economic corridor; unfortunately, RL is still in the early stage in the country. Therefore, long-term planning is required for effective recycling and waste management.

The implementation of RL will also help enterprises realize their corporate social responsibility toward environmental protection and motivate them to gain knowledge about improved product recovery systems. This study provides information about barriers that are affecting the operations of RL and can help decision-makers in better implementation. Uncertainties on the implementation of RL can be decreased with the help of multiple stakeholder perspectives, as possible thoughtful initiatives are taken. A mutual understanding between stakeholders must be developed on influential RL factors, because they play a vital role in the formation of holistic organizational strategies and effective implementation of RL. When enterprises are aware of the barriers, it allows them to prepare a priority list of action plans toward the implementation of RL. The findings of this study have valuable implications for enterprises, and can help a variety of RL stakeholders, including industry practitioners, academic researchers, and public decision-makers. The study does have some shortcomings, which could be addressed in further research. First, it only considered barriers to RL implementation in the manufacturing industry in Pakistan. However, the results can be used and varied in other countries, taking into consideration changes in rules and regulations, maturity level of RL, and companies' structures. Second, this study used SEM, which requires a large sample size; future research can consider MCDM methods such as AHP, ANP, DEMATEL, etc. to identify critical barriers to RL in other countries. Third, creating sustainable strategies to promote RL in developing countries can be a potential work. The negative relationship between barriers to RL and its adoption can also be examined.

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