Adoption barriers to green logistics in the Indian food industry: A circular economy perspective

Abstract

Logistics is among the leading contributors to pollution and greenhouse gas emissions and needs a paradigm shift to ensure sustainability. Green logistics is an initiative to reduce environmental, social, and economic damage, create a positive brand image and ensure customer loyalty to the firm. Even though green logistics yields many benefits, several factors often challenge its successful implementation. Thus, the study aims to identify and group the adoption barriers to green logistics in the food industry. The barriers perceived by food industry professionals were collected through a survey, and exploratory factor (EFA) analysis was applied to identify and group the most significant ones. EFA grouped the 19 significant barriers into six factors: organisational, regulatory, supplier, technological, customer, and financial. Identifying these adoption barriers can help organizations frame suitable strategies to overcome barriers in successfully implementing green logistics. The study also suggests strategies to address the barriers to green logistics in the food industry for the Indian economy. The study also highlights implications for practice and theory.

***Keywords**:* Green logistics, circular economy, Indian food industry, adoption barriers, factor analysis

1. Introduction

Logistics is a crucial enabler for the growth of any economy. An integrated logistics network can move the product from the point of origin to the point of end consumption with increased efficiency and reduced cost (Kumar et al., 2015). Activities such as transportation of freight, handling of materials, inventory storage, processing and sharing information with logistics firms involved in moving products fall under the logistics management umbrella (Maji et al., 2023). The food supply chain mainly deals with a shorter shelf life for perishable products. Therefore, efficient logistics are necessary for the on-time delivery of food products without losing quality (Mor et al., 2021a). Supply chain and logistics management in the food industry is complex due to numerous relevant criteria, such as maintaining cold-chain integrity and assuring product integrity, tight standards, and sanitary regulations. A crucial component of food quality is food safety, which aims to prevent any issues with hygiene and the harmlessness of the food that consumers ingest (Silva et al., 2016). The product's rapid perishability must

also be considered, as it impacts the storage environment, transportation, frequency and timing of orders, temperature control, packaging, origin, and traceability (Srivastava et al., 2015). As a result, more restrictions and demands are created, such as utilising transport and infrastructural facilities that provide optimum temperature control and quick loading and unloading of goods while addressing consumer demands, managing inventory and store shelves, and assuring a constant supply of goods (Alho et al., 2017). Transportation and logistics are primary sources that degrade environmental quality (Barut et al., 2022; Sharma et al., 2023). Recent studies showed that 25% of carbon emissions worldwide are from transportation alone (Larina et al., 2021). By 2050, carbon emissions from transportation will increase by 60% (Mohsin et al., 2022). Logistics can also lead to resource wastages like using low-efficient fuel vehicles and inappropriate distribution, planning and implementation (Chunguang et al., 2008). Green logistics was introduced to develop a sustainable logistics network and reduce carbon footprint, reducing greenhouse emissions and ensuring a green supply chain without compromising logistical efficiency from raw material procurement to inbound and outbound logistics stages (De Souza et al., 2022; Hassan et al., 2012). In addition to that, by understanding increased social interest in the sustainable supply chain, global logistics operators like Dalsey, Hillblom and Lynn (DHL), Hennes & Mauritz (H&M) came forward with a strategy to reduce a significant percentage of their carbon emissions shortly, for creating a positive climate environment (DHL, 2020; H&M, 2020). Other drivers for green logistics could include regulatory pressure from the government and customer preferences for greener products (Simm, 2021).

Green logistics helps achieve circular economy requirements of social, ecological, and economic efficiency (Mor et al., 2021b; Shi, 2016). Pannirselvan et al. (2016) defined green logistics as all operations involving the eco-efficient management of products and information flows between the point of origin and consumption to fulfil customer demands. The existing literature on green logistics discusses its components, drivers, and barriers (Kumar, 2015). Previous studies have explored barriers to green logistics in the Malaysian food industry, Indian chemical industry, Indian mining industry, Indian construction industry, and Ethiopian leather industry (Bala et al., 2021; Abebaw et al., 2019; Gardas et al., 2019; Mor et al., 2018; Barve & Muduli, 2013). Even though green logistics has many social, economic, and environmental benefits, organizations often find it challenging to implement. Yet, only a few studies address the barriers to green logistics in the Indian food industry and the means to address these barriers. Therefore, various studies have highlighted the need to explore this theme further (Trivellas et

al., 2020; Rahman et al., 2019; Fen et al., 2020). research gap is the motivation and objective of the study. Thus, this study aims to answer the following research question (RQ):
RQ1: What barriers do the food industry stakeholders perceive towards adopting green logistics practices?

The study adopted a quantitative approach involving data collection through an online questionnaire to answer the research question. The data was collected from various Indian food industry professionals to identify barriers to green logistics in the Indian food industry. Exploratory factor analysis was adopted to analyse the collected data. The contributions of this study are manifold and include the following: From a theoretical lens, the study identifies barriers to the adoption of green logistics from a combination of a comprehensive literature review and perspective stakeholders from Indian food industries. The study has also suggested strategies to address the barriers to the efficient adoption of green logistics. The study also contributes substantially to the existing literature on green logistics in emerging economies by reviewing the extant literature and identifying the challenging factors in implementing green logistics in the Indian food industry. The paper's organisation is as follows: section two deals with the literature review of green logistics and adoption barriers for green logistics in the food industry. Section three depicts the detailed research methodology adopted in the study, and the analysis of results is highlighted in section four. The study outcomes and conclusion are discussed in the remaining sections.

2. Literature Review

The literature review suggests various barriers to green logistics in the food industry (Mangla et al., 2019; Bag et al., 2020; Yadav et al., 2020). Firstly, key search terms, such as green logistics, green supply chain, green supply chain management, circular economy, reverse logistics, barriers/challenges of green logistics, and the food industry, were identified to address the search criterion. The terms were combined to search articles such as green logistics AND reverse logistics AND circular economy AND food industry; challenges OR barriers AND green logistics AND food industry; green supply chain management AND barrier OR challenges AND food industry. The major research databases utilised for the search were Scopus, besides ScienceDirect; Emerald Insight; Wiley Online Library; Taylor & Francis; and Springer Link. Articles focusing on barriers/challenges of green logistics in the food industry were the inclusion criteria for the search from 2010 to 2022. The study collected journal articles using the above review protocol. Accordingly, a thorough analysis of the selected research articles is discussed in the following sub-sections.

2.1 Green Logistics

Green logistic activities are expanding globally and are critical for organisational growth and competitiveness (Yingfei et al., 2022). Activities like green logistics could reduce the harmful effects of environmental pollution and create a sustainable environment (Ren et al., 2020; Liu and Ma, 2022). The various adverse effects of conventional logistics include pollution, accidents, resource wastage, infrastructure failure, noise, etc. These disadvantages can result in reduced supply chain performance at both organizational and regional levels (Chen et al., 2017). It can be considered a strategy or supply chain management process that concentrates on material handling, waste management, packaging, and transport to reduce the carbon footprint of freight distribution (Mesjasz-Lech, 2011). Green logistics is producing and distributing goods and services in an eco-friendly manner without compromising social and economic values. Green logistics can be defined as the production and distribution of goods considering environmental and social factors (Bozhanova et al., 2022). The environmental, economic, and social objectives of sustainable development are evident in green logistics (Kumar, 2015). Green logistics includes four main components: green purchasing, green manufacturing, green distribution, and reverse logistics. Every action to reduce the carbon footprint counts, no matter how many stages the firm is implementing green strategies (Manjunath, 2014).

2.1.1 Green purchasing

Green purchasing, also known as green procurement, tries to reduce the negative impact of a product over its lifecycle by reducing, reusing, and recycling materials in the process of purchasing (Manjunath, 2014). The typical 3R principle is vital in green purchasing. Green purchasing significantly influences a firm’s pollution control system and environmental and quality standards (Chan & Lau, 2002). The cost of purchasing eco-friendly materials is essential in implementing a green supply chain. Supplier selection is crucial for the successful implementation of green purchasing. Some critical factors governing supplier selection are environmental commitment, compliance with legal requirements, expenses for disposing of harmful wastes, etc. (Teixeira et al., 2018). A firm's performance is improved by implementing green purchasing, and lasting operating performance is observed when an organization establishes a long-term relationship with a supplier (Gonzales-Benito et al., 2016).

2.1.2 Green manufacturing

Green manufacturing is a modern mode of manufacturing that tries to reduce adverse environmental effects and the consumption of resources. This manufacturing method results in

high utilization of resources throughout the product life cycle from production design to reuse. Besides economic benefits, green manufacturing also ensures various social benefits (Tao & Zhao, 2016). It is a process in which the raw material, cost, energy, and process are minimized to reduce waste and pollution while satisfying customer demands (Setyaningsih et al., 2019). It includes methods like environment management tools, sustainable manufacturing, sustainable green operations, green supply chain management, and green application (Paul et al., 2014). Motivated by environmental disasters, sustainability achieved strength and aims to reduce the harmful impacts of manufacturing through sustainable manufacturing operations, considering broader environmental and socio-economic systems (Diaz-Elsayed et al., 2013). At the same time, green application includes using renewable sources for fuel, water purification, air purification, and energy conservation for a better environment (Paul et al., 2014).

2.1.3 Green distribution

Green distribution means transporting goods and services from the source to the end customer through an eco-friendly channel. The main objective of green distribution is to create a healthy environment by adopting practices that reduce carbon dioxide without adding extra costs to the distribution process (Mwaura et al., 2016). It promotes using eco-friendly, lightweight, recyclable, reusable materials for packaging so that greenhouse gas emissions and fossil fuel usage can be reduced to a certain extent (Siracusa & Rosa, 2018). Conventional distribution network adds up cost like replacement cost, environmental degradation, externalities, etc., which negatively affect the performance of firms (Angela & Thomas, 2012). The overall profitability of a firm may improve by adopting green distribution strategies. This will result in a better customer experience and supply chain cost (Chin et al., 2015).

2.1.4 Reverse logistics

The terms reverse and green logistics are often confusing as they are used interchangeably in some scenarios, but reverse logistics is a part of green logistics. Reverse logistics is organising, executing, and monitoring the cost-effective flow of raw materials, inventory during production, finished goods and related data from the point of consumption to the origin to recover the value of proper disposal (Rogers and Tibben-Lembke, 1999). Recycling and material distribution in reverse and lowering the volume of materials in the forward system are all included in reverse logistics (Carter and Ellram,1998). Reverse logistics is focused on economic sustainability, while green logistics is more concerned about environmental sustainability without compromising social and economic benefits (Scott et al., 2011). Reusing

or recycling is vital to save money and increase value in reverse logistics. Reverse logistics can be considered a part of green logistics for reduced waste and resources (Seroka-Stolka, 2014).

2.2 Green logistics and Indian food industry

The Indian food industries are steadily growing in today's global economic marketplace. The rising global population rate has made it more difficult for food industries to maintain sustainable food production, distribution, safety, and quality (Govindan et al., 2017). Adopting green logistics to achieve sustainability in the food supply chains (Chhabra & Singh, 2022). Green logistics was introduced to develop a sustainable logistics network to ensure green supply chains (De Souza et al., 2022). Trivellas et al. (2020) defined green logistics as an organisation's activity that considers environmental issues and integrates them into supply chain management to improve the environmental performance of suppliers and customers. The goal of green logistics is to reduce the negative effects of the transportation and distribution of commodities on the environment (Liu and Ma, 2022). Green logistics is essential for the food industries to lower carbon emissions, conserve resources and promote sustainability. It helps achieve three sustainability dimensions: environmental, economic, and social. Customer satisfaction, better relationships with stakeholders, increased delivery reliability and financial performance, etc., are key economic-sustainability benefits of green logistics (Muduli et al., 2021; Kumar, 2015).

Gardas et al. (2018) used interpretive structural modelling to model the crucial performance indicators of green supply chain management (GSCM) in the agricultural supply chain. The study found factors, namely, environmental management, regulatory pressure and competitive pressure, were the most significant factors. Ayoubi et al. (2023) used structural equation modelling to assess the ability of GSCM to mitigate the risks of the food industry, which affects environmental health. The study found a positive relationship between environmental health and green purchasing, cooperation, eco-designing, and internal environmental management. Mathiyazhagan et al. (2014) used the analytic hierarchy process technique to identify the factors responsible for GSCM adoption in various Indian manufacturing industries, including food industries. The study concluded that customer demand for environmental protection requirements is essential for GSCM adoption.

2.3 Impact of green logistics on sustainability

Governments and organizations emphasise eco-friendly business operations for the activities that threaten the environment, including industrial pollution, toxic waste, greenhouse gas emissions, waste disposal, etc., and green logistics is an initiative to ensure sustainability (Ashfaq, 2020). Specifically, adopting Sustainable Development Goals (SDGs) promotes

organisational operationalization and integration of sustainability. It provides a sustainable future while balancing economic, social, and environmental development. Green logistics mainly relates to SDG 12 (Responsible consumption and production) and SDG 9 (Industry, innovation, and infrastructure). Simultaneously, impacting SDG 13 (Climate action), SDG 14 (Life below water), and SDG 15 (Life on land) (Fonseca et al., 2020). The transport and logistics industries account for 25 to 30% of greenhouse gas emissions, which causes adverse effects on the environment and human health (Rodrigue, 2017). International Energy Agency (IEA) highlighted that the transportation sector causes 23% of carbon emissions and is considered one of the primary sources of air pollution (Khan, 2019). Green logistics practices like Eco-friendly design of products, green purchasing, green transportation, etc., result in positive environmental benefits. These benefits include reduced waste, air pollution, and greenhouse gas emissions (Khan et al., 2016). Environmental sustainability and logistic activities are negatively related due to carbon emissions and other forms of pollution along the supply chain from logistical operations (Khan, 2019; Tian et al., 2023). Adopting green logistics to tackle this negative effect adds extra cost. For example, logistics activities like green purchasing incur additional expenses like import duties and duties for green materials. As a result, the firm's profitability is negatively affected (Khan et al., 2016). A study by Khan and Dong (2017) revealed that green practices increase customer satisfaction and trust, thus improving the firm's economic performance.

2.4 Green logistics as a prerequisite for circular economy

Green logistics promotes sustainability and is an essential prerequisite for developing a circular economy (Zhou et al., 2023). Reducing greenhouse gases and minimizing waste generation are a circular economy's main objectives (Seroka-Stolka & Ociepa-Kubicka, 2019). The circular economy aims to balance the performance of the economy and environment by using cutting-edge approaches to handle the interaction between business and the environment. It strives to enhance total sustainable production and consumption using closed loops, regenerative and restorative physical and economic cycles, and a combination of maintenance, repair, reuse, refurbishment, remanufacturing, and recycling activities (Fonseca et al., 2018; Ellen MacArthur Foundation 2014). Rational use of resources at all stages of a product lifecycle, cleaner manufacturing, sustainable supply chain, 3R (Reduce, reuse, and recycle) principles, and green supply chain are some of the underlying concepts of the circular economy. Reduction of industrial inputs like energy and resources, the substitution of energy for manpower, etc., were the first ideas of a circular economy dating back to the 1970s (Stahel, 2016). The increased population threatens the natural resources and environment, which motivates the circular

economy to play its role in sustainable production (Arruda et al., 2021; Cheng et al., 2023). In literature, many definitions exist for the circular economy (Korhonen et al., 2018). Kirchherr et al. (2017) defined it as the essence of sustainability. Achieving economic prosperity through environmental quality is the main objective of the circular economy. It is a holistic approach to waste-free production, services and consumption to minimise energy consumption and save natural resources (Seroka-Stolka & Ociepa-Kubicka, 2019). There are three levels to implementing a circular economy, i.e., ecoregions, eco-industrial parks, and eco-enterprises. The 3R circular economy principle demands a closed logistics loop involving resources and the environment (Shi, 2016). Green packaging, transportation, environment-friendly storage and processing flow are important green logistics activities that ensure the firms' circular economy concept (Seroka-Stolka & Ociepa-Kubicka, 2019). The circular economy is the paradigm shift in development that focuses on economic growth and tries to lessen the negative impact of a firm's activities on the environment. Green logistics is essential for a circular economy since most of the time is dedicated to logistical processes rather than manufacturing activities (Shi, 2016).

2.5 Adoption barriers

Even though green logistics yields various environmental, economic, and social benefits, various barriers often challenge the implementation of green logistics. Literature reveals multiple studies analysing the barriers to green logistics. This section identifies and briefly describes adoption barriers to green logistics. In research conducted by Fen (2020) and Kumar and Kumar (2020), the 'lack of commitment from top management' is a barrier to adopting green logistics. The lack of interest in sustainable processes or commitment from management may result in poor adoption of green logistics activities (Patel and Desai, 2019). Commitment, guidance, support, and leadership from top management are required to build an eco-friendly organisation (Anass and Said, 2017). Another barrier was the 'poor cooperation between departments', which discusses that employees, irrespective of the department, must be aware of the final goals and strategies to successfully implement green strategies (Wyawahare and Udawatta, 2018). Additionally, the 'lack of training' was a barrier to adopting green logistics (Meager et al. 2020). Employees mainly deal with various stages of procurement, production, processing, transportation within the supply chain, etc. It is essential to provide training and knowledge to employees regarding green practices, as a lack of knowledge is an obstacle to adopting green strategies (Wyawahare & Udawatta, 2018). Similarly, 'inadequate knowledge and experience in green logistics' was a point of resistance to adoption (Kaur and Awasthi,

2018). It was found that professionals lack the expertise to manage green practices and initiatives in organisations due to a lack of knowledge of green supply chain management (Fen, 2020). The 'non-availability of green practitioners' could be another significant barrier. Implementing green logistics requires expert professionals like green architects, consultants, contractors, etc., with hands-on experience and knowledge in green practices (Mangla et al. (2017).

Waqas et al. (2021) identified a 'lack of proper rules and regulations' as a barrier to green logistics adoption. Government regulations regarding eco-friendly policies are not rigorous enough to make industries follow the regulations—lack recognition for an organisation that successfully implements green practices. These often fail to appreciate firms' efforts in implementing green practices. Similarly, Anass and Said (2017) & Kaur and Awasthi (2018) identified 'poor support and guidance from the authorities, and dynamic changes in rules and regulations due to the changing political climate' could also affect. The bodies fail to support organisations in maintaining a green environment properly. It is essential to introduce friendly green laws and reward systems for practitioners to stimulate adoption. Also, the dynamic changes in the political climate often led to changes in laws and regulations for various operations. These barriers include 'lack of supplier commitment' (Fen et al., 2020), 'lack of coordination' between supplier and vendor (Mudgal et al., 2010), and 'unwillingness of suppliers' to exchange information (Ojo et al., 2014). Supplier commitment is essential as products and services should have minimum adverse environmental harm; therefore, fully committed environmental suppliers are necessary. Coordination between supplier and vendor is necessary as efficient supply chain integration is possible by adequately coordinating the vendor and supplier. It is essential to share and update information between vendor and supplier for better effectiveness and efficiency of the adoption process.

Also, Kaur & Awasthi (2018) and Wyawahare & Udawatta (2018) highlighted 'difficulty in maintaining, monitoring, and measuring supplier performance' as one of the barriers. Measurement of supplier performance acts as a barrier due to the complexities in measuring and monitoring the environmental practices of suppliers, as it requires additional time and effort. Kaur et al. (2018) identified the 'lack of a training/reward system' for suppliers as a barrier to green logistic adoption. A proper training system can help the suppliers understand how to reduce carbon emissions without compromising the quality of the supplies. If the firms recognise and award their activities, they will feel motivated to be consistent in eco-friendly actions. Dashore & Sohani (2013) and Khushbu (2014) suggest that 'unwillingness to accept new technology' is a significant barrier as new technologies require

continuous up-gradation to match up with greener perspectives and different technologies for every green practice/initiative often make it difficult to adopt green logistics. Since green logistics demands effective research and development for modifying and developing existing processes, Xia et al. (2015) found the 'lack of research & development capacity' as a barrier. Govindan et al. (2014) and Balasubramanian (2012) found 'design complexity to reduce/reuse /recycle' the used products as a barrier as developing new energy-efficient reuse and recycling technologies is often complicated. Lack of customer awareness (Alzawawi, 2013), Lack of environmentally responsible customers (Govindan et al., 2014) and Lack of public participation/commitment (Khushbu, 2014) were identified as significant barriers as customers are primarily unaware of green products and their benefits. Also, customers often think sustainability issues are the responsibility of manufacturers alone and are least bothered about the environment. Customer support is vital in satisfying customers, resolving complaints, and creating a brand image, especially for a new concept like green logistics; Kaufmann et al. (2012) argued the 'absence of effective customer support' as a barrier to adopting green logistics. Ojo et al. (2014) found 'insufficient social pressure and customer demand for greener products' as barriers. The demand for greener products can push organisations to change or adopt greener technologies and initiatives.

Further, 'high initial investment' (Gioconda et al., 2011) and 'unavailability of financial resources' (Jayant and Azhar, 2014; Li et al., 2015) are barriers to green logistics adoption. Implementing green logistics requires various practices like green design, manufacturing and packaging, etc.; thus, adopting new technologies and systems is often expensive. There is a lack of financial resources, and obtaining bank financing is difficult. Similarly, the barrier of 'high unit cost of production' for greener products compared to conventional products needs research and development, additional expenses for sustainable packaging material, new technologies, etc., and influences the price hike (Ullah & Iqbal 2021). The 'cost of collecting and recycling the used products' considers the high-cost requirements for initial investment, monitoring systems, etc. As a result, the collection and recycling of used products are often expensive (Govindan et al. (2014); Waqas et al., 2018).

3. Methodology

The present study explores the adoption barriers of green logistics for the food industry. Based on the literature review protocol, adoption barriers related to green logistics were determined. These barriers were finalized with the help of experts in the industry and academia. The identified barriers were further analysed using exploratory factor analysis (EFA). EFA is a

technique that reduces and summarises data to a more manageable size (Schreiber, 2021). Figure 1 presents the methodology followed.

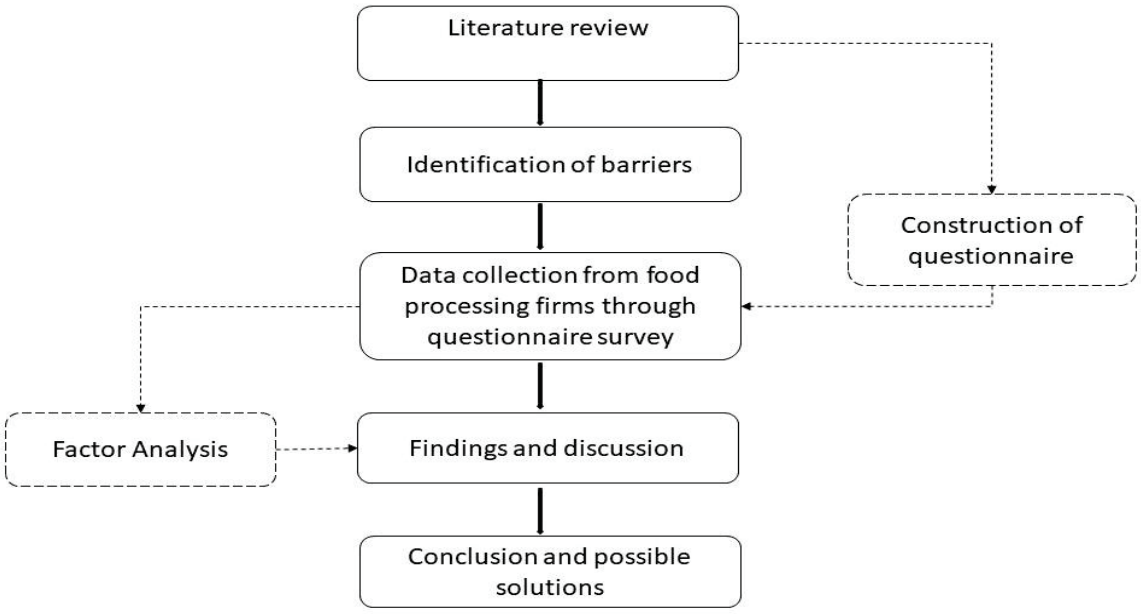

Figure 1. Methodology

3.1 Data collection

The study aims to identify the adoption barriers to green logistics in the food industry. Initially, 31 barriers were identified through a literature review, out of which five were removed due to their repetitive nature. A structured questionnaire was developed based on the 26 barriers identified. The study employed a questionnaire survey as a data collection approach. The survey approach helped deal with geographic distances by saving time and expenses (Kamble et al., 2019). The questionnaire was divided into two sections. The first section consists of demographic information, i.e., name, email, name of the organization, location of the firm, etc., and was collected for reliability purposes of the data. In the second section, the respondents were asked to rate barriers according to their understanding and experience. A five-point Likert scale was used to rank the barriers from 1, indicating a less critical challenge, to 5, showing a critical challenge. The survey questionnaire was shared via email with professionals in the Indian food industry. The survey was floated among various Alumina databases of food and agricultural universities, assuming respondents from these universities would be aware of the adoption barriers of green logistics in the food industry. Respondents were selected based on their knowledge and awareness of green logistics in the food industry to ensure the content validity of the survey. Initially, the questionnaire was shared with 300 respondents. The total

number of responses collected was 103, out of which five were removed due to incomplete information. Finally, 98 responses were considered for analysis.

4. Analysis and Findings

The data collected from the survey were subjected to principal component analysis (PCA) with varimax rotation for grouping the significant barriers. Factor analysis was carried out using the SPSS 25.0 version. The sample adequacy was good because the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was obtained as 0.833 (Table 2). A KMO value between 0.8 and 0.9 represents a significant level of sample acceptance.

Table 2. KMO and Bartlett's Test

Kaiser-Meyer-Olkin measure of sampling Adequacy		.833
Bartlett's Test of Sphericity	Approx. Chi-Square	1123.084
	df	325
	Sig.	.000

A satisfactory correlation between the population's attributes was obtained as Bartlett's sphericity test was highly significant. The commonality value for each challenge was 0.45 or higher. Factor analysis revealed that out of the 26 items, 19 were grouped under six factors, and seven were found insignificant based on the eigenvalue. All the factor loadings are greater than 0.45 and lie between 0.470- 0.810; this shows a strong relationship between the items and components. The mean and standard deviation of all items were also calculated. The six factors together account for 61.46% of the total variance in which organizational barriers account for 12.731 %; regulatory barriers account for 12.121 %, supplier barriers account for 10.648%, technological barriers account for 9.78 %, customer barriers account for 8.13 %, financial barriers account for 8.05% of the total variance (Table 3).

5. Discussion

The major barriers to implementing green logistics are discussed in the sub-sections below.

5.1 Organizational barrier

Organizational barriers are crucial in implementing green logistics (Galvão et al., 2018; Rizos et al., 2015). Adopting green logistics is successful only with proper commitment and coordination of top management. The top management should be focused and formulate strategies to implement green logistics successfully. Implementing green logistics requires the firm's extra effort, resources, and time. This demotivates the firm to implement green practices. Even after overcoming all these barriers to implementation, other barriers like cooperation

between departments also arise. Green logistics requires proper communication and coordination at all levels of an organization, and sustainability isn't possible in isolation. The environmental goals and strategies of the organization must be known to everyone so that all employees can work towards a common goal. Similarly, Kalpande and Toke (2020) concluded that poor commitment from top management is a prominent barrier to green supply chain management in the Indian food/beverage manufacturing industries.

5.2 Regulatory Barriers

The government is the most powerful stakeholder in green logistics and can strictly enforce laws to ensure sustainability throughout the supply chains. Even when environmental initiatives are rising, the supply chain is often overlooked. Lieder and Rashid (2020) highlighted the crucial role of government in achieving a circular economy. The first challenge under regulatory barriers is the lack of proper rules and regulations. The authorities often lag in formulating and implementing strict laws and environmental certifications like ISO 14001. Organizations usually only adopt the standards they are supposed to follow and lack the inner motivation to follow sustainable practices that are not enforced by laws. Organizations not into sustainability also find no extra benefits in investing resources in sustainability. Long-term sustainability will help protect the planet, and the government should provide proper support and guidance. This support can be in the form of incentives, schemes to encourage environmental action, subsidies, motivating customers to buy green products, etc. Awareness and training programs in green supply chain management are also good initiatives from the government. Such support and guidance are lacking, and political changes also negatively influence organizations regarding frequent changes in laws and regulations. Similarly, the study by Liu et al. (2021) and Bai and Satir (2020) concluded that weak enforcement of environmental regulations is a crucial barrier for food supply chains from a circular economy perspective.

Table 3. Exploratory Factor Analysis

Factor(s)	Items	Commonality	Factor Loadings						Measurement on a five-point Likert scale		Overall score of factors	
			F1	F2	F3	F4	F5	F6	Mean	SD	Mean	SD
Organizational Barriers												
F1	Lack of commitment from top-level management	0.701	0.810						3.653	1.149	3.546	1.072
	Lack of cooperation between departments	0.674	0.769						3.439	0.996		
Regulatory Barriers												
F2	Lack of proper rules and regulations	0.604		0.665					3.816	0.956	3.737	0.977
	Lack of recognition for an organization which successfully implements green practices	0.615		0.684					3.673	0.917		
	Poor support and guidance from the government	0.638		0.738					3.796	0.984		
	Dynamic changes in rules and regulations due to changing political climate	0.596		0.543					3.663	1.05		
Supplier Barriers												
F3	Lack of commitment from suppliers	0.646			0.481				3.745	0.956	3.661	0.96
	Lack of coordination between supplier and vendor	0.627			0.719				3.694	0.842		
	Difficulty in maintaining, monitoring & measuring the performance of suppliers	0.699			0.764				3.653	0.932		
	Unwillingness of suppliers to exchange information	0.680			0.470				3.551	1.037		

	Lack of training/reward system for the supplier	0.636	0.670			3.663	1.035		
Technological Barriers									
F4	Unwillingness to accept new technology	0.653	0.654			3.561	1.026	3.667	0.997
	Lack of research & development capacity	0.540	0.464			3.776	0.969		
Customer Barriers									
F5	Lack of customer awareness	0.656		0.739		3.776	0.936	3.697	0.932
	Lack of environmentally responsible customers	0.694		0.715		3.684	0.926		
	Absence of effective customer support	0.637		0.629		3.633	0.935		
Financial Barriers									
F6	High initial investment	0.658			0.769	4.133	1.012	4.037	0.907
	High unit cost of production for greener products compared to conventional products	0.663			0.742	4.020	0.861		
	The cost involved in the collection and recycling of used products	0.696			0.749	3.959	0.849		

Notes *- Extraction Method: Principal component analysis; Rotation method: Varimax with Kaiser normalization; F1-F6 represents individual factors*

5.3 Supplier Barriers

The supplier is one of the critical actors in the supply chain and is crucial for the efficiency and effectiveness of the whole process. Proper commitment from the supplier is essential when we try to incorporate sustainability into the supply chain. Suppliers mainly lack interest in integrating sustainability into their operations. Lack of awareness, knowledge, training, new technology requirements, etc., makes suppliers reluctant to adopt green practices. The organization also has a significant demotivating role, like they often do not coordinate well about the requirements on time. Even if a supplier is following green practices, firms usually do not put effort into appreciating the supplier for his performance. But a long-term successful relationship with a supplier is very much beneficial for a firm. As a result of numerous factors like these, suppliers often show less commitment to adopting eco-friendly actions. The need for environmentally responsible suppliers and their role and impact in implementing green logistics and circular economy is also discussed by De Souza et al. (2022). Agyemang et al. (2018) also found that poor supplier commitment between organizations impedes adopting green supply chain management in the emerging economy for the cashew supply chain.

5.4 Technological Barriers

Even though green logistics is not a new concept, the successful implementation of green logistics requires the design and development of existing and new technology. Any initiatives that can reduce carbon footprint can be considered green; therefore, a new technology that is more efficient than the old can also be a part of green technologies. The technologies with increased efficiency, effectiveness, reduced wastage, etc., can all be included under green initiatives. Green logistics involves incorporating technology at various stages and developing a sustainable supply chain. Adopting new technology demands trained and skilled individuals, extra time and effort for training, additional expenses incurred for designing and developing the new system, etc. Technology design, redesign, development, updating, etc., requires adequate research and development. Organizations must be more dedicated to making their existing products and processes greener. Many technologies specifically for circular economy and green logistics are still not developed into a marketable form. Rahmen et al. (2019) concluded that insufficient technology and infrastructure in manufacturing processes lead to more significant hazards and energy losses. Thus, technological inventions play a vital role in adopting green practices in supply chains from an emerging economy perspective. Lack of adequate testing and trials, practical application in daily operations, etc., make technological integration difficult (Takacs et al., 2022).

5.5 Customer Barriers

Customers can exert both a positive and negative influence on sustainability. If the customers demand green products, organizations do not have any other options and must make the products and processes greener to satisfy customer demand. Organizations fear loss if consumers do not demand or purchase greener products. So, green logistics' ultimate success and failure depend mainly on customer attitude and perception. A positive attitude can boost the sales of green products, while a negative attitude will demotivate organizations to adopt green practices. Many customers are unaware of their influence in making the planet safe. Customers mainly focus on the price they want to satisfy their demands at the lowest possible cost without compromising quality. Many customers are ready to pay for brand value but not for a green product. The lack of awareness about green products, processes, benefits, etc., is a critical barrier to adopting green practices. Another significant challenge is that customers think that only organizations are responsible for embracing sustainability and that customers do not have any role in it. The indisputable fact is that customers should be the main driving forces for organizations to change their activities, ensuring less environmental damage. Green product is a new concept for customers; therefore, the organisation should have adequate customer care support to help the customers clear their confusion. However, good customer care support for greener products is lacking. Lack of customer awareness, interest and knowledge makes customers unwilling to pay for a circular economy (Takacs et al., 2022). Wang et al. (2016) also concluded that poor customer awareness is a significant barrier to implementing green supply chain management in the Indian food packaging industry.

5.6 Financial Barriers

Green logistics is in the emergent stage at many organizations, and adopting green practices requires the latest technologies, changes in production processes, new raw materials, training for employees, research and development, and many more. These activities require capital for their implementation. A shift to sustainability demands additional resources, adding up the cost required for production. Greener products require comparatively expensive raw materials, processes, and transportation methods since carbon footprints are considered. Another important challenge lies in reverse logistics. Reverse logistics is an essential component of green logistics. The products must be returned from the customer after use and recycled. This is also one of the critical areas that make green logistics expensive. Respondents consider the financial barrier as more critical than other barrier groups. Hina et al. (2022) and Tumpa et al. (2019) found financial constraints as the main barrier to adopting green supply chain

management in an emerging economy. The financial barrier should be considered vital in green logistics and circular economy implementation, and collaboration between all stakeholders is necessary to overcome this challenge.

5.7 Implementation strategies for green logistics

Various barriers, viz. organizational, technological, customer, supplier, regulatory, and financial, shall be removed to implement green logistics successfully. The success of sustainable practices requires proper coordination and commitment from all stakeholders. The strategies should consider all the actions along the supply chain to make the carbon footprint minimum. The top management should develop a commitment and motivation to adopt green practices. Sustainability should not be a choice but a requirement. The government has a significant role in making firms adopt greener practices. Stringent laws, regulations, and environmental compliances will create external pressure on the organization to practice green activities. The government can generate awareness through media and appreciate organizations implementing green logistics. A positive brand image will motivate the organization to be consistent in eco-friendly actions. Incentives, schemes, financial support for sustainability, etc., will also help many organizations enter the sustainability field. The green strategies developed by the organization should be communicated to all levels of the organization so that every employee will know the goal they want to achieve. This will help to have a well-directed action and avoid confusion. Interdepartmental cooperation should be ensured for availing help during the action plan. Employees should be given training in new technologies, processes, etc., to work well in the new system.

Utilization of environmentally friendly raw materials, design of products and processes with reduced energy consumption, waste reduction, emissions, scrap sale, etc., are some strategies that can be implemented at the organisational level. Incorporating technology to make products and processes efficient and reduce energy consumption is essential for implementing green logistics. Skilled professionals can be hired to develop and supervise respective fields. The new technological interventions should be familiarized to employees through proper training sessions. The environmental requirements of the purchased materials should be communicated with the supplier, and firms should adequately coordinate with the supplier for a successful implementation of green procurement. If required, provide the necessary training for building supplier environmental management capacity. There should be proper tracking and monitoring systems for measuring environmental performance. The organization must try to develop a long-term relationship with the environmental supplier.

Better modes of transportation, i.e., using alternate fuels for reducing emissions, optimising the scheduling of trucks, etc., are some strategies that can be incorporated during transportation. Customer demand is an important factor in driving the successful implementation of sustainability. Organisations must automatically opt for sustainable production methods if customers demand greener products, and awareness is necessary. Green logistics can be improved further by implementing cutting-edge business excellence models like EFQM 2020 (European Foundation of Quality Management), which is based on the relationship between an organization's mission and strategy and is in line with the SDGs of the United Nations. This model can assist an organization in assuring transition while delivering performance, producing long-lasting value for its key stakeholders and achieving exceptional outcomes (Fonseca, 2021; Murthy et al., 2021).

Green logistics can also be supported by the adoption of logistics 4.0 (Emerging Industry 4.0 digital technologies like the internet-of-things, autonomous vehicles, automated guided vehicles, artificial intelligence, blockchain, cloud computing, augmented reality, additive manufacturing, advanced robotics, and electronic/mobile marketplace (Das et al., 2023; Krstić et al., 2022). Customers must be aware of the possibilities of recycling and the role of customers in waste segregation. It's essential to take care of successfully implementing green logistics in practice. The government should devise supportive initiatives for green logistics through financial support, schemes, Greener Organization Awards, etc., for promoting greener activities. This would encourage organizations to adopt green strategies. Research and development towards green technologies need strengthening and energy-efficient techniques for efficient management and utilization of resources. Using biofuels reduces the number of distribution trips by ensuring transportation with total capacity is one way the logistical network can be greener. Further, lifecycle assessment-based effective policies and standards, supporting circular products, circular start-up models, and social awareness could help manage circularity in business operations. (Hartley et al., 2020; Henry & Kirchherr, 2020).

6. Implications for practice and theory

The study has various implications for managers. Managers are responsible for implementing changes and monitoring an organization's progress. The increased population and environmental damage always call for a production system with less ecological damage. Management should implement green strategies at various stages of logistics due to the alarming greenhouse emission rate in the logistics sector. Formulating strategies requires a clear understanding of the problems, their severity, and their probable impacts. This study

identified various barriers to implementing green logistics and their consequences. This research can help managers acquire knowledge of the barriers specific to the Indian food industry. Management can develop strategies focusing on identified six factors to reduce the impacts of adoption barriers. The study also highlighted the critical stakeholders in the implementation of green logistics. Everyone must know their goal, from the suppliers to the distributors and the firm's employees. Managers should be able to communicate their plan and mode of operations along and across different levels of the organization. Successful implementation of green logistics requires committed and skilful managers who can adequately lead the organization towards sustainability. This study can help managers enhance their wisdom and knowledge and act as a guide in formulating and implementing strategies. This study derived various barriers to green logistics and their influence in the food industry for emerging economies like India.

The circulation of green matter is an essential aspect of the circular economy, and green logistics can be considered as a means for the same. Economic prosperity cannot be achieved sustainably if there exist factors that affect environmental quality. Therefore, barriers interfering with green logistics directly impact the circular economy. These six factors directly hinder the circular economy and should be managed effectively to obtain a circular economy. The strategies adopted to overcome the barriers in green logistics help close the circular economy loop. Regarding theoretical contribution, the study offers various implications for researchers and academicians. There are studies on basic concepts of green logistics; however, there is a gap in the literature on studies related to barriers to green logistics in the Indian food industry. This study tried to identify and categorize those barriers, particularly in the Indian food industry. The results classified the barriers into six factors based on factor loading. The six factors are organizational, regulatory, supplier, technological, customer, and financial barriers. This study can help the organization have a proper understanding of these barriers.

A detailed study of individual barriers and their impact on green logistics will help firms formulate strategies to overcome barriers. Successful execution of green logistics in firms can result in social, economic, and environmental benefits. The major environmental benefits are reduced greenhouse gas emissions, pollution, energy consumption, etc. Apart from all these benefits, it will create a positive brand image for organizations implementing green logistics. Long-term consistency in sustainability can help our planet to remain safe to live. Thus, the study can positively impact both the environment and the firm. Also, this study will help researchers enhance their knowledge of green logistics and circular economy.

7. Conclusion

Sustainability is a concerning topic, and logistics is one of the critical sources affecting the environment, thus emphasizing transforming firms' logistics operations into greener. Green logistics is one of the crucial solutions for making the supply chain eco-friendly and can be implemented at various supply chain stages, from procurement to the end customer. The activities that try to lessen harmful environmental impact can be considered green. However, implementing green logistics requires the coordination of all stakeholders, and there exist many hurdles to successfully implementing green logistics. In line with this, the study aims to address the research gap by exploring the adoption barriers of green logistics in the food industry. Barriers to implementing green logistics were identified from the literature and measured on a Likert scale. Twenty-six items were considered for the factor analysis.

The data collected was then subjected to exploratory factor analysis on SPSS 25.0 software. The Bartlett test of the sphericity of each item was conducted to confirm the applicability of the factor structure, and the KMO value confirmed the appropriateness of the sampling. To further confirm the EFA, the communalities for each item were examined. Using SPSS software, EFA was carried out using a PCA approach and varimax rotation. It revealed all the values were within acceptable ranges. The factor analysis reduced 26 items into six factors, namely, organizational, regulatory, supplier, technological, customer, and financial barriers, which accounts for a total variance of 61.46%. These findings can be generalised for other developing nations and various food industry sectors depending upon the requirements and resource availability.

The study has a few limitations; the literature on the adoption barriers of green logistics for the Indian food industry is limited. Thus, future studies can further extend the context of this research with a higher number of responses from professionals in the food industry. Future studies could replicate the analysis further by utilising rigorous statistical tools for other countries. A similar study can be conducted for specific food products and supply chains, and individual barriers' impact could also be studied. A comparative analysis could assist the generalizability of the study results.

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