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Decisive Drivers Contributing towards Modern Last Mile Delivery Operations: A Qualitative Analysis using ISM

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Abstract
This research article investigates the drivers of logistics management for Last-Mile Delivery (LMD) in a contemporary business situation. It refers to the 21st century's innovative and revolutionary changes in the logistics sector. It explains advanced technology and the digital revolution as driving forces in the modern logistics industry. This study adopts a qualitative approach and presents a conceptual model developed through expert discussion and Interpretive Structural Modelling (ISM), for formulating the proposed model of modern logistics in the era of Industry 4.0 (I4.0). According to ISM and MICMAC analysis, cost-effectiveness and green technology efforts are independent driving variables for efficient and green logistics management. It offers a road map for organizing the drivers in the logistics 4.0 conceptual framework. The scope of work is restricted to only operational logistics management aspects for smooth LMD. This study is confined to only LMD operations and technological advancements in logistics. The research provides valid factors for increasing the LMD efficiency of logistics networks. The importance and relationships between the various drivers are discussed and analyzed to increase the supply chain's sustainability and efficiency.

Keywords- Last mile delivery, Drivers, Technology adoption, Decision Making, ISM, Industry 4.0.

1. Introduction

According to worldwide analysts and market specialists, "the global logistics market was worth 10.32 billion USD in 2017 and is projected to rise to 12.68 billion USD by 2023 with a CAGR (compound annual growth rate) of 3.49% between 2017 and 2023 "(Pannest, 2021). With the industrial rise in emerging nations' worldwide economic activity, there has been an increase in trade agreements and innovations, particularly in information technology and transportation. The Asia-Pacific region is predicted to reach new economic and investment heights to become the future global logistics industry leader (Kumar et al., 2022). The logistics business is here to stay. As long as there are enterprises producing consumer goods, there will be a need to transfer those goods. Not only that, but with the expected rise of the worldwide economies, this market is likely to expand in tandem. Furthermore, Third-party logistics (3PL) suppliers are projected to continue to dominate the industry. Logistics is the business and commercial activity of transporting products from their source or availability point to their desired destination for consumption and usage. This complicated procedure involves the coordination, movement, and storage of supplies. The rapid and unanticipated rise of the logistics industry has compelled logisticians to devise quick and efficient solutions to thrive in a globally competitive market. Those with drive and determination will discover endless prospects for professional fulfilment and financial success in this fascinating field (Qureshi, 2022). The successful implementation of supply chain management is dependent on the timely completion of each operation involved in the cycle or network, from raw material collection to production and then a warehouse for Last-Mile Delivery (LMD), as well as changes at any section as required to avoid any delays in LMD and consumer consumption (Kembro & Norrman, 2022).

Logistics is an essential component of any material sector and will remain so as long as things are produced. I4.0 technologies are used in each segment of the transport and delivery system in a smart logistics network (Ismail & Jokonya, 2023). It offers a driving force for logistics companies to collect and organize real-world data in order to provide intelligent solutions and automate activities regulated by AI and Machine Learning. As a result, on-time LMD is done with increased capacity and cost optimization. Digital and robotic techniques aid warehouse personnel in properly sorting out orders, guaranteeing that numerous items are delivered efficiently. Any disparities are promptly flagged by smart warehouse technologies, eliminating human mistakes (Van-Geest et al., 2021). Self-governed and autonomous technology eliminates the manual part of warehouse management, lowering costs and increasing production. LMD is a logistical game-changer. As consumer society shifts to E-Commerce platforms, it is critical to improve delivery speed and efficiency in order to boost customer happiness. The shipment has been delivered to the distribution center. It has arrived at the nearest inventory store but is not yet available for delivery (Merkert et al., 2022). This is the most difficult logistical obstacle. Customer purchase cancellations are sometimes caused by inefficiency and delays in LMD. As a result, improving LMD service is critical to fulfilling logistics. In comparison to in-house delivery services, 3PL service providers can readily help minimize LMD expenses. The consumer base will be reduced if the purchase is cancelled or there is a protracted delay in delivery. "LMD industry is expected to increase by $165.6 billion between 2023 and 2027, at a 15.62% CAGR" (Wood, 2022). A developing worldwide e-commerce business, luxury products and merchandise delivery services, and a significant number of warehouses are driving the market. Every successful brand's future development is very much dependent on customer satisfaction, and LMD plays the most important role in how customers view the brand.

India's LMD market is trending in the same manner as those in the United States and China. In India, LMD has a market share of more than 10%. India's LMD sector would cost around $6-7 billion by 2024, as per predictions. E-commerce shipments are expected to rise to 5 billion by 2025, up from 1.36 billion in 2020 (Wahab, 2022). Furthermore, LMD is critical to customer satisfaction, making it even more critical to get right. It saves a huge amount of time and money if you do it effectively, making your organisation significantly more productive, profitable, and respected. However, failure to master the process might spell doom for your company's long-term viability. LMD services are significantly more sophisticated than first-mile delivery services. This is because it entails delivering several items to a wide range of distinct addresses. This can become more time-consuming and costly in a big metropolis with significant traffic congestion on the roadways. Evaluating last-mile processes to increase visibility and automation is critical to ensuring smooth operations. As many businesses discovered during the epidemic, a lack of visibility makes it difficult to adapt rapidly when necessary. Without visibility, fleet operators and management struggle to make educated decisions. Finally, firms that achieve enhanced fleet transparency may minimize friction, improve operational efficiency, and, most importantly, better handle the unexpected. Of course, providing consumers with real-time updates on their purchases is only useful if displayed in a way that isn't messy (Esmaeilian et al., 2020).

Logistics management depends on transparency and visibility, which lead to better customer service. That is why exceptional customer experiences rely on optimized routes with reliable logistics networks. A route optimization option offers significant drivers optimal routes and detailed directions for each operation, ensuring that they arrive on time the vast majority of the time. Therefore, there is a need to develop a model that constitutes the decisive factor in logistics management for the fourth industrial revolution. The Industry 4.0 (I4.0) revolution in the logistics sector has increased automation and digitalization with a combinational approach of artificial intelligence and human intelligence for decision-making (Golovianko et al., 2023). Researchers in recent times have tried to model the I4.0 challenges and barriers mathematically to plan and execute supply chain initiatives for new technological advancements (Osunsanmi et al., 2023; Nakandala et al., 2023). This study aims to investigate and analyze the crucial I4.0 drivers for logistic management, specifically those contributing to LMD operations. The various driving factors are determined from published literature and analyses to determine their relational importance. The accessibility and reachability of efficient LMD are determined at various levels. The study focuses on analyzing the present logistics network and provides a conceptual model for efficient operations in the I4.0 era.

In this research article, after the Introduction in Section 1, the Literature review describing the background of logistics and recent developments in the era of Industry 4.0, along with the decisive drivers, is presented in Section 2. In Section 3 of the article, the Methodology adopted is explained and Interpretive Structure modelling (ISM) is implemented for deriving the results. In Section 4, Results are derived and discussed in Section 5. Section 6 gives the Conclusions of the research conducted. The future scope and directions are given in Section 7 of the research article.

2. Literature Review

Logistics is the process of moving items from their starting point to their final destination. The Greeks and Romans first discussed logistical systems in their battle strategies. The Roman military generals used specific procedures to ensure that food, weaponry, and ammunition were delivered to their soldiers on time. Military commanders known as "logistikas" were held accountable for all resource management on battle grounds for their military (Faber et al., 2013). The supply chain network was designed to ensure consistent and on-time supplies during wartime in the most dangerous areas. This was accomplished by utilizing all available transportation mediums and routes, including sea and land. Forts and castles evolved into storage facilities, aided by the surrounding countryside's resources. During World Combat I, trains and ships served as important resource providers for all forms of combat equipment and gear. During the same period, the first industrial revolution arose, ushering in mass production and supply.

The advanced transportation possibilities afforded by IC engines led to the extensive employment of motor vehicles during the conflict. During World War II, there was a mad dash towards industrialization and the development of military factories (Kane et al., 2001). The United States has developed into a significant industrial hub for all modern technology, weapons, and automobile suppliers. Following WWII, the United States moved its attention from war to business, supplying all products throughout the world and establishing a global logistics network. Outbound operations were prioritized at the beginning of physical product delivery. During World Combat I, trains and ships served as important resource providers for all forms of combat equipment and gear. During the same period, the industrial revolution arose, ushering in mass production and supply. This generated the need for prioritizing operations regarding product delivery.

Many organizations currently outsource some or all of the management of their supply chain tasks, which has resulted in the emergence of third-party logistics firms for efficient product movement and tracking. The advent of the industrial age significantly altered logistics (Mothilal et al., 2012). Technological advances in tools, equipment, transportation, and communication revolutionized not just military operations but also everyday life, enterprises, and the global economy. Railroads, steamships, and the telegraph transformed how armies, authorities, businesses, and people communicated and moved in the late 1800s. More people and goods could be managed and carried over to larger areas as technology advanced. New organizational and operational plans were necessary to keep up with the global competition. For a productive and efficient system, logistics management began to evolve in military units and industry. These significant developments coincided with the data revolution ushered in by the emergence of personal computers in the 1980s and the introduction of the Internet in the late 1990s.

By utilizing computer-controlled technologies and map-based interfaces, logistic enterprises were able to improve their planning and execution processes. Large-scale optimization models were created and then used in corporate operations. During this time, technological advances led to developments in robotics and automation. Enterprise Resource Planning (ERP) Systems were developed to integrate several data sources. These systems might combine several data sources, increase data accuracy, and help with material and logistical planning. Logistics management is undeniably growing "smarter" in the twenty-first century (Atieh et al., 2016). In today's modern logistics systems, CPSs use I4.0 technologies such as IoT and AI to monitor and control the movement of products and information. This contributes to a stronger relationship between the provider and the client. It is projected that the role of technology in logistics will grow at a faster rate in the future. It will be beneficial to have more optimized, less expensive solutions, better route planning, and green transportation (Tom, 2015).

2.1 Recent Developments in the Modern Logistics Domain

Logistics 4.0 revolutionized every aspect of the sector, including marketing, warehouse management, supply chain management, and so on. In order to develop an automatically feasible and responsive supply chain, logistics management does not just disseminate I4.0. Table 1 presents recent studies in the field of logistics management.

Table 1. Recent studies in the field of logistics management.

S. No.	Year	Authors	Purpose	Role in Logistics for LMD
1.	2023	Schaumann et al. (2023)	The paper focuses on examining the various challenges related to route planning and LMD operations.	The article discusses the need for an integrated system that handles the whole product path from raw material collection to LMD under global standards.
2.	2023	Ismail & Jokonya (2023)	This study looks at the major factors driving the adoption of emerging technologies in retail LMD.	The readiness of evolving technologies in LMD within the retail business was the primary technological element influencing their adoption.
3.	2023	Marculetiu et al. (2023)	The research examines numerous aspects of the green supply chain to establish the major alterations in the current logistics network.	It was determined that in order to achieve efficiency and sustainability, training and technological assistance were required at each level of delivery.
4.	2022	Balaska et al. (2022)	The study investigates the concept of LMD by autonomous vehicles without the need for drivers to operate the vehicles. It also addresses the difficulties associated with I4.0 adoption in LMD.	This article examines the urbanization and smart city principles inherent in contemporary logistics for autonomous car use. It also addresses the numerous issues associated with Industry 4.0 deployment in the modern supply chain.
5.	2021	Suguna et al. (2021)	The paper discusses the fundamental variables impacting the LMD key performance parameters of the e-commerce and retail sectors in COVID- 19.	Based on the analysis, the primary components for LMD operations during COVID-19 include commodity categories and achieving routing efficiency. It describes satisfying delivery timelines, using a comprehensive interpretive structural modelling technique during the COVID-19 period.

Table 1 continued…

6.	2020	Lu et al. (2020)	This study looks into how parcel delivery businesses might use driver assistants most effectively. We then provide an alternate approach that, in such instances, can produce better results than those provided by current practice.	The authors suggested a unique approach in this work that allows LMD for organizations to make better use of vehicle time, and researchers did numerical tests using the proposed model to get managerial insights into how drivers can enhance overall efficiency.
7.	2020	Jiang et al. (2020)	The purpose of the article is to analyze the quality of services for rural LMD networks.	The work proposes an integrated FCE and ISM technique. It demonstrates that the assessment indices of correct product arrival and timely responsiveness should be emphasized.
8.	2019	Jiang et al. (2019)	The decision-making tools are used to analyze the critical rural sustainability variables. It also focuses on strategies for e-commerce enterprises to provide efficient LMD services in remote locations.	The study suggested an integrated technique of FAHP, ISM, and MICMAC to identify the elements impacting rural LMD sustainability. It also developed the driving and reliance power enabling mechanisms in order to investigate the operational impact of the variables in LMD operations.
9.	2019	Huang & Ardiansyah (2019)	The paper focuses on providing a decision-making tool for LMD planning, significantly addressing the concept of crowdsourcing.	The study derived the heuristics algorithm, which is expected to produce a high-quality, quick response to the technological and managerial challenges.
10.	2018	Awwad et al. (2018)	The purpose of this article is to provide a framework for further reducing greenhouse gas (GHG) emissions, with a particular emphasis on CO2 emissions, in order to establish the idea of sustainability in logistics management.	The study addresses the use of alternative and renewable fuel and energy sources for modern transportation facilities such as e-vehicles, etc. The numerous optimization strategies and government rules for enhancing environmental conditions and lowering carbon footprints are explored.
11.	2017	Oliveira et al. (2017)	The study's goal was to discover the various types of vehicles that may be used in the LMD of urban freight distribution.	According to the findings of this study, successful LMD may be achieved by lowering vehicle size, capacity, and trip duration, resulting in reduced logistical expenses. It will aid in the improvement of LMD in urban regions and is a more sustainable business decision.

2.2 Drivers of LMD Operations in Logistics Management

The drivers of I4.0 in logistics management for LMD are the social and managerial components involved in adopting new technologies and improving overall system performance. Omni-channel buying and transportation routing, for example, aid in intelligently selecting between various supply and delivery sources Technology and strategic drivers may be used for managing the supplier and source of supply selection, alongside the distribution system for internal locations. The following Logistics 4.0 features relate to important performance with the assistance of LMD operational drivers. Table 2 presents significant Drivers for LMD Operations in modern logistics management.

Table 2. Significant drivers for LMD operations in modern logistics management.

S. No.	Driver	Source & Year	Description
1.	Cost Optimization	(Salam, 2021; Mangiaracina et al., 2019; Kumar et al., 2018)	Many logistical processes may now be automated and digitally documented, increasing transparency and efficiency in resource management. It leads to lower data adulting and maintenance costs while keeping optimized operating costs.
2.	Cost-Effectiveness	(Fu et al., 2015; Roblek et al., 2016; Jennings & Figliozzi, 2020)	Many logistical processes may be automated and digitally documented, resulting in lower spending on data audits and maintenance while maintaining effective operations.
3.	Customization	(Abdirad & Krishnan, 2020; Bakhtari et al., 2021; Aggarwal et al., 2022),	The mass customization paradigm is built on flexibility and rapid reactivity in creating, producing, promoting, and delivering items that can please as many clients as possible without significantly raising prices.

Table 2 continued…

4.	Omni channel (OC) Retailing	(Kumar et al., 2018; Olsson et al., 2019; Osakwe et al., 2022),	Omni-channel retailing is the capacity of a logistics planning network to intelligently pick between different sources of supply from available resources. This applies to every aspect of the selection of suppliers and sources in conjunction with the logistics network for domestic locations.
5.	Product Distribution	(Abdel-Aal, 2019; Angreani et al., 2020), Ding et al., 2021)	Distribution logistics includes all duties related to the planning, management, and movement of goods and information between manufacturing organizations and customers.
6.	Route planning	(Chaabane et al., 2021; Chandrasiri et al., 2022 ; Ezaki et al., 2022),	Inadequate delivery route planning results in suboptimal scheduling, pushing delivery employees to take unnecessary long trips. Estimated arrival times are delayed by more than 25% owing to incorrect distribution and route planning.
7.	Government Policy	(Lai et al., 2018; Parhi et al., 2022)	It deals with government support and policies providing improvements in operations involved in logistics 4.0.
8.	Delivery Time	(Salam, 2021; Mothilal et al., 2012; Orji et al., 2022)	The phrase "Delivery Time" refers to the date(s) on which the goods and products will be delivered or the time(s) during which the services will be provided to customers.
9.	Global Competitiveness	(Hosseini et al., 2019; Garay- Rondero et al., 2020; Ali & Kaur, 2021)	The rising globalization of markets, more worldwide competition, and more complicated product manufacturing require the use of new technology, methodologies, and organizational procedures. Rapidly changing market conditions and variable client expectations require the efficient functioning of logistics systems.
10.	Transport Management	(Boysen et al., 2021; Siddiqui, & Vita, 2021; Ding et al., 2021)	Advanced software analyses incoming data streams from the device to optimize routes. Predict vehicle breakdowns and provide inputs to improve driving habits, which helps reduce costs while increasing service availability.
11.	Customer Satisfaction	(Gutierrez-Franco et al., 2021; Sorooshian et al., 2022; Jiang et al., 2020)	Customer experience automation is a comprehensive method of streamlining and automating customer cycles via the use of RPA, ML, and AI solutions. Automation may appear to be an oxymoron. I4.0 technology uses automation to make a significant difference by accelerating basic yet repetitive processes. CXA, on the other hand, considers the larger picture and unifies siloed tools. In fact, this is one of the primary differences between it and marketing automation.
12.	Green Technology Initiation	(Xu et al., 2022; Komninos, 2022; Ghadge et al., 2022)	Digitalization promises a new age of greener logistics, including transportation, distribution, and warehousing. I4.0-governed Intelligent technologies have become an essential component of warehouse operations, fleet management, and transportation operations.

Mass customization refers to the capacity to make things for clients on a budget while maintaining efficiency. The goal is to increase the importance of the consumer in the production process. In Logistics 4.0, this is reversed. Sensors and communication technology have enabled machines on the factory floor to communicate, gather data, and transmit instructions independently (Aggarwal et al., 2022). Supply and transportation networks, as well as other corporate divisions, might be linked to these measurements, increasing efficiency savings even further. Real-time product tracing, OEE optimization, supply chain communication, and other duties are performed. Supply chain companies, especially those with dynamic truck routing, are clamoring for an automated solution to help them realize their full potential. I4.0 must be implemented in order to prepare businesses for dynamic supply chain networks. Despite the fact that the Dynamic Vehicle Routing Problem (DVRP) has been the focus of countless studies, there hasn't been much research into how I4.0 may affect it (He et al., 2020). It has been recommended that I4.0 be used for difficulties with dynamic vehicle routing since there is a compelling need to construct and comprehend it. This acknowledgment is the outcome of extensive research into current writing on supply chain networks and dynamic vehicle routing issues.

The ability of a transport planning system to make educated judgments while deciding between potential supply sources. This is true when it comes to selecting suppliers, a supply source, and a network of service providers for interior sites. The preceding era's rapid expansion of sales and distribution channels, which was primarily focused on the customer-centered purchase experience and the rising significance of more specialized items and faster delivery, gave rise to the present Omni-channel trend. Increased demand for customized goods and services, along with novel information and manufacturing technology, is pushing advancements in manufacturing and support systems. When drivers are deployed correctly and supported by data, I4.0 technologies have the potential to significantly increase consumer happiness. When you provide customized and seamless experiences that suit specific needs, customer satisfaction levels can increase.

As a result, the literature review demonstrates the need to investigate the role of decisive factors in Logistics 4.0 and the level at which they influence decision-making in modern logistics management. The relevance of technology diffusion in the logistics industry must be researched using a proper technique in order to explore prospects for optimizing LMD operations. The literature shows a strong gap for new models in the era of Industry 4.0, particularly for LMD. The identified drivers are present in the literature, which may provide a conceptual model for investigating decision-making in modern supply chain logistics operations.

3. Methodology

The methodology adopted for conducting the research is a qualitative-based approach. This study is conducted in various steps to determine the importance and impact of the various I4.0 drivers of logistics management. In step 1, this study reports the identified drivers using existing literature and articles. Step 2 consists of brainstorming meetings with professional help and ideas to finish the 12 found drivers. Step 3 defines each driver's significance for LMD transportation within the scope of I4.0. In step 4, selection of the method or technique and Implementation of ISM (Interpretive Structural modelling) are done. In steps 5 and 6, results and conclusions are drawn from the proposed model for decisive drivers of modern logistics for LMD operations.

3.1 Selection and Implementation of ISM Method

To prioritize the variables under examination, researchers use a range of methodologies, including the Analytic Hierarchy Process (AHP), the Vikor method, the Analytic Network Process (ANP), DEMATEL, TOPSIS, and others. The study discovered that Interpretive Structural modelling (ISM) was better suited for optimizing strategies for establishing connections and identifying the most essential components. Similar methods, DEMETAL and TOPSIS, also provide a large range of decision-making options but are unable to provide multiple stages of a process. This type of LMD problem, where the components are linked and interactive decision-making is required, lends itself well to ISM (Bakhtari et al., 2021; Senna et al., 2022). ISM may rank the relevance of several factors and offer links between them, as well as information on how effectively each element influences the others. ISM may rate and recommend models based on the inputs of each element to the overall system. Consequently, the ISM technique was chosen for the creation of modern LMD drivers. The methodology for drivers is demonstrated in LMD Figure 1.

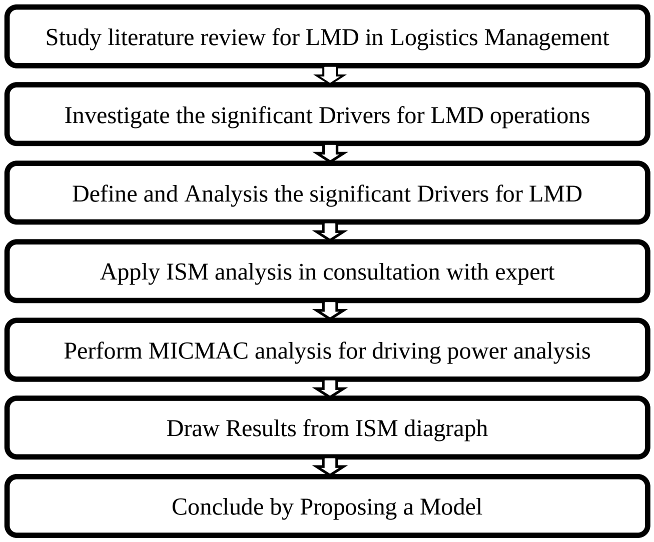

Figure 1. Methodology for drivers of LMD.

3.2 ISM for Preparing Structural Self Interaction Matrix (SSIM)

During the subsequent round of expert discussion and brainstorming meetings, the SSIM matrix is generated. SSIM is formed to demonstrate links between tools for I4.0 implementation in logistics through element-to-element mapping. The following established terminology is used:

- "V: Finding component *j* requires finding factor *i.*
- A: Finding component *i* requires finding factor *j*.
- X: There is a relationship between factors *i* and *j*.
- O: Factor *i* and factor *j* are unrelated

The SSIM for I4.0 in the application of transportation management is shown in Table 3. This approach to estimating variables is widely used.

Table 3. Structural self interaction matrix (SSIM).

j		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
i	1	x	A	A	O	V	A	V	V	A	V	V	A
	2		x	V	V	O	X	V	V	A	V	V	A
	3			x	V	V	V	V	V	X	X	V	O
	4				x	X	A	V	O	V	O	O	O
	5					x	A	V	V	A	V	V	O
	6						x	A	O	X	V	V	X
	7							x	O	A	V	V	X
	8								x	O	V	V	O
	9									x	V	V	X
	10										x	V	O
	11											x	X
	12												x

1.	Cost optimization	7.	Government policy
2.	Cost-effectiveness	8.	Delivery time
3.	Customization	9.	Global competitiveness
4.	Omnichannel (OC) retailing	10.	Transport management
5.	Product distribution	11.	Customer satisfaction
6.	Route planning	12.	Green technology initiation

3.3 Reachability Matrix (RM)

The above-developed SSIM matrix is converted into a binary shape known as an RM by replacing V, A, X, and O with 0s and 1s. Applying the following established ISM principles:

- "If the (*i*, *j*) entry in the SSIM is V, the (*i*, *j*) entry in the RM becomes 1 and the (*j*, *i*) entry becomes 0.
- If the (*i*, *j*) entry in the SSIM is A, the (*i*, *j*) entry in the RM becomes 0 and the (*j*, *i*) entry becomes 1.
- If (*i*, *j*) in the SSIM is X, both (*i*, *j*) and (*j*, *i*) entries in the RM become 1.
- If (*i*, *j*) in the SSIM is O, both (*i*, *j*) and (*j*, *i*) entries in the RM become 0."

Table 4 presents RM for I4.0 enablers in the logistics management system.

Table 4. RM for I4.0 enablers in the logistics management system.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	1	0	1	0	1	0	1	1	0	1	1	0
2	1	1	1	1	1	1	1	1	0	1	1	0
3	1	1	1	1	1	1	1	1	1	1	1	0
4	0	0	0	1	1	1	1	1	1	1	1	0
5	0	0	1	1	1	1	1	1	1	1	1	0
6	1	1	1	1	1	1	1	1	1	1	1	1
7	1	0	1	1	1	1	1	0	1	1	1	1
8	0	0	0	0	0	0	0	1	0	1	1	0
9	1	1	1	1	1	1	1	1	1	1	1	1
10	1	0	1	1	1	1	0	1	0	1	1	0
11	0	0	0	0	0	0	0	0	0	0	1	1
12	1	1	0	0	0	1	1	0	1	0	1	1

3.4 Canonical Matrix

In its canonical form, a standard way of describing an item is with a scientific and mathematical countenance in order to extract critical evidence through investigation. It was designed using the accessibility grid. All enabling factors are combined to form a canonical matrix. Digraph is therefore ready to graphically show enabler components with their connections and hierarchy levels since the top triangle has 0 elements and the bottom triangle has 1. The cluster is shown at various levels in the rows and columns of Table 5. By summing the figures along the row and column, the motor power and reliance power are computed.

Table 5. Canonical matrix for LMD operations.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**DRP**
1	1	0	1	0	1	0	1	1	0	1	1	0	7
2	1	1	1	1	1	1	1	1	0	1	1	0	10
3	1	1	1	1	1	1	1	1	1	1	1	0	11
4	0	0	0	1	1	1	1	1	1	1	1	0	8
5	0	0	1	1	1	1	1	1	1	1	1	0	9
6	1	1	1	1	1	1	1	1	1	1	1	1	12
7	1	0	1	1	1	1	1	0	1	1	1	1	10
8	0	0	0	0	0	0	0	1	0	1	1	0	3
9	1	1	1	1	1	1	1	1	1	1	1	1	12
10	1	0	1	1	1	1	0	1	0	1	1	0	8
11	0	0	0	0	0	0	0	0	0	0	1	1	2
12	1	1	0	0	0	1	1	0	1	0	1	1	7
DPP	8	5	8	8	9	9	9	9	7	10	12	5	

3.5 Levels Achieved after Iterations

The various levels achieved after the iteration of the canonical matrices are shown in Table 6, with six levels in which customer satisfaction trends out to be the true goal of the LMD supply.

Table 6. Levels achieved after iterations of drivers.

Levels	Variables
1	11
2	8,10
3	4,5,7
4	1,3
5	2,6
6	9,12

Hence, the reachability, canonical, and final level matrices attained after ISM implementation are shown in Tables 4,5 and 6. We can establish the connection and determine the route from one I4.0 driver to another I4.0 of logistics management with the aid of reachability and the canonical matrix. By examining the relationship driving and dependency power among the I4.0 drivers of logistics management for LMD operations, the canonical matrix aids in structuring the model. The final iteration levels for building an ISM model are shown in Table 6, along with their relative importance to the contemporary logistics scenario. The results of the derived Tables are discussed in the next section.

4. Results

ISM diagraph, MICMAC analysis, and the proposed model are discussed as part of the results and discussion.

4.1 ISM Diagraph

Figure 2 demonstrates the ISM digraph that appeared following the level section. This section covers the many levels and linkages of the tools that will improve LMD operations and client experiences. Robots, drones, and self-driving cars will be considered critical components of a full-fledged I4.0 application in LMD operations.

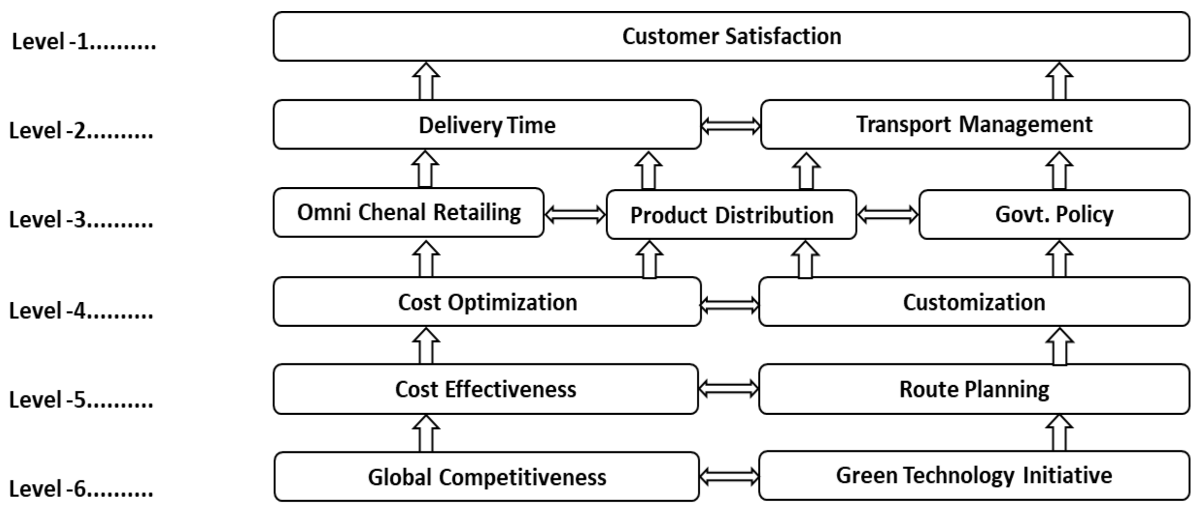

Figure 2. ISM diagraph for drivers of LMD in logistic management.

4.2 MICMAC Analysis

The driving and dependence grid in Figure 3 examines the variables' potential to drive and be driven by other factors. Cost-effectiveness and green initiatives come out to be the independent driving forces for LMD operations in logistics management. Cost-effectiveness has emerged as an independent driving factor as the cost analysis for each product and delivery is a customized phenomenon independent of other factors involved in the logistics operations. Each product has its own cost-effectiveness and delivery statistics. Green initiatives are also an independent factor as the type of product, delivery place, and availability of energy sources for transportation at different geographical locations are customized and altered for efficient delivery considering environmental issues. Delivery time and customer satisfaction are dependent on many factors in the modern logistics scenario, as per the MICMAC analysis. While all other drivers act as a bridge and link to the LMD service in the logistics sector. There is no autonomous driving factor among the selected drivers. The MICMAC analysis for drivers in logistics 4.0 results are shown below in Figure 3.

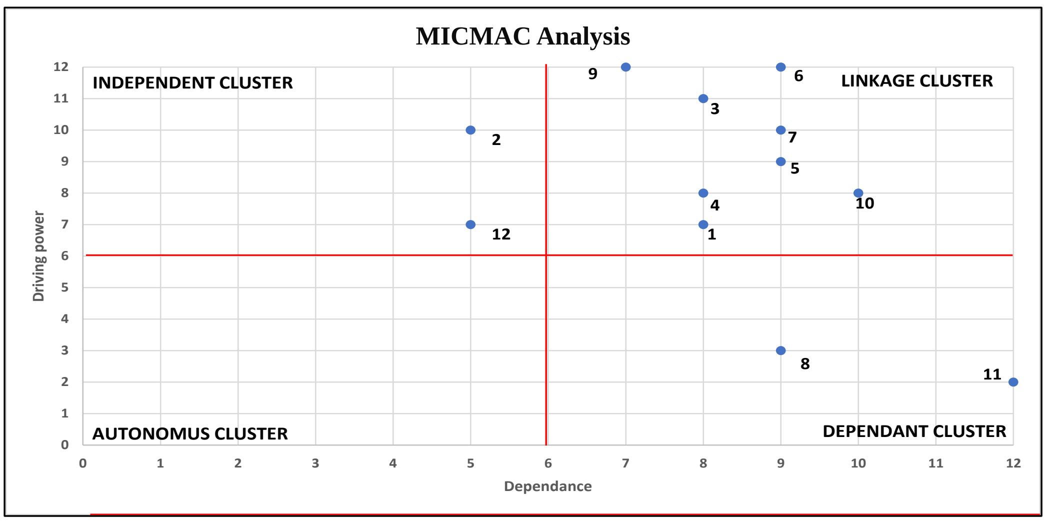

Figure 3. MICMAC analysis for drivers in logistics 4.0.

4.3 Proposed Model

The proposed model shows modern logistics functions that are governed by strategic and operational drivers. The flow of product and money are both dependent on the driving forces in the modern supply chain. Figure 4 explains the proposed conceptual model of modern logistics management for LMD.

Customer satisfaction is the central objective that is required to be achieved by any supply chain (Mothilal et al., 2012). The model at the initial level depicts global trends and green technology initiatives around the world. This has become crucial to understanding the present scenario and staying updated with changing trends for sustainable growth. Transport management and route planning remain the critical and decisive drivers for the adoption of I4.0 technologies for the modernization of the logistics sector. Logistics 4.0 needs to be equipped with better transportation facilities using advanced, unmanned, and artificial intelligence-governed vehicles for efficient LMD. Similarly optimized and accurate path selection helps organize quick and cost-effective LMD operations. It also accumulates cost-effectiveness, route planning, customization, and cost optimization as one of the fundamental strategy-driving forces in the logistics network. Product distribution, Omni channel retailing, and government policy remain the crucial blocks for efficient LMD services. Transport management and delivery timing have a direct and strong impact on LMD services and customer satisfaction in the modern logistics network.

Figure 4. A proposed conceptual model of modern logistics management for LMD.

5. Discussion

The results have shown the importance of drivers in decision-making while adopting I4.0 technologies in modern logistics. Logistics 4.0 emerged as a crucial research area at a global level as it plays an important role in global competitiveness and sustainability initiatives. Any industry focusing on logistics 4.0 aspects leads the supply chain and has an advantage over other distributors and manufacturers. Global dominance can be created in business through effective and technologically advanced supply chains. Logistics 4.0 adoptions also require a lot of digital infrastructure and investment at the initial level, which are also required to be considered while deciding decisive drivers for industries. Some of the theoretical and practical implications of Logistics 4.0 for LMD operations are discussed below.

5.1 Theoretical Implications

Our research makes two-directional theoretical contributions. For starters, working in the logistics sector adds to a research gap by connecting the three study fields of I4.0 implementations, innovation capabilities, and decision sciences. To the best of our knowledge, not many studies have studied these three characteristics concurrently and specifically in the context of LMD operations. Therefore, our findings add to the literature on technological innovation, organizational competence, and creativity. Second, it provides a conceptual model developed mathematically by ISM to serve as a foundation for the growing Logistics 4.0 idea in operations management.

5.2 Practical Implications
The major disruptions to enterprises over the previous decade, caused by the global financial crisis, conflicts, and the ongoing COVID-19 epidemic, highlight the need for routes to business agility. The extended COVID-19 pandemic crisis has resulted in a tremendous surge in the adoption of digital technology by businesses as they strive to navigate these difficult times (Nakandala et al., 2023). Modern Supply chains are exemplifying this trend, embracing front-end I4.0 technologies in response to pressures for higher performance, asset utilization, and production capacity, decreased lead times, inventory, and labor costs, and enhanced resilience. Logistics 4.0 provides the utility of autonomous vehicles and drones as an effective solution to certain specific problems. I4.0 has many practical technological solutions for LMD issues, leading to profitable business and higher customer satisfaction.

5.3 Managerial Implications
Logistics 4.0 is a data-enabled logistics network where supply chain managers can utilize data analysis to predict, schedule, plan, and execute the demand and supply of products in modern logistics cycles. The rise of interactive delivery solutions such as crowd-shipping and networks of peers is facilitated by Logistics 4.0 (Rauniyar et al., 2023). Managers might look into forming associations with local companies or people who can act as distribution agents, taking advantage of their accessibility to clients. Managers can track the location and progress of deliveries, providing them with more visibility throughout the LMD process. This visibility aids in the resolution of customer queries, the management of exceptions, and the improvement of overall customer happiness.

6. Conclusion
Strategic drivers serve as a logistics and supply chain management company for its customers. It frequently owns and maintains distribution centers and sources of transportation. These combine the resources of manufacturers, retailers, and third-party logistics providers to provide a system-wide improvement in logistics management. They mostly give organizational knowledge in order to manage LMD activities (Gutierrez-Franco et al., 2021). Global competitiveness aided in the establishment of a worldwide network of industrial operations, suggesting that producers and consumers are often geographically separated, necessitating complicated transportation services. Manufacturers and merchants are increasingly focusing on their main business (known as their core competencies) and subcontracting areas such as logistics, where they have less competence. The purpose is to promote the respective production and distribution specializations. Improved use of transport assets leads to cost-effectiveness and cost optimization. Logistics management techniques improve transportation asset utilization by balancing the demands of numerous client shippers across transportation and distribution operations, locations, Omni channel commerce, and so on. Managerial and information technology skills can lead to cost, reliability, and productivity advantages in supply chain management. This helps to achieve customer satisfaction and create a path for business growth. The study also presents the approach of adopting green initiatives initially for a sustainable approach towards global logistics network development. The model helps to provide a more calculative and decisive approach to the adoption of I4.0 technological solutions in the logistics sector.

7. Future Scope
In the current era, suppliers form the primary part of an organization's supply chain. Suppliers are treated as partners by the manufacturers. The recommended model is derived by examining the factors from the business perspective of logistics management. It is advisable to conduct further studies (based on this model) in other major industries to generalize the influence of real-time information emerging from IoT on Supply Chain Management. It would be fascinating to look at the pioneers in other transportation sectors in the future and see how I4.0 will impact their companies. The suggested technique can also be

applied to other supply chains where LMD is a barrier, such as the supply chain for fragile foods and refrigerated items, as well as in the healthcare and leisure industries. In the future, practical studies can evaluate the enablers and suggest models to increase the effectiveness of the e-commerce sector for LMD. To link to important technologies, a variety of techniques for predicting client satisfaction metrics may be used. By developing a customized case study and model, the model may be further evaluated with real-time data collected by RFID and IoT to calculate its influence on a certain organization's LMD efficiency. This model might serve as a conceptual framework for the case study. The study is limited to generalized concepts. Small-scale and medium-scale enterprise issues can also be added to the present model to increase the approach and range of the research.

Conflict of Interest

The authors hereby declare that there are no financial or other conflicts of interest between them or any of the firms to which they are connected that would affect the objective presentation, interpretation, or conclusion of the study's findings. Furthermore, the planning, execution, or reporting of this work was not influenced by any financial interests, funding sources, connections to commercial entities, or other affiliations.

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