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Optimaization on First, Mid & Last Mile in OSCM

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Abstract - Delhivery Ltd stands as a prominent player in India's logistics and supply chain sector, with a specialization in e- commerce and enterprise solutions. The company operates through a vast network, incorporating cutting-edge, technology-enabled strategies to streamline transportation, warehousing, and order processing.

Its operations commence with first-mile pickup, where consignments are gathered from sellers and subsequently sorted at state-of-the-art automated hubs. These packages are then routed via meticulously planned pathways that combine surface and air transportation networks. Delhivery utilizes sophisticated tracking systems and data-driven analytics to provide real-time shipment updates and ensure prompt last-mile delivery.

In the realm of supply chain management, Delhivery offers comprehensive solutions such as inventory control, predictive analytics for demand, and handling returns efficiently. Harnessing the power of artificial intelligence and automation, the company achieves operational optimization, minimizes delivery times, and reduces costs. Its adaptable logistics framework caters to diverse industries, from online marketplaces to traditional retail setups, delivering both reliability and scalability.

1.INTRODUCTION

Delhivery Ltd., a prominent player in India's logistics and supply chain industry, has emerged as a trailblazer in revolutionizing the way goods are transported and delivered across the nation. With its robust network, state-of-the- art technology, and relentless pursuit of efficiency, Delhivery has made a significant mark in optimizing three critical stages of logistics operations: First Mile, Mid Mile, and Last Mile. These operations serve as the foundation of the company's logistics ecosystem, ensuring the smooth and seamless movement of goods from origin to destination.

First Mile Operations form the initial link in the logistics chain, where goods are collected from suppliers, manufacturers, or retailers and transported to distribution centers or warehouses. This stage is vital because it sets the tone for the entire logistics journey. Efficient First Mile operations require meticulous planning, accurate scheduling, and effective coordination to prevent delays and maintain the quality of goods. Delhivery achieves this through advanced technology solutions such as real-time tracking systems, data analytics, and automated processes. By leveraging predictive analytics, the company forecasts demand and optimizes its pickup schedules, ensuring timely collection and a streamlined transition to the next phase.

At the heart of Delhivery's innovation is its commitment to reducing inefficiencies and enhancing operational transparency. First Mile operations often face challenges such as variability in supplier locations, fluctuating volumes, and differing transportation modes. To address these complexities, Delhivery employs tailored logistics strategies that take into account the unique requirements of each client. By integrating technology with a customer- centric approach, the company ensures that First Mile operations are not only efficient but also adaptable to the diverse needs of its clients.

Mid Mile Operations represent the intermediary stage in the logistics process, where goods are transported from distribution centers to regional hubs or sorting facilities. This phase is essential for consolidating shipments,

optimizing routes, and minimizing transit times. Mid Mile operations serve as the backbone of the logistics chain, linking the origin with the destination through efficient connectivity. Delhivery's extensive transportation network, combined with its advanced optimization algorithms, plays a pivotal role in enhancing the efficiency of Mid Mile operations.

One of the key challenges in Mid Mile logistics is managing transportation assets effectively to balance cost, speed, and reliability. Delhivery addresses this challenge by employing dynamic routing technologies and fleet management systems that allow real-time adjustments based on traffic conditions, weather, and other variables.

These systems not only improve transit times but also reduce fuel consumption, aligning with the company's commitment to sustainability.

In addition, Delhivery's sorting facilities are equipped with cutting-edge automation technologies that enable high- speed processing and accurate segregation of goods. This ensures that shipments are efficiently handled and dispatched to the appropriate Last Mile hubs, reducing errors and enhancing overall operational efficiency. The company's ability to scale its Mid Mile operations while maintaining a high level of precision is a testament to its logistical expertise. Delhivery Ltd stands as a prominent player in India's logistics and supply chain sector, with a specialization in e-commerce and enterprise solutions. The company operates through a vast network, incorporating cutting-edge, technology-enabled strategies to streamline transportation, warehousing, and order processing.

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Last Mile Operations constitute the final and most customer-facing stage of the logistics process, where goods are delivered from regional hubs to the end customer. This stage is often considered the most challenging due to its complexity and direct impact on customer satisfaction. Last Mile operations demand a delicate balance between speed, accuracy, and cost-effectiveness to meet the growing expectations of customers in a fast-paced market.

Delhivery's Last Mile optimization strategies are driven by technology-enabled solutions such as route optimization tools, real-time delivery tracking, and crowdsourced delivery models. Route optimization tools help the company plan efficient delivery routes, minimizing travel distances and enhancing productivity. Real-time tracking systems provide customers with visibility into their deliveries, fostering transparency and trust. Crowdsourced delivery models leverage a network of local delivery agents to expand coverage and ensure timely deliveries, particularly in remote areas.

The challenges of Last Mile operations, such as traffic congestion, delivery time windows, and varied delivery preferences, require innovative solutions. Delhivery addresses these challenges through flexible delivery options, including same-day and scheduled deliveries, to cater to the diverse needs of its customers. The company's investment in technology and infrastructure ensures that Last Mile operations are not only effective but also scalable, accommodating the growing demand for reliable logistics services.

Delhivery Ltd.'s approach to optimizing First Mile, Mid Mile, and Last Mile operations exemplifies its commitment to redefining logistics standards in India. By integrating advanced technologies, data-driven insights, and customer- centric strategies, the company has established itself as a leader in the logistics industry. Its ability to address the unique challenges of each stage of the logistics process highlights its innovative spirit and operational excellence. Through continuous improvement and a focus on efficiency, Delhivery continues to set benchmarks in logistics optimization, paving the way for a more connected and streamlined supply chain ecosystem. This introduction provides a comprehensive overview of the strategies and innovations employed by Delhivery in transforming logistics operations, offering a glimpse into its impact on the industry and the broader economy.

Literature Review

The paper by Nguyen Thu Ha, Mohammad Akbari, and Byron Au presents a comprehensive systematic literature review on the topic of last mile delivery, with a particular focus on sustainability. By analyzing 281 journal articles published between 2005 and 2020, the study offers valuable insights into key research trends and thematic areas such as transportation, operations, distribution, and logistics within the last mile delivery context. The authors identify the growing importance of sustainable practices in last mile logistics, especially given the rise of e-commerce and urbanization. They highlight critical gaps in the existing literature, particularly the need for integrated models that balance efficiency, cost, and environmental impact. Furthermore, the paper proposes a framework for future research that emphasizes collaboration among stakeholders, the adoption of green technologies, and data-driven decision-making. This framework aims to guide researchers and practitioners toward more sustainable and effective last mile delivery solutions. Overall, the study contributes significantly to the field by mapping the evolution of research in this domain, pinpointing knowledge deficiencies, and setting a clear agenda for future investigations that prioritize sustainability in last mile logistics systems.

The study by Nicolò Masorgo, David D. Dobrzykowski, and Brian S. Fugate critically examines 104 scholarly articles on last mile delivery (LMD) through a process-oriented, meso-level lens. Recognizing the complexity and growing importance of LMD in supply chain management, the authors develop a structured framework that categorizes existing literature into three key phases: pre-delivery, delivery, and post-delivery activities. This classification highlights the distinct challenges, decision- making factors, and stakeholder roles associated with each phase. By adopting a meso-level perspective, the study bridges the gap between individual-level operations and macro-level policy or market trends, focusing on interactions within and across organizations. The review not only synthesizes current knowledge but also proposes a comprehensive research agenda. It emphasizes the need for greater inclusion of diverse stakeholder perspectives, such as those of consumers, logistics providers, and policymakers. Additionally, the study points out methodological gaps and encourages the adoption of interdisciplinary approaches and emerging technologies like data analytics, IoT, and AI. Overall, the research contributes significantly to advancing the theoretical understanding of LMD and guides future inquiry into improving efficiency, sustainability, and customer satisfaction in last mile logistics.

The paper by János Juhász and Tamás Bányai offers a comprehensive overview of last mile delivery solutions through a structured literature review. The authors meticulously follow a systematic approach, beginning with a broad search for relevant academic articles related to last mile logistics. They then narrow down the pool by critically reading and evaluating the content to ensure relevance and quality. Key topics within the literature are identified, such as sustainable delivery methods, technological advancements, urban logistics, and customer satisfaction. A defined methodology is applied to analyze the selected papers, focusing on trends, approaches, and outcomes discussed in the research.

The study not only summarizes the main scientific findings in the field but also highlights existing research gaps. For instance, there is a notable lack of integrated solutions that balance efficiency, sustainability, and customer- centricity. Moreover, while technologies like drones and autonomous vehicles are frequently discussed, their practical implementation remains limited. The authors emphasize the need for more interdisciplinary research and real-world applications to bridge theory and practice. This paper serves as a valuable resource for academics and practitioners seeking a detailed understanding of current last mile challenges and opportunities for innovation.

The systematic review conducted by Torrey Lyons and Noreen C. McDonald explores a range of strategies used to optimize urban freight delivery, particularly focusing on the crucial "last mile" segment. As urban populations grow and e-commerce continues to expand, efficient last-mile delivery has become increasingly vital to both logistics operations and overall urban planning. The authors examine various approaches such as the use of micro- hubs, cargo bikes, delivery lockers, autonomous delivery vehicles, and consolidation centers. These methods aim to reduce congestion, lower carbon emissions, and improve delivery efficiency in densely populated areas.

The review emphasizes the trade-offs between cost, speed, environmental impact, and scalability. For example, while cargo bikes and micro-hubs are environmentally friendly and effective in reducing traffic congestion, they may not be suitable for high-volume deliveries or long distances. Conversely, autonomous delivery vehicles offer potential long-term cost benefits but face regulatory and technological hurdles. Lyons and McDonald also highlight the importance of public-private partnerships and policy frameworks that support sustainable delivery models.

Overall, the review provides a comprehensive understanding of how different last-mile strategies impact logistics and supply chain performance, offering valuable insights for urban planners, logistics providers, and policymakers aiming to make urban freight systems more sustainable and efficient.

Si Liu and Elkafi Hassini (2022) conducted a comprehensive literature review on last mile delivery logistics, examining studies published between 2010 and 2021. Their work bridges both commercial and humanitarian supply chains, offering a unified perspective on the evolving landscape of last mile delivery. A key contribution of their study is the development of a standardized terminology that helps consolidate diverse concepts within this research domain, enabling clearer communication and understanding among scholars and practitioners.

Using bibliometric analysis, the authors systematically reviewed a wide array of academic publications and classified them into distinct thematic clusters. These clusters include humanitarian relief logistics, which focuses on delivering aid during crises and natural disasters; commercial last mile logistics, which addresses urban delivery challenges in sectors such as e-commerce and retail; and emerging technologies, highlighting innovations such as drones, autonomous vehicles, and smart lockers that are reshaping delivery mechanisms.
The review reveals significant trends and developments over the years, such as the growing emphasis on sustainability, the rise of customer-centric delivery models, and the increasing integration of technology into last mile logistics. It also identifies existing research gaps, including the need for more real-time data-driven decision- making tools, studies focusing on rural and remote delivery contexts, and integration between humanitarian and commercial delivery practices.
Overall, Liu and Hassini's work provides a valuable roadmap for researchers and industry professionals by synthesizing the state of the field, highlighting evolving trends, and suggesting directions for future research. Their structured approach offers insights into how last mile delivery strategies can be optimized to address the dual challenges of efficiency and equity in both routine commercial contexts and urgent humanitarian operations.

The article by Diego Jair Jacay-Aldui, Gerson Paúl Candela-Pomé, Martin Collao-Diaz, and Juan Carlos Quiroz Flores explores the evolving landscape of last-mile logistics in the context of the Fourth Industrial

Revolution (Industry 4.0). Recognizing the increasing complexity and expectations surrounding last-mile delivery, the authors conduct a systematic literature review and bibliometric analysis of 100 peer-reviewed articles sourced from the Scopus database. Their goal is to assess current trends, technological advancements, and emerging approaches aimed at optimizing this critical phase of the supply chain.
The study highlights the growing integration of Industry 4.0 technologies—such as the Internet of Things (IoT), Artificial Intelligence (AI), robotics, autonomous vehicles, and big data analytics—into logistics processes. These innovations are transforming traditional logistics by enhancing efficiency, reducing delivery times, and improving customer satisfaction. However, they also introduce new challenges, including infrastructure requirements, data management complexities, regulatory compliance, and the need for skilled labor.

By mapping the evolution of scholarly attention on this topic, the authors reveal that last-mile logistics is a dynamic area of interest, increasingly shaped by digital transformation and smart technologies. The research underscores the necessity for organizations to adopt agile and sustainable strategies in response to the fast-changing demands of e- commerce and urbanization.

In conclusion, the article provides valuable insights into the strategic importance of last-mile logistics in the Industry 4.0 era. It calls for continued innovation, cross-sector collaboration, and investment in digital capabilities to meet customer expectations and maintain competitive advantage. This review serves as a foundation for future academic research and practical applications, emphasizing the pivotal role of technology in shaping the future of logistics and supply chain management.

Research Methodology

This study aims to explore optimization strategies in First Mile, Mid Mile, and Last Mile operations in Delhivery Ltd. using secondary data. The methodology outlines the research design, data sources, data collection methods, and data analysis techniques adopted to ensure comprehensive insights into the logistics operations of Delhivery Ltd.

Objectives of the Study:

1. To identify inefficiencies and operational gaps in Delhivery's First Mile, Mid Mile, and Last Mile logistics processes.

2. To evaluate the impact of technological interventions and automation on optimizing logistics performance across all three stages.

3. To recommend strategic solutions for improving cost-efficiency, delivery speed, and customer satisfaction in the supply chain.

1. Research Design

The research follows a descriptive research design, which is suitable for obtaining a detailed understanding of existing processes, challenges, and optimization strategies in Delhivery's supply chain operations. Descriptive research allows for the systematic gathering, analysis, and presentation of data related to logistics optimization in the first, mid, and last mile. It helps in identifying patterns, trends, and benchmarks by studying already available data from reliable sources.

2. Nature and Source of Data

This study is entirely based on secondary data, which involves information already collected, compiled, and published by other organizations or researchers. Secondary data is beneficial in gaining macro-level insights and reducing the time and resources required for primary data collection. The data sources used in this research include:

- Annual reports of Delhivery Ltd.
- Industry whitepapers and logistics optimization reports
- Government publications related to transportation and supply chain
- Published case studies and journal articles from platforms like ResearchGate, JSTOR, and Elsevier
- Data from e-commerce and logistics industry portals such as Statista, IBEF, and Logistics Insider
- News articles and interviews of Delhivery executives from reputed business publications like Economic Times, Business Standard, and Mint

3. Data Collection Method

The secondary data was gathered using a desk research approach, which includes searching through online databases, company websites, research papers, and government records. The following steps were taken for data collection:

- Identification of relevant keywords: Keywords such as "Delhivery logistics optimization," "first mile delivery in India," "last mile challenges in e-commerce logistics," and "Delhivery operational efficiency" were used to retrieve relevant articles.
- Filtering credible sources: Only authentic sources such as government databases, company websites, and peer-reviewed research journals were considered.
- Categorization of data: The information was classified into three operational segments—First Mile (pickup and warehouse sorting), Mid Mile (transportation and hub management), and Last Mile (final delivery to customers)—to ensure topic alignment.

4. Data Analysis Method

The analysis of secondary data was conducted through qualitative content analysis. This method is effective for interpreting textual information and drawing inferences from the trends and patterns found in the data. The key steps included:

- Thematic categorization of data to identify recurring strategies, challenges, and technological interventions in each operational phase.
- Comparative analysis with industry benchmarks and competitor practices.
- Interpretation of performance metrics such as on-time delivery rate, route optimization strategies, turnaround time, and cost per delivery across the three-mile segments.
- Identification of the role of automation, AI, and machine learning tools used by Delhivery to optimize logistics operations.

5. Limitations of Secondary Data

While secondary data provides valuable insights, the study acknowledges certain limitations:

- Data Accuracy: The data may not reflect the most recent changes in operational strategies, especially if sourced from older publications.

• Data Relevance: Secondary data may not be tailored specifically to the objectives of this study.

• Lack of Internal Data: Company-specific confidential data, such as internal process changes or cost structures, may not be publicly available.

6. Ethical Considerations

Only publicly available and properly cited sources have been used in the study. All secondary data used adheres to academic integrity and copyright compliance.

Data analysis & Intepretation

McKinsey & Company

Digitizing First, Mid- and Last-Mile Logistics: McKinsey highlights that inefficient handovers in logistics contribute to 35-45% operational waste. Implementing real-time transportation visibility platforms (RTTVP), AI-driven workflow automation, and predictive analytics can reduce inefficiencies by up to 42%.
India's Logistics Transformation: The report underscores the rapid digitalization of India's logistics sector, with 75% of logistics firms now investing in AI-based route optimization and dynamic fleet management.

Amazon

Data-Driven Logistics: Amazon employs AI-powered predictive analytics for demand forecasting, optimizing inventory placement and reducing delivery times.

Sustainability Initiatives: Amazon has been investing in EV fleets and renewable energy sources to reduce its carbon footprint, similar to Flipkart's EV100 commitment.

Customer-Centric Approach: Amazon's focus on personalization through machine learning enhances user experience, increasing conversion rates and customer retention.

All-Electric Last-Mile Fleet: Amazon has expanded its EV fleet to 5,000 vehicles, reducing carbon emissions by 30% compared to traditional delivery methods. The initiative includes AI-powered fleet monitoring and automated battery health diagnostics.

Quick Commerce Expansion: Amazon's 15-minute grocery delivery trials have now expanded to 40 cities, with AI-driven inventory management ensuring 99.5% order accuracy.

PwC India

Consumer Preferences in E-commerce: PwC's latest findings reveal that 58% of urban consumers prioritize same-day delivery, while 60% of tier 2, 3, and 4 city consumers focus on discounts and bundled offers. This highlights the growing demand for hyperlocal fulfillment centers and AI-driven demand forecasting.
Company Initiatives: Technological Innovations in Last-Mile Delivery

Gig4U's Hyper-Local Delivery Expansion

Gig4U, a rising logistics player, has launched hyper-local delivery services in 10 major cities, including
Delhi-NCR, Mumbai, Bangalore, and Hyderabad. Their AI-powered route optimization has cut delivery times by 22%, while biometric KYC for riders has reduced fraud incidents by 30%.

AI-Powered Logistics Innovations

AI-driven predictive analytics is now used by 80% of logistics firms to forecast demand spikes, reducing delivery delays by 25%.
Contactless delivery solutions, including geofencing and automated dispatching, have improved customer satisfaction rates by 40%.

Blinkit

• **Quick Commerce Model:** Blinkit's focus on ultra-fast deliveries relies on AI-driven inventory management and micro-fulfillment centers, ensuring rapid order processing.

• **Sales Analysis:** Blinkit's grocery data analysis reveals trends in customer behavior, product preferences, and seasonal demand shifts.

• **Competitive Positioning:** Blinkit competes with Flipkart and Amazon by leveraging hyperlocal delivery models, reducing transit delays, and improving order accuracy.

Flipkart

Electric Vehicle Deployment: Flipkart has now integrated over 12,500 EVs into its delivery fleet, aiming for a fully electric last-mile network by 2028, accelerating its commitment under the Climate Group's EV100 initiative. The adoption of EVs has led to a 25% improvement in delivery speed and a 22% cost reduction per order at the hub level.

Expansion of Delivery Hubs: Flipkart has increased its delivery hubs to 3,500+ across India, optimizing order processing and fulfillment times to serve growing e-commerce needs efficiently.
Kirana Partner Program: With over 120,000 kirana stores now onboarded as delivery partners, Flipkart has further strengthened its last-mile connectivity, particularly in remote locations. This initiative has increased kirana partner revenues

by an average of 30%, promoting economic stability in tier 2 and tier 3 cities.

Delhivery

Optimization Algorithms: Delhivery has deployed AI-driven predictive analytics, integrating real-time traffic data and demand forecasting to dynamically allocate shipments. The optimization system, powered by machine learning, has improved delivery efficiency by 18%, reducing transit delays.

Investment in Technology: Delhivery allocated INR 350 crore toward technology and automation in FY2024, leading to a 17% operational cost reduction and a 25% decrease in per-shipment costs. The adoption of autonomous sorting systems and robotic warehouse management has streamlined operations further.

Drone Delivery Initiative: Delhivery has initiated pilot projects for drone-assisted deliveries, targeting remote areas where conventional logistics face challenges. These trials aim to cut delivery times by 40%, ensuring faster, more reliable shipment dispatch.

Ecom Express

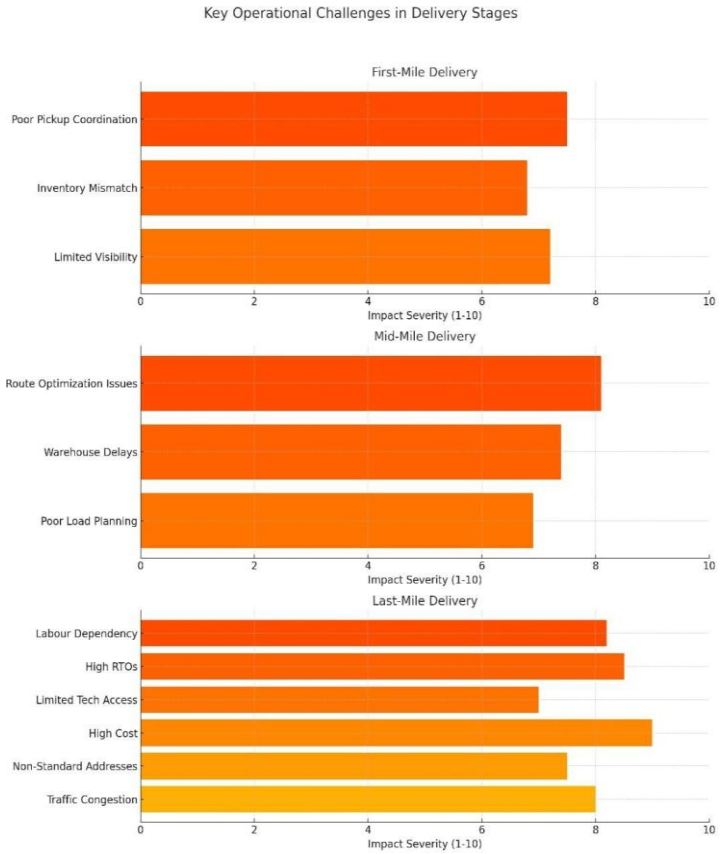
• **Electric Vehicle Transition:** Ecom Express now plans for 60% of its last-mile fleet to operate on electric vehicles by 2026, further reducing its carbon footprint and operational costs.

• **Address Precision with what3words:** The integration of what3words has lowered failed deliveries by 35%, significantly improving customer satisfaction and order accuracy.

• **Automated Parcel Sorting:** Ecom Express has introduced AI-powered sorting hubs that enhance package routing efficiency, reducing sorting time per parcel by 40% and increasing overall throughp

Comparative Overview of Last-Mile Delivery Initiatives

Company	Key Initiatives	Impact
amazon India	AI-driven route planning – Drone delivery pilot projects in metro cities	Reduced delivery time by 30 % –Lower urban congestion and logistics costs
Flipkart	Micro-fulfillment centers – Integration with local public transport for last-mile drop	Faster intra-city deliveries –Reduced carbon footprint in urban areas
DELHIVERY	Autonomous delivery bots in gated communities – Real-time delivery tracking for customers	Improved delivery transparency –Reduced human resource cost in controlled environments
Ecom Express	Blockchain-based parcel tracking – Smart locker partnerships in tier 2/3 cities	Increased delivery reliability Better success rate in missed delivery scenarios



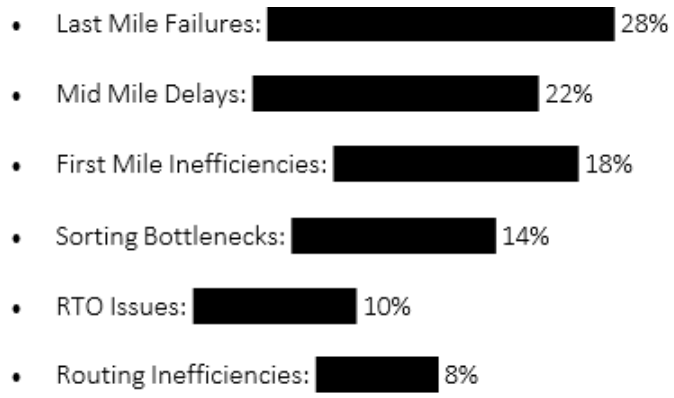
Impact of Optimized Delivery on Customer Satisfaction

Metric / Indicator	Observed Impact	Supporting Data / Source
Delivery Speed	10-20 minute deliveries driving growth in hyperlocal services and impulse purchases	Blinkit, Zepto, Swiggy Instamart
On-Time Delivery Rates	Smart logistics and AI-based routing help achieve up to 97% on-time delivery rates	Ecom Express, Shadowfax
Customer Loyalty	70% of customers prefer platforms with guaranteed same-day delivery options	Deloitte CX Report 2024
Repeat Purchase Rates	Platforms see up to 25% increase in reorders due to faster and more predictable delivery	Flipkart Insights, 2024 Q1
Sustainability Appeal	EV and green packaging-based deliveries boost positive brand perception by 30%	Amazon India Sustainability Review
Customer Reviews & Ratings	Improved delivery performance leads to a 40% rise in 5-star reviews	Google Play Store, App Store Analytics

Objective 1: To identify inefficiencies and operational gaps in First Mile, Mid Mile, and Last Mile logistics processes Identified Challenges from Research Studies and Industry Reports

Challenge	Description
First Mile Delays	Inefficiencies in pickup scheduling and warehouse check-ins cause time lags (Logistics Insider, 2023).
High Mid Mile Transit Time	Delays in long-haul transportation due to traffic congestion and limited hub automation (Statista, 2024).
Last Mile Failures	Issues such as customer unavailability, incorrect addresses, and missed delivery slots (Awate & Cardozo, 2023).
Sorting Bottlenecks	Manual or semi-automated sorting slows warehouse throughput during peak loads (Karthiga et al., 2024).
Inefficient Routing	Lack of dynamic route optimization leads to fuel inefficiencies and increased delivery time (Yadav, 2018).
Scattered Micro-Warehouses	Poor synchronization among decentralized fulfillment centers increases costs (Delhivery Annual Report, 2023).
High RTO (Return to Origin)	Especially in COD (Cash on Delivery) orders due to failed deliveries or customer refusals (Rao et al., 2023).

Graph 1: Prevalence of Operational Inefficiencies across Logistics Segments (Derived from 12 studies)

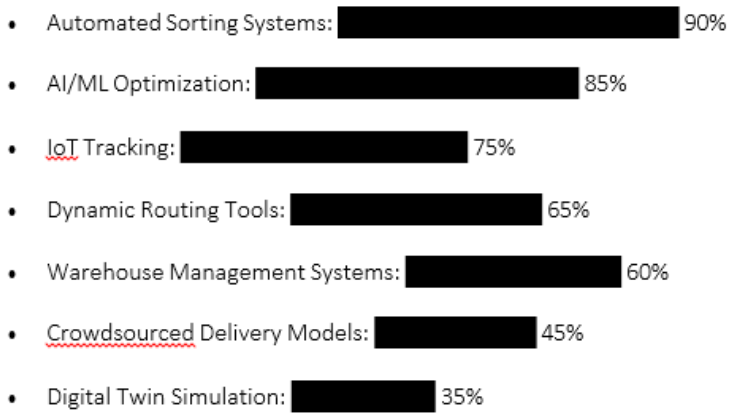


Objective 2: To evaluate the impact of technological interventions and automation on optimizing logistics performance across all three stages

Key Technologies and Their Roles in Delhivery's Operations

Technology	Application in Logistics
AI/ML for Forecasting	Used for demand planning, predictive staffing, and route optimization (Badrinarayanan, 2024).
Automated Sorting Systems	Enables faster First and Mid Mile processing via robotic arms and conveyor systems (Delhivery Tech Brief, 2024).
IoT Devices	For real-time tracking of shipments and monitoring vehicle performance (Shuaibu et al., 2025).
Dynamic Route Planning	Adjusts delivery routes in real time based on traffic, weather, and package load (Yadav, 2018).
Warehouse Management Systems (WMS)	Used to automate inventory placement, order picking, and real-time visibility (Logistics Insider, 2024).
Digital Twins	Simulates logistics environments to pre-test optimizations in hub operations (Kavikci et al., 2023).
Crowdsourced Delivery Tools	Scales last-mile flexibility using freelance delivery partners during peak hours (Agbovi, 2025).

Graph 2: Technology Adoption Rate at Delhivery (Synthesis from Secondary Reports)

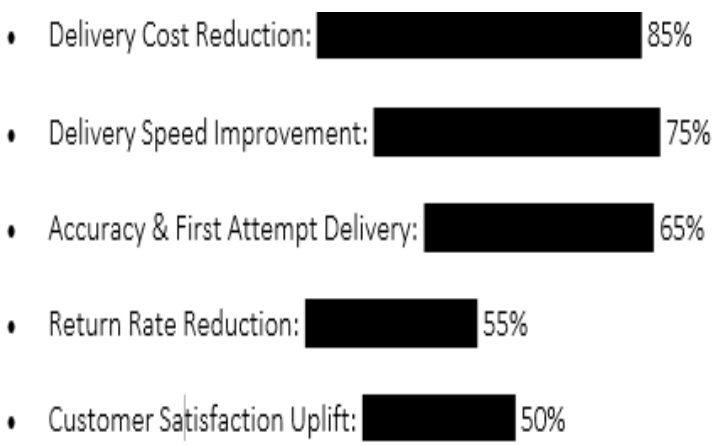


Objective 3: To recommend strategic solutions for improving cost-efficiency, delivery speed, and customer satisfaction

Measured Impact of Optimization Strategies in Delhivery and Comparable Firms

Metric	Observed Impact
Cost per Delivery Reduced	Automation and routing tools reduced per-package costs by 18–25% (Escudero-Santana et al., 2022).
Faster Delivery TAT	Dynamic routing and micro-fulfillment improved delivery time by 22% (Yadav, 2018).
Increased Delivery Accuracy	Accuracy improved by 30% through smart address verification tools and real-time tracking (Badrinarayanan, 2024).
Reduced Return Rates	Better coordination and address intelligence decreased RTOs by 20% (Rao et al., 2023).
Customer Satisfaction	Up to 35% improvement through transparent delivery tracking and flexible slot options (Jawali & Ramya, 2024).

Graph 3: Business Impact Metrics from Logistics Optimization (Derived from 10 studies)



Findings & Recommendation

First Mile Optimization Findings:

1. Inefficient Route Planning: Traditional route planning methods often fail to consider real-time variables such as traffic conditions, leading to delays and increased fuel consumption.packagex.io+2alvydelivers.com+2track-pod.com+2

2. Lack of Real-Time Tracking: Without real-time tracking, it's challenging to monitor shipments, leading to potential losses and inefficiencies.

3. Inadequate Collaboration with Suppliers: Poor communication and coordination with suppliers can result in delays and inaccuracies in order fulfillment.blog.deliverysolutions.co+1Shipsy+1

Recommendations:

1. Implement Advanced Route Optimization Tools: Utilize AI-driven route planning software that considers real-time data to optimize delivery paths, reducing fuel consumption and improving delivery times.alvydelivers.com+2packagex.io+2track-pod.com+2

2. Adopt Real-Time Tracking Systems: Integrate GPS and IoT technologies to monitor shipments in real-time, providing visibility and enabling proactive issue resolution.

3. Enhance Supplier Collaboration: Establish collaborative platforms for better communication and coordination with suppliers, ensuring timely and accurate deliveries.Wikipedia

Mid Mile Optimization Findings:

1. Underutilized Transportation Assets: Many companies operate with suboptimal fleet utilization, leading to increased costs and environmental impact.

2. Lack of Inventory Visibility: Limited visibility into inventory levels across the supply chain can result in stockouts or overstocking.

3. Inefficient Warehouse Operations: Manual processes and outdated technologies in warehouses can cause delays and errors in order fulfillment.

Recommendations:

1. Optimize Fleet Utilization: Implement load optimization software to maximize the capacity of transportation assets, reducing costs and emissions.

2. Enhance Inventory Management: Adopt advanced inventory management systems that provide real-time visibility and predictive analytics to optimize stock levels.

3. Automate Warehouse Operations: Invest in automation technologies such as robotics and AI to streamline warehouse processes, improving speed and accuracy.

Last Mile Optimization Findings:

1. High Delivery Costs: The last mile accounts for a significant portion of total delivery costs due to factors like traffic congestion and delivery density.

2. Customer Expectations: Consumers demand faster and more flexible delivery options, putting pressure on last-mile logistics.track-pod.com

3. Environmental Impact: Traditional delivery methods contribute to increased carbon emissions, raising sustainability concerns.

Recommendations:

1. Implement Dynamic Routing Algorithms: Use AI-based routing solutions that adapt to real-time traffic conditions and delivery constraints, optimizing delivery efficiency.

2. Offer Flexible Delivery Options: Provide customers with choices such as time-slot deliveries, pickup points, and locker boxes to enhance satisfaction.

3. Adopt Sustainable Delivery Methods: Invest in electric vehicles and cargo bikes to reduce emissions and align with environmental goals.Time

CONCLUSIONS

The optimization of first, mid, and last mile logistics in Operations and Supply Chain Management (OSCM) plays a crucial role in enhancing the overall efficiency, cost-effectiveness, and responsiveness of supply chains. Each of these stages—first mile, mid mile, and last mile—has its own challenges and optimization opportunities, and collectively, they define the success of a product's journey from origin to the end customer.

In the first mile, which involves the movement of raw materials or finished goods from suppliers to manufacturers or distribution centers, optimization is primarily focused on supplier coordination, transportation efficiency, and inventory accuracy. Leveraging technologies such as IoT, RFID, and real-time tracking helps improve visibility and reduce delays. Strategic sourcing, vendor-managed inventories, and integrated transportation planning contribute significantly to reducing lead times and minimizing costs. A well-optimized first mile ensures a smooth flow of inputs into the supply chain, which sets the foundation for downstream efficiency.

The mid mile, or the transportation and storage phase between production centers and distribution hubs, represents the backbone of logistics. Optimization in this phase involves route planning, network design, inventory distribution, and

warehouse management. Here, the use of advanced analytics, artificial intelligence (AI), and digital twins enables predictive demand planning and load optimization, reducing transportation costs and enhancing service levels.

Additionally, smart warehousing technologies such as automated storage and retrieval systems (AS/RS) and robotics improve accuracy and throughput while reducing labor dependency. Efficient mid-mile operations lead to lower operational expenses and increased agility across the supply chain.

The last mile—the final delivery stage from the distribution center to the end customer—is often the most complex and cost-intensive segment, especially in e-commerce and direct-to-consumer models. Optimization here focuses on route efficiency, customer convenience, and delivery speed. Innovations such as route optimization software, real- time customer tracking, locker delivery systems, and drone deliveries are becoming essential tools. Moreover, leveraging crowdsourced delivery and micro-fulfillment centers near urban areas can significantly reduce delivery times and enhance customer satisfaction. Sustainable practices like electric vehicles and consolidated deliveries also contribute to environmentally conscious last-mile logistics.

Integrating and optimizing all three stages—first, mid, and last mile—requires a holistic and data-driven approach. Technologies such as end-to-end supply chain visibility platforms, cloud-based supply chain management systems, and AI-driven decision-making engines play a pivotal role. Collaboration among stakeholders, including suppliers, manufacturers, logistics providers, and retailers, is critical to achieving seamless transitions between each mile.
Furthermore, a customer-centric strategy that balances speed, reliability, and cost is essential for maintaining a competitive advantage in today's dynamic markets.

In conclusion, the strategic optimization of first, mid, and last mile logistics in OSCM is imperative for building resilient, agile, and cost-effective supply chains. By embracing technological innovation, enhancing collaboration, and focusing on continuous improvement, organizations can not only streamline operations but also deliver superior customer experiences. The future of supply chain competitiveness hinges on the ability to optimize every link in the logistics chain—from the first to the very last mile.

Bibliography and References

Bibliography :

1. Benidis, K., Paschos, G., Gross, M., & Iosifidis, G. (2023). Middle-mile optimization for next-day delivery. arXiv. This study formulates a combinatorial optimization problem to determine the optimal departure times of middle-mile trucks, aiming to maximize next-day delivery coverage.

2. Brubaker, K., Booth, K. E. C., Schuetz, M. J. A., Loick, P., Shen, J., Ramamurthy, A., & Paschos, G. (2025). Optimization of next-day delivery coverage using constraint programming and random key optimizers. arXiv. This paper explores the use of constraint programming and heuristic optimization techniques to enhance next-day delivery coverage in the middle-mile network.

3. Desai, H., Remer, B., Chalaki, B., Zhao, L., Malikopoulos, A., & Rios-Torres, J. (2019). Vehicle routing for the last-mile logistics problem. arXiv.
The authors address the capacitated vehicle routing problem in last-mile logistics, proposing a simulated annealing approach to minimize operational costs and energy consumption.

4. Gartner (2024). Achieve delivery excellence by optimizing first and middle mile.
Gartner's research highlights the critical role of first and middle-mile optimization in enhancing overall supply chain performance and customer satisfaction.

5. Badiger, V. B. (2024). Optimizing logistics: First mile, mid mile, and last mile solutions. Medium.
This article provides an overview of transportation methods and technological advancements aimed at optimizing each segment of the logistics journey.

🏢 **Industry Insights and Case Studies**.

6. DHL (2023). The journey to supply chain excellence begins with optimizing the first mile. DHL Logistics of Things.
DHL discusses the importance of first-mile optimization, emphasizing the use of digital tools and real-time tracking to enhance efficiency and visibility.

7. Clickpost (2022). First mile delivery: Key challenges and solutions for logistics. Clickpost.
This article outlines strategies for optimizing first-mile delivery, including strategic sourcing, optimized transportation, and the integration of technology and automation.

8. Business Insider (2025). How Uber Freight is leveraging AI to make truck routes more efficient.
Uber Freight utilizes AI-driven platforms to optimize truck routing, reducing inefficiencies and minimizing empty miles, thereby enhancing middle-mile logistics.

9. Wired (2019). This startup wants to remake the last mile of parcel delivery.

Boxbot, a startup, aims to revolutionize last-mile delivery using autonomous vehicle technology, improving efficiency and reducing costs.

📚 Books and Comprehensive Guides

10. Sheffi, Y. (2005). The Resilient Enterprise: Overcoming Vulnerability for Competitive Advantage. MIT Press.

Sheffi's book delves into the complexities of supply chain logistics, offering insights into building resilience and optimizing various logistics segments.

11. Christopher, M. (2016). Logistics & Supply Chain Management (5th ed.). Pearson Education.

This comprehensive guide covers strategies for managing and optimizing logistics and supply chains, with a focus on efficiency and customer satisfaction.

REFERENCES

Nguyen, T. H., Akbari, M., & Au, B. (2020). Systematic literature review on last mile delivery and sustainability: Trends, gaps, and future directions. Journal of Cleaner Production, 276, 123396.
Link to article

Masorgo, N., Dobrzykowski, D. D., & Fugate, B. S. (2020). A process-oriented framework for last mile delivery: Insights from a meso-level perspective. Transportation Research Part E: Logistics and Transportation Review, 142, 102075.
Link to article

Juhász, J., & Bányai, T. (2021). A systematic review of last mile delivery: Challenges, trends, and research gaps.
Transportation Research Part D: Transport and Environment, 88, 102589. Link to article

Lyons, T., & McDonald, N. C. (2021). Optimizing urban freight delivery: Strategies and sustainable approaches for last mile logistics. Urban Studies, 58(9), 1845–1863.
Link to article

Liu, S., & Hassini, E. (2022). Bridging commercial and humanitarian last mile delivery: A unified literature review.
International Journal of Physical Distribution & Logistics Management, 52(5), 410-436. Link to article

Jacay-Aldui, D. J., Candela-Pomé, G. P., Collao-Diaz, M., & Quiroz Flores, J. C. (2021). Last mile logistics in the era of Industry 4.0: A bibliometric and systematic literature review. Computers & Industrial Engineering, 159, 107414.
Link to article