TRANSFORMING LAST-MILE DELIVERY IN INDIA: SMART AND ECO-FRIENDLY SOLUTIONS

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Abstract

This article contains a critical analysis of the topic 'Transforming last-mile delivery in India: smart and eco-friendly solutions.' The traditional last-mile delivery practices, smart and eco-friendly solutions and opportunities and challenges of smart and eco-friendly solutions in India are discussed. The article is divided into an abstract, introduction, research object and methods, research results and discussion and conclusions. Whether the last mile delivery in India has been transforming or is still following the traditional methods is evaluated. The secondary data collection method was followed and the data was collected from online and offline articles, books, online news and reports. A case study analysis was completed. The companies in India are still behind traditional last-mile delivery, like manual processing, two-wheelers for delivery and cash on delivery. However, Flipkart, Amazon, DTDC and Apollo hospitals are following smart and eco-friendly solutions in last-mile delivery, like using EVs for delivery and drones. The analysis found that cost saving, reducing carbon emissions and improving customer satisfaction are the opportunities of smart and eco-friendly solutions; yet, high initial cost and poor infrastructure in India would be barriers to follow. It may take years for the large use of smart and eco-friendly solutions in the Indian market.

***Keywords*:** last-mile delivery, smart, eco-friendly, solutions, India, practices, Indian market.

Introduction

Last-mile delivery is the stage in the supply chain process where customers receive the product they ordered from a brand through a delivery agent. The product will reach the hands of customers from a delivery unit or warehouse (Ha et al., 2023). This is a crucial step in the supply chain process of an organisation due to its direct connection with the customer. From a customer's perspective, last-mile delivery is very critical for the organisation as it determines customer satisfaction and engagement (Sharma et al., 2022). Likewise, Last-mile delivery is challenging because of the rising traffic congestion and increased numbers of deliveries every day for organisations (Masorgo et al., 2024).

In the Indian market, the Last-mile delivery has been changing by adopting Smart and Eco-Friendly Solutions (Upadhyay et al., 2021). However, this often occurs in metro cities. This has been causing the Indian cities to witness unsustainable delivery acts, which are against the United Nations Sustainable Development Goals [UNSDGs] (Hassani et al., 2021). In this context, the current article assesses the transformation of last-mile delivery in India with a special focus on smart and eco-friendly solutions. After assessing the current and smart solutions, advanced smart and eco-friendly solutions are recommended. The critical discussion in the article will be contributing to the sustainable logistics of India and thereby supporting the UNSDGs.

Research aim: To identify and analyse the transformation of last-mile delivery in India, especially the smart and eco-friendly solutions adopted in the Indian market.

The following **objectives** have been set to achieve the aim:

1. To assess the traditional last-mile delivery practices in India and the associated challenges for companies and customers.
2. To evaluate the smart and eco-friendly solutions adopted by companies in the Indian market for last-mile delivery.
3. To analyse the opportunities and challenges of smart and eco-friendly solutions in the last-mile delivery practices for companies in the Indian market.
4. To provide advanced smart and eco-friendly solutions for companies in India for sustainable logistics.

Research object and methods

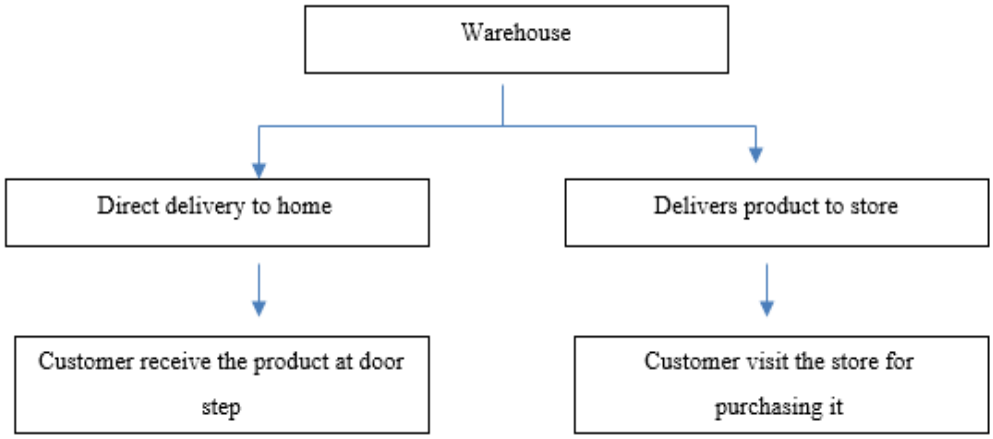
The current research has pursued a case study analysis considering the last-mile delivery case of India. As part of this, a secondary data collection method was used for the data collection. Journal articles and online articles were referred. In this way, traditional last-mile delivery practices in India and the associated challenges, smart and eco-friendly solutions adopted by companies in the Indian market and opportunities and challenges of smart and eco-friendly solutions were identified. On the basis of this understanding, advanced smart and eco-friendly solutions are recommended for Indian companies.

Research results and discussion

Traditional last-mile delivery practices in India: Challenges for companies and customers

Manual processes in delivery practices, especially in the planning of routes and manual writing of notes and addresses, is a notable current practice followed by some companies in India, including local companies (Singh, 2019). The manual route planning and writing are time-consuming, and also, the chances of errors are high, which will increase

fuel consumption as well. Likewise, Patil and Majumdar (2022) observed that two-wheelers are commonly used in India for delivery, anticipating road traffic and long routes. As a result, companies are not able to deliver bulk orders, which is time-consuming as different trips are needed for the delivery on the same routes.



Source: Created by the author

Fig 1: Traditional last mile

Though online and instant payment are used in India for home delivery, cash on delivery is still a common and accepted payment method in India (Chhapia, 2024). This has been affecting the job satisfaction of delivery employees due to the risks of financial management and the probability of high theft.

In the opinion of Deb et al. (2024), the remote and village areas of India, the delivery services are managed by local courier agents that are often unreliable and take a long time for the delivery. Because of the poor infrastructure and technologies, these agents cannot provide reliable and on-time delivery, which reduces customer satisfaction and trust.

Delayed on-road delivery due to high traffic in the urban areas of India, like Bangalore, Hyderabad and Mumbai, must be noted here (Tomtom, 2024). Here, the delivery boys are forced to wait long term on the road which leads to delayed delivery and thereby customer dissatisfaction and dumbing of many orders in the warehouses. This practice has been adversely affecting the revenue of companies and customer engagement.

The smart and eco-friendly solutions adopted by companies in India related to last-mile delivery

The deployment of EVs [Electric Vehicles] is a notable smart and eco-friendly last-mile delivery practice adopted by companies operating in India. In 2023, the e-commerce giant Amazon expanded its EVs to 6000 for the delivery service (Abrar, 2023). Likewise, Flipkart, the e-commerce rival of Amazon, has expanded the EVs to 10000 units (Electrive, 2024). Here, these companies are attempting to reduce carbon emissions and pollution and thereby contributing to the SDGs of the United Nations. In addition, Amazon and Flipkart are able to reduce the travel cost for product delivery through EVs, which again makes them smart and eco-friendly initiatives.

Drone delivery of products in India by companies is another smart and eco-friendly last-mile delivery practice. However, this practice is in the initial stage by different companies. For example, DTDC, an international courier company, launched Drone delivery, consuming 3.4 minutes for a product to deliver within 7.5 km. The incident occurred in Bilaspur to Gurugram in India, and the company accomplished this by joining Skye Air (The Hindu, 2024). Here, DTDC anticipated speed delivery to improve customer satisfaction along with avoiding pollution and carbon emissions by on-road delivery.

In 2025, Apollo hospitals in India initiated drone delivery for the delivery of medical samples, like biopsy samples (The Stat, 2025). Here, the management anticipated speed and on-time delivery of samples for the life-saving efforts. The e-commerce giants, like Flipkart and Amazon, have announced the potential to practice drone delivery to manage traffic and also for on-time delivery for better customer satisfaction (Sony, 2022; Bose, 2023). However, the implementation of this plan may take much more time.

Launching local warehouses is a notable last-mile delivery practice followed by Indian companies, especially e-commerce companies, like Amazon, Flipkart and Myntra (Juneja, Choudhary, 2024). This effort allows the companies to manage the traffic by serving products from the local area. As a result, customers can obtain the parcels on time and also, pollution and emissions are able to be controlled by the companies. Similarly, sustainable packaging has been adopted by e-commerce giants to achieve sustainability in last-mile delivery. Amazon, Flipkart, DTDC, Meesho and Myntra are some of the companies that uphold sustainable packaging (Sarkar et al., 2024). The recyclable and biodegradable materials used in the sustainable packages help the companies reduce waste and pollution.

Additionally, even if Indian businesses are progressively moving towards environmentally friendly and intelligent last-mile delivery options, a comparison with other international markets reveals important distinctions and potential areas for development. Last-mile delivery is becoming more and more optimised in developed economies like the US and Europe through automated warehouses, sophisticated AI-powered logistics, and widespread EV adoption (Javadnejad et al., 2024). In order to increase efficiency and decrease delivery times and fuel consumption, US companies such as

Amazon and Walmart have included AI-driven route optimisation and real-time tracking (Shavarani et al., 2018; Forbes, 2024). Similar to this, in order to streamline operations and save emissions, European firms such as DHL and DPD have implemented cargo bikes, autonomous delivery robots, and urban micro hubs (İNDAP, 2019).

Nevertheless, compared to well-planned cities like Berlin or San Francisco, the deployment of automated last-mile delivery vehicles is more complicated due to the unstructured nature of urban and rural road networks. Indian companies must make investments in modernising its infrastructure, encourage public-private collaborations, and look into sustainable models like government-subsidized EV charging stations and laws that allow drones in order to get beyond these challenges. The implementation of smart delivery solutions is slowed in India by structural constraints, regulatory barriers, and a lack of EV charging infrastructure (Pandit et al., 2023).

Thus, beyond EVs and drones, Indian businesses might investigate cutting-edge alternatives to improve last-mile delivery sustainability. In cities and suburbs, autonomous delivery vehicles (ADVs) like Amazon Scout and Nuro can lower expenses and dependency on human delivery workers (Srinivas et al., 2020). Additionally, dark stores and micro hubs can lower last-mile transportation costs and simplify inventory management. By forecasting client demand trends, streamlining delivery routes, and cutting fuel usage, AI algorithms can improve last-mile logistics. By constantly altering routes in response to traffic and meteorological circumstances, AI-driven routing solutions can assist Indian logistics companies in their fight against urban congestion (Sawik, 2024).

Furthermore, smart lockers and designated pickup locations which are already in use in China and Europe might be a useful way to cut down on last-mile inefficiencies in India (Zhang, Zhang, 2024). Similarly, to maximise order fulfilment, retail behemoths like Tata Cliq and Reliance Retail might use such methods. Furthermore, by guaranteeing real-time shipment tracking and confirming delivery completion, blockchain technology can improve transparency in last-mile delivery. This can increase customer and business trust, especially when it comes to expensive items like luxury products and technology.

The opportunities and challenges of smart and eco-friendly solutions for companies in the Indian market

Companies in India could enjoy and contribute to a greener environment through smart and eco-friendly solutions like drone delivery and EVs. This will not only contribute to the UNSDGs but also ensure a better living location for the Indian people and visitors (Omahne et al., 2021). In this way, social development can be contributed by companies. On the other hand, the e-commerce giants and local companies are able to save costs by adopting smart and eco-friendly solutions. For example, EVs would allow them to use charging points and electricity for the ride, which is comparatively lower cost than petrol and diesel (Siragusa et al., 2022). The drone delivery reduces delivery time, which also allows the companies to save costs without using fuels for the vehicle used for delivery (Eskandaripour, Boldsaikhan, 2023).

As per Vakulenko et al. (2019), better customer satisfaction is attainable for companies through smart and eco-friendly solutions in last-mile delivery. For example, the EVs' use will create a positive image of companies among customers as an outcome of sustainable actions to protect the environment in the form of electric vehicles. Likewise, drone delivery will ensure early delivery of products without delay (Eskandaripour, Boldsaikhan, 2023). Moreover, sustainable packaging also polishes brand image due to no harm to people and the environment by natural packaging (Boz et al., 2020). These lead to better customer satisfaction.

There are significant financial benefits to switching to intelligent and environmentally sustainable last-mile delivery. Businesses that invest in drones and EV fleets could expect long-term cost savings despite the high upfront price. For instance, in India, electric vehicles, which also have lower maintenance costs, are supported by government incentives such as reduced taxes and subsidies (Zhu et al., 2023; International Council on Clean Transportation, 2024). Similarly, drones can significantly lower fuel costs and facilitate faster delivery, increasing customer satisfaction and brand loyalty.

From an environmental perspective, reducing carbon footprints through sustainable delivery methods aligns with India's commitment to the global climate targets. The transport sector in India accounts for almost 12% of all CO2 emissions (IEA, 2023), and optimising last-mile delivery may be crucial to achieving sustainability targets. Thus, ingenious solutions like EV adoption and optimised routing could also reduce last-mile carbon footprints.

However, the companies may have an economic burden while incorporating EVs and drones as the particulars need high initial cost (Aurambout et al., 2019). Likewise, the lack of development of infrastructure, like charging stations and local workshops, may be a barrier to adopting EVs for last-mile delivery (Chhikara et al., 2021). Moreover, the nonavailability of apt locations in remote areas for drone delivery may be a challenge to implement the particular.

Conclusions

Though it continues to combine modern and ancient methods, last-mile delivery in India is changing. Many businesses still use traditional techniques like manual processing, two-wheelers for delivery, and cash-on-delivery payment schemes, even though large corporations like Flipkart, Amazon, DTDC, and Apollo Hospitals have embraced intelligent and environmentally friendly solutions like electric vehicles (EVs) and drones. The continuation of these customs underscores India's infrastructure constraints as well as the inclinations of Indian consumers and enterprises. But as businesses look for sustainability, cost-effectiveness, and efficiency, innovative logistics solutions will inevitably be adopted.

Additionally, intelligent and environmentally responsible last-mile delivery options provide significant opportunity. As EVs take the place of fuel-dependent cars and drones ease last-mile traffic, cost reductions become a significant benefit. Significant environmental advantages also result from lower carbon emissions, which support both

the UN Sustainable Development Goals (SDGs) and India's sustainability objectives. Better customer satisfaction is also a major result of these developments since quicker, more dependable, and ecologically friendly delivery systems increase customer loyalty and confidence.

Despite these advantages, a number of obstacles prevent broad implementation. Many businesses, particularly small and medium-sized businesses (SMEs), continue to be hampered by the large initial investment needed for drone technology and EV fleets. Significant obstacles are also presented by India's infrastructure, which includes a dearth of EV charging stations and restrictions on drone use. The scalability of these solutions is further constrained by semi-urban and rural areas' sluggish adoption of new technologies.

Therefore, a multi-stakeholder strategy is required to hasten this transformation. Businesses should be encouraged to invest in sustainable logistics by government policies that provide subsidies and infrastructure development. A more seamless integration of modern solutions can be achieved through cooperation between logistics companies, technology suppliers, and legislators. Future studies ought to examine the long-term financial effects of intelligent delivery systems as well as how AI might improve last-mile logistics. With sustained innovation and encouraging regulations, India's last-mile delivery system has the potential to set a global standard for effective and sustainable logistics.

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