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Innovation in Last Mile Delivery and Entrepreneurial Opportunities

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Abstract. Contextually, post-pandemic and e-commerce boom era has attributed to the optimizations of Last-mile delivery (LMD) however this has created a set of new challenges for both the logestics service performance and overall business success. Issues such as labour shortages, failed delivery attempts, traffic congestion, and carbon emissions highlight the importance of innovation. Therefore, this study reviews the challenges and obstacles in LMD, with a particular focus on the Saudi Arabian context. It also presents some key advancements in LMD and discusses real-world, successful cases, such as RedBox, which reflect the rebirth of logistics-centred entrepreneurship.
Furthermore, it highlights key directions for future research and opportunities for entrepreneurial investments, aiming to inform both scholars and practitioners navigating this rapidly evolving space.
Keywords: Last Mile Delivery, Innovation, Out of Home Delivery, Entrepreneur, Opportunities, Review.

Introduction

In the context of post-pandemic and e-commerce boom era, optimizations of Last-mile delivery (LMD) is proving to be evermore challenging for both the logestics service performance and overall business success (Suguna et al., 2022; Ma et al., 2022; Tsai et al., 2024). The LMD performance efficiency is a focal point when it comes to consumer delivery experience, since it relies profoundly on online and mobile commerce efficacy during product delivery (Kawa, 2020). This interaction creates a competitive space for e-retailers and logestic service providers (Mohri et al., 2024). Therefore, effective logistics processes intails knowledge on both consumer expectations and delivery strategies (Olsson et al., 2023).

A noted growth leap in Saudi Arabia's e-commerce sector has highlighted progress expectations in retail and logestics (Aljohani, 2024). Stimulated by digitization and increasing customer expectations, the e-commerce market in Saudi Arabia is projected to have an upwards trend from USD 27.96 billion

in 2025 to USD 49.49 billion in 2030, achieving a Compound Annual Growth Rate (CAGR) of 12.1% respectively (Statista, 2025). Moreover, consumer behaviour is rapidly shifting, with online shopping frequency doubling in the past two years and nearly 40% of shoppers purchasing groceries weekly online (McKinsey, 2024). Therefore, sustainable, scalable, efficient LMD solutions are paramount to the Saudi Arabia's modernization of its logistical landscape, addressed in its vision 2030, which sets future plans catering to these projected demands.

Despite the evident momentum, there is limited scholarly focus on how entrepreneurial ventures are leveraging emerging innovations (e.g., parcel lockers, autonomous delivery, crowdsourcing, and AI) to address last-mile delivery challenges—particularly within the Saudi Arabian context. The applicability of technological solutions were adamantly explored in the literature (e.g., drones, lockers, electric fleets), however the localization, feasibility, and entrepreneurial commercialization of these solutions within Saudi Arabia's regulatory, economic, and cultural context were not addressed sufficiently (Alhothali et al., 2024).

Innovation permits seeding entrepreneurial activity, empowering new firms and start-ups to emerge, have onset innovations capitalization, gain competitive advantages, and address the "last mile" challenges (Nagadeepa et al., 2024).

This study is a conceptual review paper that aims to explore how innovations in LMD add value to the emergence of entrepreneurial opportunities with a focus on the Saudi Arabian context. It elaborates on academic studies, real-world industry cases, and national strategic initiatives to illustrate whats new in the scope of urban delivery technological innovations, such as the use of smart lockers, autonomous vehicles, and crowd logistics. Furthermore, it highlights key directions for future research and investment, aiming to inform both scholars and practitioners navigating this rapidly evolving space.

Literature review

LMD is the final stage in the logistics supply chain, connecting product delivery from local warehouses to customers (Janinhoff et al., 2024). Moreover, LMD can be the most costly phase, accounting for approximately 50% of overall logistics expenses (Wise Systems, 2023; Skyes, 2023). Besides cost, Boysen et al. (2021) discussed five main challenges faced in LMD: Increasing volume of shipments driven by urbanization and the growth of e-commerce, sustainability, and the increased volume of shipments necessitating more delivery vehicles, which negatively impacts the environment, health, and infrastructure, and contributes to congestion (Sahu et al., 2021). The costs of traditional delivery methods, such as those using vans or bikes, are expensive. Costs are further inflated by traffic congestion and the scarcity of parking in urban areas. Failed deliveries attempts can also be challenging to overcome, since it is heavily influenced by logistical factors, such as: uncertainty about parking, accurate customer addresses, and customer availability (Mohammad et al., 2023; Wang et al., 2023). Time pressure: The rise in e-commerce has led to a significant increase in parcel volume, as well as a growing demand for faster deliveries, including next-day or same-day services (Vakulenko et al., 2018; Yuen et al., 2019). LMD operations must follow very tight deadlines, and they contend with stochastic workloads that fluctuate significantly throughout the week and year, necessitating flexible and scalable solutions (Mangiaracina et al., 2019). Additionally**,** they must contend with an ageing workforce. Urban areas tend to have a more aged population in comparison to rural areas which may resulted in a shortage of parcel delivery personnel, a physically demanding profession (Mohammad et al., 2023).

Recent studies have reported numerous developments aimed at reducing these inefficiencies. Zhu et al. (2023) lists several methods of LMD transportation, to decrease costs, burden of environmental impacts, and associated-consumer pressures with traditional LMD:

- **Bicycles**: Including traditional and electric cargo bikes, which are seen as a more sustainable option for dense urban areas (Narayanan& Antoniou, 2022).
- **Tricycles**: Often used in specific contexts, such as in China, for their flexibility in certain urban environments (Xu et al., 2022).
- **Trucks**: The conventional method, often used as a baseline for comparison or in combination with newer technologies (Kostrzewski et al., 2022).
- **Crowd Logistics**: Leveraging a network of non-professional couriers to perform deliveries, often coordinated through digital platforms (Shahin et al., 2025). (e.g., Amazon Flex and Uber Eats represent global leaders in this model, allowing independent contractors to complete deliveries.).
- **Parcel Lockers**: Automated stations for self-service parcel pick-up and delivery, offering a flexible and contactless option for consumers (Mangiaracina et al., 2019; Tsai et al., 2021).
- **Electric Vehicles (EVs)**: Specifically, electric light commercial vehicles (eLCVs), which help reduce carbon emissions compared to traditional combustion engine vans (Tsakalidis et al., 2020).
- **Autonomous Vehicles**: Self-driving vans or cars used for parcel delivery, representing a move towards greater automation in logistics (Chen et al., 2021).
- **Autonomous Drones**: Unmanned aerial vehicles used for delivering packages, noted for their potential to speed up delivery and navigate difficult terrains (Mohsan et al., 2023).
- **Autonomous Robots**: Ground-based robots that travel on sidewalks or streets to deliver goods directly to consumers (Alverhed et al., 2024).

Therefore, the development of transportation modes has shifted focus over the years: first, research centred on efficiency (e.g., trucks, tricycles), then evolved into greater environmental consciousness (leading to crowd logistics and bicycles), and culminated in complete automation (robots and drones). Also, out-of-home delivery (OOHD) technologies have garnered much attention among all such innovations. For example, Smart parcel lockers (SPLs), parcel stores, and mobile collection points facilitate delivery collection, reduce unsuccessful delivery efforts, and offer consumers enhanced flexibility in parcel retrieval (Janinhoff et al., 2024; Kawa, 2020). DHL's German locker network expanded from 4,000 units in 2019 to 8,500 in 2021, with a target of reaching 15,000 by 2023 (DHL, 2022).

Furthermore, the COVID-19 pandemic expedited the implementation of lockers, offering contactless and secure options amid heightened health concerns (Hu et al., 2024). By increasing the perceived value of contactless services and accelerating the shift to e-commerce, the pandemic created an environment where consumers were more willing to adopt self-service technologies, such as SPLs, leading to significant network growth and the potential formation of lasting consumer habits (Tsai et al., 2024; Wang et al., 2023).

Janinhoff et al. (2024) in addition outlined three business models for out-of-home delivery (OOHD) by categorizing the different types of service providers involved:

1. **Facility Providers**: Companies operating OOHD infrastructure and selling storage capacity to other companies. Examples include Pick in Singapore and Hive Box in China.
2. **Delivery Service Providers:** Businesses that use third-party OOHD facilities to deliver parcels. Examples are UPS and FedEx.
3. **Logistics Service Providers**: This model combines the first two; these companies both build and operate their own proprietary OOHD infrastructure, handling parcel deliveries themselves. This model is typically adopted by larger companies, such as DHL, GLS, DPD, and national postal services, as the high cost of setting up a proprietary network is justified by the large volume of parcels.

Each model generates opportunities for new ventures. Start-ups can focus on digital orchestration platforms, sustainability-certified fleets, or mobile parcel lockers that can be adjusted to underserved areas. Also, facility providers can scale their networks through partnerships with retailers. Logistics operators can differentiate themselves by offering hybrid door-to-door and locker services. (Pourmohammadreza et al., 2025). Critically, these models demonstrate that the last mile is open to competition from agile, entrepreneurial firms, rather than being a closed market controlled by large incumbents.

Whereas technological innovation addresses many of the operational inefficiencies of last-mile delivery (LMD), entrepreneurship is needed to convert these innovations into practical, scalable, and context-adaptive business models. By understanding market gaps, accommodating adaptive solutions, and forming strategic collaborations, entrepreneurial firms can fully leverage the decentralized nature of LMD to their own advantage. This fills an intermediary valuable gap between emerging technologies, such as smart parcel lockers, crowd-sourced delivery platforms, drones, and robotic cars, and the complex logistical requirements of cities. (Zhu et al., 2023; Ma et al., 2022). Entrepreneurial firms are equally critical in emerging markets, wherein government-private sector collaborations and policy inducements (e.g., Vision 2030 in Saudi Arabia) are creating space for start-ups and Small and Medium Enterprises (SMEs) to promote LMD modernization (Alharbi et al., 2022; Mahdaly & Adeinat, 2022). Here, it is thus necessary to innovate technically while building an entrepreneurial ecosystem capable of designing, prototyping, and adjusting last-mile solutions to varying urban, regulatory, and consumer conditions.

How Innovative Solutions Drive Entrepreneurial Success in Logistics

The link between entrepreneurial opportunities and the enhancement of last-mile logistics is synergetic. Entrepreneurs may identify inefficiencies in the current system and introduce innovative answers that create value for both consumers and logistics operators through:

1. **Addressing Market Gaps:** Traditional delivery systems often fail to meet modern consumer expectations on speed, flexibility, and sustainability. Entrepreneurial endeavors offer services such as 24/7 parcel lockers, instant drone delivery, or eco-friendly delivery options, which may fill these gaps.
2. **Cost and Efficiency Gains:** Solutions like parcel lockers and Pick-Up and Drop-Off (PUDO) services create operational efficiencies by consolidating deliveries (Wu & Li, 2023), which entrepreneurs can leverage to offer more competitive pricing.
3. **Technological Enablement:** Advances in Internet of Things (IoT), Artificial Intelligence (AI), and automation enable new business models that were previously unfeasible (Lafuente & Sallan, 2024).

4. **Value Co-creation:** Many innovative solutions actively involve the consumer in the delivery process (e.g., self-collection) (Wang et al. 2020; Wang et al. 2021b). This creates an opportunity for entrepreneurs to design services that offer desired customer experiences, focusing on factors like convenience, security, and reliability, which in turn drive customer satisfaction and adoption.

Entrepreneurship is central to developing technological innovations into scalable, efficient LMD solutions (Goldsby et al., 2023). Various innovative business ideas are currently emerging, ranging from parcel lockers and crowd-sourced platforms to green and autonomous delivery technologies, as illustrated in **Table 1.** These technologies, address major LMD challenges such as inefficiency in delivery, cost, and emissions, and also address novel entrepreneurial opportunities (Nguyen et al., 2025). Specifically, there are opportunities in creating locker infrastructure optimization tools based on artificial intelligence, drone delivery systems, and green delivery (Zou et al., 2023). In Saudi Arabia, Vision 2030 projects have initiated innovation pilots, such as drone delivery pilot projects in Jeddah and the expansion of smart locker networks, emphasizing the growing encouragement of entrepreneurial initiatives in logistics modernization.

Table 1. Entrepreneurial Opportunities in Last-Mile Delivery (LMD).

Innovation Type	**Description & Applications**	**Entrepreneurial Opportunities**	**Real-life Examples (International & Saudi Arabia)**
Out-of-Home Delivery (Parcel Lockers & Pick-up Points)	Self-service lockers and attended services reduce failed deliveries and emissions.	- Locker network operators (e.g., Hive Box) - Retail partnerships for pick-up/drop-off points - Maintenance, siting, and locker software solutions	**-Global**: DHL, FedEx, Hive boxes **-Saudi Arabia**: RedBox, Parcelat.
Autonomous Delivery (Drones & Robots)	Drones and ground robots offer fast, contactless delivery—ideal for remote areas or closed environments.	- Tech start-ups in drone/robot manufacturing - Route planning SaaS - Ground support and regulation navigation	**-Global**: Zipline (Rwanda, Ghana), Starship (USA/EU), Wing (Google) **-Saudi Arabia**: Jeddah drone pilot project (SPA, 2025)
Autonomous Delivery Vehicles (ADVs)	Road-based self-driving vans used for parcel delivery; early-stage but rapidly developing.	- Start-ups in navigation systems, AI for urban mapping - Fleet coordination and monitoring software	**-Global**: Nuro (USA), JD.com (China) **-Saudi Arabia**: Exploratory stages via MoT & Vision 2030 R&D programs

Crowdsourced Delivery Platforms	Leverages gig workers to perform deliveries via flexible platforms.	- Build local platforms (e.g., Mrsool) -Develop APIs for e-commerce integration - Rider management and rating systems	**Global**: Amazon Flex, Glovo, Stuart **-Saudi Arabia**: Mrsool (local leader), Jahez, and Aramex fleet.
AI, Analytics & Optimisation	Predictive analytics for routing, forecasting demand, locker siting, and real-time fleet coordination.	- SaaS firms offering logistics analytics - CO_2 tracking tools - AI-based routing and load optimization	**-Global**: Routific, Onfleet (Canada, USA) **-Saudi Arabia**: Opportunities in Vision 2030-linked smart cities & logistics zones
Green & Sustainable Delivery (Microhubs, Cargo Bikes, Electric Vehicles (EVS))	Urban logistics solutions help reduce emissions and improve efficiency in densely populated areas.	- Operate microhubs in city centres - EV/cargo bike rental & logistics services - "Green delivery as a service" for retailers	**Global**: Amsterdam, Paris microhubs; NYC cargo bike trials **-Saudi Arabia**: Vision 2030 emphasizes EVs, sustainable logistics zones, and ESG-aligned delivery services

Saudi Arabia: Vision 2030 and Local Innovations in Last-Mile Delivery

Saudi Arabia's Vision 2030 and the National Industrial Development and Logistics Program (NIDLP) are reshaping national logistics with over 100 billion USD in planned investments for smart corridors, digital infrastructure, and integrated supply chains (Saudi Logistics Consulting, 2025; Vision 2030; U.S. Department of Commerce, 2024). This strategic initiative is creating fruitful ground for entrepreneurial innovation LMD and is helping Saudi Arabia emerge as a global logistics hub (Ministry of Transport and Logistics; AJOT, 2024).

Saudi Post national company exemplifies the state-driven modernization initiative in Saudi Arabia, by developing an electric delivery vehicle in partnership with Barq EV (SPL, 2022). As well as, integrating with national address systems aiming to minimize delivery failures by (Saudi Post SPL, 2023).

In the non-government sector, RedBox demonstrates the potential for scalability in smart locker entrepreneurship. Its services include 24/7 pick-up and drop-off, and it aims to target 10,000 lockers in the MENA region by 2030. To date, RedBox has facilitated over 10 million parcel deliveries, demonstrating robust consumer uptake and investor interest (Logistics Middle East, 2025).

Among the platform-style delivery companies, Jahez is now considered one of the leading Saudi logistics and food delivery ecosystems. Since its establishment in 2016, it has served more than 68 million orders, established 12,000 outlets for merchants, and in 2022, completed an IPO valued at USD 2.4 billion (Jahez Annual Report, 2021; Arab News, 2022; Entrepreneur, 2023).

"Parcelat", through collaboration with DHL Express Saudi Arabia, incorporates the lockers shared aspect within DHL's services. This alignment enhances flexibility in delivery and allowing parcels to be dropped off or picked up using intelligent lockers. This expands the reach of the last mile for DHL (Parcelat, 2025).

Alharbi et al. (2022) quantified both the business model prospects (such as dynamic pricing and social incentives) and the obstacles (trust deficits and regulatory confusion) for crowd logistics in Saudi Arabia. Khan (2025) conducted a qualitative evaluation of IoT-driven smart lockers, highlighting efficiency gains but also uptake challenges related to cultural factors and locker maintenance.

Together where Vision 2030 initiatives, postal restructuring, start-ups, and delivery platforms intersect, these ingenuities reveal a rapidly changing Saudi LMD market. However, empirically examined measurements of consumer reaction, business value, and long-term performance are scarce, indicating potential future research imperatives.

Conclusion

Innovations in LMD are no longer a choice—urbanization, customer needs, and environmental demands are driving them. With traditional systems hindered by inefficiency, congestion, and failed deliveries, innovations such as smart parcel lockers, self-driving delivery robots, and crowdsourced logistics are redefining the final stretch of the supply chain. These innovations are driven by both technological and entrepreneurial.

Entrepreneurship is crucial to bridging the gap between innovation and implementation. It is what gives rise to smart locker networks, drone pilot programs in logistics, and application-based crowd shipping networks catering to the more refined needs of the modern customer.

Vision 2030 have identified investment streamlines that created fertile ground for logistical initiatives and start-ups, offering localized, flexible, and sustainable services that align with larger economic and sustainability agendas.

LMD innovation, in turn, will reveal not just operational efficiencies but also new economic potential for entrepreneurs seeking to optimize the logistics sector.

Future Research Avenues

Further studies should explore if certain innovations—such as smart parcel lockers, drones, or AI-driven optimization—translate into effective business models, particularly in developing markets.

Another promising venue is exploring the ineraction between policy configurations and entrepreneurship in LMD. Additional work should explore government support, regulatory bodies, and public–private partnerships that encourage the adoption of innovation in LMD ecosystems, particularly if policy aims to create logistics hubs and encourage SME and start-up involvement.

Furthermore, similar to previous entrepreneurial intention models, it is essential to empirically test consumers' convenience expectancies, risk perceptions, and trust, as well as their role in shaping the diffusion of entrepreneurial solutions in LMD.

Lastly, researchers could explore placing green delivery innovations not just as technological solutions but also as entrepreneurial niches that support global sustainability.

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