International Journal of Innovative Research and Scientific Studies, 8(6) 2025, pages: 3249-3264

IJIRSS
International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

Improving last-mile delivery in Amman: An exploratory study of challenges and solutions

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Abstract

Urban last-mile delivery (LMD) is a challenging and costly endeavor, particularly in developing cities. This study examines the challenges of LMD in Amman, Jordan, through a qualitative analysis of 20 semi-structured interviews with local logistics stakeholders. The respondents, including delivery drivers, fleet managers, coordinators, and others, provided insights into operational realities. The interviews were analyzed using thematic coding to identify key obstacles and potential enablers. Findings reveal that Amman's last-mile sector faces critical cost pressures, driven by high fuel prices, vehicle maintenance, and labor expenses. Traffic congestion and infrastructure constraints (e.g., narrow streets, address issues) cause delivery delays and inefficiencies. Operational challenges peak during high-demand periods, as companies struggle with tight time windows and a lack of unloading zones. Intense price competition in the courier market is eroding profit margins, affecting service sustainability. Human resource issues also emerged, including difficulty retaining couriers and an aging workforce that struggles with physical and technological demands. Participants further highlighted environmental and sustainability pressures, noting limited adoption of green delivery modes due to infrastructure gaps. Policy and regulatory factors, such as parking restrictions, also hinder last-mile operations. The study contributes a contextual understanding of LMD challenges in a Middle Eastern city. It offers recommendations for local practitioners and policymakers, from investing in electric vehicles and route optimization systems to improving urban infrastructure and delivery regulations, and outlines recommendations for future research.

Keywords: Amman, Developing countries, Jordan, Last-mile delivery, Logistics challenges, Qualitative study, Urban logistics.

DOI: 10.53894/ijirss.v8i6.10322
Funding: This study received no specific financial support.
History: Received: 09 July 2025 / **Revised:** 12 August 2025 / **Accepted:** 14 August 2025 / **Published:** 29 September 2025

Competing Interests: The author declares that there are no conflicts of interests regarding the publication of this paper.
Transparency: The author confirms that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Publisher: Innovative Research Publishing

1. Introduction

The "last mile" of delivery, which involves moving the product from a distribution hub to the end user, is widely recognized as the most expensive and complex segment of the supply chain [1]. It can account for a large proportion of total logistics costs, in some cases up to half or more [2] while also generating negative externalities, such as congestion and emissions, in urban areas [3]. The growth of e-commerce and increased consumer expectations for fast and reliable

shipping have only intensified last-mile challenges [4]. Companies worldwide are under pressure to offer rapid deliveries and real-time tracking; however, doing so profitably is challenging due to inherent inefficiencies in urban delivery networks [5]. Last-mile logistics often involves multiple stops with low drop sizes, resulting in higher unit transportation costs and productivity losses compared to line-haul transportation [4]. Furthermore, last-mile operations contribute significantly to traffic congestion, air pollution, and noise in cities [6]. These impacts heighten the need for sustainable urban delivery solutions.

Developing countries face additional constraints in LMD. Prior research indicates that cities in emerging markets often face limited logistics service coverage and infrastructure deficiencies, such as poorly planned road networks and a lack of formal addresses [7]. For example, a lack of proper addressing systems is a common barrier, impeding reliable home deliveries in many developing contexts [7]. Urban growth in such cities tends to outpace infrastructure development, resulting in traffic bottlenecks and inadequate loading and unloading spaces for delivery vehicles [8]. The systematic review conducted by Arvianto, et al. [8] also found that the literature on city logistics in developing economies emphasizes challenges such as fleet capacity shortfalls and a lack of dedicated delivery zones. In contrast, developed countries focus more on regulatory issues and advanced business models. Developing cities may also lag in technological adoption; for instance, smaller delivery firms might still rely on manual routing and communication methods due to cost or resource constraints [5]. These contextual differences underline the importance of examining last-mile issues in specific emerging urban settings.

Despite a growing global literature on urban logistics, there is a scarcity of academic studies focusing on LMD in the Middle East, including Jordan. Amman, Jordan's capital and largest city, presents a compelling case with its rapid urbanization and booming e-commerce activity. Amman's metropolitan area has expanded rapidly, resulting in urban sprawl and strains on infrastructure [9]. Recent research on city logistics in Jordan from an urban planning perspective highlighted regulatory inefficiencies, inadequate information systems, and coordination gaps among stakeholders [3]. However, little is known about the micro-level, day-to-day challenges faced by LMD operators in Amman. This study addresses that gap by investigating the LMD challenges in Amman through primary qualitative data. By capturing the perspectives of a range of logistics actors – from delivery drivers and fleet managers to logistics coordinators – it provides an empirical account of the operational hurdles and contextual factors shaping urban deliveries in a developing city environment.

This paper aims to achieve three main objectives. First, this research identifies and articulates the key challenges faced in LMD within the urban context of Amman, as reported by practitioners in the field. Second, it connects these findings to the existing literature on urban LMD, highlighting both similarities and discrepancies, and derives theoretical and contextual implications. Lastly, it offers practical recommendations for managers and policymakers to enhance last-mile efficiency and sustainability in Amman and similar cities. To achieve these objectives, 20 in-depth interviews were conducted, and a thematic analysis was performed to identify the dominant themes.

2. Literature Review

2.1. Urban LMD Challenges

Urban LMD is often regarded as the most inefficient and costly phase of the supply chain. This segment, typically comprising the journey from a local distribution center to the end customer, can account for an estimated 13% to 75% of total logistics costs, depending on the context [10]. A commonly cited figure is that last-mile activities make up around 41% of overall supply chain costs on average [4]. The reasons for this disproportionate cost are well-documented. LMD involves many stops with low drop densities, resulting in poor economies of scale, unlike long-haul trucks that transport thousands of items to a single destination [4]. Additionally, failed delivery attempts and return logistics add to last-mile inefficiency [5]. These factors drive up fuel consumption and labor hours per package delivered.

Beyond cost, LMD poses significant environmental and social challenges in cities. The proliferation of delivery vehicles contributes to urban congestion, increased emissions, and noise pollution. Studies in large cities have shown that the growth of e-commerce has led to a surge in light goods vehicle traffic in urban centers [11]. In London, for example, van traffic associated with online retail rose markedly, exacerbating peak-hour congestion [11]. The externalities of LMD include not only traffic delays but also higher greenhouse gas output and local air quality impacts from delivery trucks and motorbikes [12] found that traditional diesel van deliveries produce substantial emissions, motivating a search for cleaner last-mile modes. Moreover, the social externalities include safety concerns, such as increased traffic on narrow streets and interactions with pedestrians, as well as a reduced quality of life in neighborhoods due to noise and visual intrusion from frequent delivery stops [1].

Another major challenge in LMD is meeting the rising expectations of customers. Modern consumers, conditioned by e-commerce giants, demand faster and more flexible delivery options, such as same-day delivery, along with end-to-end visibility of their shipments [13]. Such expectations put pressure on logistics providers to invest in advanced tracking systems and to tighten delivery windows, which can further reduce efficiency. Indeed, offering fast deliveries often requires additional resources, such as drivers and micro-fulfillment centers, that raise operational costs [4]. Tight delivery time windows also tend to increase failed attempts and suboptimal routing, as vehicles must crisscross cities to meet specific customer time demands [5]. In summary, urban LMD is a complex balancing act between efficiency (cost and time) and service quality; achieving both simultaneously remains challenging. Figure 1 illustrates the main challenges facing LMD, as identified by Boysen, et al. [14]. In a review article, Bosona [15] categorized last-mile logistics challenges into four main categories: technological, infrastructural, managerial, and cost-related challenges.

Figure 1.
Last-mile delivery challenges.

2.2. Last-Mile Constraints in Developing Countries

Developing urban centers often lacks well-organized street networks, sufficient road capacity, or appropriate loading zones, which complicates delivery operations [8]. A systematic review comparing city logistics in developed vs. developing economies found that "inadequate loading/unloading spaces" and the need for fleet expansion are predominantly highlighted in developing country contexts [1]. Another critical issue is the lack of formal addressing systems and reliable maps. The absence of a proper postal addressing system makes LMD particularly challenging, as noted by Rodriguez [7].

Resource limitations for local delivery service providers also shape LMD in developing contexts. A recent study found that in some developing markets, only the major carriers have begun integrating advanced IT systems, while smaller companies lag behind [5]. Labor constraints are another factor – while labor costs may be lower than in developed countries, courier jobs often experience high turnover due to challenging working conditions (long hours in traffic, relatively low pay), as well as limited career advancement opportunities. In certain cases, an aging workforce in the logistics sector further complicates matters, as older drivers might struggle with physically intensive tasks and adapting to new technologies [14].

Cultural and regulatory environments contribute to last-mile challenges as well. Some developing cities do not yet incorporate freight considerations into urban planning, resulting in a lack of integration between city authorities and logistics needs Alnsour, et al. [3]. Arvianto, et al. [8] noted that public policy issues were underrepresented in the logistics literature of developing countries, implying that less policy attention has been given to city logistics in these contexts compared to Europe or North America.

2.3. LMD in Amman

With a population exceeding 4.5 million people, an approximate area of 800 km², and an estimated five million transportation trips per day [16]. Amman is Jordan's economic hub and has experienced a surge in e-commerce in recent years. Amman's rapid growth (partly fueled by regional migration and refugee influx) has led to urban sprawl and informal housing areas where roads may be narrow or unpaved [17]. Delivering to such areas can be time-consuming; drivers frequently must rely on local knowledge or phone guidance. Albatayneh, et al. [18] argue that Amman's accelerated metropolitan expansion imposes distinctive pressures on its urban transport network, pressures shaped by the capital's complex topography, sociocultural environment, and existing infrastructural constraints. Traffic congestion is another prominent issue in Amman [16]. The city's vehicle ownership rates have increased, and public transportation remains underdeveloped [18] leading to a heavy reliance on cars.

Recent studies and reports specific to Jordan underscore similar points. Alnsour, et al. [3] in a survey-based study of city logistics management in Jordan, found that urban authorities recognized a need for improvement in the cost efficiency and sustainability of logistics, pointing to factors such as regulatory inefficiencies and suboptimal human resource performance as impediments. They recommended measures such as amending outdated regulations and strengthening

infrastructure for information systems to support logistics. One prior study relevant to Jordan's last-mile is Al-nawayseh, et al. [19] which explored online grocery delivery in Jordan. Although somewhat dated, the research concluded that setting up pickup point networks for online grocery retail might be more cost-effective than direct home delivery in Jordan's context [19]. This insight aligns with a broader trend in literature suggesting alternative delivery models (like pickup lockers or parcel shops) can mitigate last-mile inefficiencies in areas with infrastructure limitations [20].

2.4. Technology Enablers and Innovative Solutions for Last-Mile

In response to LMD challenges, a range of technological and operational innovations have been investigated in the literature. One major category of solutions is route optimization and IT-enabled delivery management. Advanced algorithms, often driven by Artificial Intelligence (AI) and real-time data, can significantly improve routing efficiency for delivery fleets [21]. Studies have documented substantial savings from such systems. However, the adoption of these technologies varies; larger firms and those in developed markets lead the way, whereas smaller couriers in developing cities may still be transitioning from manual planning [5].

Another set of innovations involves alternative delivery methods and modes. To alleviate congestion and mitigate emissions, cities and companies are exploring alternative modes, such as electric vehicles (EVs), cargo bikes, and on-foot deliveries, for the LMD. Siragusa, et al. [22] conducted an economic and environmental assessment of using electric vehicles for last-mile B2C deliveries, finding that EVs can substantially reduce CO_2 emissions and even achieve cost parity with diesel vans under favorable conditions (given lower energy and maintenance costs). Many European cities have pilot programs for cargo e-bikes, which can navigate dense urban areas faster and park more easily than trucks. For example, research in Italy's Pro-E-Bike project demonstrated that e-bikes could handle a significant portion of small parcel deliveries with higher speed in congested zones and a positive environmental effect [23].

Autonomous delivery vehicles, including drones (unmanned aerial vehicles) and ground delivery robots, represent more radical innovations on the horizon. Research suggests drones could be beneficial for delivering lightweight parcels, especially to hard-to-reach rural or peri-urban areas, or for time-sensitive deliveries [24]. They offer speed and point-to-point routing, but face serious regulatory, safety, and payload limitations. Autonomous delivery robots could reduce labor costs and operate 24/7, but they require supportive infrastructure and clear legal frameworks. According to Mohammad, et al. [25] drones and autonomous ground robots are still considered "near-future" concepts rather than current mainstream solutions.

A more immediately viable innovation is leveraging the "sharing economy" or crowdsourcing for deliveries, often referred to as crowdshipping. In crowdshipping, individuals (not professional couriers) carry packages on their regular commutes or trips, coordinated via digital platforms Carbone, et al. [26]. Huang and Ardiansyah [27] developed a decision model for integrating crowdsourcing into LMD planning, finding that it can be cost-effective under specific demand and incentive conditions, e.g., when there's a dense network of available crowd carriers and the delivery time requirements are flexible.

Finally, logistics network innovations, such as parcel lockers, pickup points, and micro-distribution centers, are proving effective in various contexts. Parcel lockers, automated locker banks placed in accessible locations, enable customers to collect packages at their convenience, which significantly reduces failed deliveries and consolidates multiple deliveries into a single stop [20]. For example, Poland's national implementation of parcel lockers demonstrated improved efficiency, as couriers could drop off multiple packages at a single locker location instead of individual homes [20]. Additionally, micro-fulfilment centers can help logistics and supply chain professionals mitigate the challenges of urban LMD [28]. This is particularly useful for groceries and fast-moving goods, enabling very quick delivery promises. Mohammad, et al. [25] conducted a literature review on innovative solutions for LMD challenges, discussing cargo bikes, self-service techniques, drone parcel delivery, and robot-assisted delivery.

3. Methodology

3.1. Research Design and Context

This study adopted a qualitative research design to deeply explore the phenomena of LMD challenges and solutions in Amman. A qualitative approach was appropriate, given the exploratory nature of the research, allowing for rich and detailed insights into stakeholder experiences [29]. Semi-structured interviews were employed as the primary data collection method, involving key stakeholders in LMD operations. Interviews are a well-established qualitative tool for obtaining in-depth information and were chosen to allow participants the flexibility to share detailed experiences while still covering specific topics [29, 30].

To standardize data collection, a semi-structured interview guide was designed, grounded in themes extracted from the literature, while intentionally leaving scope for participants to introduce additional insights beyond those published in research. Table 1 summarizes the guide's principal categories, their sub-categories, and corresponding analytical objectives.

Table 1.
Interview guide categories and analytical aims.

Main Category	Sub-categories explored	Analytical aim of the questions
Respondent profile	Position, core duties, service area, product types, and years of experience.	Establish contextual background for interpreting responses.
LMD challenges	Cost-related challenges such as fuel, labour, and routing.	Identify the primary barriers and inefficiencies that shape LMD performance.
	Environmental and sustainability issues, such as vehicle emissions and packaging.	
	Time pressure and operational issues, such as tight delivery windows, parking constraints, and peak demand surges.	
	Demand and competition factors, such as price wars and customer expectations.	
	Workforce and human resource issues, such as driver turnover and an aging workforce.	
	Technology and infrastructure challenges, such as GPS reliability issues, EV charging problems, loading bays, and other infrastructure concerns.	
Existing mitigation practices	Route optimization tools.	Document existing solutions and assess their perceived effectiveness.
	Flexible delivery scheduling.	
	Peak-period planning.	
	Workforce incentives/training.	
Potential innovations and adoption barriers	Electric vehicles.	Evaluate stakeholder perceptions of advanced technologies, expected benefits, and implementation constraints.
	Cargo bikes and e-bikes.	
	Crowdshipping.	
	Parcel lockers and micro-fulfilment hubs.	
	Drones.	
	Autonomous delivery robots.	
Policy and regulatory environment	Impact of existing regulations.	Understand how governance frameworks hinder or facilitate efficient, sustainable LMD.
	Desired policy changes.	
Future outlook	Emerging trends.	Capture strategic visions for the evolution of LMD in Amman.
	Organizational preparedness.	

Open-ended questions were also included for participants to share any other challenges or suggestions they had. This guided format ensured that each interview addressed core research questions while still allowing interviewees to elaborate on issues they considered important.

3.2. Sampling and Participants

The LMD sector in Amman includes local courier companies, international parcel firms, e-commerce retailers with in-house delivery fleets, and crowdsourced delivery platforms. This study sought participants from various organizations to capture diverse perspectives. A purposive sampling strategy was employed to select interview participants, complemented by a snowball sampling technique to recruit additional participants. Initially, convenience sampling facilitated the recruitment of accessible participants [31]. Subsequently, some interviewees referred us to other knowledgeable individuals in the field, which broadened the sample to include a variety of perspectives. The final sample comprised 20 participants, which was sufficient to achieve data saturation, i.e., no new themes emerged in the last interviews [32]. In addition, the sample size was also aligned with the recommendations of Guest, et al. [33] for qualitative research, where 12–20 interviews are often sufficient to capture broad thematic saturation. Participants were selected based on their roles and experience in LMD, ensuring a mix of operational and managerial viewpoints. Table 2 presents an overview of the interviewees' positions, years of experience, and the types of products they handle. All participants were based in Amman and had direct involvement in LMD activities.

Table 2.
Profile of interview participants.

Interviewee Number	Position	Years of Experience	Primary Product Categories Handled
I1	Operation manager	15 years	Electronics
I2	Courier	4 years	Groceries and other consumer goods
I3	Senior delivery operation officer	6 years	Pharmaceuticals and health care supplies
I4	Logistics department manager	10 years	Wide range of products
I5	Manager of LMDs	7 years	Electronics and fitness equipment
I6	Route optimization analyst	5 years	Groceries, clothing, and electronics
I7	Delivery driver	5 years	Wide range of products, from small parcels and documents to electronics and household items
I8	Warehouse manager	8 years	Clothing, groceries, household items, and seasonal items
I9	Fleet manager	5.5 years	Baby products
I10	Dispatch Coordinator	5 years	Medical supplies and office equipment
I11	Logistics Coordinator	3 years	Clothing and household items
I12	Delivery tracker	3 years	Groceries
I13	Operation manager	5 years	Food and groceries
I14	Delivery manager	2 years	Clothing and fashion items
I15	Logistics Coordinator	10 years	Electronics and small home appliances
I16	Logistics Coordinator	5 years	Automotive parts
I17	Delivery operations manager	7 years	Furniture and household items
I18	Delivery operations manager	6 years	Groceries and household items
I19	Return & reverse logistics manager	12 years	Electronics and clothing
I20	LMD micro-fulfillment manager	10 years	Office supplies, books, and media products

Ethical considerations were addressed by obtaining informed consent from all interviewees. Before each interview, the researcher explained the study's purpose and assured participants of confidentiality. Interviewees were asked for permission to record the conversation for transcription purposes. Participants were assigned codes, I1 through I20, to ensure anonymity. In quotations presented in the results, the interview codes were paired with a generic role descriptor, e.g., "I7, Delivery Driver", to provide context.

3.3. Data Collection

Interviews were conducted face-to-face, each lasting approximately 30–50 minutes. All sessions were held in an informal, conversational manner to help respondents feel comfortable discussing operational challenges [30]. With participants' consent, detailed notes were taken during each interview, rather than audio recordings, as several interviewees preferred not to be recorded. The note-taking process captured key points and verbatim quotes where possible. All participants were assured of confidentiality to encourage open and honest discussion.

A preliminary pilot interview was undertaken with an experienced logistics manager to evaluate the comprehensibility, sequencing, and face validity of the semi-structured interview guide. Consistent with methodological guidance that recommends piloting to refine qualitative instruments [34] the transcript was reviewed and minor revisions—such as simplifying specialist jargon and adding illustrative questions to elicit richer responses—were incorporated. As the pilot data satisfied the study's inclusion criteria, it was retained in the final corpus and coded as Interviewee I4.

3.4. Data Analysis

A hybrid thematic analysis was conducted following Braun and Clarke [35] procedure. First, a deductive coding frame—drawn from the interview guide categories in Table 1 and informed by the literature review—steered the initial coding of transcripts toward recognized LMD issues. Second, an inductive layer of coding captured additional themes that surfaced when participants responded to open-ended questions (e.g., "Are there any other last-mile challenges we have not discussed?"), ensuring that context-specific insights beyond the extant literature were incorporated.

This research adopted Braun and Clarke [35] six-phase framework for thematic analysis and operationalized it using a hybrid deductive–inductive coding strategy, as recommended by Fereday and Muir-Cochrane [36]. Figure 2 details each analytic phase and illustrates how the hybrid approach was implemented.

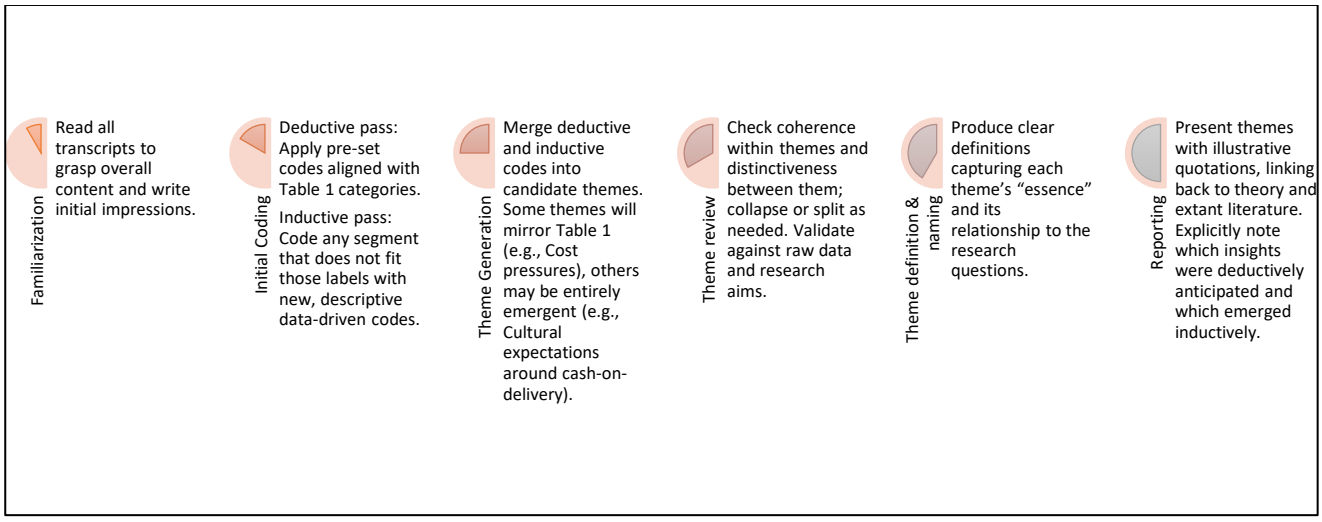

Figure 2.
Data analysis steps and their hybrid application.

4. Results

4.1. LMD Challenges in Amman

The interviews revealed a multifaceted set of challenges affecting LMD in Amman. Participants discussed obstacles ranging from high operational costs and traffic congestion to workforce issues and competition. Table 3 presents an overview of the significant challenges identified. The challenges listed on the table below align with the categories presented in the interview guide questions.

Table 3.
Key last-mile delivery challenges in Amman.

Challenge	Challenge sources	Clarification	Support from the data
Cost of LMD operations	Fuel Expenses	Fuel prices are a primary cost driver for LMD, exacerbated by traffic congestion that increases fuel consumption.	"Fuel costs, vehicle maintenance, and labor costs… are our primary financial challenges." (I4)
	Vehicle Maintenance	Heavy deterioration in delivery vehicles results in significant maintenance and repair costs, further adding to the financial burden.	"Our biggest financial concerns are rising fuel prices and auto maintaining." (I5) "Vehicle maintenance (wear and tear on vehicles, oil changes, accident repairs) [is a major cost]." (I8)
	Labor and Wages	Labor costs (courier wages and related benefits) constitute a significant portion of LMD expenses, pressuring companies, especially when margins are low.	"Labor costs are among the main cost-related challenges" (I7)
	Inefficient Routing	Suboptimal or inefficient routing results in longer distances and increased time, thereby inflating fuel and labor costs. Companies recognize that better route planning is needed to control expenses.	"Inefficient routes can lead to increased fuel consumption and wear and tear on our vehicles." (I11) "We use route optimization software to plan the most efficient routes. This helps reduce fuel consumption and delivery times." (I7)
	Failed Deliveries & Returns	Unsuccessful delivery attempts and product returns add extra transportation and handling costs, further straining LMD's profitability.	"Vehicle maintenance and delivery attempts and returns [are key challenges]." (I12) "The high cost of handling returns – including transportation, restocking, and potential loss of value – is a major issue." (I19)
Environmental and Sustainability	Vehicle Emissions & Pollution	The proliferation of delivery vehicles (especially older diesel vans) is causing air pollution and emissions in the city.	"Air pollution from delivery vehicles [is a key environmental challenge]" (I1) "Fuel consumption and smoke from delivery

Issues		Participants noted that LMD contributes to poor air quality and noise.	vans, especially old model vans that run on diesel" (I2) "The primary environmental challenges include air pollution from vehicle emissions and noise pollution." (I7)
	Traffic Congestion Impact	Severe traffic congestion in Amman not only delays deliveries but also worsens environmental impacts through increased vehicle idling and emissions during peak hours.	"Traffic congestion [is a major environmental issue]." (I13) and (I14) "Heavier traffic during peak times slows down deliveries." (I18)
	Packaging Waste	The rise in e-commerce is generating significant packaging waste (e.g., cardboard, plastics), and inadequate disposal or recycling of delivery packaging is viewed as an emerging environmental concern.	"Reducing carbon emissions and managing waste [are key challenges]." (I4) "Bad disposal of packaging materials leads to increased waste." (I8) "The increase in online shopping and home deliveries leads to a significant amount of packaging waste." (I12)
	Limited Green Vehicle Adoption	Adoption of eco-friendly delivery modes (like electric vehicles or cargo bikes) remains limited due to infrastructural and operational hurdles, meaning most deliveries still rely on conventional polluting vehicles.	"Emissions from our diesel vehicles and the lack of available charging infrastructure for electric alternatives [are challenges]." (I9) "We're starting to introduce electric vehicles into our fleet, which is helping, but the charging infrastructure is still a bit of a challenge." (I11) "No waste control and a lot of old delivery vehicles that produce bad emissions" (I17)
Time Pressure and Operational Issues	Peak Delivery Volume Surges	Sudden increases in parcel volume during peak periods (holidays, sales) strain delivery capacity, leading to operational overload and delays. Couriers must handle significantly higher workloads, sometimes necessitating the use of extra staff or overtime.	"Keeping up with the increasing volume of deliveries and adhering to tight delivery deadlines present significant challenges during peak delivery periods." (I5) "The surge in parcel volumes can strain our resources and lead to delays. It also increases the workload on staff." (I7) "When parcel volumes spike, we have to work much harder and sometimes bring in extra help." (I13)
	Tight Delivery Deadlines	Customers' expectations for fast and timely deliveries impose tight delivery windows. Meeting same-day or next-day delivery promises is challenging, especially during high demand, and often requires significant additional resources or prioritization of urgent orders.	"Customer expectations – the demand for faster delivery times, often within the same day – requires more resources." (I17) "It can be overwhelming during peak periods; we sometimes struggle to meet delivery windows." (I3) "Managing high volumes of deliveries, meeting tight deadlines… are major challenges during peak periods." (I7)
	Traffic and Urban Delays	Heavy urban traffic and unpredictable road conditions significantly slow down delivery routes. Congested streets and road bottlenecks make it challenging to maintain schedules, especially during rush hours, directly impacting delivery speed and reliability.	"Uncertain traffic conditions [are an operational challenge]." (I4) "Traffic congestion… during peak times slows down deliveries." (I18) "Dealing with traffic congestion [is one of our] major challenges during peak periods." (I7)
	Parking & Unloading Difficulties	A lack of available parking spots and unloading zones in dense or busy areas forces drivers to circle or park illegally, wasting time and complicating deliveries. Difficulty finding a suitable place to stop near the customer can cause inefficiency and occasionally result in delivery failures.	"Lack of parking spots." (I1) "Difficulty finding a parking space in large crowds." (I4) "Limited unloading and loading zones [in busy areas]." (I8)
Demand and Competition	Price Competition &	Intense price-based competition among delivery companies is driving down	"Price competition forces us to find ways to cut costs without compromising service

Factors	Profit Margins	delivery fees, which in turn erodes profit margins. Firms feel pressure to cut costs to match their competitors' low prices, which threatens their financial sustainability.	quality." (I1) "Price competition can lead to reduced profit margins, which affects our ability to invest in better service." (I7) "When companies lower prices to compete, they might not make enough profit…." (I14)
	Pressure to Cut Costs & Service Quality	To remain competitive in a crowded market, companies are compelled to reduce operational costs, but this can come at the expense of service quality. Some participants noted that under pricing pressures, there's a risk of reducing service levels.	"Price competition often pushes companies to cut costs to stay competitive." (I13) "To maintain profitability under price pressure, companies might cut corners in service." (I17) "To remain competitive, companies might cut costs, potentially impacting service quality." (I18)
	Workforce Impact of Competition	Aggressive competition and cost-cutting measures can hurt employees, potentially leading to lower wages or even layoffs. The struggle to offer the lowest delivery prices sometimes translates into constrained labor budgets and reduced staff morale or stability.	"Workers are forced to either accept lower-paying jobs or move to find a different job." (I16) "In some cases, we have to do budget cuts and lay off employees." (I19)
Workforce and Human Resource Issues	High Turnover & Retention Difficulties	Delivery firms face challenges in retaining drivers and recruiting new ones. High turnover rates are attributed to harsh working conditions (long hours, traffic stress, relatively low pay), making it hard to maintain a stable, experienced workforce.	"An aging workforce and hiring challenges are significant issues." (I6) "We have difficulties in hiring and retaining delivery personnel." (summary of multiple interviewee comments; e.g., I6, I19) "Reducing driver turnover is important because hiring and training new employees is costly." (I1)
	Aging Workforce Limitations	In cases where the delivery workforce is older, employees may struggle with the physical demands of the job and have difficulty adapting to new technologies. Older couriers often experience fatigue and may be less inclined or able to use new delivery apps or GPS tools, affecting efficiency.	"The aging workforce may face physical challenges and may be less familiar with new technologies." (I7) "It's challenging to keep up with the speed required for efficient deliveries and sometimes [older couriers] can't work long hours, which may slow us down." (I8)
	Workforce Skills and Training Gaps	(Emergent in some responses) There is a need for continuous training and upskilling of delivery staff. As technology becomes increasingly integral to LMD (routing software, tracking systems), ensuring that all employees, regardless of age, are proficient is an ongoing challenge.	"Older employees [have a] hard time with skill development." (I3) "Our delivery personnel are trained to handle packages carefully and to communicate effectively… [but adapting to new systems is ongoing]." (I11) "We provide training and a supportive work environment for our delivery staff." (I14)
Technology and Infrastructure Challenges	Inadequate Urban Infrastructure	Poor physical infrastructure in parts of Amman, including narrow streets, informal neighborhoods with no road access, and incomplete addressing systems, makes deliveries time-consuming and inefficient. Drivers often must take detours or spend extra time locating recipients.	"In areas with poor or no street access, delivering packages can be very challenging and impacts our delivery times and efficiency." (I5) "In some parts of Amman, addressing systems may be incomplete or outdated, making it difficult to locate specific delivery addresses… Navigating poorly accessible areas requires more time for route planning and execution." (I11) "Poor infrastructure can lead to longer delivery times and increased operational costs." (I7)
	Limited EV Charging Infrastructure	The infrastructure to support electric delivery vehicles is lacking. There are not enough public charging stations in the city, and charging is time-	"Not enough charging stations and lack of infrastructure." (I1) "The limited number of charging stations and the time required to charge are the main

		consuming, hindering the broader adoption of electric vans or bikes for LMD.	challenges [with EVs].” (I7) “Limited availability of charging stations and the time it takes to charge vehicles.” (I5)
	GPS and Connectivity Issues	Unreliable GPS signals and data connectivity issues in some urban regions can disrupt navigation and tracking. Deliveries can be delayed when devices lose signal or when digital maps are inaccurate, requiring drivers to rely on local knowledge or customer guidance.	“We use multiple GPS providers and have offline maps available to mitigate issues with signal reception and data loss.” (I1) “Train drivers on how to handle situations when GPS signals are lost, including procedures for using alternative methods.” (I17)
Policy and Regulatory Challenges	Traffic and Parking Regulations	Delivery operators in Amman must contend with regulations such as road access rules, parking restrictions, and occasionally municipal bylaws (for example, heavy vehicles might be restricted on certain streets or at certain times).	“Parking and traffic regulations often pose challenges, as they can limit where and when our drivers can make deliveries.” (I10) "Regulations help but sometimes cause delays, especially with parking." (I16) "Policies make it hard to deliver on time due to strict rules." (I15)
	Compliance and Operational Costs	Regulations that increase operational expenses due to compliance with labor laws and safety standards. These regulations, though beneficial for order and safety, increase administrative burdens and operational costs.	"Some regulations, like labor and emission standards can be challenging to meet." (I5) "Regulations regarding driver work hours, wages, and working conditions can affect scheduling and operational costs." (I13) "Rules are fair but increase our costs to comply." (I18)
	Regulatory Clarity and Consistency	Issues arising from unclear, inconsistent, or frequently changing policies and regulations create operational disruptions and confusion regarding compliance.	"Policies keep things orderly but can be hard to follow when they change." (I17) "Lack of clarity and consistency." (I10) "Restricted working hours (labor laws) and Regulations on where micro fulfillment centers can be located." (I20)

In addition to the predefined categories, interviewees mentioned a few other challenges that fell outside the main guide topics. These emergent themes shed light on unforeseen disruptions, security concerns, and delivery accuracy issues. Table 4 highlights these emergent challenges.

Table 4.
Emergent challenges for last-mile delivery in Amman.

Challenge	Key Finding	Support from data
Unforeseen Disruptions (Weather, Road Closures)	Unexpected events, such as extreme weather, sudden road closures, or traffic accidents, can disrupt delivery routes with little warning. Such events cause delays and require on-the-fly route adjustments, challenging delivery reliability.	“Unexpected road closures and extreme weather [are challenges].” (I1) “Dealing with unexpected events like accidents and road closures and the sudden issues that may occur [is difficult].” (I8)
Package Security & Theft	Ensuring the security of packages during the LMD is a concern. There is a risk of packages being stolen or tampered with, especially when left unattended at drop-off, and drivers must be vigilant about safety and security in certain areas.	“One additional challenge is ensuring the security of packages.” (I7) “Safety and security issues.” (I20)
Addressing Errors & Delivery Accuracy	Delivering packages to the correct address and recipient is not always straightforward. Mistakes in addresses, a lack of precise location information, or parcel mix-ups can result in misdeliveries. Ensuring high delivery accuracy is an ongoing concern.	“Delivery accuracy – ensuring the correct packages are delivered to the right addresses – can be challenging.” (I18) “Addressing systems may be incomplete or outdated, making it difficult to locate specific delivery addresses.” (I11)

4.2. Mitigation Practices and Potential Innovative Solutions

In addition to these central themes, the interviews included a forward-looking discussion on emerging delivery innovations – essentially, how participants view the potential of drones, autonomous robots, crowdshipping, and other novel solutions in Amman. Many interviewees expressed interest in technologies like drones, but immediately noted practical barriers. For instance, I1 suggested *"drones could be used for deliveries in hard-to-reach areas or during peak traffic times, but regulatory and safety concerns need to be addressed."* Most respondents were aware that Jordan currently lacks a regulatory framework that would easily facilitate commercial drone deliveries in urban airspace, and they also doubted that drones could handle more than small parcels. Similarly, on autonomous robots, a delivery manager (I5) mused that *"they might be useful for short-distance deliveries in the city, but we'd need the right infrastructure and rules in place."* There was also a sense that the Amman urban environment, with hilly terrain, uneven sidewalks, and heavy traffic, is not immediately robot friendly.

Crowdshipping was something a few participants had heard of or even tried on a small scale. I7 noted that *"crowdshipping can be cost-effective, leveraging existing travel plans of individuals,"* which reflects the theoretical benefits found in the literature (e.g., utilizing people's routine trips to carry packages). However, he and others quickly pointed out concerns about reliability and security: entrusting packages to non-employees requires systems to ensure those individuals are accountable and packages are safe. One interviewee (I13) mentioned that crowdshipping *"might be effective in Amman's more densely populated areas, but not as successful in less populated areas,"* highlighting that it could work for intra-city deliveries where there are many potential citizen-couriers, but perhaps not for outskirts or low-density deliveries. On a positive note, electric cargo bikes received a relatively favorable view. Several participants, especially those familiar with international trends, noted that e-bikes could be particularly suitable for Amman's congested districts. I1, for instance, stated that *"electric cargo bikes are highly suitable for dense urban areas with traffic congestion,"* emphasizing their ability to maneuver through jams and park easily. Yet even here, limitations were noted: I9 remarked that *"their load capacity is an issue, and they are not efficient in hard weather conditions,"* alluding to hot summers or the city's hilly topography that might strain e-bike performance.

Overall, these emerging solutions were seen as promising but not yet a reality in Amman. The practical mindset of the practitioners came through – they were interested in innovation but grounded in today's challenges. As one fleet manager wryly noted, "Before drones, I'd just like better road infrastructure and addresses; those would make a bigger difference right now." This sentiment reinforces that while innovation is exciting, addressing basic logistics infrastructure and policy in developing cities might yield more immediate gains.

5. Discussion

The qualitative findings from Amman's LMD sector highlight both commonalities with global urban logistics challenges and distinctive aspects related to the developing city context. In this section, the results were interpreted in light of prior research, discussing how this study extends understanding of LMD issues and what theoretical or contextual insights emerge. This study also outlines the contributions of these findings to the literature on urban freight and explains why the Amman case provides a valuable perspective.

5.1. Comparing Findings with Prior Studies

Many of the challenges identified in Amman resonate strongly with those reported in other cities worldwide, confirming that some LMD issues are near-universal. For example, traffic congestion and urban infrastructure limitations were a dominant theme in the interviews, and these are consistently cited in metropolitan logistics studies [37, 38]. The respondents' struggles with narrow streets and a lack of parking echo findings from the European city logistics literature, which suggests that inadequate unloading spaces hinder delivery efficiency. Arvianto, et al. [8] specifically noted that such issues are more acute in developing countries, which the Amman case supports – participants gave concrete examples of how older neighborhoods and informal road networks in Amman create daily inefficiencies. This alignment reinforces existing theory that infrastructure is a critical enabler or bottleneck in LMD performance [39] where infrastructure is lacking, delivery systems compensate through workarounds that raise costs and times.

The cost pressure theme in Amman also mirrors global observations. The high fuel, vehicle, and labor costs that burden Amman's couriers are essentially the local manifestation of what literature refers to as the cost inefficiency of the LMD Gevaers, et al. [40]. Mangiaracina, et al. [4] identified cost reduction as a primary driver for seeking innovative LMD solutions in e-commerce, and this study illustrates why: operators in Amman are squeezed by fuel prices (Jordan's fuel costs are relatively high due to imports and taxes) and cannot easily increase delivery fees due to competition. This finding aligns with Rodriguez [7] noting that transport costs in developing countries can be prohibitive for e-commerce growth. One interesting nuance from Amman is the effect of price competition on reinvestment – drivers and managers reported that slim margins make it hard to invest in new technology or vehicles, which could trap firms in a low-productivity equilibrium. These complements supply chain literature on the innovation adoption gap in emerging markets: firms may be aware of efficiency-enhancing tools but lack the capital or margin to implement them. Thus, the findings provide a lived example of how competitive pressures can perpetuate operational challenges, a relationship also noted by Boysen, et al. [14] for LMD startups in competitive environments.

The interviews also shed light on operational challenges and customer expectations, which can be linked to studies on service quality in LMD. Customer demand for fast and timely delivery is rising universally [41]. Amman's couriers described tight deadlines and peak-period stress, reinforcing that even in a developing city, consumers now expect high reliability. Allen, et al. [11] observed seasonal peaks and surges in London's parcel volumes; the data in this research show

similar phenomena in Amman (e.g., around Ramadan sales or end-of-year holidays), indicating that peak management is a critical capability across contexts. What differs is the resource buffer – large firms in developed markets often hire seasonal staff or use advanced forecasting to manage peaks. In contrast, in Amman, smaller players may stretch existing staff to the limit. A theoretical implication is that the concept of logistics agility [42] is equally relevant in developing cities; however, the means to achieve agility (such as extra fleet capacity and IT systems) may be constrained, making peaks relatively more disruptive.

The findings on workforce issues – especially aging and retention – bring a human resource perspective that is less frequently detailed in LMD literature. Boysen, et al. [14] highlighted the aging workforce as a challenge to innovation adoption, which the study confirms anecdotally: older couriers in Amman indeed struggled with new technology tools and the physical demands. This resonates with broader transport industry concerns that aging driver populations (common in many countries) could create labor shortages and productivity issues. Additionally, high turnover among young drivers in Amman corresponds with studies in similar economies that find logistics jobs have low retention due to working conditions. The implication is that human factors – training, job design, incentives – should be part of LMD optimization discussions, not just vehicles and routes. This study contributes to the understanding that soft issues, such as worker fatigue or skill gaps, can significantly impact delivery performance. This point is sometimes underemphasized in quantitative models of LMD.

The Amman case also highlights the significance of local governance and policy in achieving LMD efficiency, aligning with notions from the city logistics literature on multi-stakeholder coordination. Interestingly, Arvianto, et al. [8] found that public policy received less focus in logistics research in developing countries. Yet, the participants identify policy gaps as a problem, suggesting a disconnect between the emphasis in literature and on-the-ground needs. This might imply that, in practice, policy support (such as creating delivery zones or enforcing rules against private cars blocking curbs) is crucial, even if it hasn't been intensely studied in those contexts. This research thus calls for greater scholarly and practical attention to urban policy interventions in cities like Amman – an area ripe for future research and pilot projects.

5.2. Theoretical and Contextual Contributions

From a theoretical standpoint, this study contributes to the logistics and supply chain management literature by providing an empirical qualitative validation and elaboration of LMD challenge frameworks in a developing city context. Many conceptual models of last-mile logistics, such as the 'last-mile logistics framework' by Olsson, et al. [43] are mainly derived from developed country cases and emphasize cost, service, and sustainability dimensions. The study findings affirm these dimensions but also suggest re-weighting and additional elements when applying the framework to developing cities. For instance, infrastructure quality and addressing systems emerge as foundational enablers in the Amman context, more so than in a city like London, where infrastructure is mature. This implies that theoretical models of urban logistics performance should explicitly include infrastructure adequacy as a variable (as some city logistics theories do) and possibly treat it as a precondition that moderates other factors (e.g., the effectiveness of a technology solution might depend on a baseline level of infrastructure).

Another theoretical insight relates to the interplay of market competition and operational efficiency. This study illustrates a feedback loop: competitive pressure keeps delivery prices low, which constrains investment in efficiency improvements, potentially keeping costs high. This suggests that researchers should consider market structure and competition intensity when studying the diffusion of LMD innovations: in fragmented, competitive markets like Amman's, collective efficiency gains might require either consolidation or external support (e.g., government incentives), aligning with economic theories of collective action.

The findings on technology enablers, or the current paucity thereof, provide context for the theoretical discussion on the adoption of logistics innovations. While drones, robots, and crowdshipping are hot topics in literature and pilot projects, this study shows the reality gap in a city like Amman: these innovations are recognized but not yet implemented due to practical barriers. This contributes to theory by reinforcing the concept of innovation readiness and context – as per Rogers' Diffusion of Innovation theory, the perceived relative advantage of an innovation must outweigh complexities and be compatible with the local context for adoption to occur [44]. In Amman, the relative advantage of drones is questionable when weighed against the complexity of regulations and associated risks, according to the respondents. Similarly, crowdshipping's compatibility with local trust and business culture is uncertain. Thus, this work empirically grounds the often optimistic tone of innovation literature in a real-world context, suggesting a more tempered, staged approach for technology adoption in developing cities. Theoretically, it implies that frameworks of LMD innovation should incorporate contextual readiness factors (e.g., infrastructure for drones, digital literacy for E-Systems, social trust for crowd models) as critical moderating factors.

In terms of contextual contributions, the Amman case can inform neighboring cities that share some characteristics (rapid growth, car-centric transport, informal addressing), suggesting that they are likely to face similar LMD issues. This research also highlights some potential cultural factors in LMD – for instance, the reliance on phone communication to find addresses, or the tendency of customers in Amman to prefer cash-on-delivery (COD) payments (mentioned by one interviewee, although not a central theme). Although not extensively explored in this study's results, such contextual insights can inform future research questions tailored to developing markets.

6. Conclusions, Implications, and Limitations

This study provides a comprehensive examination of LMD challenges in Amman, Jordan, drawing on qualitative insights from industry stakeholders and situating them within the current literature. The findings confirm that urban LMD

in a developing city context faces a confluence of issues – high operational costs, infrastructural and traffic impediments, intense competition, workforce constraints, and an evolving technological landscape – which collectively hinder efficiency and sustainability. By systematically analyzing interviews with 20 logistics actors, this study identified key themes and illuminated how these challenges manifest on the ground in Amman.

Several conclusions can be drawn. First, many LMD challenges in Amman are similar to those in developed cities. Still, their intensity is often greater due to contextual factors such as weaker infrastructure and less supportive policies. Second, the interdependencies between challenges necessitate holistic solutions. Efforts to reduce delivery costs, for example, are closely tied to solving traffic delays and failed deliveries; addressing one aspect without the others yields limited benefits. Third, there is a clear gap between the promise of technological innovations and the current reality in Amman. The adoption of such innovations remains nascent, hindered by both resource constraints and regulatory uncertainty. Finally, on a positive note, this research indicates that stakeholders are aware of numerous potential improvements – from flexible delivery scheduling to the use of electric vehicles – and, with proper support, they are willing to embrace these changes.

The challenges identified in Amman's LMD system highlight several areas where targeted actions by companies and policymakers can lead to improvements. In this section, the findings were translated into actionable managerial implications for logistics service providers and policy recommendations for authorities and regulators.

6.1. Implications for Logistics Managers

1. Given the heavy congestion and addressing issues, companies should prioritize implementing route optimization software and GPS-based delivery management systems to improve efficiency. The findings suggest that drivers often rely on personal knowledge; however, this approach is not scalable or consistently efficient. By utilizing route optimization tools, managers can minimize unnecessary mileage and fuel consumption, thereby mitigating cost pressures.
2. With workforce issues such as high turnover and varying skill levels, managers should implement measures to support better utilization of their human resources effectively. This includes comprehensive training for drivers on navigation skills, the use of digital tools (such as apps and GPS), and customer service protocols. Companies might consider incentive schemes for timely deliveries or safe driving, as well as non-monetary benefits such as more flexible shift scheduling (as one interviewee mentioned, offering flexible hours helped with retention).
3. To combat issues of low drop densities and failed attempts, companies can explore consolidation strategies. For example, setting up local pickup points or parcel lockers in partnership with convenience stores or malls in various neighborhoods could significantly reduce last-mile distances, allowing customers to retrieve packages at their convenience. Moreover, firms with high volume might invest in micro-fulfillment centers (small urban distribution hubs) closer to customer clusters. These measures directly address traffic and time window challenges by bringing the goods closer to consumers and aggregating deliveries.
4. Collaboration among logistics providers is an underutilized strategy that could alleviate competition-driven inefficiencies. Managers could consider co-loading or network sharing arrangements, in which multiple companies share delivery resources for specific areas. Such horizontal collaboration has been encouraged in city logistics literature to reduce duplicate trips [45]. Additionally, managers can cautiously pilot crowdshipping for specific scenarios – for example, using contract drivers during peak periods or employing ride-hailing drivers to deliver parcels when they have empty return trips. The interviews conducted showed interest in this, but also concerns.

6.2. Recommendations for Policymakers and City Authorities

1. The Amman municipality and relevant transportation authorities should take concrete steps to address the identified infrastructure bottlenecks. A top recommendation is to designate and enforce dedicated loading and unloading zones in busy commercial and residential areas. This measure would directly address participants' complaints about parking difficulties, reducing the time delivery vehicles spend searching for or blocking traffic. Additionally, city planners should integrate freight considerations into urban development, for instance, requiring new shopping malls or large residential buildings to include designated delivery bays or concierge services for parcel receipt.
2. Authorities should accelerate the development of a unified digital address database for Amman. This could involve mapping every building to a geocode and disseminating a standardized address format. Additionally, integrating this database into popular map applications and making it accessible to logistics companies will allow couriers to locate destinations more easily. By solving the "where" of deliveries, authorities empower all logistics players to operate more effectively.
3. To promote greener and more efficient deliveries, policymakers should introduce incentives and supportive regulations. For example, the government could offer tax breaks or subsidies for electric vehicles used in delivery fleets. High initial costs of EVs were noted as a barrier; reducing import duties or providing financial incentives for purchasing electric vans or electric bikes would encourage companies to invest in them. Simultaneously, the city should invest in or facilitate the installation of charging infrastructure. Participants explicitly cited a lack of charging stations as a hindrance to EV adoption. Policymakers can also trial low-emission delivery time windows or zones, for instance, allowing only electric or low-emission vehicles to deliver in certain congested areas during peak hours.

4. City authorities can facilitate collaboration among logistics industry stakeholders to address common challenges through establishing a forum that regularly brings together delivery companies, e-commerce firms, city planners, and traffic police. By acting as an impartial facilitator, the city can help overcome some of the trust barriers that companies face when working together. Additionally, policymakers should update and clarify regulations to enable innovations such as drone delivery trials in specific areas (with safety provisions) or clarify legal liability for crowdshipping arrangements.

The recommendations presented here are complementary to one another: improving addresses helps route software perform more efficiently; loading zones make cargo bike use more feasible; driver training and policy incentives for EVs, when combined, improve sustainability and service. For other cities similar to Amman, these implications are likely applicable as well.

6.3. Limitations and Future Research Directions

This study has limitations that open avenues for future research. One limitation is that the data are cross-sectional and qualitative; this study captured perceptions and experiences at a single point in time. Future research could adopt a longitudinal approach to examine how LMD challenges and adaptations evolve, particularly as new technologies or policies are introduced. For example, investigating the impact of implementing a new addressing system or measuring improvements after loading zones are established would provide causal insights.

Another limitation is that this study focused on the supply side (logistics providers and managers). Customer perspectives were outside the scope of this research but are crucial to a complete understanding of LMD dynamics. Future studies might survey or interview e-commerce customers in Amman to examine issues like delivery preferences, tolerance for delays, and willingness to use alternatives (lockers, pickups). This would complement the supply-side view and help align service improvements with customer acceptance.

Moreover, while this study touched on emerging solutions, this research's exploration of innovations like drones and robots was based on interviewee speculation rather than observed trials (since such trials are yet to happen). Future research could engage in action research or pilot studies – for instance, partnering with a local firm to test a crowdshipping platform, and then evaluating outcomes quantitatively (delivery time, cost, customer satisfaction) and qualitatively (driver and customer feedback). Another promising research direction is analyzing policy implementation and governance models. As the city or national government acts to improve logistics, researchers could study the process, for example, through interviews with policymakers, analysis of policy documents, and surveys of industry responses. Such work could identify enablers and barriers in the policy environment for LMD, contributing to the literature on public-private collaboration in urban freight.

Finally, a comparative study across cities could be insightful. By replicating a similar research framework in multiple developing cities, this study can discern which LMD challenges are general versus those that are culture- or city-specific. It would also allow evaluating different approaches cities have taken, and cross-case analysis might highlight effective strategies transferable to others.

References

[1] V. Silva, A. Amaral, and T. Fontes, "Sustainable urban last-mile logistics: A systematic literature review," *Sustainability*, vol. 15, no. 3, p. 2285, 2023. https://doi.org/10.3390/su15032285

[2] C.-N. Wang, Y.-C. Chung, F. D. Wibowo, T.-T. Dang, and N.-A.-T. Nguyen, "Sustainable last-mile delivery solution evaluation in the context of a developing country: A novel OPA–Fuzzy MARCOS approach," *Sustainability*, vol. 15, no. 17, p. 12866, 2023.

[3] J. Alnsour, A. R. Arabeyyat, K. Al-Hyari, S. A. Al-Bazaiah, and R. Aldweik, "Enhancing city logistics for sustainable development in Jordan: A survey-based study," *Logistics*, vol. 8, no. 1, p. 1, 2023. https://doi.org/10.3390/logistics8010001

[4] R. Mangiaracina, A. Perego, A. Seghezzi, and A. Tumino, "Innovative solutions to increase last-mile delivery efficiency in B2C e-commerce: A literature review," *International Journal of Physical Distribution & Logistics Management*, vol. 49, no. 9, pp. 901-920, 2019. https://doi.org/10.1108/IJPDLM-02-2019-0048

[5] M. Kiba-Janiak, J. Marcinkowski, A. Jagoda, and A. Skowrońska, "Sustainable last mile delivery on e-commerce market in cities from the perspective of various stakeholders literature review," *Sustainable Cities and Society*, vol. 71, p. 102984, 2021. https://doi.org/10.1016/j.scs.2021.102984

[6] A. McKinnon, M. Browne, A. Whiteing, and M. Piecyk, *Green logistics: Improving the environmental sustainability of logistics*. London: Kogan Page Publishers, 2015.

[7] L. Rodriguez, "The role of transport and logistics in promoting e-commerce in developing countries," *UNCTAD Transport and Trade Facilitation Newsletter*, vol. 77, p. 17, 2018.

[8] A. Arvianto, B. M. Sopha, A. M. S. Asih, and M. A. Imron, "City logistics challenges and innovative solutions in developed and developing economies: A systematic literature review," *International Journal of Engineering Business Management*, vol. 13, p. 18479790211039723, 2021. https://doi.org/10.1177/18479790211039723

[9] J. A. Alnsour, "Managing urban growth in the city of Amman, Jordan," *Cities*, vol. 5, pp. 93-99, 2016.

[10] R. Gevaers, E. Van de Voorde, and T. Vanelslander, "Characteristics of innovations in last-mile logistics-using best practices, case studies and making the link with green and sustainable logistics," *Association for European Transport and Contributors*, vol. 1, p. 21, 2009.

[11] J. Allen *et al.*, "Understanding the impact of e-commerce on last-mile light goods vehicle activity in urban areas: The case of London," *Transportation Research Part D: Transport and Environment,* vol. 61, pp. 325-338, 2018. https://doi.org/10.1016/j.trd.2020.102443

[12] M. A. Figliozzi, "Carbon emissions reductions in last mile and grocery deliveries utilizing air and ground autonomous vehicles," *Transportation Research Part D: Transport and Environment,* vol. 85, p. 102443, 2020. https://doi.org/10.1016/j.trd.2020.102443

[13] McKinsey, *How customer demands are reshaping last-mile delivery*. New York: McKinsey & Company, 2016.

[14] N. Boysen, S. Fedtke, and S. Schwerdfeger, "Last-mile delivery concepts: A survey from an operational research perspective," *Or Spectrum,* vol. 43, no. 1, pp. 1-58, 2021. https://doi.org/10.1007/s00291-020-00607-8

[15] T. Bosona, "Urban freight last mile logistics—Challenges and opportunities to improve sustainability: A literature review," *Sustainability,* vol. 12, no. 21, p. 8769, 2020.

[16] L. Shbeeb, "Traffic and environmental impacts of constructing and operating a BRT service: Case study in Amman, Jordan," *Cogent Engineering,* vol. 10, no. 2, p. 2283316, 2023.

[17] J. Meaton and J. Alnsour, "Spatial and environmental planning challenges in Amman, Jordan," *Planning Practice and Research,* vol. 27, no. 3, pp. 367-386, 2012.

[18] O. Albatayneh, S. M. Gaweesh, and D. A. Husein Malkawi, "Forward-thinking for sustainable shared mobility solutions in amman," *Sustainability,* vol. 16, no. 2, p. 732, 2024.

[19] M. K. Al-nawayseh, M. M. Alnabhan, M. M. Al-Debei, and W. Balachandran, "An adaptive decision support system for last mile logistics in E-commerce: A study on online grocery shopping," *International Journal of Decision Support System Technology,* vol. 5, no. 1, pp. 40-65, 2013.

[20] S. Iwan, K. Kijewska, and J. Lemke, "Analysis of parcel lockers' efficiency as the last mile delivery solution–the results of the research in Poland," *Transportation Research Procedia,* vol. 12, pp. 644-655, 2016. https://doi.org/10.1016/j.trpro.2016.02.018

[21] Y. Wang, D. Zhang, Q. Liu, F. Shen, and L. H. Lee, "Towards enhancing the last-mile delivery: An effective crowd-tasking model with scalable solutions," *Transportation Research Part E: Logistics and Transportation Review,* vol. 93, pp. 279-293, 2016. https://doi.org/10.1016/j.tre.2016.06.002

[22] C. Siragusa, A. Tumino, R. Mangiaracina, and A. Perego, "Electric vehicles performing last-mile delivery in B2C e-commerce: An economic and environmental assessment," *International Journal of Sustainable Transportation,* vol. 16, no. 1, pp. 22-33, 2022.

[23] R. Nocerino, A. Colorni, F. Lia, and A. Luè, "E-bikes and E-scooters for smart logistics: environmental and economic sustainability in pro-E-bike Italian pilots," *Transportation research procedia,* vol. 14, pp. 2362-2371, 2016.

[24] J. K. Stolaroff, C. Samaras, E. R. O'Neill, A. Lubers, A. S. Mitchell, and D. Ceperley, "Energy use and life cycle greenhouse gas emissions of drones for commercial package delivery," *Nature Communications,* vol. 9, no. 1, p. 409, 2018. https://doi.org/10.1038/s41467-017-02411-5

[25] W. A. Mohammad, Y. Nazih Diab, A. Elomri, and C. Triki, "Innovative solutions in last mile delivery: Concepts, practices, challenges, and future directions," *Supply Chain Forum: An International Journal,* vol. 24, no. 2, pp. 151-169, 2023.

[26] V. Carbone, A. Rouquet, and C. Roussat, "The rise of crowd logistics: A new way to co-create logistics value," *Journal of Business Logistics,* vol. 38, no. 4, pp. 238-252, 2017. https://doi.org/10.1111/jbl.12164

[27] K. Huang and M. N. Ardiansyah, "A decision model for last-mile delivery planning with crowdsourcing integration," *Computers & Industrial Engineering,* vol. 135, pp. 898-912, 2019. https://doi.org/10.1016/j.cie.2019.06.059

[28] A. Karaoulanis, "The role of micro fulfilment centers in alleviating, in a sustainable way, the urban last mile logistics problem: A systematic literature review," *Sustainability,* vol. 16, no. 20, p. 8774, 2024.

[29] K. M. Mwita, "Strengths and weaknesses of qualitative research in social science studies," *International Journal of Research in Business and Social Science,* vol. 11, no. 6, pp. 618-625, 2022.

[30] A. Elhami and B. Khoshnevisan, "Conducting an interview in qualitative research: The modus operandi," *Mextesol Journal,* vol. 46, no. 1, pp. 1-9, 2022.

[31] M. A. Adeoye, "Review of sampling techniques for education," *ASEAN Journal for Science Education,* vol. 2, no. 2, pp. 87-94, 2023.

[32] P. I. Fusch Ph D and L. R. Ness, "Are we there yet? Data saturation in qualitative research," 2015.

[33] G. Guest, A. Bunce, and L. Johnson, "How many interviews are enough? An experiment with data saturation and variability," *Field Methods,* vol. 18, no. 1, pp. 59-82, 2006. https://doi.org/10.1177/1525822X05279903

[34] E. Van Teijlingen and V. Hundley, "The importance of pilot studies," *Social Research Update,* vol. 16, no. 40, pp. 1-4, 2001.

[35] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative Research in Psychology,* vol. 3, no. 2, pp. 77-101, 2006. https://doi.org/10.1191/1478088706qp063oa

[36] J. Fereday and E. Muir-Cochrane, "Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development," *International Journal of Qualitative Methods,* vol. 5, no. 1, pp. 80-92, 2006.

[37] L. Dablanc, "City distribution, a key element of the urban economy: Guidelines for practitioners." Cheltenham, UK: Edward Elgar Publishing, 2011.

[38] M. Savelsbergh and T. Van Woensel, "50th anniversary invited article—city logistics: Challenges and opportunities," *Transportation Science,* vol. 50, no. 2, pp. 579-590, 2016. https://doi.org/10.1287/trsc.2016.0675

[39] J. Muñuzuri, J. Larrañeta, L. Onieva, and P. Cortés, "Solutions applicable by local administrations for urban logistics improvement," *Cities*, vol. 22, no. 1, pp. 15-28, 2005. https://doi.org/10.1016/j.cities.2004.10.003

[40] R. Gevaers, E. Van de Voorde, and T. Vanelslander, "Cost modelling and simulation of last-mile characteristics in an innovative B2C supply chain environment with implications on urban areas and cities," *Procedia-Social and Behavioral Sciences*, vol. 125, pp. 398-411, 2014. https://doi.org/10.1016/j.sbspro.2014.01.1483

[41] A. H. Hübner, H. Kuhn, and J. Wollenburg, "Last mile fulfilment and distribution in omni-channel grocery retailing: a strategic planning framework," *International Journal of Retail & Distribution Management*, vol. 44, no. 3, pp. 228–247, 2016. https://doi.org/10.1108/IJRDM-11-2014-0154

[42] M. Christopher, "The agile supply chain: Competing in volatile markets," *Industrial Marketing Management*, vol. 29, no. 1, pp. 37-44, 2000. https://doi.org/10.1016/S0019-8501(99)00110-8

[43] J. Olsson, D. Hellström, and H. Pålsson, "Framework of last mile logistics research: A systematic review of the literature," *Sustainability*, vol. 11, no. 24, p. 7131, 2019. https://doi.org/10.3390/su11247131

[44] E. M. Rogers, "Diffusion of innovations," 5th ed. New York: Free Press, 2003.

[45] F. Basso, N. Dovichi, and F. Mazzarella, "Horizontal collaboration in logistics: A review of the literature and outlook," *Sustainability*, vol. 11, no. 21, p. 6102, 2019.