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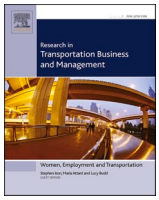

Tackling urban freight distribution: A public-private perspective

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ABSTRACT

Effective Urban Freight Distribution (UFD) relies heavily on the collaboration between government authorities and logistics agents. However, this collaboration can be influenced by the unique interests and requirements of each party involved. The aim of our research is to identify the main challenges and concerns in public-private UFD interactions and to propose solutions to enhance these interactions in cities. To achieve this goal, we conducted semi-structured interviews with key logistics agents operating in the Metropolitan Region of Barcelona, including both government authorities and private operators. The interviews were transcribed, coded, and analysed using the coefficient of co-occurrence method to determine the most significant relationships. Our results highlight a preference for creating a unified spokesperson role and underscore the need to harmonise regulations and unify operating criteria across neighbouring municipalities. Additionally, we suggest solutions to transition towards a more sustainable model and discuss the future viability of various logistics innovations.

1. Introduction

Freight transport has been one of the most dynamic economic sectors in recent years. In Europe alone, the volume of freight carried per kilometre increased by 13.8%, reaching 2.478 trillion tn-km, from 2000 to 2016, with road transport being the predominant mode, representing 72.8% of the total (EEA, 2019). The impact of these operations on urban areas is well-known, encompassing issues such as air and noise pollution, traffic congestion, accidents, and the fragmentation of natural habitats (Kowe, Mutanga, & Dube, 2021; Yang, Chen, & Yuan, 2021). Nevertheless, the trend in freight traffic continues to rise. The surge in e-commerce is reshaping the traditional structure of commerce and distribution channels (Nanda, Xu, & Zhang, 2021). Consumers are increasingly turning to online shopping with home delivery, requiring a complete redesign of company logistics and distribution chains. This has resulted in reduced use of traditional B2B channels (involving urban retailing and shopping centres) and an increase in home parcel delivery (Filiopoulou, Bardaki, Boukouvalas, Nikolaidou, & Kourouthanassis, 2022). The new scenario implies profound changes for businesses. Factors influencing factory and warehouse locations are transitioning, creating logistics sprawl around large conurbations (Dablanc, 2023; Trent & Joubert, 2022). Freight carriers and distributors are required to adapt to new locations and delivery conditions (small volumes, multiple stops, traffic restrictions, etc.), generating significant tensions in their operations (Bjørgen & Ryghaug, 2022).

Despite the growing awareness of issues in freight transport, most municipal authorities in Europe do not yet possess the necessary expertise to manage Urban Freight Distribution (UFD), especially in small cities and towns (Fossheim & Andersen, 2017). A comprehensive understanding of the complexity of city logistics is required to identify and implement policy measures that facilitate, limit or manage freight distribution at different regulatory levels and allow for stronger links between transport planning and land use (Bjørgen, Bjerkan, & Hjelkrem, 2019). To contribute to the knowledge on UFD, our article aims to provide a better understanding of recent transformation processes and the difficulties faced by public-private interactions involved in city logistics, addressing our research question: "***What is the relationship between the public-private agents involved in UFD?***" The starting hypothesis is that there are inefficiencies in the operation of UFD and conflicts of interest between the public-private agents, leading to the identification of contradictory solutions. In response to this dilemma, semi-structured interviews were conducted with numerous agents related to UFD operations in the Metropolitan Region of Barcelona (RMB). Specifically, 16 interviews were conducted with logistics operators, freight carriers, retailers, and government authorities, among other groups. The interviews were transcribed, coded, and analysed using co-occurrence analysis with Atlas.ti to determine relations with greater significance. Having identified the co-occurrences, we present and discuss the results.

In the dynamic landscape of UFD, a significant research gap emerges,

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hindering a comprehensive understanding of the intricate relationships and operational challenges among public-private agents involved in UFD. Despite the acknowledged negative externalities and the urgent need for innovative approaches to optimise positive aspects and minimise drawbacks (Brettmo & Sanchez-Diaz, 2022), existing research falls short of providing a nuanced examination of these complexities. Stakeholders, serving different sectors with varied interests, introduce additional layers of intricacy (Le Pira, Marcucci, Gatta, et al., 2017). Municipal authorities, tasked with urban mobility and logistics policymaking, grapple with the translation of high-level goals into measurable objectives, further exacerbating the challenges in UFD (Akgün, Monios, Rye, & Fonzone, 2019; Holguín-Veras, Leal, Sanchez-Diaz, Browne, & Wojtowicz, 2020a, 2020b).

Our research motivation is deeply rooted in addressing this critical research gap to navigate the multifaceted landscape of UFD. While previous studies shed light on potential solutions and emphasise stakeholder engagement (Bjørgen & Ryghaug, 2022; Brettmo & Sanchez-Diaz, 2022), they lack a comprehensive examination of the intricate relationships and collaboration hindrances within UFD. This study aims to provide a nuanced perspective by conducting a detailed analysis of potential solutions for public-private interactions and emphasising the crucial dialogue between them. Furthermore, the inclusion of behavioural research as a fundamental aspect ensures that UFD policies are not only effective but also aligned with industry reactions, mitigating the risk of counterproductive measures (Holguín-Veras et al., 2017). Through this holistic exploration, our research endeavours to fill the existing knowledge void, offering actionable recommendations for urban planners, policymakers, and industry professionals grappling with the intricacies of contemporary city logistics.

The article comprises seven sections. Following this introduction, the literature review and the context of our study are outlined. The fourth section describes the working methodology, including data collection and processing. The fifth section provides the results, and the sixth analyses and discusses them in relation to the existing literature. The last section presents the conclusions.

2. Literature review

The increasing rise of e-commerce and the need for freight delivery in urban areas have generated a greater demand for efficiency in UFD. However, the implementation of sustainable logistics strategies is a complex challenge that involves multiple actors with often divergent interests. In this context, UFD has become a key focus to improve the efficiency and sustainability of city logistics. The main literature on the significance of stakeholders involved in city logistics, the challenges in the application of the UFD policies and the need for collaboration among all stakeholders to achieve an optimal UFD implementation is explored below.

2.1. Stakeholders involved and the challenges of implementing UFD policies

The transportation of goods plays a crucial role in sustaining the modern economy; however, it is marred by significant challenges within the realm of city logistics. Unfortunately, UFD is plagued by negative externalities that demand the adoption of innovative approaches to enhance its benefits and mitigate adverse effects. This challenge becomes more complex due to the diverse needs of various sectors, such as fashion, food, or furniture, each requiring tailored logistics solutions (Le Pira et al., 2017). Key stakeholders in the freight transportation industry represent a diverse group, encompassing private entities like haulage and shipping companies, retailers of all types, logistics operators, as well as public bodies, including government authorities at the national, regional, and local levels, and, not to be overlooked, the citizens themselves.

The intersection of stakeholder engagement and emerging technologies holds a pivotal role in modern UFD. This integration is indispensable for navigating the intricacies of contemporary city logistics, where the delicate balance between efficiency and environmental and social sustainability is paramount (Holguín-Veras et al., 2020a, 2020b). At the core of this approach lies the concept of inclusivity, ensuring that technological advancements in UFD resonate with a wide array of stakeholders, including urban planners, logistics providers, businesses, and local communities (Le Pira et al., 2017). This multi-stakeholder approach facilitates a comprehensive understanding of the city logistics landscape, aligning technological solutions with diverse needs and challenges. Recent studies have underscored the critical role of stakeholder engagement in the successful implementation of logistics technologies, highlighting its impact on sustainability and efficiency (Segura et al., 2020).

Typically, it is municipal authorities who bear the responsibility for urban mobility and logistics policymaking. Research spanning multiple cities indicates a commonality in high-level goals, yet these goals are often not translated into tangible objectives with measurable outcomes (Akgün et al., 2019). Moreover, after an in-depth examination of the Paris region, Dablanc (2023) concluded that stakeholders believe regional governance is better suited for enacting policies that can effectively enforce and standardise municipal regulations. While enforcement is inherently a local matter, local authorities often grapple with selecting effective solutions. The complexity of local governance is highlighted by the challenges faced in policy implementation, suggesting a disconnection between policy making and on-ground applicability (Nocera, Pungillo, & Bruzzone, 2020).

The interplay of multiple stakeholders' interests in urban freight logistics necessitates a broader range of strategies that transcend conventional approaches. This echoes the sentiments of Holguín-Veras et al. (2020a, 2020b), who emphasise the critical need for collaborative engagement among all stakeholders, including public administrations, private entities, and civil society, to achieve effective and sustainable urban freight solutions. The scholarly consensus emphasises the value of employing a range of measures tailored to the diverse nature of stakeholders' expectations when determining the most suitable interventions (Kin, Verlinde, Mommens, & Macharis, 2017). Furthermore, establishing inclusive frameworks that facilitate data sharing and joint analysis is crucial, as it fosters trust and sustains the value proposition of collaborative initiatives (Kiba-Janiak, Browne, & Cheba, 2018).

This intricate tapestry of interests within UFD demands a multidisciplinary approach that not only encompasses the integration of various measures but also aligns with a long-term commitment and understanding of stakeholder dynamics, which are essential for making impactful decisions (Holguín-Veras et al., 2020a, 2020b; Katsela & Pålsson, 2019). These insights contribute to a more comprehensive guideline for stakeholders' interaction, which is crucial for advancing city logistics initiatives.

2.2. Collaborating for efficient and sustainable UFD

Previous research has demonstrated that the negative impacts of urban freight can be alleviated with a better understanding of the system and by identifying and engaging influential stakeholders (Bjørgen & Ryghaug, 2022; Brettmo & Sanchez-Diaz, 2022). It has also emphasised the importance of structuring stakeholder participation and acceptance of any transport policy (Bjørgen, Fossheim, & Macharis, 2021; Perera & Thompson, 2021). However, collaboration is hindered since logistic service providers and carriers traditionally view similar organisations as competitors rather than collaborators, and often cooperation between different authorities and jurisdictions fails (Kervall & Palsson, 2022). The necessity of overcoming this competitive mindset is echoed in the works of Katsela and Pålsson (2019), who argue that harmonising stakeholders' interests leads to more aligned motives and collaborative goal-setting in city logistics initiatives.

In parallel, technological innovation is reshaping the landscape of

UFD. This transformation, including the application of Artificial Intelligence (AI) in logistics planning, the utilisation of the Internet of Things (IoT) for smarter infrastructure, and the integration of blockchain for enhanced supply chain transparency, is revolutionising UFD (Kiba-Janiak et al., 2018). These advanced technologies offer numerous benefits, such as operational optimisation, reduced environmental impact, and improved service quality (Amaya, Delgado-Lindeman, Arellana, & Allen, 2021). Notably, the introduction of electric and autonomous delivery vehicles, complemented by AI-driven routing algorithms, addresses both efficiency and environmental concerns in urban freight systems (Baker et al., 2023). The synergy between stakeholder collaboration and technological innovation presents an opportunity to mitigate the challenges of UFD effectively.

Analysing all potential solutions for the different stakeholders represents the first step towards successfully designing efficient, sustainable and innovative city logistics strategies (Fancello, Paddeu, & Fadda, 2017). Dialogue between all stakeholders is crucial, as imposing specific unilateral measures tends to have unexpected and, more importantly, undesired outcomes (Viu-Roig & Alvarez-Palau, 2020). This is particularly evident in the context of the COVID-19 pandemic in RMB, where the lack of communication between logistics agents during the implementation of public space reassignments led to operational disruptions (Castillo, Viu-Roig, & Alvarez-Palau, 2022).

Transportation systems, particularly UFD, are complex, heterogeneous, and often poorly understood by policymakers. Timely consultations with key stakeholders could provide critical information to the public sector on how best to achieve these goals, without inadvertently adding problems elsewhere (Holguín-Veras et al., 2020a, 2020b). The importance of such consultations is further highlighted by Kiba-Janiak et al. (2018), who stress the need for data and information-sharing frameworks to build trust among stakeholders in urban freight initiatives. Bjørgen et al. (2021) show that every hypothetical measure implemented has facilitators and obstacles for each stakeholder. They introduced the concept of “common ground”, referring to the abstract area where measures (or rather combinations of measures) that are most likely to be both effective and accepted by all stakeholders are found. For these authors, the perception of common ground demonstrates the logic of collaborative processes in UFD.

However, realising the full potential of these technological innovations requires supportive policy frameworks and adaptable regulations (Bachofner, Lemardelé, Estrada, & Pagès, 2022). It is incumbent upon local governments to develop and implement policies that encourage technological adoption, foster public-private collaborations, and incentivise the use of green technologies (Dolati Neghabadi, Evrard Samuel, & Espinouse, 2019). Such policies play a critical role in ensuring a balanced approach to innovation and regulatory compliance in city logistics systems (Segura et al., 2020).

Meanwhile, the best way to avoid negative outcomes is to ensure UFD policy is supported by behavioural research (Holguin-Veras, Leal, & Seruya, 2017). These authors conclude that the first step should be to use in-depth interviews to obtain as much information as possible regarding the industry's potential behavioural reactions to new policies. Taking full advantage of the potential of behavioural research is a cost-effective way of ensuring sound UFD policies, particularly considering the high risk of ineffective and counterproductive ones.

3. Study context

UFD plays a vital role in the modern economy, with cities acting as crucial hubs for their efficiency and sustainability (Mansouri, Sahu, & Ülkü, 2023). The RMB, encompassing 164 municipalities with a population of 5,151,263 in an area of 3,126.16 km^2, presents an excellent case study.[1] Within the RMB lies the Barcelona Metropolitan Area (AMB), a region of significant importance. As one of the most populous areas in Europe, the AMB is home to over 3.2 million people across 636 km^2. The AMB operates as a public administration with responsibilities across various sectors, including social cohesion, regional and urban planning, mobility, and the economic promotion of the metropolitan built environment. This area is a major contributor to Catalonia's Gross Domestic Product (GDP), representing 52% of the total. Specifically, Barcelona city's contribution is €75,430.4 million. This economic activity is supported by 20.83% of the region's active population.[2]

Additionally, the AMB attracts more than 10 million tourists annually, reflecting its considerable impact on regional mobility. This area is distinguished by its advanced logistics and urban mobility infrastructure, which favours the efficient distribution of urban goods both within and beyond its borders.[3] Barcelona, for instance, accounts for 16% of the entire vehicle fleet in Catalonia and sees over 7.02 million daily trips, underscoring the AMB's fundamental role in urban freight transport dynamics.

Besides its logistical strengths, the AMB confronts significant challenges that are pivotal to understanding its role in the UFD. Issues such as traffic congestion (Soriano-Gonzalez et al., 2023), deteriorating air quality (Rodriguez-Rey et al., 2022), and increasing demand for quick deliveries, especially in the food sector, necessitate a critical reevaluation of its sustainability and economic efficiency (Alvarez-Palau, Calvet-Liñán, Viu-Roig, Gandouz, & Juan, 2022). These challenges are crucial not only for Barcelona but also have broader implications for the entire RMB, impacting its environmental, economic, and social landscape.

Logistical facilities like the Barcelona Logistics Centre (BLC) enhance supply chain efficiency, while events such as the International Logistics and Maintenance Exhibition (SIL) encourage industrial collaboration and knowledge exchange. The diversity of stakeholders, including governmental bodies, autonomous agencies, and private companies, offers a comprehensive perspective for studying UFD in this region.

The regulation of UFD in the RMB, encompassing multiple levels of government (as illustrated in Fig. 1), adds another layer of complexity to the study. Barcelona city council regulates urban freight within its jurisdiction, focusing on aspects such as loading/unloading (L/U) zones and vehicle restrictions. The AMB collaborates with municipalities on low-emission initiatives, while the Barcelona Metropolitan Transport Authority (ATM) plans mobility through the Mobility Master Plan. The Provincial Council of Barcelona (DIBA), although not directly involved in freight transport, provides mobility and logistics planning support, and the Generalitat of Catalonia (GENCAT) enacts broader transport legislation. Additionally, the Spanish government ensures compliance with European directives. This multi-level regulatory framework positions the RMB as a fascinating subject for a multidisciplinary and collaborative study on UFD like ours.

4. Material and methods

4.1. Selection of the study method

An exploratory study is necessary to establish a knowledge base when there is insufficient evidence in a research field (Silverman & Patterson, 2021). While some literature discusses UFD management in large cities (de Carvalho, Vieira, da Fonseca, & Dulebenets, 2020), it lacks an in-depth analysis of the vision and experience of different UFD agents. Studies such as Amaya, Arellana, and Delgado-Lindeman (2020) only analyse stakeholders' perceptions of specific issues, such as delivery outside rush-hours, without considering related cases or government authorities' opinions. Therefore, we conducted an inductive research

[1] For statistical data, see IDESCAT (2021).

[2] http://barcelonacatalonia.cat/b/wp-content/uploads/2012/12/logistica-ANGLES-19-07ok.pdf

[3] https://www.amb.cat/en/web/territori/infraestructures-metropolitanes/sobre-infraestructures/transports

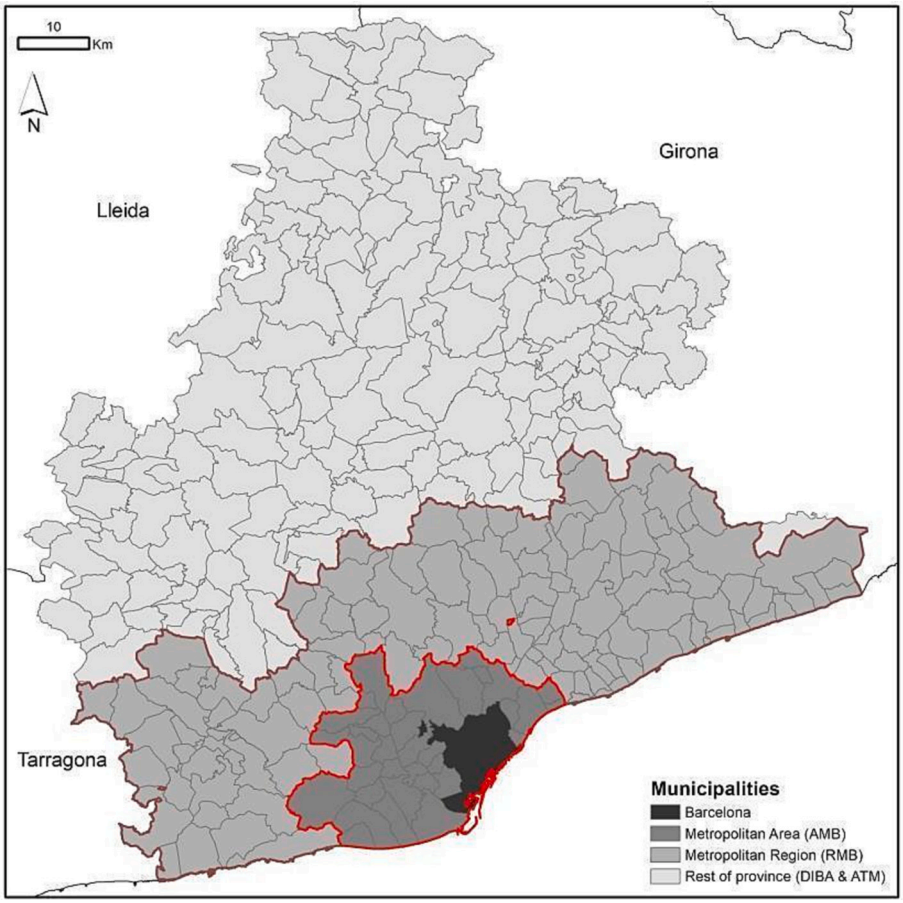

Fig. 1. Area of study and territorial scope of different government authorities.

design with UFD agents' interviews to complement the current literature.

4.2. Selection of the study sample

The interviewed agents were required to meet a set of previously defined characteristics. The inclusion criteria were as follows: (1) Logistics agents related to UFD in Catalonia; (2) the interviewees possessed knowledge of the activity of the organisation they represent and its relationship with UFD; and (3) the selected organisations represented a variety of different sectors. In total, 16 agents who met the selection criteria were interviewed. This sample size was sufficient for the study context, considering the criterion established in the literature (Hennink & Kaiser, 2022), which stipulates that for a qualitative case-based research such as ours on UFD, a valid sample size should range from 15 to 30 interviews. Additionally, it is important to highlight that some of the logistics agents interviewed are associations that represent a larger number of companies, potentially making our sample even more representative. A summary of the interviewed companies that constituted our final sample, along with a brief description of each, can be seen in Table 1.

4.3. Data collection method and interview conditions

The method of semi-structured interviews with a predefined script was employed, allowing flexibility in the formulation and sequence of questions (Brinkmann, 2022). The interviews took a predominantly open-ended approach, fostering a deeper exploration of ideas. Conducted between January 2021 and December 2022, this period held particular significance for RMB as it redefined its UFD policy in the post-pandemic era, aiming to make its model more sustainable (Calvet et al., 2021; Castillo et al., 2022).

All interviews were recorded with consent for subsequent transcription, without time restrictions, via video conference using Zoom. The initial choice of video conference was a response to mobility limitations imposed by the COVID-19 pandemic; however, after the lifting of these restrictions, video conference were retained for the convenience of the interviewees. Each interview involved the participation of at least two researchers, with only one formulating questions while the other recorded the most relevant aspects of non-verbal communication with the interviewees. The observation of reactions justifies the use of interviews over questionnaires, allowing for a deeper understanding of the interviewees and providing context for subsequent transcriptions, with video conferencing being fully valid as a method for conducting interviews (Khan & MacEachen, 2022).

A total of 815 min of recordings were collected, with an average of 50.97 min per interview, resulting in 117,658 words.

4.4. Data management

We transcribed the interviews using Transcriber and double-checked them. We coded the transcripts using Atlas.ti and obtained 105 codes related to the research topic. We also extracted the technical vocabulary used in the sector (see Table 2), following the guidelines in Saldaña (2021).

4.5. Method for data analysis

After coding, we analysed each interview in its entirety and then in blocks. This provided a specific view of each agent interviewed and

Table 1
Classification of agents interviewed by type.

Government authorities

1. ***Government of Catalonia:*** The Regional Government of Catalonia has exclusive control over several areas related to transport and logistics, and an enforcement role in others.
2. ***Barcelona Metropolitan Transport Authority (ATM):*** This public entity coordinates and plans public transport in the metropolitan area of Barcelona, taking decisions and designing strategies for efficient and effective operation.
3. ***Barcelona Metropolitan Area (AMB):*** This public entity serves as a supramunicipal administration for the metropolitan area of Barcelona, encompassing 37 municipalities. Thus, it performs functions and takes decisions for the entire metropolitan area, rather than just one city or municipality.
4. ***Barcelona Provincial Council (DIBA):*** Provincial government institution that collaborates with town councils to improve the lives of citizens in 311 municipalities by offering services and programs that promote progress and well-being.
5. ***Granollers City Council:*** Local government for Granollers, a municipality with a population of 62,419 (IDESCAT, 2024) and an area of 14.87 km2, responsible for managing public affairs and making decisions for this municipality.
6. ***Vic City Council***: Local government for Vic, a municipality with a population of 47,630 (IDESCAT, 2024) and an area of 30.58 km^2, responsible for managing public affairs and making decisions for this municipality.

Public logistics management company:

7. ***Centres and infrastructures for mobility and logistic activities (CIMALSA):*** This public company, owned by the Government of Catalonia, manages and promotes transport and logistics infrastructures to benefit society. Its turnover in 2019 was €7 M.

Grocery

8. ***Mercadona:*** Largest grocery chain in Spain, with 25% market share and a turnover of almost €30B in 2022.
9. ***Condis:*** Grocery chain with a significant presence in the region. Its market share in 2022 was 8% and it had a turnover of €773 M.

Textile

10. A Catalan company in the fashion sector that preferred to keep their name out of this study for reasons of confidentiality.

Construction, civil engineering and fitters

11. ***Grupo Lymet:*** Corporate group representing four companies (Lymet SA, Lymet Obra Civil SL, UTE MTBT Barcelona and MV Instalaciones. Its turnover in 2022 was €40 M.

Freight carriers

12. ***Catalan Freight Federation of Barcelona (TRANSCALIT):*** Organisation comprising nine transport associations, representing a total of 500 companies.

Hospitality industry

13. ***Catalan Association of Food and Beverage Logistics and Distribution Companies (ADISCAT):*** Organisation comprising eight hospitality industry associations, representing a total of 115 companies.

Last-mile carrier start-ups

14. ***Vanapedal:*** A company that operates from a micro-platform and uses cargo bikes to make deliveries in the last mile segment.
15. ***CargoBici:*** They distribute exclusively and provide official technical service for XYZ cargo bikes in Spain and Portugal.
16. ***Ecopol:*** Sustainable transport company with a large presence in Barcelona.

Table 2
Code book used in this research.

1. **UFD-related codes:**

(1) Normal L/U; (2) night-time L/U; (3) L/U problems; (4) with traffic problems; (5) without traffic problems; (6) UFD difficulties; (7) daily distribution; (8) e-bike; (9) e-commerce; (10) increase in trips; (11) increase in UFD zone; (12) increase in users; (13) urban planning limitation; (14) last-mile; (15) illegal parking; (16) better UFD operation; (17) limited mobility; (18) user mobility; (19) new UFD regulation; (20) specific sector ordinance; (21) lorry parking; (22) mobility plan; (23) storage size problems; (24) consolidation point; (25) collection point; (26) insufficient time restriction; (27) with weight restriction; (28) without weight restriction; (29) UFD zone revisers; (30) empty transport; (31) temperature traceability; (32) use of rail UFD; (33) future vision of UFD; (34) pedestrian zone, (35) unifying UFD criteria

2. **City-related codes:**

(36) Cycle lane; (37) old town; (38) public space; (39) smart city; (40) superblocks; (41) traffic safety

3. **Government-related codes:**

(42) Government outside the metropolitan area; (43) political decision; (44) government dialogue; (45) dialogue with other external government authorities; (46) economic difficulty; (47) emissions label; (48) excessive bureaucracy; (49) lack of government resources; (50) lack of qualified personnel; (51) public logistics management; (52) single spokesperson; (53) logistics sector board; (54) authority lenience; (55) little lenience; (56) council property; (57) drawing up best practices; (58) subsidy; (59) e-bike subsidy; (60) without subsidy; (61) without competencies; (62) without vandalism; (63) with vandalism

4. **Codes related to other agents:**

(64) Dialogue with businesses; (65) dialogue with neighbours; (66) dialogue with logistics companies; (67) HORECA[a]; (68) fitters; (69) third party integration; (70) food sector; (71) without conflicts with residents; (72) with conflicts with residents; (73) conflict between sectors; (74) university; (75) competition between sectors; (76) reverse logistics; (77) outsourced logistics; (78) without own fleet; (79) without stock; (80) maintenance; (81) no H&S; (82) little participation

5. **Codes related to technology and its use:**

(83) Technology absent; (84) big data, (85) barcode; (86) sharing information; (87) digitalisation; (88) GPS; (89) RFID; (90) without KPI; (91) use of KPI; (92) route software; (93) without data; (94) expected route

6. **Type of transport-related codes:**

(95) Problems with electric vehicles and weight; (96) no future vehicle plan; (97) diesel vehicle; (98) electric vehicle; (99) gas vehicle

7. **Other:**

(100) Lack of initiative; (101) penalise; (102) reward; (103) pilot test; (104) sustainability; (105) use as an example

[a] Hospitality, restaurant and catering.

overall conclusions from all the agents (Glaser & Strauss, 2017). We started by analysing data from codes grouped into families (Table 2). This grouping helped identify codes by topic and understand the context without focussing on the interviewee. Thus, we identified the predominant concepts in each segment of the interviews analysed. Co-occurrences were analysed to establish the different relations between the codes used. Atlas.ti's co-occurrence analysis helps researchers find connections between codes or themes in their data. It identifies instances where codes or themes appear together in documents or sections, revealing patterns and associations (Berthet et al., 2023). The C coefficient measures code co-occurrences, ranging from 0 to 1 (Garcia, 2005). A C value nearing 1 indicates a strong relationship between codes (Friese, 2019).

The C coefficient is calculated using the following formula:

$$C = \frac{n_{AB}}{(n_A + n_B) - n_{AB}} \quad (1)$$

Where:

- C represents the co-occurrence value.
- n_{AB} stands for the number of instances in which codes A and B co-occur together in the data.
- n_A represents the number of instances in which code A is found.
- n_B represents the number of instances in which code B is found.

The C coefficient method is justified in qualitative analysis for multiple reasons. Firstly, it offers an objective measure of code relationships, avoiding subjectivity (Berthet et al., 2023). It identifies strong relationships, saving time and enhancing credibility. Moreover, it uncovers unique patterns (Paulus & Lester, 2016), making it valuable in exploring complex interview data (Friese, 2019). Recent literature demonstrates the use of this method in various disciplines, aiming to conduct exploratory studies, such as in assessing the impact of lockdowns on city logistics agents (Castillo et al., 2022), or identifying the various emotions of workers during the implementation of a lean manufacturing improvement in their company (Castillo, 2022).

For the analysis, we have established the following criteria for the relationship between codes, considering the C coefficient value. These criteria have been selected based on comprehensive reviews of current academic literature, though it is important to acknowledge that there are no universally accepted criteria for classifying the values of the C coefficient. Our methodology is inspired by the significant contributions of researchers like Castillo (2022), Castillo et al. (2022), and Choe, Lee, and Lee (2022), whose works in impactful academic journals have provided valuable guidelines in defining these thresholds.

According to our criterion, when the C value is:

- Less than 0.05, the relationship between codes is considered weak. This classification is based on the general understanding that lower values of co-occurrence imply a less significant connection between codes.
- Between 0.06 and 0.15, the relationship is moderate. This intermediate category reflects a notable but not predominant co-occurrence, in line with previous studies identifying this range as significant but not conclusive.
- Between 0.16 and 0.49, the relationship is deemed strong. This threshold has been determined considering the literature suggesting that, in this range, co-occurrence begins to be sufficiently relevant to indicate a consistent association between codes.
- Between 0.50 and 1, the relationship is rated as very strong. This criterion is grounded in the interpretation of Garcia (2005) and others, who argue that a co-occurrence above 0.50 is indicative of a high correlation, and therefore, considered elevated.

5. Results

The value of the relations between the codes extracted from the interviews is concentrated in a 105 × 105 matrix. Atlas.ti provides the C coefficient for each.[4] Based on the relation criteria described above, we highlighted relations between codes considered 'strong' or 'very strong' in the co-occurrence matrix (Table 3).

Table 3
Classification of the relations between codes according to the criteria established in our study methodology.

Strong relations between codes [C (0.16–0.49)]		
Dialogue external authorities	Dialogue logistics companies	0.16
L/U problems	e-commerce	0.16
L/U problems	Insufficient time restriction	0.16
Urban planning limitation	User mobility	0.17
Subsidy	Gas vehicle	0.17
Use of rail UFD	HORECA	0.17
Normal L/U	Illegal parking	0.17
Traffic problems	Emission label	0.17
Excessive bureaucracy	Little lenience	0.18
Last-mile	Electric vehicle	0.19
Collection point	Reward	0.19
L/U problems	Conflict between sectors	0.19
UFD difficulties	e-commerce	0.19
Storage size problem	No H&S	0.20
Better UDF operation	Digitalisation	0.21
Night-time L/U	No weight restriction	0.22
No weight restriction	Dialogue government	0.22
Unifying criteria	Single spokesperson	0.22
Dialogue other external authorities	Dialogue with businesses	0.22
Better UDF operation	Unifying UFD criteria	0.22
Increase in trips	Storage size problem	0.23
L/U problems	UFD difficulties	0.25
Problems with electric vehicles and weight	No future vehicle plan	0.25
Economic difficulty	Without subsidy	0.27
Lack of government resources	Big data	0.28
Dialogue with businesses	Dialogue logistics companies	0.28
Daily distribution	Without stock	0.33
Very strong relations between codes [C (0.50–1)]		
Public logistics management	Use as an example	0.50

[4] The software also uses different tones of green to highlight relations between codes. Thus, the closer the relation to 1, the darker the green.

6. Analysis and discussion

In this section, we present and discuss our findings, drawing on the interviews, the analytical methods employed, and the extent to which our results align with the existing literature:

6.1. Learnings from RMB's region

6.1.1. Regulation and enforcement mechanisms

Logistics agents are increasingly concerned about the management difficulties in UFD. An important issue, highlighted by the lack of specific ordinances for each sector {c = 0.19}, is leading logistics agents to make strong demands for reconsideration {c = 0.22}. The diversity between sectors becomes evident, with each having unique distribution needs depending on the type of goods, customers (B2B, B2C), and order size/frequency. This diversity impacts the fleet of vehicles, parking times, and the average number of stops per route in the city's unique urban environment.

This is supported by the words of a private agent:

> *"The one-size-fits-all approach in current ordinances just doesn't work for us. Different sectors have varied needs, especially in urban areas".*

Proposition 1. Ordinances regulating UFD fail to adapt to the specific requirements of each sector.

The critique of the current UFD model, especially regarding the deficiencies of the ordinances, has also been addressed by Holguín-Veras et al. (2017). They offer a data-driven model to estimate transport volumes, taking into account sector-specific variables such as the location of industrial premises or employment levels. This model could be adapted by RMB's public authorities to create tailored ordinances for each UFD sector. In fact, these authorities could define policies that specifically address the unique needs of each agent, thus alleviating the current management challenges faced in UFD.

6.1.2. Management of L/U parking

The rise of e-commerce has highlighted the challenges in UFD {c = 0.19}, particularly regarding the availability and suitability of parking for L/U activities {c = 0.16}. According to most logistics agents and authors like Bosona (2020), the allotted time windows for parking are considered insufficient. In contrast, parcel companies operating in the region {c = 0.02} cite a shortage of available spots but find the standard 20-min parking regulation to be adequate. Regardless, the inefficient management of L/U zones frequently results in illegal parking {c = 0.03}, an issue that is especially severe in the historic city centres of RMB {c = 0.11}.

At this point, the perspective of one of the interviewees adds depth to this issue:

> *"Finding a parking spot for quick delivery feels akin to winning the lottery, especially in the era of ubiquitous online shopping. We almost invariably encounter problems, either resorting to illegal parking or experiencing delays beyond anticipated delivery times".*

Authorities should increase parking and allow flexible L/U zone timings to ease congestion (Roca-Riu, Cao, Dakic, & Menendez, 2017). Both businesses and authorities agree that off-peak and night-time operations can reduce congestion {c = 0.22}. System inflexibility and limited enforcement exacerbate bureaucracy and ineffectiveness {c = 0.18}, solvable through tailored ordinances with justified exceptions {c = 0.11}. Misuse of L/U zones by non-commercial vehicles needs addressing {c = 0.17}. UFD issues, often linked to parcel deliveries, are also caused by service providers like installers occupying L/U zones {c = 0.13}. Allowing night-time access for heavier vehicles could reduce trips and L/U operations {c = 0.22}, and many RMB municipalities already grant weight restriction exceptions upon request {c = 0.06}.

In areas with restricted mobility but high business concentration, especially historic centres, a debate on parking conditions is needed. RMB logistics agents favour weight limits {c = 0.08} but highlight L/U zone scarcity {c = 0.06} and short parking durations {c = 0.06}, complicating UFD {c = 0.08}. Proposals include sustainable solutions like micro-platforms and electric tricycles for last-mile deliveries, aligning with global research (Arnold, Cardenas, Sörensen, & Dewulf, 2018; Elbert & Friedrich, 2020).

Proposition 2. The effective management of UFD is impeded by the inadequate handling of L/U zones, yet offering flexibility could bolster UFD efficiency.

This proposition is consistent with Holguín-Veras et al. (2020a, 2020b) recommendation for deliveries outside standard hours as a strategy to mitigate negative externalities. Their advice to adjust the timing, frequency, and destinations of deliveries to reduce daytime traffic congestion and pollution is particularly relevant to RMB's urban framework. This approach, which underscores the importance of receivers as key decision-makers in UFDs, advocates for voluntary participation and economic advantages. The correlation between our study and broader research like Holguín-Veras et al. (2020a, 2020b) is clear: both endorse temporal modifications in UFD practices, especially in L/U operations, to reduce congestion and enhance efficiency.

6.1.3. Digitalisation

The current scarcity of data presents a challenge for the effective management of UFD. However, through the adoption of digital tools, valuable data could be collected, aiding policymakers and practitioners in improving daily operations and identifying long-term trends.

In RMB, growing recognition of digitising UFD areas' benefits is evident, with initiatives like the SPRO project, led by AMB, being notable. This project involves multiple municipalities using a unified app for L/U zone management. Digitalisation of L/U operations, well-received by interviewees, aims to improve L/U zone management and offer vital data for optimising size and efficiency. Public authorities' interviews indicate positive outcomes from digitising UFD areas {c = 0.27}. Yet, the full potential of these digital systems faces obstacles such as a scarcity of data management skills {c = 0.28} and local officials' limited experience with advanced technology {c = 0.07}. There's a need for more data and analytical tools to gain meaningful insights for decision-making, considering RMB's unique urban dynamics.

An interviewed public official commented on its potential:

> *"The digitalisation of UFD could change the rules of the game. It's not just about technology; it would help us make smarter decisions based on real data that truly reflect the unique logistics landscape of the city. Data that, until now, have only fallen into the hands of private companies and have not reached public administrations".*

Proposition 3. The current low degree of digitalisation in RMB's UFD areas significantly hinders potential improvements in urban freight management.

Holguín-Veras et al. (2020a, 2020b) emphasise the hindrance of inadequate digitalisation, particularly in Real-Time Information Systems (RTIS), to city logistics progress. In RMB, RTIS could offer vital real-time data on traffic, local rules, and supply chains for effective UFD management. Studies like Kalahasthi et al. (2022) confirm this, showing digital apps' benefits in managing urban parking, cutting vehicle miles, and providing real-time L/U zone availability. Additionally, Vertical Height Detection Systems, preventing vehicle accidents in narrow streets by warning of height limits, illustrate digitalisation's role in improving UFD.

6.1.4. Data-driven urban planning

ICT projects can improve public space planning and UFD operations by providing insights into the diverse behaviours of the region's municipalities. Logistics operators are burdened by inconsistent regulations and control mechanisms across municipalities. This often results from local policymakers unintentionally creating logistical disruptions by adapting ordinances from neighbouring areas (Kiba-Janiak et al., 2018). Data availability could help compare regulations and spot conflicts.

Data-driven planning can also address cycle lane designs that neglect motorised UFD traffic, enhancing road safety {c = 0.13}, and refine access restrictions in delivery-impeding zones {c = 0.09}. Technologies like GPS {c = 0.15} and temperature traceability {c = 0.10} are vital in UFD management. Utilising these tools ensures efficient UFD operations. Logistics agents in RMB should optimise vehicle loads to reduce trips {c = 0.13} and use specific route planning to lessen trip number and duration {c = 0.11}.

Research by Kechagias, Gayialis, Konstantakopoulos and Papadopoulos (2020) shows that digitisation, via dynamic routing and real-time data, can significantly improve UFD, benefiting RMB. These systems reduce mileage, increase driver productivity, and hasten deliveries. Gutierrez-Franco, Mejia-Argueta, and Rabelo (2021) highlight the importance of using algorithms and real-time data in managing unforeseen events like traffic congestion, crucial for last-mile efficiency in dense areas like RMB. Thus, integrating digital technologies is key to efficient, sustainable UFD management in urban settings.

Proposition 4. In RMB, the absence of comprehensive datasets and effective tools for utilising real data in managing traffic, parking, and other logistics-related aspects significantly affects the operations of logistics companies.

The value of real data in city logistics, as highlighted by Kalahasthi et al. (2022) through parking data analysis, supports this proposition. Their research, relevant to RMB, involved creating models to predict parking demand and the likelihood of trucks parking over a minute, considering factors like vehicle weight and business proximity. Private sector efforts in RMB to model L/U zone parking demand and set parking durations can significantly improve route planning for logistics. This helps navigate restrictions and avoid costly issues like double parking. The study confirms the proposition that RMB's lack of technological solutions and underuse of real data can markedly impact operational efficiency, underlining the urgent need for digital tools to optimise UFD operations.

6.1.5. Carrot and stick policies: Restrictions, pricing and subsidies

Public administrations have the responsibility of designating restricted areas, specifying vehicle types, and defining L/U zones to minimise environmental impact. However, it's crucial that these regulations are not implemented without reaching a consensus with logistics operators, as argued by Katsela and Pålsson (2019). Our interviews indicate that such a consensus is currently lacking in RMB, posing a significant obstacle to efficient UFD management. Operators believe that public authorities often give preference to measures that promote sustainable mobility {c = 0.17}, sometimes at the expense of options that could support sustainability without adversely affecting UFD {c = 0.08}.

One of the interviewed private agents expressed their frustration about this situation:

> *"We're all in favour of sustainability, but the current one-size-fits-all regulations don't always align with our operational realities. It seems like there's a gap in understanding between us and the policymakers".*

Local and regional authorities need to regulate public space use and minimise externalities (Fried, Goodchild, Browne, & Sanchez-Diaz, 2023). Traffic restrictions for social and environmental conservation, like Barcelona's superblocks, should be planned to avoid negative logistics impacts {c = 0.17}. Low Emission Zones (LEZ) aim to enhance air quality by limiting polluting vehicles, but face criticism over limited

zero-emissions UFD vehicles and financial strain on small businesses for fleet renewal {c = 0.08}. The sector calls for a regulatory framework that reflects their reality {c = 0.25}, with demands for subsidies to soften restriction impacts {c = 0.27}, expansion of electric charging points {c = 0.07}, and government plans for vehicle types. Weight restrictions for heavy lorries, increasing trip numbers {c = 0.13} (Calvet et al., 2021), and a need for harmonised weight criteria across municipalities {c = 0.22} are additional concerns.

Proposition 5. Logistics companies need incentives to offset the financial impact of fleet renewal, especially given the current lack of sustainable alternatives for heavy vehicles. Additionally, the harmonisation of criteria for regulating municipal restrictions is essential for efficient UFD management.

This proposition echoes Brettmo and Browne (2020), who advocate Business Improvement Districts (BIDs) for fleet renewal incentives, especially for smaller, financially constrained businesses contributing more to pollution. Holguín-Veras et al. (2020a, 2020b) stress that incentives for eco-friendly vehicles or changed distribution behaviours work best with regulations rewarding good practices and penalising bad ones. They also note the key role of consumer awareness in promoting sustainable supply practices. Standardising municipal regulations to cut business costs and coordinating with BIDs is crucial for initiative success, despite inevitable regulation variations and impacts across different city areas (Browne, Brettmo, & Lindholm, 2019).

6.1.6. Communication between agents

The management of UFD logistics reveals conflicting interests among various stakeholders, as noted by Holguín-Veras et al. (2020a, 2020b). A significant challenge is achieving consensus among the many involved parties, which impedes the formulation of agreements that are satisfactory to all {c = 0.15}. Logistics agents in RMB stress the importance of harmonising UFD criteria across different municipalities {c = 0.22} and suggest the appointment of a unified spokesperson to coordinate all relevant ordinances and policies {c = 0.22}.

As highlighted by a private sector representative interviewed:

> *"We're in a complex net of regulations that vary from one municipality to another. Having a single point of contact who understands our challenges and can synchronise these regulations would make a huge difference".*

Local governments, while engaging in dialogue and collaboration with logistics agents for regulation {c = 0.12}, face challenges in effective implementation. A potential solution is appointing a government spokesperson with operational expertise to work closely with these agents {c = 0.10}. The existing logistics sector board in Catalonia, though valued for fostering dialogue {c = 0.08}, lacks efficacy in driving UFD efficiency measures. Operators suggest using the board to choose a spokesperson for evaluating policies, harmonising criteria, and aiding enactment {c = 0.08}, and stress involving conventional parcel delivery operators. However, a lack of skills and expertise may hinder effective UFD policy decisions {c = 0.08}. Addressing expertise and political will gaps is crucial, possibly through public companies experienced in private logistics as intermediaries between public and private sectors {c = 0.50}, offering a strategy to tackle current challenges.

Proposition 6. It is proposed to establish a spokesperson endowed with the necessary skills to coordinate the implementation of municipal UFD ordinances, along with enhancing public-private partnerships to improve UFD management.

This proposition aligns with the role of BIDs in managing collective urban interests through public-private partnerships, showcasing effective collaboration between businesses and public authorities. It supports the need for a centralised spokesperson to streamline UFD management, advocating for collective action and sustainable logistics. This cooperative approach, reinforcing the notion of a unified spokesperson for UFD efforts, is mirrored in Amaya et al. (2021), who observed a direct correlation between heightened UFD awareness and the adoption of sustainability and efficiency measures.

6.1.7. Storage capacity of commercial premisses

A key issue identified from the interviews pertains to the management of L/U areas. While digitalisation and data collection are recognized as facilitators for decision-making {c = 0.27}, they are not viewed as the only necessary solution. The widespread overuse of L/U zones in RMB is partly attributed to the limited or non-existent storage capacity within local businesses. The insufficient enforcement of regulations regarding the size of storage spaces often leads to frequent stockouts, requiring almost daily restocking by businesses {c = 0.33}. Consequently, this need for frequent restocking results in an increased number of trips by logistics companies within the city, contributing to traffic and congestion issues {c = 0.42}.

An individual from the private sector shared their insights on this matter:

> *"Many companies, especially the smaller ones, simply don't have space for large inventories. This means we're back and forth, all day, every day. It's inefficient for everyone involved".*

Interviewed agents propose setting sector-specific minimum storage space requirements {c = 0.14}, which could shorten L/U zone occupation times {c = 0.09}. In the HORECA sector, they stress enforcing occupational health and safety standards in storage facilities, as non-compliance burdens UFD {c = 0.27} and extends L/U times {c = 0.05}. Addressing these issues is vital, as increased service time raises costs significantly in HORECA (Verlinden, Van de Voorde, & Dewulf, 2020). Agents often reconfigure delivery routes for businesses lacking adequate storage, particularly in areas difficult for motorised traffic {c = 0.11}, and call for urban planning mandates on minimum storage sizes for each sector {c = 0.06}. Moreover, efficient route management can improve reverse logistics, the process of collecting and returning materials for reuse {c = 0.09}.

Proposition 7. Adjusting regulations to mandate minimum storage capacities and uphold safety standards in commercial premises can streamline delivery routes and alleviate congestion in L/U zones.

This proposition, calling for a reassessment of municipal regulations concerning minimum storage capacities and safety standards in commercial spaces, resonates with the findings of Holguín-Veras, Rivera-González, Caron, Amaral, and Ismael (2023) and Castrellon, Sanchez-Diaz, and Kalahasthi (2023). Both studies advocate for UFD regulations that are sensitive to the local economic context and propose dynamic, real-time adaptable regulations. Such an approach underpins our findings on optimising logistics routes and reducing congestion in RMB's L/U zones by tailoring regulations to meet the specific needs and conditions of local commercial activities.

6.1.8. Sustainable UFD management systems and delivery points

E-commerce and rapid delivery services have contributed to increase negative externalities such as traffic congestion, noise, and pollution in UFD (Ballare & Lin, 2020). Micro-platforms and cargo bikes have emerged as sustainable alternatives, aiming to reduce the number of half-empty vans on the road, alleviate city traffic, and lower operating costs.

One of the interviewed individuals from the private sector commented:

> *"Implementing micro-platforms is a step in the right direction, but we're still figuring out the best ways to integrate them into our existing systems. It's about striking the right balance between sustainability and operational practicality".*

In the RMB, the logistics industry largely supports micro-platforms as key to UFD's future {c = 0.13}, though sectors like HORECA view them as less practical due to specific goods and competition {c = 0.14}. Micro-

platforms and cargo bikes are sustainable, especially in restricted traffic zones {c = 0.18}. Pilot projects in RMB using cargo bikes have lessened L/U zone issues, congestion, and conflicts in historic and residential areas (c = 0.54). Yet, their broader use is limited by load capacity and profitability concerns (Alvarez-Palau et al., 2022; c = 0.05). Integrating these with micro-platforms can enhance distribution while being eco-friendly (Fikar, Hirsch, & Gronalt, 2018), but expansion is hampered by lack of subsidies {c = 0.27}. Using collection points like lockers can help ensure delivery success and reduce environmental impact (Arnold et al., 2018; Liu, Wang, & Susilo, 2019). A sustainable UFD model in RMB should promote such points and discourage home deliveries {c = 0.11}, incorporating e-commerce innovations in future ordinances {c = 0.10}. Additionally, combining rail transport with micro-platforms at stations could further lessen environmental impacts {c = 0.17}.

Proposition 8. In UFD management, there should be incentives for alternative distribution methods and collection points, such as micro-platforms, cargo bikes, lockers, and convenience stores, to transition away from the traditional home delivery model.

This finding aligns with the research by Ranjbari, Goodchild, and Guzy (2023), which highlights the evolving nature of last-mile delivery in urban contexts, particularly influenced by the COVID-19 pandemic. Their study points to the effectiveness of parcel lockers, as exemplified in Denmark, in reducing delivery times. This research underscores the importance of hands-on management and provides valuable lessons from pilot projects, crucial for developing and implementing future urban freight solutions in RMB. These insights support the proposition's emphasis on diversifying and financially backing sustainable, alternative UFD methods in the city.

6.2. Applicability of RMB's case results to other contexts

Generalising RMB's UFD findings to other metropolitan areas requires a nuanced understanding of how these practices intertwine with the complex dynamics of city logistics. Urban freight systems, as intricate as the cities themselves, comprise a network of cultural, social, economic, and environmental interactions (Youn et al., 2016). Presenting RMB's UFD initiatives thus provides a multifaceted perspective for other regions to examine their logistics challenges and opportunities.

The first lesson from our study is the complexity of the UFD sector in RMB, a characteristic shared with other Spanish and European cities. The sector, primarily led by private initiatives but regulated at various public administration levels, presents a web of interlinked governmental competencies. Local administrations, dealing with the day-to-day management of UFD processes, add another layer of complexity, as neighbouring administrations may adopt different regulations and compliance mechanisms. The intrinsic complexities of UFD, such as sector diversity, traffic and parking issues, the rise of e-commerce, and urban environmental externalities, position it as a primary urban challenge. In line with Baker et al. (2023), more education around UFD should be promoted, adopting an interdisciplinary approach that incorporates practical skills. This challenge is not exclusive to RMB but is a universal issue, as echoed by Fried et al. (2023), who advocate for a theoretical basis in urban freight research. Implementing such educational reforms would arm future professionals with the tools to navigate urban freight logistics complexities in various settings.

Secondly, our research identifies conflicts between public regulation and private operators. Public administrations strive for a sustainable future, minimising externalities, but this often conflicts with companies' daily operations. Conflicts emerge due to measures like motorised access restrictions, vehicle size limits, or delivery time windows. For example, the night-time delivery restrictions similar to the London Lorry Control Scheme (LLCS) in RMB highlight the complexity of urban freight policy implementation. As Kaszubowski (2012) notes, such policies, intended to mitigate environmental impacts, can lead to unintended outcomes like increased fuel consumption due to longer delivery routes. This emphasises the need to tailor UFD policies to each city's unique urban dynamics. Our study underlines the importance of appointing a single spokesperson to bridge the gap between logistics operators and public administrations, keeping all parties engaged. Effective stakeholder engagement, as suggested by Katsela and Pålsson (2019), is vital for successful UFD initiatives. This requires platforms for dialogue and diverse stakeholder participation, from local governments to private companies and community members. Such collaboration is crucial for customising UFD strategies to various urban areas' specific needs.

Finally, reflecting on the opportunities presented by new technologies and organisational models is important. The digitisation of the sector allows for data collection and the development of analytical tools. Yet, the 'Big-No-Data' paradox, as Gonzalez-Feliu (2019) describes, illustrates the challenge many cities face in gathering and analysing data for informed UFD decision-making. RMB's initiative to develop apps for UFD management and data collection offers a model for other cities facing similar challenges. Operationally, the innovative use of micro-platforms, cargo bikes, and collection points is a central theme in our research. This approach is aligned with the global trend towards sustainable urban freight systems (Baker et al., 2023). However, replicating this strategy in other regions requires more than just adoption; it necessitates adaptation to each region's unique urban layout, traffic conditions, and environmental priorities. For instance, the emphasis on stakeholder engagement in RMB, as noted by Katsela and Browne (2019), underscores the need for participatory planning processes. This is in line with the broader industry movement towards more collaborative approaches (Holguín-Veras et al., 2020a, 2020b; Errampalli, Tavasszy, & Borst, 2021).

Therefore, applying RMB's UFD insights to other contexts is a complex task that demands careful consideration of local urban dynamics, stakeholder engagement, and the integration of sustainable practices and data-driven decision-making. While RMB's methods provide valuable lessons, their strategies must be adapted, not directly copied, acknowledging the unique challenges and opportunities of each city and its metropolitan area. This tailored approach ensures the development of efficient and equitable urban freight systems that meet the diverse needs of urban environments around the world.

7. Conclusions, limitations and future lines of research

Our research aimed to understand the recent transformations and challenges in UFD, hypothesising operational inefficiencies due to divergent interests and contradictory solutions among stakeholders. This hypothesis is confirmed; interviews show communication gaps between private companies and government authorities in UFD management. Our findings, aligning with Przybylska, Kramarz, and Dohn (2023), reveal misalignment and limited cooperation between local authorities and stakeholders, highlighting the need for a skilled spokesperson for effective UFD management. Prioritising harmonisation of restrictions, considering sector-specific conditions, is essential. These challenges are consistent with existing literature on L/U zones configuration (Alho, e Silva, de Sousa, & Blanco, 2018; Muñuzuri, Cuberos, Abaurrea, & Escudero, 2017), city weight limits (Calvet et al., 2021), delivery time windows (Bosona, 2020), and warehouse storage space to reduce deliveries (de Oliveira, Pimentel, Godina, Matias, & Garrido, 2022). Improving communication may involve public companies skilled in private logistics management. Specific, harmonised measures are preferred over broad plans. Digitalising UFD areas could inform ordinance creation and modification. Interviewees call for targeted subsidies for sustainable transport, notably electric cargo bikes for last-mile delivery, and encourage incentivising collection points and micro-platforms to raise sustainability awareness in home deliveries.

7.1. Theoretical and practical implications

This research contributes to UFD academic literature, emphasising

the crucial role of cooperation between government authorities and logistics agents for efficient urban distribution. These findings resonate with prior studies on the importance of stakeholder collaboration in city logistics (Nocera et al., 2020). It highlights the need for harmonising municipal regulations and standardising operational criteria across municipalities, exploring the consequences of a lack of harmonisation and fragmented logistics systems that cause inefficiencies and increased costs for operators.

Using qualitative methods and interview coding, this study pioneers bridging social sciences methodologies with logistics, introducing a new perspective to the field (Katsela & Pålsson, 2019). Practically, it suggests appointing a coordinator for municipal UFD regulations, acting as a central spokesperson to improve public policy efficiency in city logistics. Furthermore, it recommends alternative distribution methods like micro-platforms and lockers to reduce dependence on traditional delivery systems, in line with research advocating innovative solutions for reducing congestion and enhancing sustainability (Othman, De Nunzio, Di Domenico, & Canudas-de-Wit, 2019).

7.2. Limitations and future research

Although our study achieves its goal and enhances the understanding of the various agents in UFD logistics, certain limitations exist in extrapolating our results. The interviews, conducted with representatives from each entity, might reflect subjective opinions not necessarily representing their organisations. Orlovsky, Ready, Gutchess, Heideman, and Martins-Klein (2023) observe that interviewees often mix real experiences with subjective elements, a tendency amplified when they become agitated, as noted in our interviews (Nichols & Loftus, 2019). A future longitudinal study could mitigate this, involving follow-ups and notebooks for interviewees to record experiences and opinions in real-time (Adeoye-Olatunde & Olenik, 2021).

Another limitation is the structural differences in government authorities outside RMB, requiring an understanding of relationships between various UFD-regulating authorities for each study area. Future research could explore diverse scenarios, like digitalisation's implications in UFD areas across a representative sample of cities (Mor, Speranza, & Viegas, 2020), the private sector's role in urban mobility and city logistics, and the impact of their participation (Amaya et al., 2020). Additionally, further research on optimising micro-platforms for a more effective, sustainable model is warranted (Fikar et al., 2018).

CRediT authorship contribution statement

Cristian Castillo: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Marta Viu-Roig:** Data curation, Formal analysis, Investigation, Writing – original draft, Writing – review & editing. **Marc Nicolàs:** Resources, Validation, Visualization, Writing – original draft. **Eduard J. Alvarez-Palau:** Conceptualization, Funding acquisition, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Eduard J. Alvarez-Palau reports financial support was provided by European Union.

Data availability

The data that has been used is confidential.

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