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Space-sharing and kerbside conflicts in urban deliveries: A framework for understanding space allocation challenges

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ABSTRACT

Increasing demand for scarce urban streetside creates space-sharing conflicts, compromising cities' liveability. Conflict assessments predominantly adopt traffic-centric perspectives, neglecting access and place-making functions of streets and the role of freight in this regard. This paper investigates space-sharing conflicts between freight and other streetside users during delivery operations, aiming to understand challenges in creating liveable streets. Based on empirical evidence from the West End of Central London, a framework is proposed to systematically identify these conflicts, and explore implications on the health, social, economic, and environmental value dimensions of streets, from the freight operators' perspective. The framework proposes four types of freight-related space-sharing conflicts: collision risk, traffic obstruction, space overuse, and pavement damages. Findings highlighted the pressures the identified conflicts create on freight operators, exposing them to high-stress levels and endangering both their own and other street users' health and safety. Additionally, the framework informs right-of-way decisions by considering freight aspects across three distributive justice principles, i.e., sufficientarian, utilitarian, and egalitarian. Analysing last-mile freight operations and their interactions with other users introduces a novel approach to city logistics that traditionally studies freight in isolation. Furthermore, the paper contributes to urban planning, providing insights for right-of-way decisions that include the freight perspective – often overlooked in urban studies.

1. Introduction

Kerbside and pavements, collectively termed streetside, have become a highly contested public infrastructure, as demand from several uses coexists in that limited urban space (Allen & Piecyk, 2022). The rapid growth of urban populations, advances in transport technologies, and the rise in e-commerce have intensified this competition, prompting the need to address the allocation problem of scarce urban streetside space. Failing to solve this problem threatens the *value* streets provide to public space users, defined as the importance, worth, or usefulness of streets in providing health, social, economic, and environmental benefits (Carmona, 2018).

While the streetside space may be invisible or disregarded by some users, issues arise when they encounter difficulties in accessing it. The result of tensions among different users in the access to streetside space is referred to as *space-sharing conflicts*, defined as the *streetside supply and demand imbalance that leads to two or more uses competing for the same streetside space simultaneously, either in the present or the near future* (Markkula et al., 2020). Space and time are two dimensions motivating the conflicts, acknowledging that space-sharing conflicts refer to the competition for access to limited streetside space rather than necessarily physical co-presence in the same area at the same time. This definition implies that space-sharing conflicts occur even in segregated street designs due to competing needs for space allocation and access. Space-sharing conflicts arise from decisions, or the absence thereof, regarding who, how, and when streetside space is utilised, as all street users claim they should not be left out from the space allocation (Lawanson, 2023). The challenge lies in how space is distributed, the extent to which users can access it when needed, and the resulting tensions when space is insufficient, or its allocation is contested.

In managing the public realm and aiming at solving space-sharing conflicts, local authorities define hierarchies to guide discussions and form a consistent allocation method when considering streetside uses. The expected outcome of decisions based on these hierarchies is the

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optimisation of streets value in the fulfilment of their access, movement, place-making, and environmental functions (Sheikh-Mohammad-Zadeh et al., 2022). The movement function of a street is concerned with the facilitation of efficient mobility for people and goods. The place-making and environmental function refers to the role of streets as public spaces that support social interaction, economic activity, and urban liveability. The access function, while often overlapping with the other two, is distinct in that it focuses on how users, e.g., pedestrians, public transport passengers, drivers, or freight operators, gain direct access to adjacent properties, businesses, services, and transport infrastructure. Previous studies have highlighted the conflicts arising when streets must balance these functions, particularly in high-density urban areas (Jones & Boujenko, 2009; Nello-Deakin, 2019).

Besides the challenge in balancing street functions, Allen and Piecyk (2022) and Williams and Carroll (2015) discussed how current hierarchies and street design approaches for liveable cities, e.g., healthy streets, complete streets, and flexi streets, do not consider all the street users, overlooking, for instance, those involved in freight deliveries. Haarstad et al. (2024) emphasized the limited attention given by researchers in urban studies to interventions, and solutions addressing freight needs in urban planning. Since goods (un)loading competes with various other street uses –including private car parking, pedestrian pavements, bike lanes, street furniture, outdoor dining, e-scooters and bike parking, public transport stops, construction sites, and service vehicles–, the omission of freight aspects in street design approaches itself is a cause for space-sharing conflicts (Conway et al., 2018).

Williams and Carroll (2015) defined the *liveability and freight movement paradox* to describe how initiatives fostering liveable communities simultaneously increase freight demand while restricting freight access, e.g., mixed land use, vibrant streets, and active mobility initiatives. Elevated emissions, congestion, and extra costs can result from double parking and cruising for parking due to insufficient space for freight (Castrellon & Sanchez-Diaz, 2024; Dalla Chiara & Goodchild, 2020).

Including freight considerations in urban planning requires the development of frameworks and methodological tools that inform policymakers' decisions facing space demands from several actors (Pitera et al., 2017). Moshiri et al. (2022) acknowledged the lack of multi-actor tools to support assessments of streetside conflicts and their effects on liveability. Likewise, Butrina et al. (2020) reported that policymakers from the US perceived streetside space allocation as more an art than a science. Consequently, the management of streetside space amid conflicting interactions between freight deliveries and other streetside users is a research avenue to be further explored and developed (Sears et al., 2022).

To address this gap, prior research in urban freight has proposed solutions for allocating streetside space to freight, typically based on demand assessments and considerations of the built environment (Alho et al., 2018; Castrellon et al., 2024; Comi et al., 2022). However, these contributions have often focused solely on modelling freight demand for space, posing a challenge for public authorities tasked with managing space for a broader array of users beyond just freight. Additionally, the conceptualisation of conflict types and assessments about how they affect the value that streets provide in terms of health, economic, social and environmental dimensions, remains only partially addressed, as prevailing approaches focus on traffic evaluations (Creutzig et al., 2020). Furthermore, little attention has been devoted to analysing freight operations on the streetside, overlooking (un)loading and portering activities–carrying or transporting goods by hand or with the assistance of carts or trolleys– required to reach final delivery points, including receivers' establishments, mailboxes, homes, and so forth. Conflicts occurring in this last leg of goods distribution relate to space utilization and interactions with non-motorized users which is fundamental for addressing issues regarding the access function of streets (Ismail et al., 2011; Sheikh-Mohammad-Zadeh et al., 2022), requiring assessments beyond collision risks, i.e., competition for space (Dang et al., 2023). Access ensures that vehicles, pedestrians, and transit users can enter, exit, and use the infrastructure effectively, and it is of particularly relevance to freight operations, as deliveries require streetside space to facilitate the transfer of goods from vehicles to final destinations.

Therefore, this paper's aim is two-fold. Firstly, it analyses freight-related space-sharing conflicts based on identified tensions in the interaction between freight and other streetside users during urban deliveries. Secondly, it explores the implications these conflicts have on the value provided by streets to freight operators, in terms of health, social, economic and environmental dimensions, reflecting on potential space distribution approaches to mitigate adverse effects.

This paper is structured as follows: Section 2 introduces definitions of key concepts and elucidates how their applicability extends to the domain of urban freight transport. Section 3 explains the methodology, introduces the study context and data collection methods. Section 4 presents the results of the conflicts identification that led to the proposed framework for conflicts and assessment of value of streets. Section 5 discusses the results in light of distributive justice principles as potential approaches to allocate streetside space while mitigating detrimental effects of conflicts on liveability. Section 6 addresses conclusions and future research directions.

2. Background

Three concepts shaped the development of this research, i.e., space-sharing conflicts, value of streets, and right-of-way allocation decisions. This section presents the definition of space-sharing conflicts (Section 2.1) and how they affect the value of streets from the freight operators' perspective (Section 2.2). Finally, the section introduces the concept of right-of-way (ROW) allocation decisions (Section 2.3), and different approaches to fairness in the distribution of space.

2.1. Space-sharing conflicts

From the urban planning perspective, conflicts are the result of imbalances between space allocation and access demand by public space users. The present paper adapts the definition of *space-sharing conflicts* proposed by Markkula et al. (2020) as the imbalance between users' spatial access needs (demand) and the actual space allocated to them (supply), resulting in competition among users of street space. Hereafter in this paper, conflicts refer to space-sharing conflicts. While the conflicts categories in Markkula et al. (2020) only encompass users in motion, including the place-making street function implies a more comprehensive approach to conflict analysis. Considering the place-making function involves space uses that contribute to streets as social, economic, and/or recreational destinations. This expanded approach incorporates static uses that also compete for streetside space, e.g., street furniture, trees, parklets, al-fresco dining, etc.

Consistent with the prevailing emphasis on movement-based conflict analysis, previous studies involving freight operations have focused on conflicts related to obstructed paths and crossing paths. Additionally, studies about conflicts delimit their scope by defining the users under analysis and the type of interaction. For instance, Conway et al. (2013) assessed conflicts affecting cycling in New York, having as empirical evidence the number of obstructions caused by parked trucks within or across bike lanes. The authors defined conflicts as situations where cyclists had to deviate due to lane obstructions. Although the research reported in Conway et al. (2013) was oriented towards users in movement, the findings offer insights into space-sharing aspects, including the correlation between land use, business density, kerb regulation, and conflict occurrence. Employing a traffic safety approach, Pokorny et al. (2018) studied conflicts in truck-bicycle interactions in Norwegian cities. Results indicated that obstruction path was the most frequently reported conflict type by bike users. Moshiri et al. (2022) proposed a decision support tool for de-conflicting freight–pedestrian interaction at street intersections, acknowledging the relevance of both pedestrian-

and freight-friendly design of streets.

The literature addressing conflicts with a place-making orientation remains in its early stages, mainly due to the ambiguous definition of conflicts and the inherent difficulties in their assessment and measurement (Dang et al., 2023; Gössling et al., 2016). Expanding the analysis of conflicts beyond collision counts, some contributions have evaluated conflicts based on built environment characteristics, imbalances between the supply of and the demand for street space, and the impact of conflicts on users' travel behavior. Gkekas et al. (2020), for instance, included aspects such as pedestrians and cyclist crowding, uneven pavement, and weather conditions into conflict assessment, concluding that crowded spaces are significant conflict sources discouraging active mobility behaviours. Popescu (2022) conducted an ethnographic study in Bucharest to explore parking practices over the pavement, revealing narratives of hostile public space for pedestrians, pavement privatization, and car-centric urban environments as dominant conflict sources. Lefebvre-Ropars et al. (2021) examined supply and demand imbalances using a multimodal analysis comprising private cars, pedestrians, cyclists, and public transport.

Space-sharing conflicts are not limited to interactions between freight and other street users but can also arise among freight operators competing for limited streetside space. Previous studies have shown that these conflicts can originate from both inadequate provision of (un) loading space and its inappropriate use (Dalla Chiara & Goodchild, 2020). Alho et al. (2018) showed that the configuration and availability of dedicated freight parking, together with compliance with parking regulations, influence double-parking practices and their impacts on surrounding traffic. Similarly, Ezquerro et al. (2020) quantified inappropriate use of loading bays in Santander (Spain), showing that unauthorized use and excessive parking durations reduced the availability of designated loading space and contributed to freight vehicles double parking or occupying pavements and restricted areas. These findings illustrate how insufficient, inefficient, or inappropriate use of loading space can create supply-demand imbalances for freight operators. The resulting responses can extend the initial freight–freight competition to other street users and functions through traffic obstruction and occupation of adjacent public space.

Despite ongoing efforts to study multimodal conflicts in streetside spaces, a key challenge is the inclusion of freight, extending the scope beyond mere movement implications to encompass its role in place-making. Freight operators interact not only with pedestrians, cyclists, public transport and private vehicles, but also with other freight operators and static uses of streetside space. Understanding these interactions requires examining how freight operators respond when their access needs cannot be accommodated and how these responses can generate further competition for space. This broader perspective also calls for assessing space allocation decisions beyond traffic performance, considering their implications for the health, social, economic, and environmental value provided by streets.

2.2. Value provided by streets

Urban decisionmakers, as highlighted by Ringsberg et al. (2023), are motivated by the desire to establish environmentally and economically feasible cities (service interest), ensure inclusive access to infrastructure, products, and services for all citizens (accessibility interest), and investing in urban public space to support business income (economic interest). These interests are intrinsically linked to the *value of streets* defined in Carmona (2018) as *the significance, worth, and utility of streetside space in relation to public policy objectives that span health, social, economic, and environmental dimensions*.

As stated by Brown et al. (2021), the exploration of public value, particularly in the context of streets, as addressed in the current paper, requires: i) the recognition of the public, ii) assessing the interplay of the different value dimensions, and iii) reflecting on the mechanisms for resolving conflicts.

i) *the public* comprises those with a stake in the use of streetside space, including residents, business owners, public authorities, and other actors. The value of streets for these actors relates to the extent their distinct demands are met by the realisation of access, movement, place-making and environmental functions of streets. Table 1 lists some examples of demands for streetside space related to each function and contributions from literature about allocation decisions.

Freight operators play a dual role as both users and contributors to the value of streets. As users, they require access to transport infrastructure for the distribution of goods, as well as designated areas for (un)loading activities and portering. Additionally, they are directly affected by the environmental and traffic conditions of streets as they are continuously exposed to them. In their role as contributors to the value of streets, the service provided by freight operators enable the functioning of daily business and people's lives by supplying the necessary goods. For instance, previous research suggest that freight deliveries contribute to the place-making function of streets by enabling economic activities, e.g., business such as restaurants, retailers, shopping malls, among others, that enhance street vitality by attracting residents and visitors and promote social interaction (Creutzig et al., 2020). By integrating freight activities thoughtfully into urban design and planning strategies, streets can become vibrant, inclusive, and dynamic spaces. Therefore, this synergy between the movement of people and the provision of goods aligns with the overarching goal of place-making.

ii) *value dimensions*, regarding the second component of public value described in Brown et al. (2021), i.e., different dimensions of

Table 1
Demand types and street functions that influence the value of streets.

Demand type	Street functions	Examples of streetside uses	References
Access to transport services	Access	• Public transport stops • Ride-sharing pick-up and drop-off • Taxi pick-up and drop-off	(Jones & Boujenko, 2009; Nello-Deakin, 2019)
Storage		• Short- and long-term parking for private vehicles • Electric vehicle charging • Bicycle parking • Scooters parking • Garbage containers	(Mitman et al., 2018; Valença et al., 2024)
Access to goods		• Loading and unloading zones for freight • Commerce delivery	(Castrellon et al., 2024)
Movement of people	Movement	• Traffic lanes • Pedestrian alleyways • Public transport (bus lanes) • Bicycle lanes • Scooter riders	(Conway et al., 2013; Creutzig et al., 2020; Lefebvre-Ropars et al., 2021)
Street markets & vending	Place-making and/or environmental	• Street vending stalls • Famers' markets • Outdoor dining	(Carmona, 2018)
Public space amenities		• Trees • Planters • Tactical urbanism • Parklets • Seating areas	(Gössling et al., 2016)

value, the literature underscores the difficulty in objectively quantifying public value. The choice of specific indicators introduces potential biases in judgments of importance, particularly when influenced by measurement ease. Carmona (2018) conducted a systematic literature review exploring the diverse dimensions of the value of streets. From the freight operators' perspective, the value of a street can be elucidated through four dimensions, i.e., health, society, economy, and environment.

The health dimension encompasses various workplace health, safety, environment, and quality aspects relevant to freight operators when performing activities such as driving, parking, (un) loading, and portering.

Within the social dimension, the focus lies on how space access conditions affect the performance of freight operators, with implications for employment, job quality, and professional self-esteem. This dimension also addresses equity issues, particularly fairness in access to public spaces.

The economic dimension refers to the extent the streets enable the efficiency of freight operators and the development of local economy, e.g., businesses' productivity related to freight deliveries. Measures about this dimension include delivery times and last-mile costs.

In the environmental dimension, value of streets provided to freight operators relate to drivers' exposure to pollutant emissions during freight deliveries. Air quality measures inform this dimension of value.

iii) *mechanisms for addressing conflicts*, in the presence of a conflict, losses of value are generated due to the partial or total impossibility of enjoying one or more street functions by one or more of the users affected by the conflict with the corresponding impact on one or many dimensions of value. To address this, Rodriguez-Valencia (2014) formulated the right-of-way allocation problem (ROWAP), as a mechanism for mitigating space-sharing conflicts.

2.3. Right-of-way allocation decisions

Decisions regarding streetside space allocation allow decisionmakers to address service, accessibility, and economic interests within the public space. In this regard, contributions have focused on the understanding of the ROWAP among the different streetside demand types and on methods to mitigate conflicts while spurring uses that fulfil streets' functions. Thus, ROWAP is the optimisation of the distribution of the available space for the fulfilment of the street functions (Rodriguez-Valencia, 2014).

Lefebvre-Ropars et al. (2021) affirmed that the ROWAP can be approached using the lenses of three distributive justice principles, i.e., sufficientarian, utilitarian and egalitarian, and showcased their implementation in a case study.

i) *The sufficientarian principle* seeks to ensure that a minimal provision of resources is to be distributed to every member of the population (Di Ciommo & Shiftan, 2017). To this principle, every streetside user should have access to enough streetside space, rather than an equal or proportional amount (Meyer & Roser, 2009). This approach recognizes that users have different needs and preferences regarding streetside space access and that certain groups may require more or less space in order to fulfil their needs. In terms of ROWAP, the sufficientarian principle addresses inequalities in access to streetside space, ensuring that everyone has a fair and equitable share. This can involve allocating more space to certain groups or areas where there is greater need or ensuring that public space is designed and managed in a way that is accessible and welcoming to everyone.

ii) *The utilitarian principle* aims at finding the space distribution that maximizes total utility (Lefebvre-Ropars et al., 2021). This approach is based on the idea that street space is a limited resource, and that it should be allocated in a way that maximizes its value (Creutzig et al., 2020). Regarding ROW allocation decisions, the utilitarian principle seeks the efficient streetside space use by balancing competing demands and interests to produce the greatest overall benefit. This can involve prioritizing the needs of certain users that are deemed to have the greatest positive impact on a street (Pereira et al., 2016).

iii) *The egalitarian principle* refers to the uniform distribution of public space among the users involved (Lefebvre-Ropars et al., 2021). It seeks to promote social equality and eliminate unfair or unjust forms of discrimination or disadvantage through the allocation of public space. This approach is based on the principle of equal access and opportunity for all, regardless of social status, race, gender, or other factors that can lead to inequality (Pereira et al., 2016). This can involve addressing biases in public space design and allocation by providing additional resources and support to marginalized groups to ensure that they have an equal opportunity to use and benefit from public space. However, achieving egalitarianism in street space allocation is complex, as not all users require the same amount of space, nor do they use it in the same way. Nello-Deakin (2019) highlights that while the egalitarian principle in urban transport is often interpreted as providing the same infrastructure for all users, justice in space allocation must consider who benefits most from access and who suffers most from restrictions.

The debate on these distributive justice principles in allocating street space among competing users has been addressed in previous contributions within transport and urban planning literature. For instance, Nello-Deakin (2019) critically examines the concept of fairness in space allocation, questioning whether an objectively fair distribution is possible given conflicting priorities between different users. The study argues that fairness is inherently subjective and dependent on the criteria used, whether based on egalitarian, utilitarian, or sufficientarian principles.

A complementary perspective is offered by Jones and Boujenko (2009) through the Link and Place framework, which categorizes streets based on their primary function, i.e., whether as movement corridors (links) or social and economic hubs (places). This framework suggests that street space should be prioritized based on contextual function, a principle that directly applies to freight operations, which must often navigate areas serving both high-throughput movement and dense commercial activities.

Further expanding on this challenge, Valença et al. (2024) discussed the governance and complexity of reallocating road space, emphasizing how political, regulatory, and infrastructural constraints make space redistribution a contested process. The study highlights the difficulties of implementing changes in space allocation policies, reinforcing the need for data-driven and context-sensitive approaches to avoid unintended consequences, such as congestion displacement or economic inefficiencies.

The studies cited above offer insights into the fairness, functional categorization, and governance challenges of ROW allocation decisions. These perspectives align with existing distributive justice principles in ROW allocation (Lefebvre-Ropars et al., 2021) and suggest that decisions should consider not only who needs access but also when and where trade-offs must be made to maximize urban functionality and liveability. However, they largely omit a discussion on freight's place within these frameworks. Therefore, the present study builds on these perspectives by explicitly analysing freight-related space-sharing conflicts, their impacts on the value of streets, and how they can be addressed through a balanced, fairness-based approach to streetside allocation.

3. Methodology

This research adopted an exploratory approach, structured around four methodological steps examining freight-related space-sharing conflicts and their broader implications for freight operators. The methodological steps connect the concepts outlined in the background section, grounded in empirical observations from the West End of Central London. This section details the methodological steps, the characteristics of the case study, and the methods used for data collection.

3.1. Methodological steps in the research

Fig. 1 illustrates the four interrelated steps conducted for this research: (1) streets selection, informed by stakeholders' input, variations in street design, and relevance to freight operators due to high deliveries demand; (2) space-sharing conflicts identification, focusing on root causes of tensions over streetside access, and freight operators' reactions; (3) assessment of value of streets, evaluating the impact of conflicts across health, social, economic, and environmental dimensions from the freight perspective; and (4) right-of-way allocation, guided by distributive justice principles, with attention to trade-offs and implementation challenges. Conceptually, the methodology assumes that space-sharing conflicts affect how freight operators perceive the value of streets. In turn, this evaluation of value informs right-of-way allocation decisions aimed at addressing such conflicts while supporting the access, movement, place-making, and environmental functions of streets.

The streets of the West End in Central London served as the empirical setting for implementing the methodological steps. Each selected street featured a distinct built environment and was marked by one or more types of freight-related interactions at the streetside. These interactions included combinations such as freight–traffic regulations, freight–private vehicles, freight–taxis, freight–service vehicles, freight–public transport, freight–bikes/e-scooters, freight–street furniture, freight–pedestrians, and even freight–freight. The qualitative and exploratory nature of the research design aimed to provide an understanding of conflict triggers, freight operators' reactions, the nature of conflicts, and their implications for the perceived value of streets.

3.2. Case study: West End of Central London

Several studies have reported the intensity of freight transport in

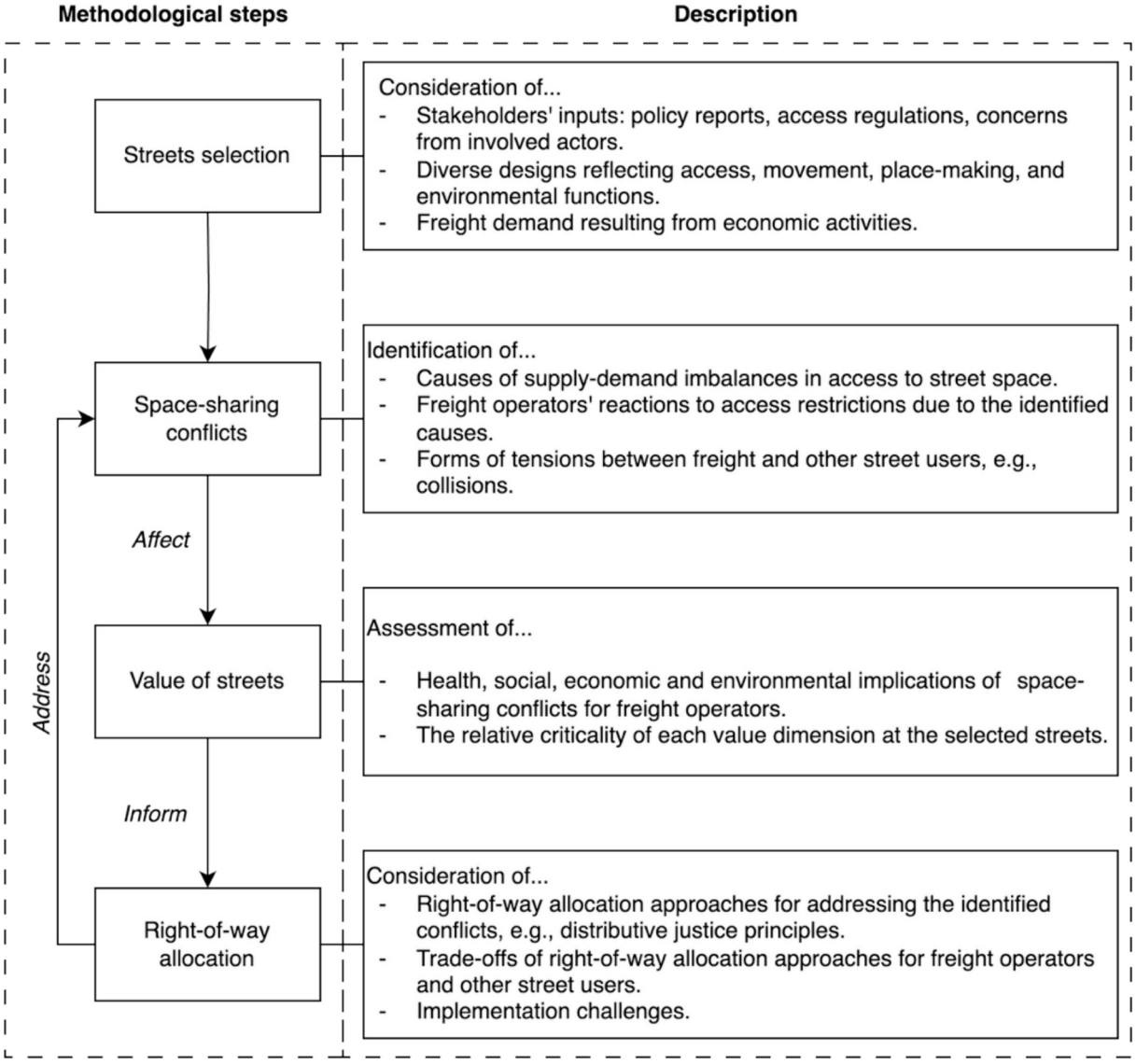


Fig. 1. Methodological steps in the research.
Source: Authors.

London that has resulted in a high demand for streetside space for deliveries. Every day, around 400,000 t of products are transported to and from London, with most deliveries and collections –approximately 80% to 90%– occurring on the streetside (Sturman & Stone, 2023).

In 2022, the Central London Freight Quality Partnership (CLFQP) –a freight transport partnership between public and private sectors aimed at improving the sustainability of freight in London (Allen et al., 2010)– created a thematic working group dedicated to examining these conflicts, focusing on freight interactions on the kerbside. The selection of streets for this study was guided by the priorities identified by this thematic working group of the CLFQP. Streets included in the study (Fig. 2) consistently emerged in discussions as areas facing significant freight access challenges. The selection was supported by documents shared by working group members, including kerbside policy reports from local boroughs, complaints and feedback from freight operators and commercial establishments, and minutes from CLFQP meetings where kerbside access issues were discussed.

In addition to this stakeholder-driven input, the selection of streets was further guided by criteria such as street functions, spatial configuration, and regulatory context. Supporting information was sourced from publicly available data on the StreetCheck platform (https://www.streetcheck.co.uk/) and local access regulations issued by borough authorities. All selected streets are located in areas with high commercial activity, significant freight demand, and regulatory constraints that impact delivery operations. Additionally, as detailed in Table 2, the selection captures a diverse sample of interactions between freight and other streetside uses.

The West End of Central London, where most of the selected streets are located, hosts some of the most popular areas of the city, attracting locals and tourists to approximately 3000 pubs and bars, 2500 restaurants, 2000 shops, 100 museums and cinemas, at streets and places such as Oxford Street, Regent Street, Covent Garden, Soho, Mayfair, and Piccadilly (Allen et al., 2018). Besides a vibrant commercial activity, the mixed land use makes it the home for 60,000 residents, 522,000 jobs, i.e., on average, 800 jobs per hectare, and 200 million visitors per year. The West End accounts for 15% of London's total gross value added (Greater London Authority, 2018).

The streets selected represent a variety of typologies, ranging from pedestrianized areas and mixed-traffic corridors to streets with restricted access, each illustrating different conditions leading to space-sharing conflicts. For instance, Charing Cross Road and New Bridge St serve as key transport corridors with lanes for public and private transport and cycling, while Kingly St prioritizes pedestrian activity with restricted vehicle access. Some streets, such as St Martin's Lane, allow limited freight loading, whereas others, like Brewer St and Old Compton St, allocate most kerbside space to other uses, forcing freight operators to park illegally.

The amount of space allocated to different transport modes varies significantly. Pedestrian infrastructure is prioritized on Kingly St, which has been pedestrianized with limited freight access during designated hours. Charing Cross Road and New Bridge St allocate a considerable proportion of their width to mixed public and private transport lanes and cycling infrastructure, whereas Old Compton St and Brewer St dedicate a greater share of space to private vehicle movement and parking. The presence of dedicated loading zones is insufficient at certain areas and times, with some streets permitting short-term loading while others impose complete restrictions, affecting the efficiency of freight operations and leading to spillover effects on adjacent streets.

Evidence from the selected streets provided the foundation for a framework aiming at assessing kerbside conflicts related to freight (see Section 4). For the purposes of this study, streets dominated by residential uses or lacking freight access restrictions were excluded.

3.3. Data collection

Semi-structured interviews (Section 3.3.1) with members of the

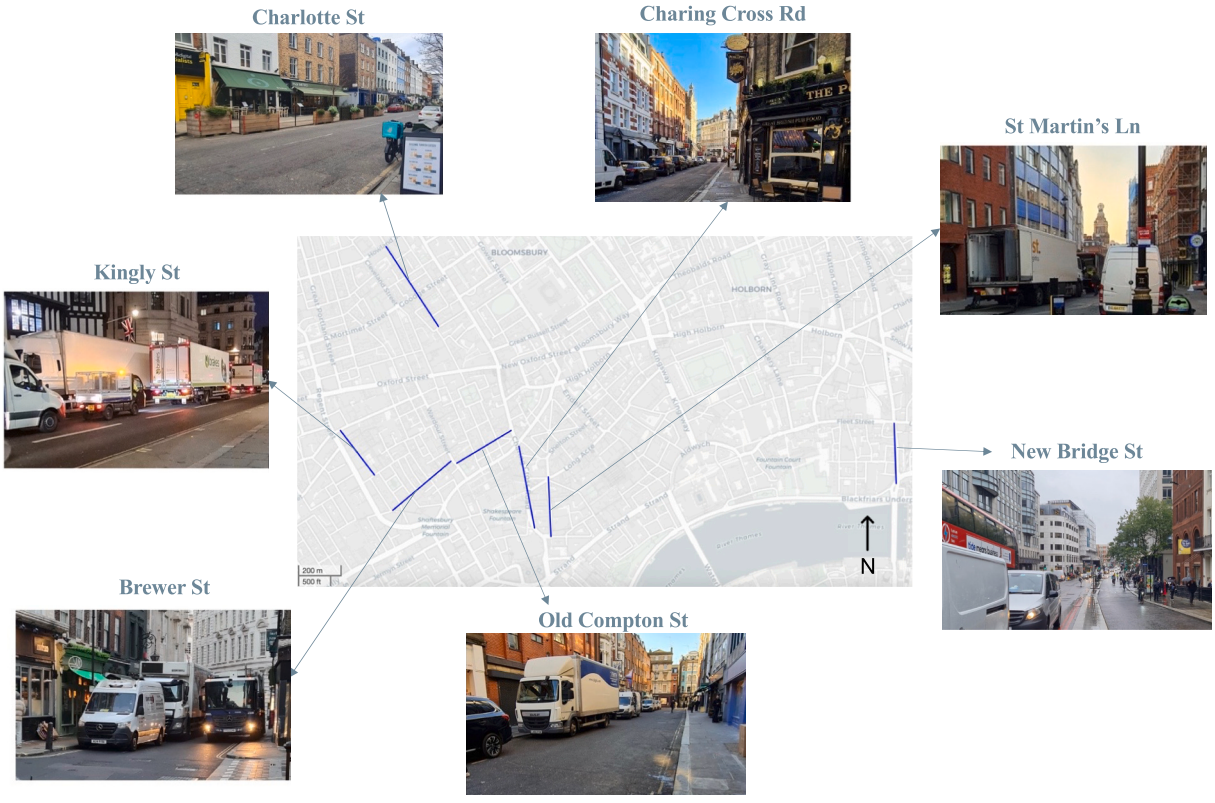
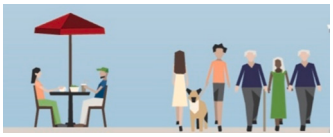
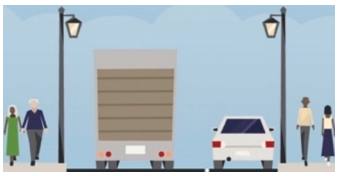


Fig. 2. Selected streets in the West End of Central London.
Source: Authors.

Table 2
Characteristics of selected streets and access conditions for freight.

Street description	Streetside access for freight	Street cross section
Street Kingly St (City of Westminster). **Land uses** Commercial + housing. **Type of flow** Pedestrian zone since 2020. Outdoor dining.	Freight vehicles are allowed Mon – Sat between 7 and 11 a.m. for a maximum duration of 30 min. Removable bollards control the access.	
Street Brewer St (City of Westminster). **Land uses** Commercial + housing. **Type of flow** One way traffic flow. Kerbside space for parking.	(Un)Loading is not allowed between 8:30 a.m. and midnight.	
Street Old Compton St (City of Westminster). **Land uses** Commercial + housing. **Type of flow** One way traffic flow. Kerbside space for parking and taxi pick-up / drop-off.	(Un)Loading is not allowed at any time.	
Street Charing Cross Rd (City of Westminster). **Land uses** Commercial. **Type of flow** Two lanes street with public transport operation. Kerbside space for parking and public transport stops.	(Un)Loading is not allowed at any time.	
Street St Martin's Ln (City of Westminster). **Land uses** Commercial + housing. **Type of flow** One way traffic flow. Kerbside space for parking.	Loading zones provided where vehicles can stay for a maximum duration of 20 min.	
Street Charlotte St (City of Westminster and Candem). **Land uses** Commercial + housing. **Type of flow** Two lanes street. Kerbside space for parking and outdoor dining.	Freight deliveries allowed at specific loading zones between 7 a.m. and 4 p.m. with a maximum duration of 20 min.	
Street New Bridge St (City of London). **Land uses** Commercial. **Type of flow** Strategic road network. Two lanes street with a bike lane. Kerbside space for parking.	Loading is allowed between 10 a.m. and 4 p.m. with a maximum duration of 40 min.	

CLFQP supported the streets selection and the identification of space-sharing conflicts. Field visits to the selected streets were conducted to collect evidence about the intensity of freight activities and the occurrence of conflicts on the streetside (Section 3.3.2). The findings from these activities were synthesized into a framework that identified conflict triggers and freight operators' responses leading to space-sharing conflicts. To ensure the robustness and applicability of the framework, a workshop (Section 3.3.3) was conducted, with the primary goal of validating the proposed framework and collecting data about value implications in health, social, economic and environmental dimensions.

Data collected from interviews, field visits and workshop provided insights about ROW allocation decisions that were assessed using the lens of the three principles of distributive justice from Lefebvre-Ropars et al. (2021). Table 3 summarizes the research strategy and the methods employed to accomplish the study's aim. Methods description is addressed in the subsections below.

3.3.1. *Interviews – CLFQP's kerbside working group*

Members of the CLFQP working group were interviewed about current issues regarding policies in the use of streetside space, conflicts on the selected streets, implications of value of streets perceived by freight operators, and potential approaches for ROW allocation decisions. In

Table 3
Research methods and contribution to the paper's aim.

Research design	Method(s)	Contribution to the methodological steps
Use cases: Seven streets in The West End of Central London	Interviews (Section 3.3.1) *Ten interviews to CLFQP members*	- Streets selection (identification + characterisation) - Space-sharing conflicts (exploration) - Value of streets (identification) - ROW allocation (exploration)
	Direct observation (Section 3.3.2) *Field visits during peak and off-peak hours/ridealong*	- Street selection (expanding streets characterisation) - Space-sharing conflicts (characterisation)
	Workshop (Section 3.3.3) *Interactive discussions about conflicts and their value implications*	- Space-sharing conflicts (validation) - Value of streets (identification + assessment)

total, ten semi-structured interviews were conducted with freight associations (2), a freight delivery crew (1), a technology provider for kerbside management (1), policymakers (4) and experts in the kerbside management field (2). Appendix A contains the guide used to conduct the interviews. Detailed notes were taken during the interviews by the researchers and reviewed immediately after each interview to ensure accuracy and completeness. To maintain consistency, the notes were structured according to the concepts presented in Section 2, i.e., space-sharing conflicts, value of streets, and ROW allocation decisions. Additionally, some participants provided documents relevant to the study, including policy reports, minutes from the CLFQP meetings, and reports from freight operators about conflicts, which were considered as supplementary data supporting the streets selection.

3.3.2. Direct observation

Field visits involving direct observation were conducted to assess infrastructure supply and identify space-sharing conflicts along the selected streets. Direct observation is recognized as a suitable method for spatial ethnography, offering insights into spatial patterns and interactions among public space users (Kim, 2015). These visits took place twice in February and November 2023, with each street observed during both peak and off-peak hours. When available, one or two members of the CLFQP accompanied the visits. The observations focused on identifying built environment conditions and streetside uses that affect freight deliveries on the selected streets.

As part of these visits, a ridealong was performed, collecting qualitative observations from a delivery crew, and counting of interactions with other users, namely pedestrians and cyclists, during loading and unloading activities in the West End of Central London. The selection of a specific industry type was guided by CLFQP recommendations, focusing on those engaged in distance-critical deliveries, i.e., deliveries occurring as near as possible to the receiver's location, due to considerations of product safety, weight, and value.

Ridealongs have been used in freight studies to analyse various aspects of delivery operations, such as driver behavior during parking, loading and unloading (Dalla Chiara et al., 2021). The ridealong method refers to the researcher accompanying delivery journeys as an observer, either for the entire route or for specific segments between the depot and delivery locations. This type of data collection offer insights into how freight vehicles and other road users interact with kerbside space. Also, it enables the collection of detailed data on loading and unloading locations, durations, and conditions, supporting assessments of the adequacy of existing parking and loading infrastructure (Allen et al., 2012).

In this study, the ridealong was conducted on February 23rd, 2023, beginning at 6:19 a.m. with the first delivery on New Bridge St and concluding at 10:55 a.m. following the final scheduled stop on Charlotte St. The delivery route covered all the streets included in the research. One of the co-authors accompanied the delivery crew, manually recording data on driving and delivery times, loading and unloading durations, and the number of interactions with other streetside users, i.e., those crossing the space between the vehicle and the delivery point. Qualitative insights were obtained through direct observation and, when possible, conversations with the delivery crew. The observations focused on challenges in locating parking, factors influencing parking decisions, and conflicts with other road and streetside users.

During the field visits and ridealong, a freight association affiliated with the CLFQP actively supported the data collection process and assisted in securing the necessary permissions and coordination of the data collection times and participants. The association also provided insights into the freight demand on the selected streets and identified specific conflicts that affect operational efficiency.

3.3.3. Workshop

To validate the conflict assessment framework and investigate the perceived value implications of kerbside conflicts, a three-hours workshop was conducted on November 13th, 2023, at the University of Westminster. A total of eleven participants were involved, representing the industry (7), public sector (3) and academia (1). Appendix B describes each participant's affiliation, role and relevance for the workshop purpose. The number of participants is consistent with recommendations from previous studies on urban planning, regarding having small groups with a deep and expert view of the discussed topic (Valença et al., 2023). Participants were selected based on their operational knowledge, planning expertise, and involvement in freight logistics or kerbside access policy. Their professional roles included senior consultants, freight and transport planners, researchers, and industry representatives with managerial responsibilities.

The purpose of the workshop was two-fold, firstly, it allowed the collection of participants perceptions about the occurrence of conflicts and the causes. Secondly, it motivated discussions about implications of space–sharing conflicts on the value of streets covering the dimensions of health, society, economy, and environment. To achieve this goal, the workshop was structured into three tasks supported by an introductory presentation of the project (15 min), printed worksheets, maps of street segments, a visual presentation showcasing space-sharing conflicts on the selected streets, and a coffee break (20 min) to encourage dialogue and spontaneous reflections on the topics discussed.

Task 1 – Conflict Assessment Framework Validation (70 min): Participants were divided into small groups and asked to evaluate the seven streets included in the study. In total, 106 written comments were collected across the selected streets regarding sources of kerbside conflicts, reactions by freight operators, and resulting consequences. The groups then reconvened for a plenary session to discuss whether the proposed conflict framework adequately captured the complexities mentioned within the groups.
Task 2 – Value Implications of Conflicts (duration 45 min): Based on the conflicts identified in Task 1, participants discussed freight delivery implications across the value dimensions: health, society, economy, and environment. A guided worksheet helped identifying affected streetside users by the space-sharing conflicts and potential performance indicators (KPIs) for assessing each value dimension.
Task 3 – Prioritizing Value Dimensions (duration 30 min): Participants reflected on which value dimension should take precedence on each of the seven streets, considering their design, regulatory constraints, and space demand for freight. A voting system was used, whereby participants allocated votes to indicate perceived priorities. Results highlighted variation in value emphasis across locations.

4. Results

This section presents the results of the analysis, which informed the development of a framework for assessing space-sharing conflicts from a freight perspective (Fig. 3). The findings are synthesized into the following components: conflict triggers, freight operators' reactions, a proposed typology of space-sharing conflicts, and consequences in terms of the value of streets dimensions.

As shown in Fig. 3, the framework categorizes conflict triggers into three groups –built environment, competing demand, and street regulations– identified as key factors prompting operators' reactions in their efforts to execute planned deliveries. These identified reactions, in turn, amplify conflict triggers, in a so-called conflicts loop, as freight actors have no other way of reacting than insisting even if it implies augmenting existing tensions, incurring in inefficient or prohibited practices to deliver. Thus, the conflict loop contributes to one or more of the proposed typologies of freight-related space-sharing conflicts: collision risk, traffic obstruction, space overuse and pavement damages. Finally, the occurrence of these conflicts leads to consequences in the value of streets perceived by freight operators.

4.1. Conflicts loop: conflict triggers and freight operators' reactions

The empirical findings from the selected streets in Central London led to the identification of tensions in the access to streetside space, clustered in Fig. 3 into the categories of built environment, competing demand, and street regulations. Each category (or their combinations) is labelled as conflict triggers because they serve as the root cause for freight operators' reactions, leading to conflicts in the use of public space.

The built environment refers to the physical design and features of the street, such as the arrangement of lanes, the presence and placement of bike lanes and parking racks, street furniture, loading zones, street hierarchy (e.g., throughway), and disruptions caused by construction works. These conditions often constrain delivery operations and lead to reactions from freight operators that affect efficiency and urban liveability. For example, dedicated bike lanes located between receivers' location and the kerbside, street furniture obstructing the access to receivers, and insufficient or poorly located loading zones restricted the space available for (un)loading goods, forcing operators to spend additional time cruising for parking, to park illegally or at inconvenient distances from their destinations, or generate safety risks to other users due to obstruction of flows. As mentioned during the interviews, "*operators have to warn cyclists about the presence of a delivery activity by using signs, since they may travel at high speeds or without noticing operators crossing or obstacles on the lane*" (Respondent from freight delivery crew). Moreover, street furniture can be damaged or destroyed by freight operators that need to manoeuvre or park close to it. This can create additional costs for municipalities and reduce the functionality of public spaces for other users.

The built environment also includes public transportation such as bus stops, train stations, and subway entrances. While essential to the urban transportation system, their location can generate streetside access conflicts with freight operators due to interferences with establishments and households' needs for deliveries, e.g., Charing Cross Rd. "*This conflict is a potential source of safety risks since freight vehicles, when parking close to public transportation stops, can interfere with the ability of passengers to access buses, trains, and subways safely*" (Respondent from freight delivery crew).

Additionally, temporary changes in the built environment, such as construction works or street redesigns, introduce additional uncertainty and further limited access, as construction works may require the use of loading zones or other streetside space that can also be needed by freight operators. Delivery failures are currently among the highest in Central London, e.g. "*This establishment may be the one with the most failed deliveries in the West End due to conflicts with the Theatre scenery changes and the construction teams*" (Expert in kerbside management). Uncoordinated construction deliveries result in further impediments to adjacent freight deliveries.

Regarding the conflict trigger related to competing demand, multiple users, including freight operators, private vehicles, taxis, public transport, service vehicles, cyclists, and pedestrians, demand limited streetside space, especially in commercially active streets. High demand from these actors lead to safety risks, and overlapping demands for space between household parking, taxi zones, and freight (un)loading needs, or service vehicles and construction activity occupying kerbside areas. For instance, zones where intense demand for goods and pedestrian activity coexist, e.g., entertainment facilities access, public transportation stops, among others, make deliveries take longer times and pose risk of collision between freight operators and pedestrians. Additionally, freight operators parking on pedestrian infrastructure or vehicles transit on pavements can create uneven surfaces that risk both walking and portering activities.

Supply-demand imbalance in the allocation of space also contributes to the tensions in the conflict trigger of competing demand. Public authorities define parking zones for households and taxis in designated

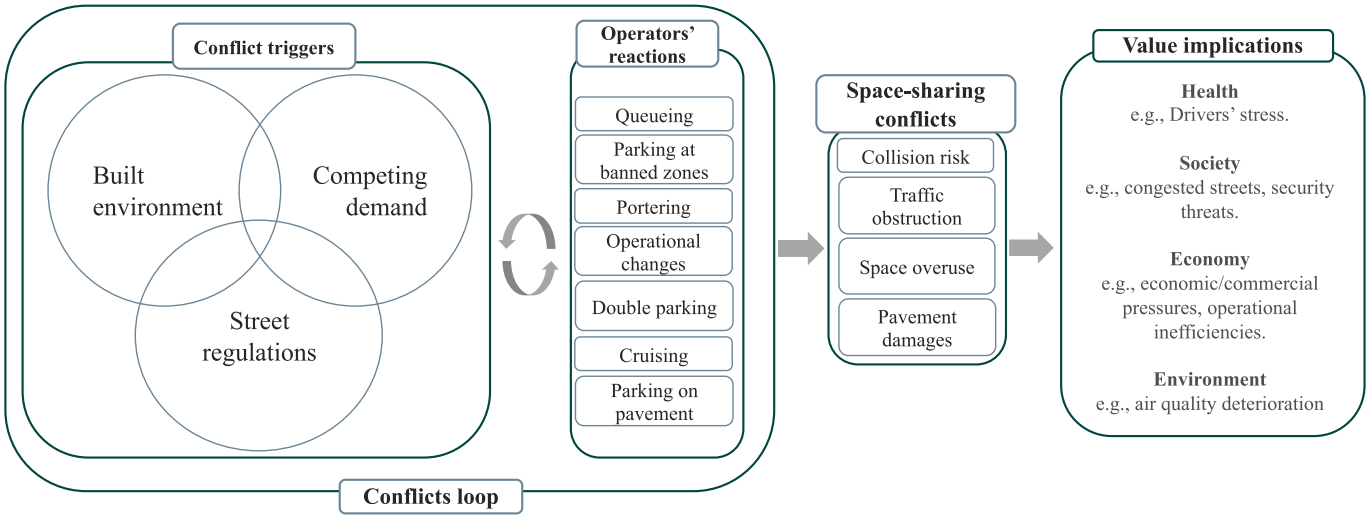


Fig. 3. Framework for assessing freight-related space-sharing conflicts.
Source: Authors.

areas that may overlap with the space required for (un)loading operations of surrounding businesses and households (e.g., for e-commerce deliveries). Empty parking spaces due to oversupply of infrastructure for households' and taxis parking at certain times of the day or week create conflicts when freight operators need to deliver goods but are not allowed to use that space, e.g., Brewer St, and Old Compton St. As a result, freight operators double park, circulate in search of space, or (un) load in unauthorized areas, which in turn generate congestion and operational delays. These pressures are amplified during peak periods, increasing the likelihood of conflicts and spillover effects on adjacent streets.

Besides the built environment and competing demand conflict triggers are the complexities introduced by street regulations. Street regulations encompass the rules, restrictions, and enforcement practices that determine who can use the kerbside, when, and under what conditions. The analysis revealed that fragmented, inconsistent, or poorly communicated regulations, such as conflicting signage between administrative boundaries (e.g., boroughs), time-restricted access windows, and selective enforcement, significantly affected the efficiency of freight operations.

For instance, each borough has its own set of kerbside regulations, which means that freight operators must navigate non-standard rules as they transit through different boroughs during a day. As mentioned during the interviews "*some London Boroughs* (districts) *and Transport for London recognise the requirements under Health and Safety guidance and have agreements with delivery companies to allow parking without enforcement, however not all of the 33 London Boroughs recognise the requirements*" (Respondent from delivery companies). The absence of harmonized and clearly communicated regulations undermines effective planning and hinders operational efficiency, contributing to broader inefficiencies within the urban freight system and reduced liveability in urban environments.

Freight operators try to adapt to the access impediments, often at the expense of operating cost, e.g., fines, longer delivery times through long on-foot delivery distances, and freight crew safety. For instance, time-based access restrictions resulted in operators queuing in adjacent streets until the designated access time, leading to congestion and unauthorized utilization of street space.

In summary, freight operators demand streetside space for (un) loading due to limited or non-existent off-street parking infrastructure and the need to park as close to destinations as possible. While using on-street infrastructure, evidence showed how freight operators faced tensions in the interactions with other public space users and the need to comply with regulations that hamper operations efficiency. The conflict triggers induced reactions from freight operators that amplified tensions over kerbside space. The observed reactions corresponded to queueing in the wait for parking space, parking at banned zones, portering (walking with goods from distant locations to the receiver point), operational changes (e.g., deliveries cancelation or postponement), double parking, cruising, and parking on the pavement.

4.2. Space-sharing conflicts related to freight deliveries

The research identified four space-sharing conflicts as a result of the conflicts loop: collision risk, traffic obstruction, space overuse, and damage to the pavement.

Collision risk refers to situations characterized by the potential for collisions involving freight vehicles, operators or goods, and other street users or infrastructure elements such as street furniture. This risk can take place on the pavement, car/bike lanes, or city squares.

Traffic obstruction encompasses situations where the flow of pedestrians, cyclists, scooters, public transport, or cars is impeded by the presence of obstacles, such as parked freight vehicles, queues, or temporary goods occupying street space.

Space overuse is characterized by prolonged dwell times or operational rework during deliveries, due to restricted access to the designated delivery location. This conflict arises because of various freight operators' reactions, including queuing, cruising, and operational changes such as distant deliveries or rescheduled delivery attempts. These responses contribute to increased street traffic due to repeated attempts to execute the same activity. Moreover, the conflict results in prolonged occupation of space, particularly when freight operators parked far away from the intended delivery point, leading to extended portering activities.

Damage to the pavement implies infrastructure affections due to parking on the pavement or un(loading) of goods. This conflict significantly impacts the safety aspects of other street users, as well as subsequent freight operators who utilize the same space for their delivery operations. The degradation of pavement integrity not only poses potential hazards to individuals navigating the area but also creates challenges for the efficient and secure execution of freight deliveries.

The occurrence of these conflicts leads to consequences in the value of streets perceived by public space users. In particular, the implications for freight operators in health, economic, social and environmental value dimensions are addressed in the following section.

4.3. Implications of space-sharing conflicts on value of streets

Space-sharing conflicts hamper the achievement of sustainable development goals at the urban level. They conduce to unequal accessibility to transport infrastructure by street users, unsafe public spaces due to traffic violations, damages to the infrastructure, collisions, illegal occupation of space, and poor air quality due to cruising or reworks after failed deliveries. These consequences concern all street users. However, this research uncovered conflict implications on the value of streets, particularly, for freight operators that, besides threatening urban conditions, entail adverse effects on health, economy, society, and environment. This section addresses these effects, brought up by the workshop participants, so that further developments in urban planning, ROW allocation decisions and access regulations include these considerations to face unintended consequences in urban liveability.

4.3.1. Health

Assessments within this dimension involved evaluating factors like driver stress levels, and occupational safety measures experienced on the analysed streets. Health implications of *collision risks* are related to the physical well-being of freight operators and other street users. Potential consequences of collisions are injuries, accidents, and fatalities, adversely affecting the overall health and safety of those involved. In terms of *traffic obstruction* and *space overuse*, health implications are related to increased stress levels and potential accidents for freight operators and other users sharing the streetside space. Elevated stress and anxiety contribute to the deterioration of mental and physical health for both freight operators and other street users. Additionally, prolonged dwell times and operational rework can lead to exhaustion for freight operators, reduced job satisfaction, and overall diminished well-being. *Distant deliveries* represent occupational risks for operators due to carrying heavy loads without proper equipment. Regarding *damages on the pavement*, health impacts compromise the physical safety of individuals navigating the area, including freight crews, posing risks of falls, and injuries.

4.3.2. Society

The identified conflicts have significant implications in the social value dimension of streets referred to congestion and compliance of traffic regulations. Moreover, these conflicts have broader implications for job quality, motivation and job stability of freight operators. *Collision risks* conflict involving freight operators can lead to traffic congestion, especially in busy areas. Impacts on congestion are the result of reflex acts for avoiding collisions and rerouting efforts that contribute to traffic violations and disruptions to the normal flow of vehicles. Also, drivers may face driving bans, as a penalty for driving behaviours causing

collisions, which take them away from their jobs. In terms of *traffic obstructions* and *space overuse*, traffic violations may occur as drivers attempt to navigate around obstructions, leading to unsafe manoeuvres and potential traffic jams and violations. Additionally, rescheduled deliveries increased street traffic due to repeated attempts to deliver planned goods, contributing to overall congestion. This results in stress and long working hours, driven by the need to complete deliveries under unfavorable conditions, negatively affect job quality. For performance evaluations based on deliveries, delays caused by congestion or rerouting can result in low scores with implications in motivation levels and job stability. *Damages to the pavement* can impede the smooth movement of pedestrians and vehicles, causing localized congestion. Moreover, vehicles attempting to navigate damaged pavement engage in unsafe manoeuvres, contributing to potential traffic violations. This conflict also raises concerns about equity, particularly regarding fair access to quality public spaces.

4.3.3. Economy

Economic implications for freight operators regarding *collision risks* relate to financial losses, including repair costs, insurance claims, and potential legal expenses. Accidents may cause delays in delivery schedules, affecting overall operational efficiency and potentially leading to penalties for late deliveries. Regarding *traffic obstructions*, obstructed flow and queues lead to operational inefficiencies, causing delays in delivery times and potentially impacting customer satisfaction. In terms of *space overuse*, prolonged dwell times and rework during deliveries increase operational costs, including labor expenses and fuel consumption, as vehicles spend more time on the streets. Cost associated to traffic fines are incurred due to prolonged parking times or illegal parking. Inefficiencies related to *space overuse* may negatively impact the competitiveness of freight operators, leading to potential loss of contracts. Regarding *damages on the pavement*, frequent damages to pavement lead to negative perceptions of the freight operator, affecting their reputation and potential business opportunities.

4.3.4. Environment

Collisions risk can lead to driving practices, e.g., sudden braking or honking, that generate additional emissions, air pollution, noise, and environmental degradation. In terms of *traffic obstructions* and *space overuse*, these conflicts generate congestion and with it, increased fuel consumption and related emissions generation. Furthermore, repeated attempts to execute deliveries contribute to traffic congestion, further intensifying environmental impacts. Cruising generates climate change impacts and local pollution. *Damages on the pavement* deteriorate street infrastructure affecting urbanism and aesthetics.

The effects of space-sharing conflicts on the value of streets vary depending on the specific conditions of each street and the streetside access priorities of the actors involved. For example, Fig. 4 shows how workshop participants assigned different priorities to each value dimension across the selected streets.

In streets where economic priorities dominated, such as Charing Cross Rd and Charlotte St, participants emphasized the need to support business operations, likely favoring regulations that maintain efficient freight access and kerbside delivery zones. New Bridge St and St Martin's Ln received the highest prioritization for health considerations, signaling concerns about air quality, stress levels of delivery crews, pedestrian and cyclist safety, and exposure to vehicle emissions.

In Kingly St and Brewer St, environmental priorities were dominant, reinforcing the need for green infrastructure, sustainable transport solutions, and reduced congestion from freight operations. Lastly, Old Compton St exhibited a more balanced prioritization between society, economy, and environment, reflecting its mixed-use nature as a commercial and social hub.

In sum, the findings reveal a loop generating freight-related space-sharing conflicts, driven by the interaction between built environment features, competing demand, and fragmented street regulations. Freight operators' reactions to these triggers –necessary to fulfil delivery tasks– often reinforce the conditions that caused the conflicts. The resulting impacts span collision risks, traffic obstruction, space overuse, and

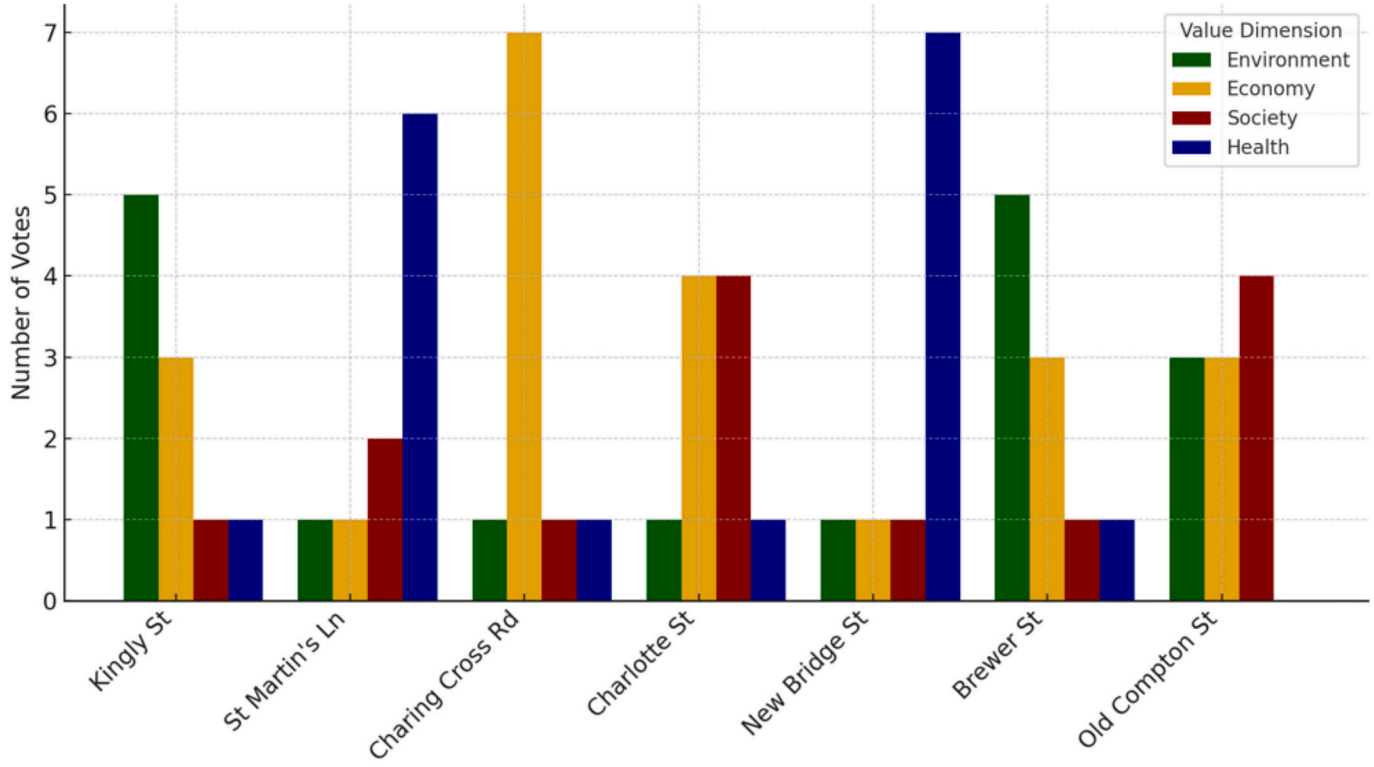


Fig. 4. Prioritization of value dimensions in studied streets.
Source: Authors.

pavement damage, all of which affect the perceived value of streets across health, social, economic, and environmental dimensions for freight operators. These dynamics, shaped by street-specific conditions and user priorities, raise critical questions for urban policy and planning. The following discussion reflects on these insights to consider implications for ROW allocation approaches considering policy and implementation challenges.

5. Discussion

This paper aimed to analyse freight-related space-sharing conflicts and explore their implications for the value streets provide to freight operators, while reflecting on potential approaches to street-space allocation for mitigating adverse effects. This section focuses on the latter, discussing approaches for including freight needs into allocation decisions, as "*space allocation for on-street parking is one the most contentious aspect of ROW decisions*" (Respondent from the public sector), in line with previous findings reported in Zalewski et al. (2012).

Interviews and workshop data provided evidence of the difficulties faced by freight operators in accessing streetside space, finding that decisions on space allocation overlook their needs and contribution to the streets functions. Therefore, it is essential that public authorities work together to develop consistent and fair regulations for streetside use with explicit consideration of freight operations, in order to avoid negative implications in the value streets provide to freight operators and other users.

In a similar vein, regarding ROW decisions, the case data showed that one of the biggest challenges faced by freight operators is the lack of coordination among public authorities from different government levels and adjacent districts, i.e., boroughs. For instance, each borough has its own set of streetside regulations, which means that freight operators must navigate non-standard rules when driving and delivering across different boroughs. This inconsistency leads to confusion and frustration and often results in costly fines for illegal parking.

The proposed framework (Fig. 4) enabled the identification of value implications of space-sharing conflicts for freight operators, which can inform ROW decisions that target conflict causes, i.e., conflict triggers. The health, economic, social and environmental considerations of value for freight operators complement the dimensions reported for other users in Gössling et al. (2016); Creutzig et al. (2020) and Lefebvre-Ropars et al. (2021). Although the proposed framework is not exhaustive in the inclusion of all the possible conditions present at every street, it allows to analyse key interactions involving freight, pedestrian, and public transport demands competing for limited space, particularly at streets with high commercial activity, strict kerbside regulations, and different levels of accessibility. As Valença et al. (2024) highlighted, the complexity of reallocating road space depends on a street's function and role in the transport network, with arterial roads facing greater constraints than local commercial streets.

Following Lefebvre-Ropars et al.'s distributive justice principles, i.e., sufficientarian, utilitarian and egalitarian, this section builds on these fairness principles of space distribution, reflecting on to what extent they cope with the identified space-sharing conflicts, their implications in policies, and implementation challenges. Fig. 5 illustrates the scope of each fairness principle (right) in the ROWAP to streetside users and demand types (left). The orange score in Fig. 5 shows what distributive criteria prevail for each of the principles.

Policymakers following a *sufficientarian* principle could consider the demand for freight deliveries in each zone, providing the corresponding space to fulfil this demand. This space can take the form of loading zones (Castrellon et al., 2024; Comi et al., 2022; Ezquerro et al., 2020) or dynamic access regulations that enable delivery operations at certain times of the day or week (Valença et al., 2023). These solutions would address conflict triggers related to competing demand in interactions between freight and taxi parking as well as freight and household parking. They also contribute to mitigating conflicts in freight-intensive areas by utilizing data on vehicle arrival and dwell times to apply regulations that smooth traffic flow. This is coupled with flexible streetside allocation, allowing freight operations when there is low demand for taxi or household parking (empty zones).

Allocating space for freight parking directly addresses the four identified types of space-sharing conflicts, and particularly impacts the

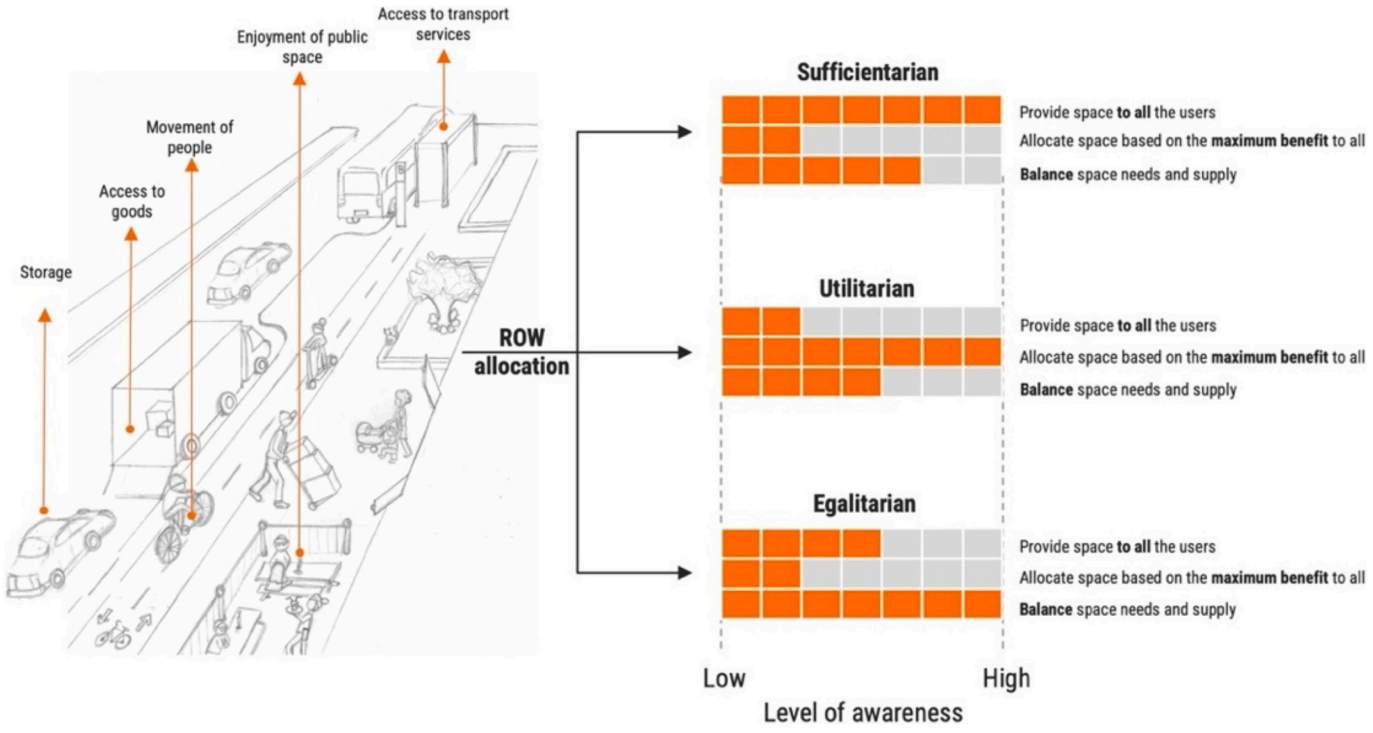


Fig. 5. Distributive justice principles in the ROW allocation.
Source: Authors.

conflict triggers related to competing demand and built environment. However, securing this access does not imply unrestricted availability but rather the need to guarantee conditions for freight operations without compromising other street functions. In this regard, policy measures such as designated loading zones, dynamic curb management, and time-based access regulations provide a way to meet the minimum operational needs of freight while ensuring that other users maintain their access to streetside space.

This approach supports the idea that streets are multifunctional spaces that should integrate rather than exclude diverse uses. The coexistence of pedestrian activity, business operations, and environmental concerns suggests that adaptive street design solutions, such as flexible kerb space that transitions between delivery zones and pedestrian areas based on time of day, may serve as a fair compromise in ROW allocation process.

Giving the value implications presented in Section 4.3, this paper provides the aspects to consider when it comes to include value dimensions from the freight operator perspective into the modelling of the sufficientarian approach. The challenge of this approach emerges in situations where the space is not enough for the demand levels from all the users and providing space to all the users is not possible. In such cases, the ROW allocation decisions should rely on either utilitarian or egalitarian principles to prioritize users accordingly.

Regarding the *utilitarian* principle, ROW allocation decisions are based on the utility freight and other users provide to the city goals. Freight, while often perceived as a disruptive element in urban environments, plays an important role in enabling economic activity, ensuring business productivity, and maintaining supply chains that support urban life. In this matter, the utility function should consider the contribution of freight to the street's economic vibrancy and to the realisation of social interactions given the access to services/products at the street. This place-making role of freight should differentiate this demand type from the movement functions or private vehicles demand for space as pointed by Creutzig et al. (2020).

Solutions to the ROWAP from this approach should also consider objective decision-making involving actors' participation to avoid misleading choices based on biased interests as suggested in Valença et al. (2024). Additionally, public sector coordination at different levels is critical as reported by Sears et al. (2022). This implies the development of tools for data-driven decisions using data sources such as historical reports of streetside use, traffic cameras, and app-based data from streetside users to estimate needs, benefits and value impacts to decide accordingly. The challenge of this approach is the access to data required to inform optimisation models that account for built-environment limitations, demand constraints, and the value generated by allocating streetside space to freight deliveries. Furthermore, although this research identified some categories and ways in which conflicts affect the value that users perceive from streetside space, there is still a need to formalize and quantify value gains and losses, so that the utilitarian problem can be formulated. This would probably need to monetize the different dimensions of value. Challenges come from the uniqueness of each situation and the variation it means in monetary terms.

It is worth noting that unregulated freight access can lead to congestion, delays, and inefficient space usage, which in turn diminish the broader urban benefits of well-managed street environments. Implementing smart loading zones (Castrellon et al., 2024), which allocate kerb space to freight at specific times based on demand, represents an opportunity to enhance both freight efficiency and overall urban mobility. By integrating dynamic space allocation mechanisms, cities can prevent inefficient freight practices, such as cruising for parking or last-minute delivery rerouting, that otherwise contribute to congestion and emissions.

Lastly, the *egalitarian* principle strives for participatory approaches for street design, assessing impacts of public space embellishment on physical, social, and psychological people's wellbeing, as well as on economic development and environment. Traditional space allocation decisions have often favoured dominant modes, such as private vehicles without fully considering the implications for freight operations. While efforts to promote pedestrianization and cycling infrastructure are valuable for urban liveability, neglecting the freight perspective in these decisions can lead to fragmented and uncoordinated regulatory environments that fail to address real-world freight demands. For instance, the 15-minute city model, as discussed in Büttner et al. (2022), supports such interventions by reclaiming space from motorized vehicles in areas where human-centered urban life is prioritized. However, further elaboration about freight in this concept is needed, having different considerations compared to private cars given the different nature of freight and contribution to public benefit.

Open innovation and city living labs have been strategies implemented in different contexts to reach solutions that balance space needs and supply for all streetside users. This research contributed by making an inventory of needs of freight actors, acknowledging that space cannot be distributed in an egalitarian way without first knowing who needs space. This assessment of space needs from freight actors is limited in the urban planning literature as mentioned in Haarstad et al. (2024). Additionally, the freight-oriented framework for conflicts assessments can inspire discussions in co-creation activities, where actors are called to discuss about conflict triggers, reactions from freight operators, conflicts generated and the corresponding implications on value of streets. The solutions emerging from these workshops could follow this loop to assess the potential impacts, as showcased in (Gateri et al., 2026).

Findings on distributive justice principles suggest a complementary way for their implementation depending on the context and specific street design, rather than aiming for a one-size-fits-all solution. Thus, ROW allocation should not rely on rigid modal hierarchies but instead adopt a more adaptive and needs-based planning framework as motivated by Nello-Deakin (2019). Urban streets differ in their built environment, competing demand, and regulatory frameworks, meaning that a rigid application of any single justice principle could create new inefficiencies rather than resolving space-sharing conflicts. Instead, a context-sensitive approach, as suggested in Carmona (2018), that dynamically integrates these principles is needed to balance freight access, pedestrian mobility, and urban liveability.

This study highlights the importance of streets accommodating freight operations where their role is essential, particularly in commercial districts and retail hubs, while also implementing alternative strategies, e.g., micro-consolidation centers or off-peak deliveries, to manage freight operations in pedestrian-dominant areas. By integrating freight into the broader debate on fairness in urban space allocation, this study contributes to understanding how distributive justice principles can be applied to address space-sharing conflicts. The results indicate that freight should not be viewed as merely a competing mode but rather as a fundamental component of urban functionality, one that requires targeted interventions to minimize externalities while maximizing its contribution to the urban economy.

Lastly, although the findings are context-specific, i.e., focused on the West End of Central London, the framework and insights regarding how different justice principles align with specific design challenges and policy responses are applicable to other urban contexts. While replication in different cities requires adaptation to local regulatory, spatial, and institutional conditions, the core concepts, data collection methodology, and the framework for assessing space-sharing conflicts remain transferable, particularly in contexts where space access must be managed to accommodate freight deliveries alongside other uses. For instance, Gateri et al. (2026) applied the space-sharing conflict framework to use cases in Nairobi, Kenya, demonstrating the relevance and utility of the framework in diverse urban freight environments.

6. Conclusions

This paper analysed freight-related space-sharing conflicts and their implications for the value streets provide to freight operators, while reflecting on approaches to street-space allocation that may mitigate their adverse effects. Based on empirical evidence from seven streets in the West End of Central London, the study identified how built-environment conditions, competing demands for streetside space, and access regulations create tensions that trigger freight operators' responses. These responses, including cruising, double parking, pavement occupation, queuing, portering, and operational changes, can reinforce the initial conditions and contribute to four types of space-sharing conflicts: collision risk, traffic obstruction, space overuse, and pavement damage. The proposed conflict loop therefore shows that freight-related conflicts are not limited to direct interactions between vehicles and other users, but emerge from the interaction between street design, regulation, competing demands, and operational responses.

The main contribution of the study is to connect these space-sharing conflicts with their implications for the value of streets from a freight perspective. The findings show that restricted or contested access to streetside space has consequences beyond delivery efficiency and costs. It can affect health and safety through stress, exhaustion, collision exposure, and difficult portering conditions; social value through working conditions and fairness in access to public space; and environmental value through cruising, repeated delivery attempts, and congestion. Consequently, interventions intended to improve liveability by restricting freight access can generate unintended effects when the underlying demand for goods and services remains unchanged. The framework captures this relationship by linking conflict triggers, freight operators' reactions, resulting conflicts, and their implications for health, social, economic, and environmental value.

These findings have implications for right-of-way allocation. Freight should not be treated solely as a movement activity to be accommodated after other street uses have been allocated. Deliveries support the access and place-making functions of streets by enabling the economic and social activities that occur at their destinations. At the same time, freight operations compete with other legitimate demands for limited public space. Right-of-way decisions therefore require consideration of trade-offs between users, street functions, and dimensions of value rather than assuming that a particular use should receive priority. Distributive justice principles provide alternative approaches for addressing these trade-offs according to local conditions, supporting more context-sensitive decisions about who should access streetside space, where, and when.

From an applied perspective, the framework provides a sequential process that cities can use to review kerbside regulations and street-space allocation. Its application starts by characterising street design and functions, access and parking regulations, freight activity, and competing demands for streetside space. Stakeholder knowledge from public authorities, freight operators, businesses, and other affected users can then be combined with field observations to identify conflict triggers, operational responses, and actual interactions in the street. The resulting conflicts can subsequently be assessed according to their implications for health, social, economic, and environmental dimensions of value and the priorities associated with the specific street context. This evidence can inform changes to access regulations, temporal allocation, infrastructure provision, or redistribution of street space. Rather than prescribing a universal allocation solution, the framework provides a context-sensitive approach for identifying where and when interventions are required and the users and value dimensions that should be considered.

The study also presents limitations that define the scope within which its findings should be interpreted. The empirical analysis covered seven streets in the West End of Central London and reflected their particular spatial, regulatory, and institutional conditions. Its predominantly qualitative and exploratory design provided an in-depth understanding of conflict mechanisms but did not quantify their frequency, intensity, or impacts in a way that can be statistically generalised. Furthermore, although the study identified four dimensions of street value and explored their relative priority across the selected streets, it did not quantify the value generated or lost through space-sharing conflicts. Future research should therefore test the framework across a larger diversity of streets and urban contexts, include a broader sample of organisations and street users, and extend observation periods to capture temporal variations in streetside demand and conflicts. Further work should also develop quantitative indicators of street value and integrate them into right-of-way allocation models, allowing the framework to progress from conflict diagnosis towards the evaluation and comparison of alternative street-space allocation strategies.

CRediT authorship contribution statement

Juan Pablo Castrellon: Writing – original draft, Methodology, Formal analysis, Conceptualization. **Michael Browne:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization. **Ivan Sanchez-Diaz:** Writing – review & editing, Project administration, Funding acquisition.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Interview guide

Value provided by streets

1. “Local authorities need to develop, assert and clearly communicate a sense of their true ownership of street and kerb space and of the common value associated with that property” What is the value of the kerbside?

2. Which metrics do you find relevant to assess kerbside management?

Space-sharing conflicts

3. What type of user tends to be more active in the claims for space?
4. How would you define "conflicts" in the context of kerbside management?
   1. How to measure them? What is the most critical?
   2. PCN – pros and cons of using them to support kerbside decisions.

ROW allocation decisions

5. What do you know about the overall right-of-way strategy of the city?
6. How is freight considered in the strategy?
7. Is there any way to measure the success of right-of-way decision?
8. How do you handle priorities among kerbside users?
9. User's priorities. How helpful are these schemes to define space allocation strategies?
10. Participatory approach, what are the risks? How mitigating them?
11. Have you seen any progress in the way that decisions are made? If you had to prioritize one solution, what would it have been? Do you foresee any pros and cons?

Appendix B. Workshop participants description

Participant #	Affiliation	Sector	Role/title	Relevance
1	Future City Logistics/CILT	Private	Moderator/Logistics Consultant	Workshop facilitator with sector-wide freight expertise
2	Brewery Logistics Group/CLFQP	Private	Industry Representative	Stakeholder in freight operations in Central London
3	Chartered Institute of Logistics & Transport (CILT)	Private	Logistics Expert	Broad view of policy and practice in logistics
4	West End Partnership/Zero Emissions Group	Public	Freight and Emissions Strategist	Local authority partnership on sustainable logistics
5	University of Westminster	Academia	Lecturer/Freight Researcher	Researcher in urban freight in London
6	University of Southampton	Academia	Freight Researcher	Researcher in urban freight in London
7	Islington City Council	Public	Transport Planner	Street access and traffic planning
8	Transport for London (TfL)	Public	Freight Planner	Strategic freight and kerbside policymaking
9	Cross River Partnership	Public	Project Manager	Urban freight pilot programs
10	British Security Association	Private	Industry Representative	Involved in delivery security and coordination
11	GRID	Private	Industry representative	Expertise in tech solutions for kerbside management

Data availability

Data will be made available on request.

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