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# CARGO BIKES IN URBAN LOGISTICS: AN INFRASTRUCTURE READINESS ASSESSMENT FOR THE CITY OF ZAGREB

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## Abstract

The growing demand for urban parcel deliveries has intensified pressure on city transport systems, particularly in dense urban areas where conventional van-based logistics face increasing constraints related to congestion, emissions, curbside availability, and operational efficiency. Cargo bikes are increasingly promoted as a sustainable alternative for last-mile deliveries, however, their large-scale deployment depends not only on vehicle performance, but also on the readiness of urban infrastructure and the integration of cargo bikes within multimodal delivery systems. This paper presents a preliminary qualitative assessment based on regulatory review of urban infrastructure readiness for cargo-bike parcel delivery, using the City of Zagreb as a case study. A multimodal perspective is adopted, comparing a conventional van-only delivery scenario with a two-stage delivery model combining vans, urban micro-hubs, and cargo bikes. The analysis focuses on the spatial layout and functional characteristics of urban infrastructure relevant to cargo bike operations, including cycling network continuity and width, curb design and accessibility, and the placement of parcel lockers and micro-hubs within the urban environment.

*Keywords: cargo bike, parcel delivery, cycling infrastructure, multimodal*

## 1 Introduction

Traditional delivery vehicles such as diesel-powered vans, significantly contribute to urban air pollution, noise, and congestion [1]. As reported by Eurosender, the rise in parcel delivery, particularly in the express segment which expanded 91% between 2017 and 2021, further amplifies the need for efficient and sustainable solutions [2]. Recognizing these externalities, the European Green Deal aims for zero-emission transport by 2050, with all new vehicles to be zero-emission by 2035 [3]. Cargo bikes are widely recognized as a sustainable solution for last-mile urban deliveries, and the continued growth of e-commerce is increasing demand for efficient and low-emission CEP logistics [4]. The European's Commission Urban Mobility Framework [5] and Croatia's National Cycling Development Plan (2023-2027) [6] adopted by the Ministry of the Sea, Transport and Infrastructure further support low-emission city logistics and promote cargo bike use for urban goods transport. Providing adequate cycling and curbside infrastructure is a prerequisite for scaling up cargo-bike-based urban logistics [7]. Despite increasing policy support, it remains unclear to what extent existing regulatory and planning frameworks translate into infrastructure conditions that enable large-scale cargo-bike deployment. This paper reviews the regulatory framework related to cycling infrastructure and urban access rules and discusses their implications for infrastructure conditions relevant to cargo-bike parcel delivery.

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In particular, the paper examines how cycling-infrastructure guidance and related urban access rules support or constrain the scale-up of cargo-bike parcel delivery in Zagreb, Croatia.

## 2 Methodology

This study applies a qualitative document review complemented by targeted operational examples to evaluate the readiness of Zagreb's urban environment for cargo-bike parcel delivery. First, a structured desk review was conducted to identify policy and technical provisions relevant to cargo-bike operations at three levels: (i) EU-level strategies and guidelines for cycling and urban logistics, (ii) selected European city/regional examples where cargo-bike infrastructure requirements are specified, and (iii) the Croatian regulatory baseline and any Zagreb-specific documents influencing cycling and cargo bicycle infrastructure. Second, findings from the review were synthesized into an infrastructure readiness framework covering three functional domains relevant to cargo-bike logistics: (1) cycling network continuity and effective width, (2) curbside design and access for stopping/loading and safe waiting at intersections, and (3) spatial integration of micro-hubs and parcel lockers as interface points for a two-stage delivery system.

## 3 Regulatory framework for cargo-bikes: EU, state and city-level policies

The European Declaration on Cycling, published by the European Commission, positions cycling as a strategic transport mode and recognizes the need for supportive policy and investment frameworks across Member States. It also explicitly references the role of cycling in urban logistics, including bike-based delivery services [7]. As e-commerce, and parcel delivery continue to grow [8], EU institutions, national governments and cities increasingly seek to influence urban infrastructure development to better accommodate cargo bicycles and other non-standard cycle types. Standards, however, are still not very widespread, but they do start to emerge [9]. At national level, LTN 1/20, promotes increasing use of cargo bikes to replace a share of van journeys in last-mile distribution [10]. Ireland's National Transport Authority (NTA) issued the "Cycle Design Manual" in 2023, in which the increased use in non-standard cycling equipment, such as cargo-bikes, tricycles etc. has been recognized. The manual states that "cycle facilities must be designed to cater for all the different types of cycle vehicles in use" and defines the "Universal Design Cycle" (2.8 m long, 1.2 m wide) so designs work for the different set of vehicles, including cargo bikes [11]. The manual also frames continuity through the "Coherence" requirement, stating that routes should not have gaps or be interrupted at difficult locations [11]. Germany's National Cycling Plan 3.0 similarly discusses cargo bikes and related infrastructure needs (routes and parking) and links cycle logistics to micro-hubs/city depots for efficient CEP operations [12]. Netherlands has several documents defining cycling in general and, beyond the infrastructure-continuity emphasis seen in other national strategies, a Dutch brochure reports a PostNL rule-of-thumb that the distance from a hub to the first delivery location should be no more than 4-4.5 km [13]. A municipal-oriented guide by Arup and Tour de Force highlights the need to plan cargo-bike logistics at both network and street level, including loading zones, infrastructure design, and parking/charging facilities [14]. Beyond the UK, Ireland, Germany and the Netherlands, national policy frameworks explicitly referencing cargo bikes (and the associated infrastructure implications) are also provided in states like Austria [15], Czech Republic [16], France [17], Italy [18], Spain [19], and Slovenia [20]. Several cities (e.g. Barcelona, Berlin, Brussels) have introduced specific regulations for cargo-bike operations. Barcelona's municipal traffic ordinance explicitly regulates cycles used for goods distribution (including multiwheel cargo cycles), defining where they may circulate, e.g. permitting them on cycle lanes where vehicle width allows and setting operational and parking conditions relevant to parcel delivery [21].

The state government of Berlin issued planning specifications which define a standardized cargo-bike parking bay [22]. The planning specification is mandatory for all city districts, and it standardizes elements like location of the parking bay, size, layout, signage and included hardware [22]. In Brussels, the regional public parking agency issued the "Parking strategy for cargo-bikes in Brussels-Capital Region", which makes a clear distinction between private cargo bike use and professional cargo bike use. For professionals, two distinct solutions are proposed, one being the development of logistic hubs, the other being the provision of secure private parking spaces [9].

## 4 Qualitative infrastructure readiness assessment

Based on the reviewed literature and guidelines, infrastructure requirements for cargo-bike logistics can be grouped into three key dimensions: (1) cycling network characteristics, including continuity, effective width, and turning geometry; (2) curbside and intersection design, including loading/unloading space, signal actuation, and safe waiting areas; and (3) logistics interface points, such as micro-hubs, parcel lockers, and cargo-bike parking/charging facilities. Cargo bikes used in CEP services are often wider and longer than standard bicycles [23]. Common commercial models, such as the EcoCargo XL [8], can reach widths up to approximately 1.2 m [24], which places higher demands on the effective width and geometry of cycling infrastructure compared with standard bicycles. However, wider vehicles like tricycles or quadricycles often require dedicated infrastructure adaptations, including wider cycle lanes, adjusted curb radii, and sufficient turning space, especially in historical urban cores [8]. To support cargo bike adoption, cities must adjust their infrastructure. Wider lanes, like those used by public transport, are preferred for better handling [25]. Adjustments to traffic signal buttons may be necessary: with long cargo bikes (e.g. "butcher's bikes"), cyclists may need to extend into the road to activate pedestrian lights, creating safety hazards [26], as observed in figure 1. The previous claim is also substantiated by guidelines applicable for the Netherlands and Flemish Belgium. Specifically, Dutch guidelines (in the article 38) state that "The push button must be mounted before the stop line belonging to the three-colored bicycle light and at a height of approximately 1.25 m" [27] while the Flemish guidelines state that "a separate, short post with a push button for cyclists at the top can be chosen. This is usually placed at least 1 meter before the stop line" [28]. Furthermore, resizing and repurposing vehicle delivery bays can also support the transition [26]. Reallocating excess space to sidewalks or bike parking enhances urban accessibility and supports sustainable mobility goals [14].

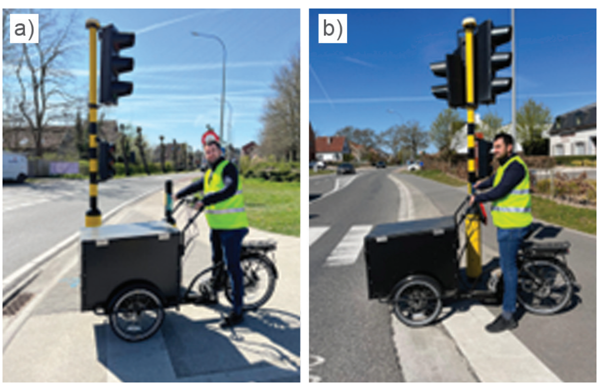


**Figure 1** (a) Preferred push-button placement: separate post set back from the stop line, allowing cargo-bike actuation without extending into the carriageway, (b) Less suitable placement: button on the signal pole at the stop line, forcing the cargo bike to overhang into the carriageway to reach the push-button (source: author's archive)

## 5 Case study Zagreb: infrastructure readiness for cargo-bike parcel logistics

The following assessment is based on the interpretation of regulatory provisions and planning documents identified in the preceding review. In Croatia, the Road Traffic Safety Act does not explicitly define cargo bikes as a separate vehicle category [29], creating legal ambiguity, while cycling infrastructure is anchored in the Pravilnik o biciklističkoj infrastrukturi (NN 28/2016), which sets general planning and design principles for cycling facilities but does not provide cargo-bike specific designs or operational requirements [30]. The National Cycling Plan 2023-2027 further frames implementation priorities and explicitly includes the establishment of public bicycle systems including cargo bikes as a measure, reinforced through the accompanying Action Plan ("Uspostava sustava javnih i teretnih bicikala") [6]. In Zagreb, despite delivery companies already operating a cargo bike delivery service around city center [8, 31], there are currently no clear, binding, and targeted municipal guidelines that would support a city-wide scale-up of cargo-bike parcel delivery. At city level, the most logistics-relevant instrument is the regulation of access and servicing in the center. The city's order governing vehicle movement in the central area and pedestrian zones establishes a restricted regime, with access subject to permits and defined operating conditions. In particular, the city specifies delivery/servicing time windows in the pedestrian zone: Mon-Fri 06:00-11:00 and Sat-Sun 06:00-10:00 [32]. These center-access constraints shape the feasibility of last-mile operations. In a van-only concept, operators must concentrate stops into limited time windows and manage permit requirements and stopping constraints in the pedestrian core, increasing sensitivity to curb availability and time losses. In contrast, a two-stage model (van - micro-hub - cargo bike) can reduce the need for vans to enter the most restricted areas and shift the final meters of delivery to smaller vehicles that are less constrained by access restrictions and are better suited to short stops and dense routing in the inner city.
Applying the readiness framework defined in this study to the reviewed regulatory and planning context of Zagreb, the following observations can be derived: network continuity and effective width: national rules provide a baseline, but cargo-bike scaling depends on whether key corridors into and within the center provide sufficient effective width, turning space and continuity (i.e., avoiding pinch points that disproportionately affect longer/wider vehicles). Curbside and intersection usability: city-center delivery windows make curbside efficiency a decisive factor, and small design details at junctions (e.g. reachable signal actuation and safe waiting positions for longer vehicles) can become binding constraints at scale. Interface points (micro-hubs/lockers): the national plan's inclusion of cargo bikes and public systems supports the direction of travel, but Zagreb still needs explicit local planning for interface locations that connect continuous cycling routes with last-mile handover points.

## 6 Discussion

Compared with cities that have begun regulating cargo-bike provisions (e.g. standardized cargo-bike parking bays, or explicit operational rules for cargo cycles), Zagreb's current framework is stronger on access regulation than on cargo-bike specific infrastructure guidance. The Croatian national baseline and Zagreb's center-access rules can support cargo-bike uptake indirectly, but dedicated local guidance would be needed to systematically address: (i) continuity and geometric "fit" for non-standard cycles on priority routes, (ii) cargo-bike-compatible curbside stopping/loading solutions near restricted zones, and (iii) intersection design details that avoid forcing long/wide bikes into unsafe waiting positions.

## 6.1 Implications for cargo-bike parcel logistics in Zagreb

European guidance increasingly treats cargo-bike readiness as a mix of inclusive network design (continuity and non-standard dimensions) and operational rules for allocating public space (loading, stopping, parking, access). In Zagreb, the strongest near-term enabler is less cargo-bike-specific standards and more the restricted-access pedestrian core (delivery time windows), which favors modes that can work efficiently with tight stops. Three implications follow: (1) scale-up depends on continuous, sufficiently wide corridors linking potential consolidation points to the centre; (2) curbside and junction details (e.g. signal actuation and safe waiting positions) can become binding constraints for professional operations; and (3) a two-stage model requires well-sited micro-hubs and parcel lockers integrated with continuous routes and short-stop space. Delivery vans remain highly sensitive to access windows and curb availability, while a van/micro-hub/cargo-bike concept is more robust if hubs connect to cargo-bike suitable corridors, supported by safe and efficient junction/curbside design.

## 6.2 Limitations, additional considerations and future work

This paper is a preliminary readiness assessment based on a structured document review complemented by targeted operational examples, rather than a full city-wide infrastructure audit. As a result, the study does not quantify:

- the extent of cycling-network discontinuities in Zagreb
- the distribution and capacity of suitable curbside delivery spaces
- or the spatial coverage of parcel lockers and candidate micro-hub sites.

The regulatory landscape also evolves quickly (e.g. city-level ordinances and operational rules), and the review should be interpreted as a snapshot of accessible guidance and provisions at the time of writing. Future work may focus on: (i) a GIS-based mapping of cargo-bike-suitable corridors, including pinch points and minimum effective widths/turning radii; (ii) a curbside inventory and classification of candidate short-stop delivery spaces near restricted zones; (iii) a spatial analysis of parcel locker coverage and the identification of feasible micro-hub locations using practical siting criteria (e.g. distance-to-service-area thresholds); and (iv) a comparative scenario evaluation of van-only versus two-stage (van–micro-hub–cargo bike) operations using representative routes, including performance indicators such as delivery time, service reliability, curbside dwell time, and emissions.

# 7 Conclusion

This paper reviews EU, national, and city-level guidance on cargo-bike logistics and interprets their implications for infrastructure readiness in Zagreb. The evidence shows a growing policy focus on network continuity, inclusive design vehicles, and public-space allocation for loading, parking, and interface points. Zagreb shows a mixed readiness profile: Croatia's rulebook provides a baseline and Zagreb's city-centre access regime creates a clear case for cargo bikes, but scaling is limited by the lack of targeted local guidance on pinch points/geometry, curbside delivery space, and intersection details. Addressing these gaps and integrating micro-hubs and parcel lockers would support a shift from pilots to scalable, multimodal cargo-bike logistics.

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