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GRETA

# Innovative solutions to promote synergies between passenger transport and freight transport

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GRETA Project

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More information about GRETA can be found on https://www.interreg-central.eu/greta/

# 1. The GRETA project

GRETA project aims to decarbonize the last mile delivery in Functional Urban Areas (FUAs) in Central Europe (CE) and create liveable and accessible cities for all by 2030. The project seeks to implement joint sustainable solutions in CE FUAs using zero-emission vehicles and cargo bikes and reorganize urban spaces with curb management. The pilot actions in the cities of Maribor, Reggio Emilia, Verona, Poznan, and Budapest (with Berlin FUA as an observer) have the potential to quickly deploy as pop-up measures in combination with existing measures. GRETA provides capacity-building activities, strategies, action plans, and tools for public authorities, enterprises, and relevant organizations to ensure financial, environmental, and social sustainability beyond the project's lifetime.

Last-mile delivery generates negative impacts, including emissions, noise, and congestion. Due to the Covid-19 crisis, global parcel distribution volume almost doubled, further adding inefficiencies in the peripheral areas. GRETA's FUAs recognize the problems that generate pollution, nuisance, noise, and congestion and jointed recognized three main problems: the lack of use of green zero-emission last-mile vehicles, conflicts between freight and public vehicles, and the lack of knowledge and strategies for a flexible and shared use of the curb and public space. Despite having SUMPs/SULPs, FUAs struggle to activate fitting measures while keeping their centres attractive and alive for residents and tourists.

GRETA addresses the common challenges of all CE FUAs by creating the conditions to promote ZE logistics through the use of micro-hubs, cargo bikes, light e-vehicles, and curb management strategies. Additionally, the project also focuses on paving the way to innovative concepts such as regional collaborative logistics, physical internet, and freight curb management. GRETA facilitates the dialogue towards the acceptance of a business and governance as a service model, where cities must equip themselves with a network of innovative services to guarantee seamless experiences for their users and a mobility plan considering different functions and priorities of the services.

GRETA's objective is to support the urban mobility transition in CE FUAs by jointly developing solutions and strategies with a huge potential for decarbonization of the last mile in line with the Green Deal and the Urban Mobility Package, abating congestion, pollution, and nuisance. The project's success relies on capitalizing on previous experiences, exploiting synergies with ongoing initiatives, testing innovative pilots, improving competences and knowledge among PPs and stakeholders.

# 2. Executive summary

This study explores cargo hitching, an innovative approach to improving transport efficiency and sustainability by synergically sharing infrastructure and vehicles between passenger and freight transport. The document aims to provide a comprehensive overview of cargo hitching, detailing its technical elements, typologies and practical applications. The methodology includes extensive desk research and case study analysis, incorporating insights from scientific literature and real-world implementations.

Cargo hitching optimizes resources by leveraging existing transport infrastructure for both passenger and freight services, addressing last-mile delivery challenges in various territorial scopes. This approach reduces reliance on dedicated delivery vehicles, leading to lower emissions and congestion. It also enhances efficiency by exploiting the spare capacity of passengers' services, thus also expanding the customer base of transport operators.

After presenting the main technical features of this concept, which is not new but still lack affirmation in ongoing and successful implementations, the study categorizes cargo hitching into three main typologies:

- industrial logistics,
- urban freight distribution and
- non-urban freight distribution

each of these with specific benefits and challenges.

Fifteen case studies provide an overview of practical implementations of cargo hitching, showcasing a diverse range of contexts and strategies. These case studies presents practical insights into how cargo hitching has been implemented in different situations, either successfully or not. An in-depth examination of one of these case studies (the Millingen aan de Rijn trial) was also included to showcase more in detail how cargo hitching can be seamlessly integrated into existing transport systems, providing efficient and sustainable solutions for freight distribution.

A thorough SWOT analysis evaluates the strengths, weaknesses, opportunities and threats of cargo hitching. Strengths include the extended reach of services to less densely populated areas, improved sustainability, and enhanced financial viability. Weaknesses involve scheduling complexities due to limited frequency of service, increased operational costs over longer distances, seasonal demand fluctuations, and security risks associated with unsupervised goods. Opportunities encompass collaborations with rural development agencies, adoption of advanced ICT technologies, innovative last-mile delivery solutions like cargo bikes and e-trucks, increased service frequency, and flexible delivery models through integration with demand-responsive transport systems. Threats highlight infrastructure limitations in remote areas, regulatory challenges, competition from traditional delivery methods, consumer expectations for fast and reliable service and the need for public-private collaboration to ensure sufficient cargo volume and service viability, as well as to cover the funding gap that often hamper the implementation of real-life trials.

Moreover, the study provides practical recommendations for stakeholders, policymakers and practitioners interested in adopting cargo hitching with relation to important aspects to be considered when developing a business model for a cargo hitching service, which includes strategic collaboration among stakeholders to clearly determine their specific responsibilities, including consolidation of parcels and handling of customers' requests. In addition, the outcomes of the analysis carried out allowed to draft a guiding questionnaire to be considered as a tool for the self-assessment of the desirability of a cargo hitching service in a specific area, thus further emphasizing which are the factors that might determine its potential success.

Cargo hitching offers significant potential to transform transport systems by creating more efficient, sustainable and integrated services. By addressing logistical and environmental challenges, it can enhance mobility and accessibility in various regions, particularly those underserved by traditional transport services.

In conclusion, this study serves as a valuable resource for understanding the cargo hitching concept and provides actionable insights for its practical implementation, aiming to facilitate the development of transport systems that are more resilient, inclusive, and environmentally friendly.

# 3. Introduction

## 3.1. Aim of the document and methodology

This deliverable is aimed at providing an overview and possible applications/implementations of the cargo hitching concept, which has been recognized by the scientific literature as one of the most promising and innovative solutions to improve mobility in urban, suburban areas (i.e. the contexts GRETA project is focusing on) and also rural ones.

Essentially, it corresponds to an innovative approach consisting in synergically sharing not only infrastructures but also conveyances (i.e. vehicles) between passengers and freight transport, in order to optimise resources and enhance the efficiency of services, including their level of sustainability.

To achieve the objectives of this document, the **methodology** employed was mainly based on two key components:

- Desk research on scientific and non-scientific literature;
- Case study research and analysis.

An extensive desk research was conducted to gather and review existing scientific literature, with a focus on relevant journal articles and papers. This provided a foundational understanding of the current state of cargo hitching, its theoretical underpinnings, and practical implementations. Non-scientific sources, such as industry news and online articles, were also reviewed to capture a broader spectrum of perspectives.

Furthermore, a detailed examination of existing case studies where cargo hitching has been implemented was performed. This involved identifying the main projects and initiatives worldwide that exemplify the concept. Each case study was analyzed to gather its main features, in order to derive specific insights and aspects that helped in drawing elements to be considered in the following SWOT analysis.

On the basis of the insights derived from the elements gathered, a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis was conducted to evaluate the cargo hitching concept from multiple dimensions, including on the basis of the different typologies of potential cargo hitching services.

Moreover, some practical recommendations aimed at stakeholders, policymakers and practitioners interested in adopting the cargo hitching concept were formulated, with the aim of facilitating potential implementation of cargo hitching initiatives to enhance the synergistic sharing of infrastructure and vehicles to create more efficient, sustainable, and integrated transport systems.

More in details, the document is structured as follows:

⇒ After a brief introduction to the theme (chapter 3.1), the following section provides an overview of the cargo hitching concept by introducing its main technical elements (chapter 3.2) and deriving a potential categorization of cargo hitching services (chapter 3.3).

⇒ Then, a total of 15 case studies are briefly presented in chapter 4.1 (all information on the 15 case studies are then provided in the Annex I), which is followed by an in-depth presentation of a specific case study (the Millingen aan de Rijn Trial).

⇒ Taking stock of main technical elements and best practices, chapter 5 offers a SWOT analysis of cargo hitching services, highlighting the advantages and disadvantages of each of the three different typologies presented in the previous sections.

⇒ Chapter 6 wraps up the document by presenting some practical suggestions on the cargo hitching business model as well as two a tool for the self-assessment aimed at entities interested in developing a cargo hitching service in order to evaluate its potential desirability.

⇒ Finally, the main conclusions are drawn.

## 3.2. Cargo hitching as an innovative solution for logistics

Both urban and suburban transportation systems are grappling with a multitude of shared emerging problems. Urbanization trends, the shift to e-commerce and the increasing fragmentation of freight transport all have negative impacts on congestion, safety, environment and quality of life in general.

The surge of e-commerce sales, which has been further accelerated by the Covid-19 pandemic, has resulted in more goods being delivered directly to consumers' homes, implying that many small deliveries to geographically dispersed locations are carried out daily. This further reduces the opportunities for consolidation and exacerbates the negative externalities of the last mile logistics operations, especially in urban areas where public space is limited and congestion higher.

At the same time, while cities are growing due to the rise of urbanization that further intensifies challenges related to pollution and congestion, suburban and rural areas are facing, since decades, the phenomenon of depopulation. Such decreasing densities, on the other hand, affects the efficiency of passengers' transport services that face increasing spare capacity and significant anti-economical operations, often leading to a limited offer or no offer at all and, therefore, in transport-related social exclusion. Similarly, freight transport in suburban areas suffer from a limited and fragmented demand that might hinder the frequency of services, thus worsening the situation of isolation of such territories.

Despite the urgency of such problems, there is a general tendency of stakeholders, actors and authorities to often address congestion, lack of space, noise and other transport-related problems in passenger and freight transport in an uncoordinated manner, which may have negative effects on overall mobility and social costs. For instance, a common policy introduced by authorities responsible for urban spaces planning concerns access restriction schemes which prevent certain categories of vehicles from entering sensitive areas, especially the crowded city centers. However, both urban and suburban areas require integrated and effective solutions for an efficient and sustainable transport of people and goods in the short and medium-haul operations.

The European Commission, recognizing this challenge, called for a new approach in its 2007 "*Green Paper on Urban Mobility*", in which it states "*Urban freight distribution could be better integrated within local policy-making and institutional settings. Public passenger transport is usually supervised by the competent administrative body while freight transport distribution is normally a task for the private sector. Local authorities need to consider all urban logistics related to passenger and freight transport together as a single logistics system*" (European Commission, 2007). Therefore, the document emphasized the need for a single logistics system, thus overcoming the traditional separation that still stands between passenger and goods transportation at urban and peripheral level that are usually planned and executed separately.

In recent years, *Sustainable Urban Logistics Plans* (SULP) and *Sustainable Urban Mobility Plans* (SUMP) have emerged as essential tools for planning and managing mobility and transport at the urban and local level. These plans are designed to promote a holistic approach to urban transportation, therefore combining various modes and ensuring the efficient movement of both people and goods in an integrated system.

These integrated systems come in various forms, with several names, including co-modality, freight on transit (FOT), combined transport, integration of passenger and freight transport (IPFT) and cargo hitching (CH). Despite the fact that there is no univocal approach to refer to this practice, the core idea, however, is simple: jointly utilize resources more efficiently by sharing the same vehicle (either private or public) or infrastructure (such as, for instance, light rail infrastructure, platforms and bus stops) for both passengers and goods.

By leveraging the spare capacity of vehicles such as buses, trams and boats, cargo hitching aims to optimize transportation resources, reduce costs and increase efficiency in goods delivery, thus maximizing the utility of transport networks. Moreover, this approach is supposed to promote sustainable, efficient and socially desirable passengers and goods mobility in both dense cities and the shrinking suburban and rural areas that surrounds them.

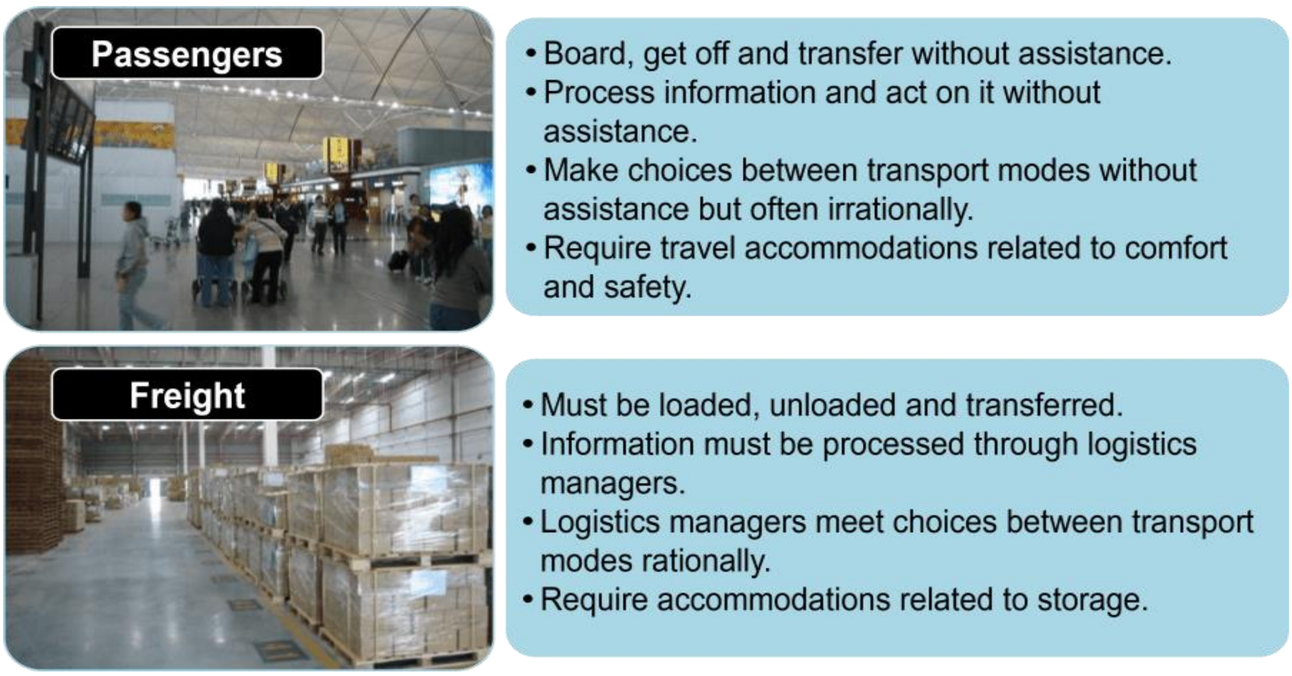
However, while the vision proposed by the European Commission in 2007 has initiated a new branch of research into integrated people-and-goods transportation systems, with a peak observed especially in the last five years when the number of papers and scientific articles on this topic has increased, it must be recognized that this concept isn't entirely new.

Long-distance travel offers several established examples of co-transport, from airplanes with belly-freight compartments that utilize space beneath passenger seating, to ships, which have historically carried both passengers and cargo, and even horse-drawn coaches of the past that combined mail, passengers and small packages. Another example is represented by the steam trains that transported both workers and the extracted coal on their way to and from the mines.

Therefore, while this solution was the norm in the past, the growing fragmentation of different demands that the transport industry had to face starting in the 1900s resulted also in the increasing segmentation and specialization of transport services – both related to freight and passengers – of these days, also due to the introduction of new logistic concepts, such as just-in-time deliveries, that depend on time, reliability and speed.

In particular, as regards to specialization, it corresponds to a common pattern that has characterized technological progress and favored economic development due to the related increases in efficiency of solutions progressively adopted over the years. Often, this implied tailoring them more and more to specific needs. In the case of transport, the peculiar and different characteristics between passenger and freight are apparent/evident. In this regard, relevant operational differences can be easily outlined (see the following figure 1). Among other things, they are related to the fact that *"while each passenger is an independent decision-making unit, each freight load must be managed from its origin to its destination, which is the purpose of logistics"* (Rodrigue, 2024).

*Figure 1. Operational differences between passengers and freight transportation*




*Source: Rodrigue, 2024*

These differences provide a key rationale for the current state-of-play, where the two categories usually move through separate conveyances (i.e. vehicles) and, in certain cases, on distinct networks. In particular, this applies to the nodes, where the higher need for specific operations and procedures to be carried out, leads to separated terminal locations.

Moreover, normative and regulatory systems, which consider logistics and passenger transport as distinct entities, have also hampered the success of wide-scale, real-life implementations of integrated passenger-freight mobility systems that are beyond pilot projects and testing, which must be accompanied by consistent policy and coherent planning.

Nonetheless, a renewed interest in cargo hitching has been recently driven by different factors, including the compelling sustainability targets that have recently been introduced at European level and that require profound changes to the current transport system, which is currently the one of the main sources of $CO_2$ emissions at EU level.

At the same time, advancements in technology and digitalization, particularly ICT tools have also supported this surge, as these facilitate real-time tracking, route optimization, fleet management and seamless coordination between passenger and freight services, thus allowing to unlock their full potential and present cargo hitching as a viable solution for various logistical needs.

As written above, this is clearly in line with the awareness of dealing with limited resources and minimizing impacts, which is foundational in the concept of sustainable development increasingly advocated in the recent decades. Furthermore, this complies to the increasingly widespread resource sharing approach (usually labelled as sharing economy), which is fostering not only sharing single resources but also adopting collaborative approaches. In this regard, different examples belonging to different fields and economic activities can be mentioned (e.g. Uber, Blablacar and Airbnb) In the case of freight transport, this leads to the development of the collaborative logistics approach, which aims to unlock and exploit potential synergies between different actors in the supply chain. For this purpose, the word "collaboration" (instead of the more generic "cooperation") is meant here to signify such a higher degree of commitment and interrelationship implying a particular coordination and organizational effort between different actors.

Nonetheless, as underlined by the literature, at present a limited number of case studies that applied the cargo hitching solution at the urban and suburban level is available – the main ones being presented in chapter 4; however, the majority represents pilot test experiences – no longer operative – mainly related to the tram mode, thus covering a range of diverse situation of application and aims that is pretty limited.

Indeed, significant hurdles remain to apply this concept, as most studies[1] so far have been explorative, either qualitative or quantitative research related to operational efficiency, as well as the analysis of performance through the adoption of KPIs; a comprehensive theoretical framework is still missing, as demonstrated – as already mentioned – by the several names that are currently used to indicate this concept.

Nonetheless, the key technical elements that must be considered to provide an overview of cargo hitching and its several potential applications are presented in the next paragraph.

### 3.2.1. Cargo hitching: main technical elements

To sum up, cargo hitching is "*the combination of passengers and goods transport flows so to increase efficiency and efficacy of operations in both central and peripherical areas*" and its main objective is "*to design integrated people and freight synchromodal transportation networks and related planning and scheduling policies to enable efficient and reliable delivery of each parcel and retail delivery*" (Bruzzone, 2019).

Designing a cargo hitching service involves establishing some basic principles, particularly regarding how goods and passengers (or passengers' transport infrastructure) will coexist in a new enhanced network. As

[1] For an all-encompassing review of the available scientific literature on the topic of cargo hitching, please see, among others, Cavallaro & Nocera, 2021; Cheng et al., 2023.

underlined in the literature, the main element of differentiation concerns the mode of operation, which specifies the elements involved in the passenger-freight integration.

Another important element is related to the means of transport involved, as well as the territorial scale on which the service operates, including the average distance covered, which also determines its main purpose.

At the same time, the nature of a cargo hitching service is highly dependent on the typology and number of available points of origin and destination assigned for freight, which may be multiple or unique.

Indeed, the implementation of the cargo hitching concept implies a complete change of the operational and business model of the transport service, including the way scheduling works, the fare system, the whole pickup, transfer and delivery process, as well as physical changes to assets (both vehicles and infrastructure).

The following table provides an overview of the criteria of differentiation and main technical elements that have been cited above.

*Table 1. Criteria to be considered for the categorization of a cargo hitching service*

| n. | Criterium | Category 1 | Category 2 | Category 3 |
|---|---|---|---|---|
| 1 | **SHARED COMPONENT** | **Shared Vehicle** (SV) | **Shared Infrastructure** (SI) | |
| 2 | **MEANS OF TRANSPORT**[2] | **Bus** (urban or medium and long-distance) | **Light Rail Vehicles** (Tram, Subway) | **Boats and Vessels** (urban or medium and long-distance) |
| 3 | **TYPOLOGY OF SERVICE OPERATOR** | **Public** operator | **Private** operator | **Public-private** partnership (e.g. consortium of multiple actors) |
| 4 | **TERRITORIAL SCALE** | **Urban** area | **Non-urban** area (peri-urban, suburban, rural) | |
| 5 | **MAIN PURPOSE** | **Industrial logistics** | **Urban freight distribution** | **Non-urban freight distribution** |
| 6 | **FREIGHT DESTINATION POINT(S)** | **Single load and unload point** (e.g. Urban Consolidation Centers, Micro-hubs, Specific location) | **Multiple load and unload points** along the route | **Almost door-to-door** delivery |

*Source: own elaboration*

The categories underlined in the table are presented in more detail below.

[2] These are the main vehicles that are cited in the literature and have been tested through practical pilot services. However, a limited number of papers are also dedicated to taxi and autonomous vehicles.

- **Shared component**

The core distinction in cargo hitching lies in the shared component. The first option is represented by the shared vehicles (SV) can be employed, where passenger vehicles simultaneously carry cargo along passengers, either in dedicated compartments (such as a freight wagon behind a passenger vehicle) or shared spaces[3].

Alternatively, shared infrastructure (SI) category, where both passengers and freight travel on or utilize the same physical infrastructure, such as railway lines or stations. In this case, freight is usually transported in dedicated units entirely devoted to this purpose.

However, these approaches aren't mutually exclusive, as a hybrid combination of SI and SV could also be implemented for optimal efficiency.

- **Means of transport**

The means of transport involved in the cargo hitching service is another crucial element. Vehicles such as buses and trams can carry small to medium-sized packages by leveraging their extensive urban networks and variable spare capacity, which is higher during off-peak hours. The freight can be stored either in dedicated trams (SI modality) or specific sections of the vehicle (SV modality), such as the luggage compartment of a bus or a dedicated goods compartment in a tram, or even in a separate unit.

The majority of the case studies and pilots that have been implemented so far have made use of these two means of transport, whose main difference is the flexibility of routes and schedules, which is lower for tram services. On the other hand, the metro system has rarely been considered due to its infrastructural barriers and the high cost of retrofitting metro stations to handle goods; despite this, a few pilot projects of cargo hitching utilizing the subway system have been implemented in Sapporo, Japan, to deliver small parcels and in New York, where garbage has been collected through dedicated subway carriages circulating on the public transit system during the night hours.

Moreover, boats and vessels could be particularly useful in cities with waterways, as they can transport goods alongside passengers; however, the feasibility of this option has only been explored for the Venice Lagoon area (Mazzarino & Rubini, 2019) in the framework of the Horizon 2020 NOVELOG project but has never been tested through practical pilot projects.

Other innovative solutions have also been tested through EU-funded projects, such as the Horizon 2020 ULaaDS project in which a small autonomous electric vehicle run for 2 months in the Belgian city of Mechelen combining passengers transport and small parcels deliveries in the city center.

The most appropriate mean of transport for a specific cargo hitching service has to be determined on the basis of several factors, including amongst others the available transport infrastructure, the goods volume and dimensions, the time-sensitivity of freight, the presence of available urban consolidation centers or micro-hubs along the route, and so on.

- **Typology of service operator**

The typology of operator who implements the service can vary. Public transport systems can be leveraged for cargo hitching, enhancing the utility of these networks and making use of their residual capacity. This is often the case of bus and tram, including their physical infrastructures, that are operated by government agencies or local/regional public transportation authorities.

At the same time, private operators such as transport companies can also introduce cargo hitching services, thus exploiting additional revenue streams and enhancing the efficiency of their operations, as in the case

[3] Some authors have identified a third form of integration that concerns the use of selected node of the network that combines passenger and freight functionalities. However, this can be considered as a sub-branch of the shared infrastructure (SI) category.

of bus lines that cover medium and distances across suburban and rural areas and transport both passengers and freight.

Moreover, public-private partnerships can combine the strengths of both sectors to provide comprehensive cargo hitching solutions to address specific needs of private companies and entities, or even public equivalent bodies.

- **Territorial scale**

Territorial scale is an important factor as well to outline a cargo hitching service's structure and objective. As a matter of fact, cargo hitching in urban areas is ideal for facilitating quick and flexible deliveries within city limits, thus being, according to the literature, the most studied and reviewed configuration among scholars and even in pilot projects and case studies. The urban scale implies, therefore, services covering a rather short distance, being focused on the more densely populated areas where freight transport is subject to constraints deriving from congestion, higher polluting emissions' levels, noise pollution and lack of public space.

However, non-urban (peri-urban, suburban, and rural) areas can also benefit from the concept of cargo hitching, particularly when it adopts a SV configuration to deliver parcels over medium and long distances, thus enhancing the efficiency of existing passengers' transport services. This modality is still in the background in the literature but could play a promising role in the near future.

Even in this case, these approaches aren't mutually exclusive; however, it would be extremely difficult to design and operate a cargo hitching service that would serve both territorial scales, with their advantages and constraints, through a single service.

- **Main purpose**

The main purpose of cargo hitching services is strictly intertwined with the territorial scale it operates in, as it can range from industrial logistics to urban freight distribution and freight distribution in non-urban areas. While the latter tackles the suburban and rural territorial level, the first two categories rather pertain to the urban landscape.

Industrial logistics typically involves the transportation over short and medium distances of goods consolidated in specific containers, commercial packages, or even industrial products such as raw materials and assembly parts, as well as waste materials. This service, which often takes the form of a freight tram making use of the tramway (SI category), may represent only a segment of a long-haul freight transport operation. It usually addresses a specific need of a private or public company to deliver and collect freight and materials in a distinct site within the city centres, whose location would hamper the use of more traditional means of transport such as commercial trucks.

On the other hand, urban freight distribution concerns the more conventional city logistics, which is devoted to the first and last mile transportation of goods and small parcels in the urban area by using public or private transport networks. In this case, the service might be directed at both individual citizens, companies and businesses whose needs are sporadic or, in any case, not as structured to justify a fully-fledged industrial logistics service.

The same logic is applied to non-urban freight distribution, which also tackle the first and last mile delivery to private individuals and businesses of small parcels, whose origin and/or final destination points are located in suburban and rural areas. This model can also benefit from the demand-responsive transport concept, in order to enhance the service's efficiency by making it more flexible and adaptable to the specific needs of its recipients.

- **Freight destination point(s)**

Finally, the destination points for freight in a cargo hitching system can vary. Goods can be delivered to a single point of unload, such as warehouses, urban consolidation and distribution centres (UCC) or micro-hubs, where parcels are prepared to be delivered to their final destination. This is the case of conventional public transport, whose fixed routes prevent the possibility to provide door-to-door services; in this case, all goods and parcels are unloaded at UCC or micro-hubs, where they are transhipped to support vehicles, such as small electric vehicles or cargo bikes, that are typically used for last-mile deliveries within the more densely populated urban center. In addition, supportive vehicles can also be used to perform the first mile delivery from a UCC or micro-hub to tram and bus stations, where freight is loaded – thus with a single origin point – to continue its journey through the urban center via the public transport network to its final destination, where they are either delivered to customers or to another UCC. The industrial logistics is also based on this concept, as it often caters to the need of a single entity who designs the service in order to receive freight and materials to a specific destination, which is often located in the urban area.

On the other hand, a cargo hitching service may also foresee multiple load and unload points along its given route, rather than a single destination. At these locations, freight can either leave or enter the vehicles, being dropped off and/or collected to the final client, which is either an individual or a private business, or by a different logistics operator who is in charge of the first and last mile. In addition, this model might also be operated through the implementation of multiple UCC or micro-hubs along the transport route, in order to offer a wider variety of load and unload points. The unload points could also correspond to simple lockers, which could easily be reached by customers while travelling through the transport network.

Lastly, the cargo hitching service could be designed in a way to provide almost door-to-door deliveries at the sender and recipients' locations, offering enhanced convenience. This would involve picking up parcels at a specific destination and delivering them to their point of arrival, catering to the needs of individuals and businesses. This model is certainly more suitable for non-urban areas, where the transport services' route might be more flexible and adaptable to customers' demands, especially in conjunction with a service of demand-responsive transport on a short and medium haul.

In all the possible configurations that a cargo hitching service may adopt, an important role is played by innovative IT tools and ICT technologies, which represent an essential element to support the development and implementation of integrated IT passenger and freight transport systems. As a matter of fact, such technologies are crucial, among others, to:

- Enable a seamless collection and exchange of data between these systems, which are also necessary in the preparatory phase to ensure a proper planning of the route, capacity and structure of the service;
- Manage and streamline the service and information to all users, including both passengers and clients or businesses that make use of the freight-related side of the service who may require a real-time tracking to follow their parcels;
- Enhance the necessary cybersecurity protections in order to safeguard sensitive information while enabling data sharing and analysis.

On the topic of ICT technologies for cargo hitching, an innovative project named LogIKTram[4] has been developed by a public-private consortium in Karlsruhe, Germany, thanks to the funds made available by the Federal Ministry for Economic Affairs and Climate Action. The aim is to promote the development of a logistics concept as well as an information and communication technology (ICT) platform for a future freight transport system in streetcar and light rail vehicles to be implemented in the Karlsruhe region, supplying both companies and households with short and medium-haul deliveries. LogIKTram is part of the overall

[4] More information on this project is available at the following weblink: https://logiktram.de/en/logiktram-the-freight-tram/

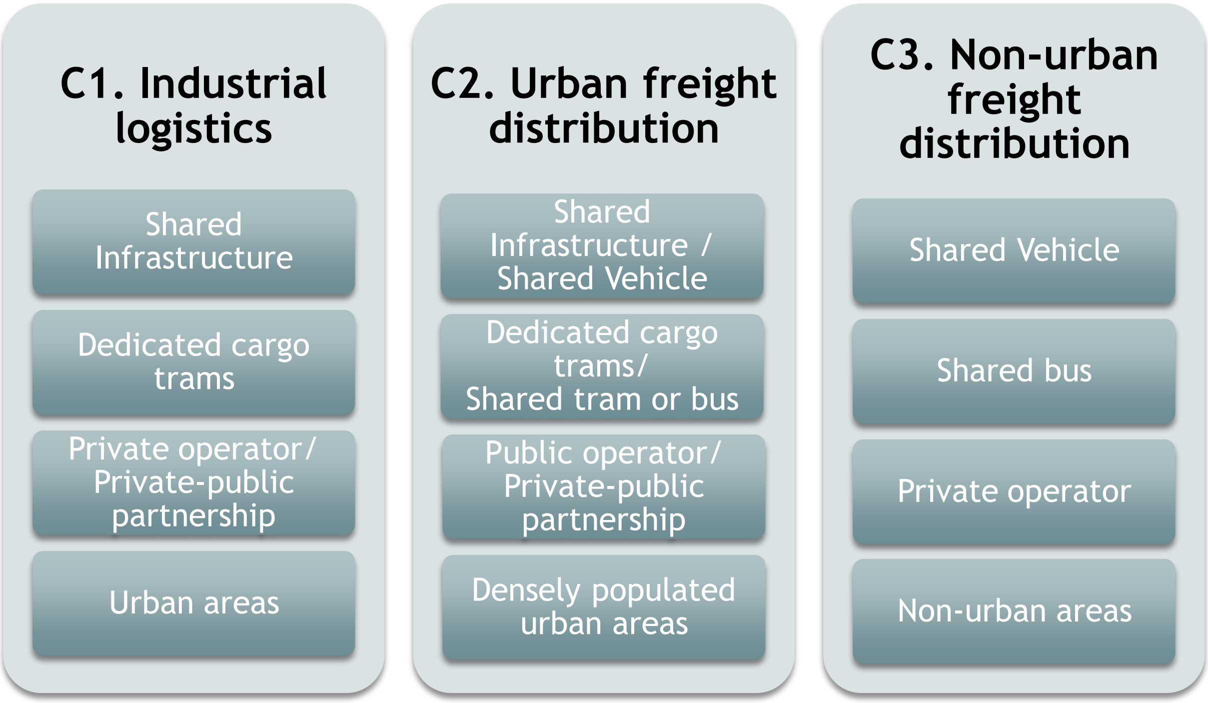
regioKArgo initiative, whose partners want to research and implement new forms of cross-modal goods loading and delivery transport.

### 3.2.2. Cargo hitching: main typologies

The technical elements that have been described so far allows to delineate three main general typologies of cargo hitching services, which are actually in line with the potential main purposes that have been presented above and the case studies that will be outlined in chapter 4.

These three categories and their main features are presented in the figure below.

*Figure 2. Main typologies of cargo hitching systems*



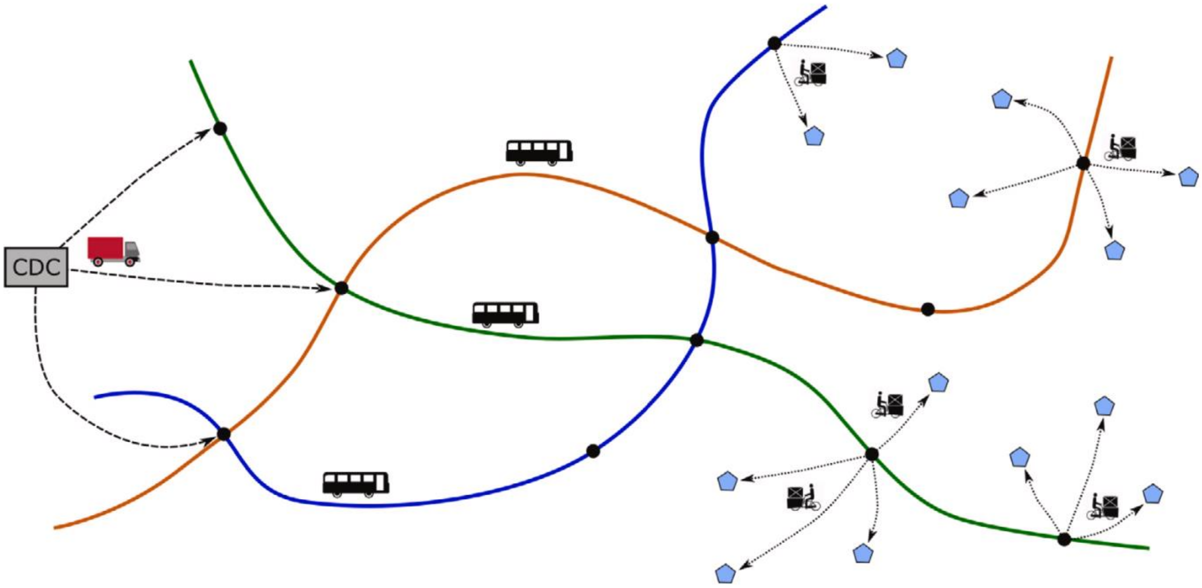

*Source: own elaboration*

The first typology (C1) concerns an **industrial logistics cargo hitching** service for a private company or through a private-public partnership, which often make use of cargo trams (SI category) using the public transit infrastructure within the urban area, where ”conventional” means of transport would aggravate the existing problems of congestion and pollution. Generally, there are no direct interactions with passengers, as goods and materials are moved on dedicated freight vehicles that run in parallel to passengers’ transport schedule. This typology of cargo hitching often foresees specific load and unload points, which may correspond to a warehouse or a factory from which the tram handles both supply and disposal, in line with the needs of the promoting entity.

The second category (C2) has to do with the **urban freight distribution** within densely populated areas, which typically covers the first and last mile logistics of small and medium parcels and goods deliveries. It can either be implemented as SI or SV service, operated in parallel to the passenger service and on the same trains and/or buses. Goods may be located alongside passengers, in separate cargo areas, or in trailers attached to the vehicle. The service can be structured as having a single load and unload point such as central distribution centres and micro-hubs, even though a variety of them is a more common option.

For instance, a viable model could foresee the operation of lockers at the main bus and tram stops. Then, depending on the structure of the service, the very last mile of deliveries can be carried out through ancillary sustainable vehicles, such as e-trucks and cargo bikes, as represented in the figure below.

*Figure 3. Illustrative example of cargo hitching applied to an urban freight distribution system*




*Source: Delle Donne et al., 2023*

Last but not least, the **non-urban freight distribution** (C3) represents the third category. This kind of service generally covers medium and long-haul journeys in suburban and rural areas and collects and delivers parcels at multiple locations that are widely distributed, thus almost providing a door-to-door service. This kind of service is often (but not exclusively) implemented by private companies that already operate in the passengers' transport business and have buses that cover existing long-distance transit routes connecting regional centres and rural area. Freight utilises the available space on passenger vehicles, such as the luggage compartment or a dedicated goods compartment of a bus. Small and medium parcels are, then, delivered either to unload points (e.g., lockers located at the main stops) or directly to their final recipients at the bus stops along the line.

This typology could also be adapted into an innovative and flexible paradigm that foresees a fully-fledged demand-responsive transport service, which would be ideal to cater to the need of contexts with a low density of people – both of travellers, consumers and citizens – and therefore of demand. As a matter of fact, such contexts typically lack a significant critical mass to justify a conventional transport service, which would not be financially sustainable. In this case, the combination of passengers and occasional deliveries of small parcels to users and small businesses could provide an additional stream of revenues, thus making the service more viable from the economic point of view.

In this purpose, an innovative concept presented in the literature is represented by a bus-pooling service implemented at a railway station, where demand-responsive buses pick up passengers and parcels and deliver them to their destinations. Parcels with similar itineraries and departure times to passengers were matched and inserted into bus routes following the shortest road route (Peng et al., 2021).

This model is mostly significant in relation to the increasing volume of e-commerce purchases, which result in a stream of deliveries that is fragmented and unsystematic, especially in non-urban areas. In this framework, synergies between the concept of cargo hitching and demand-responsive transport take on a renewed importance and meaning.

In any case, as mentioned above, an important driver is ICT technology to manage and make efficient the service and information to users, which in the case of both demand-responsive transport and e-commerce take on an active and interactive role, with the related need for real time updates and routing strategies to accommodate the transport of both passengers and goods.

Ultimately, which of these types of cargo hitching transport is appropriate for which transport flow depends on multiple factors, including amongst others the available transport infrastructure, the existing spare capacity of already operated services, the goods volume and final destination, the time-sensitivity of goods to be transported, the availability of consolidation centres or micro-hub in urban areas to serve as load and unload points for freight, and so on.

In chapter 4, a list of relevant cargo hitching case studies and pilot projects is presented to provide an overview of what has been already implemented and which elements contributed to either its success or failure.

## 3.3. Evidence from the territorial needs assessment in GRETA's FUAs

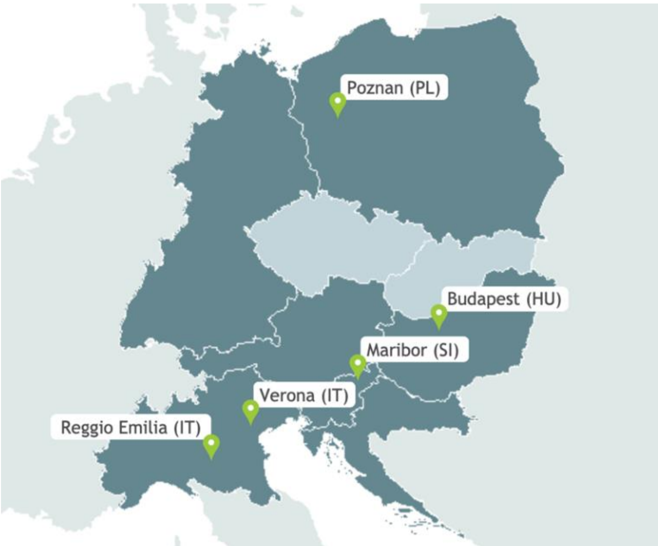
*Functional Urban Areas (FUAs)* are geographic areas characterized by strong economic, social, and functional interconnections, involving cities and their surrounding hinterlands, often beyond the administrative boundaries of a single municipality. They serve as important hubs with high population density, mixed land use, and a high level of commuting. This makes them particularly challenging to plan for mobility, as it requires coordination between multiple municipalities and transportation authorities.

In the framework of the GRETA project, a FUA consists of a densely inhabited city (a core area) and a less densely populated commuting zone whose labour market is highly integrated with the city.

More in particular, GRETA FUAs are located in:

1. Budapest (Hungary)
2. Maribor (Slovenia)
3. Poznan (Poland)
4. Reggio Emilia (Italy)
5. Verona (Italy

*Figure 4. Map of GRETA FUAs*




*Source: GRETA project - 2nd newsletter*

For each of these, several parameters and KPIs are being collected in the framework of a dedicated deliverable (*D1.2.2 Territorial needs and gaps carried out in all the GRETA FUAs)* to understand the needs, gaps and initiatives implemented by FUAs in freight transport.

From a preliminary assessment of data[5], it emerged that, despite their geographical differences, all five GRETA FUAs face two primary challenges: high car dependency and excessive transport emissions. Over-reliance on cars exacerbates congestion and increases emissions, while pollution and noise from transport

[5] More information will be available in Deliverable *D1.2.2 Territorial needs and gaps carried out in all the GRETA FUAs*, which is currently under preparation as data collection is still ongoing.

activities significantly impact urban life quality and environmental sustainability. In addition, the FUAs exhibit common issues such as congestion in urban centres and a lack of efficient, integrated transport services that cater to both passengers and freight, hindering optimal mobility solutions.

To address these challenges, FUAs have outlined various investments and strategies that are being either implemented or evaluated for future implementation, which are resumed in the table below.

*Table 2. Overview of transport measures and investments either implemented or planned by GRETA FUAs*

| Investments finished in the last 3 years | Investments currently in progress | Investments planned |
|---|---|---|
| - Transport infrastructure renovation/construction<br>- Public transport investments (infrastructure, rolling stock)<br>- Restricted zones<br>- Mobility applications<br>- Bike sharing service<br>- E-vehicles in public transport<br>- Park&Ride parking<br>- SUMP<br>- Public awareness | - Transport infrastructure renovation/construction<br>- Public transport investments (infrastructure, rolling stock)<br>- Micro mobility network<br>- Micro consolidation centres<br>- SULP, metropolitan SUMP, FUA public transport and bicycle plan<br>- Investment into cycling (bicycle lanes/highways, stations, racks, incentives, bike sharing) | - Parking regulations, parking plan<br>- Public transport investments (infrastructure, rolling stock)<br>- Universal parcel locker network<br>- Micro consolidation centres<br>- Micro mobility network<br>- Restricted zones (emissions)<br>- Safety (speed monitoring) |

*Source: own elaboration on the basis of the data provided by GRETA FUAs*

Indeed, many of these investments actually support the implementation of the cargo hitching concept. For instance, the establishment of micro consolidation centers and universal parcel locker networks provides essential infrastructure for cargo hitching by enabling the aggregation and efficient distribution of freight. Investments in public transport systems, including infrastructure and rolling stock, can be adapted to accommodate cargo hitching, either through minor modifications or by designing dual-purpose vehicles that transport both passengers and freight. Additionally, improvements in transport infrastructure, mobility applications and the implementation of low emission restricted zones create a conducive environment for the integration of cargo hitching into urban transport networks.

In conclusion, the strategic investments in FUAs align with and support the implementation of cargo hitching services, which can play a crucial role in addressing the common mobility challenges of congestion, emissions, and inefficient transport services. By leveraging these investments, FUAs can optimize their transport systems, making them more sustainable and efficient while enhancing the overall quality of urban life.

Given this context, the self-assessment questions proposed in chapter 6.2 can serve as a valuable tool for local and regional authorities. These questions help gauge the desirability and feasibility of implementing cargo hitching services within their jurisdictions. By adopting these self-assessment tools, authorities can perform a preliminary evaluation of the potential benefits and challenges of cargo hitching, tailored to their specific urban contexts.

# 4. Case studies and best practices of cargo hitching

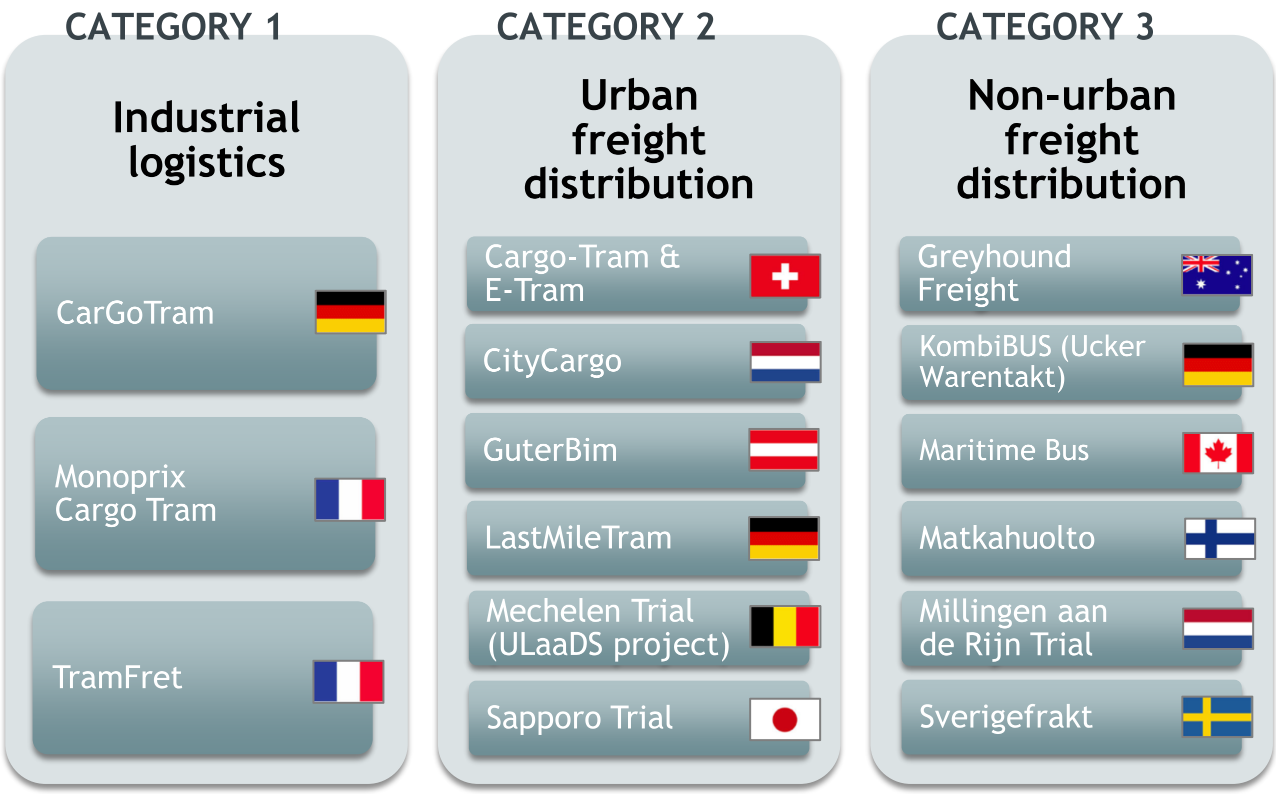
## 4.1. Main characteristics of case studies

Transportation systems across different territorial levels are incorporating more collaborative elements between passengers and freight. While numerous innovative projects have failed in practice, some continue to operate successfully. This section reviews various trials and implemented initiatives focusing on the cargo hitching concept that have been identified through literature review and desk research, for a total of 15 case studies spanning across different geographical regions and modes of transportation.

Each of these projects demonstrates different approaches and scales of application, from privately owned routes to municipal services focusing on niche markets like waste recycling and retail freight. Moreover, real-life implementation has emerged both with regards the urban centres and the less densely populated areas of suburban and rural territories.

Therefore, based on their operational focus and features, case studies have been categorized according to the three recurring typologies identified in the preceding sections (industrial logistics, urban freight distribution, and non-urban freight distribution), as represented in the figure below.

*Figure 5. Overview of collected case studies divided by category*




*Source: own elaboration*

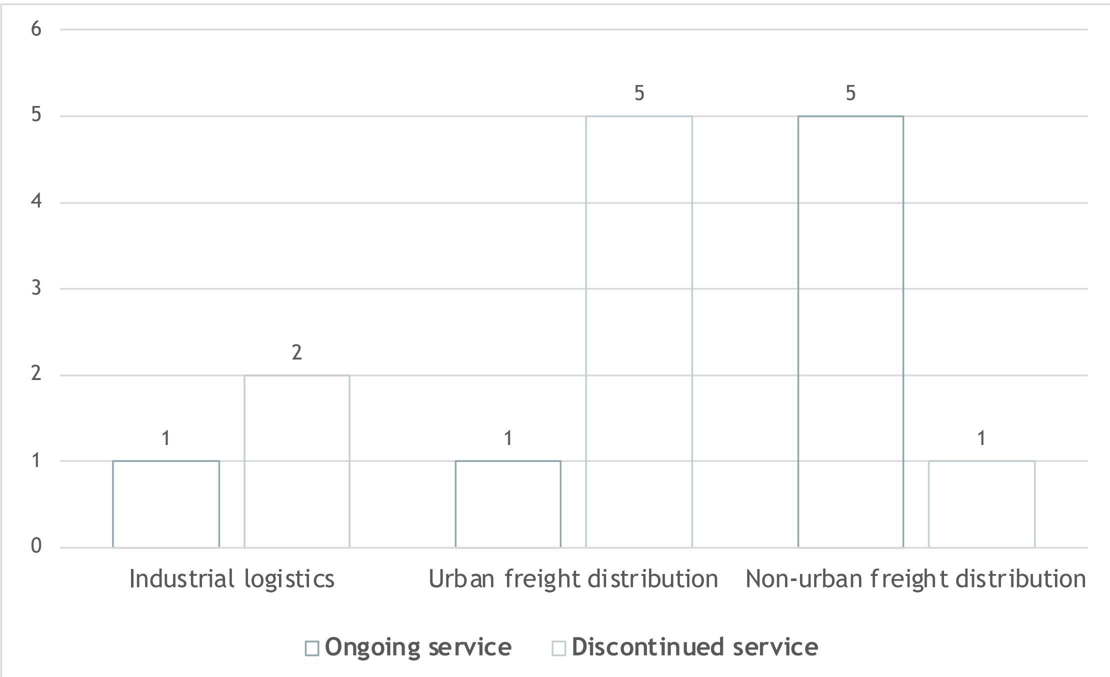
The category of industrial logistics includes freight operations primarily supporting industrial activities, such as the transport of industrial materials and waste for a specific private company or operator (SI modality). Notable examples of this typology, which is the less developed as can be seen by the number of collected case studies, include the CarGoTram in Dresden, which supplied a Volkswagen factory, the Monoprix Cargo Tram in Paris, aimed at transporting various retail goods in Paris for Monoprix, and lastly the TramFret, which – similarly to the Monoprix case – tested the transport of retail goods in Saint-Etienne.

The category of urban freight distribution encompasses freight operations within urban areas (both SV and SI modalities), aimed at optimising the last-mile delivery of goods and reducing urban congestion. Significant examples include the Cargo-Tram in Zurich dedicated to bulky and electronic waste items and other projects and trials dedicated to the delivery of small and medium parcels (operated by various logistics couriers) either through dedicated trams (CityCargo in Amsterdam, GuterBim in Vienna, LastMileTram in Frankfurt), a shared autonomous vehicle (ULaaDS project trial in Mechelen) or shared carriages of the underground transit (trial in Sapporo).

Lastly, the category of non-urban freight distribution involves freight operations connecting suburban and rural areas, typically using medium and long-distance bus passengers‘ routes by exploiting the spare capacity of the baggage compartment (SV modality). Examples of cargo hitching services that utilize buses to transport parcels across vast distances include Greyhound Freight in Australia, Matkahuolto in Finland, Maritime Bus in the Maritime provinces of Canada and Sverigefrakt in Sweden. Additionally, two case study are located in non-urban territories but rather cover short and medium-haul distances; these are the KombiBUS in the Uckermark District and the trial implemented in Millingen aan de Rijn, which will be described in detail in chapter 4.2.

The case studies identified include both ongoing and discontinued projects and trials. More in particular, the following figure depicts the distribution of case studies by their status across the three main categories of cargo hitching services.

*Figure 6. Case studies distribution by category and services‘ status*




*Source: own elaboration*

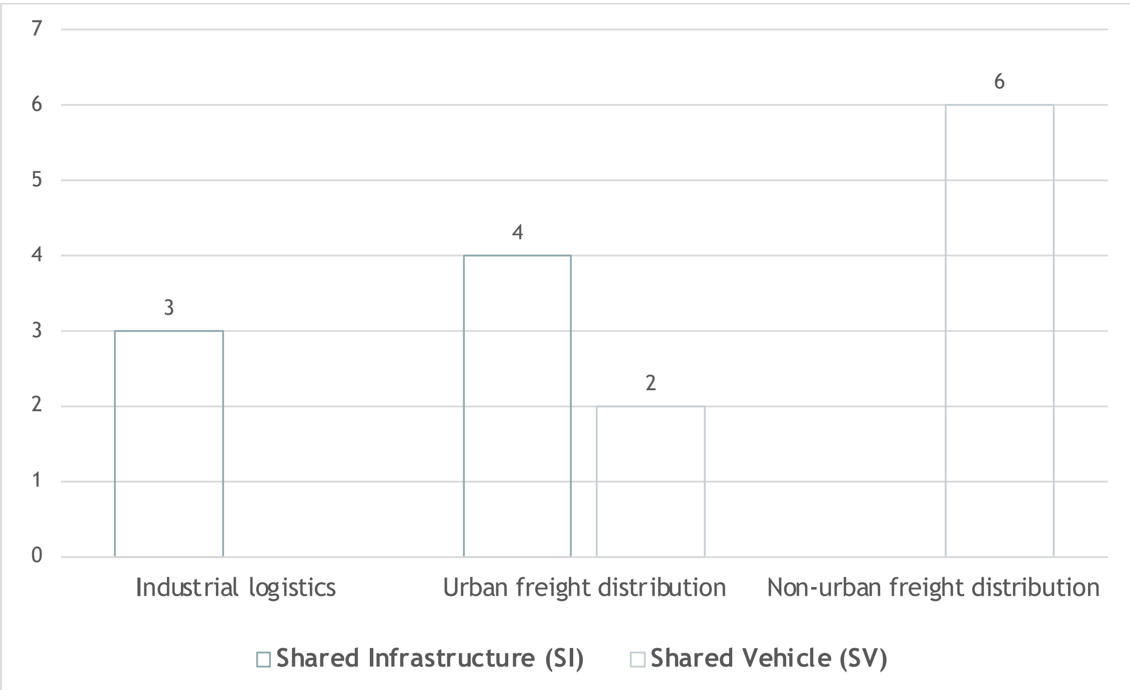
In the realm of industrial logistics, the predominance of discontinued services (two out of three) underscores significant hurdles in sustaining these projects. Despite their potential, industrial logistics initiatives often encounter substantial obstacles such as high operational costs, regulatory barriers, and limited stakeholder engagement. The lone ongoing project highlights that while there is promise, the sector requires robust frameworks and more resilient business models to overcome these challenges.

Urban freight distribution also shows a majority of discontinued services, indicating that urban logistics projects face similar, if not more complex, challenges. The urban environment presents unique difficulties such as traffic congestion, stringent regulatory frameworks, and the need for extensive stakeholder cooperation. The limited number of ongoing projects suggests that while there is enthusiasm for integrating freight transport into urban settings, successful implementation requires overcoming significant financial and operational hurdles. This category's struggle points to the need for innovative solutions that can seamlessly integrate with existing urban infrastructure and garner broader stakeholder support.

On the other hand, non-urban freight distribution stands out with a majority of ongoing services. The stark majority of ongoing services in this category, compared to the discontinued ones, points to a higher success rate for non-urban freight initiatives. The involvement of private operators in medium and long-haul passenger transport services, such as Greyhound Freight in Australia and Matkahuolto in Finland, appears to contribute significantly to this success. These private stakeholders' ability to implement paid parcel delivery services highlights the potential for financial viability and operational sustainability in non-urban contexts.

As of the shared component, an overview of the distribution of the cargo hitching case studies analysed is presented in the next figure.

*Figure 7. Case studies distribution by category and shared component*




*Source: own elaboration*

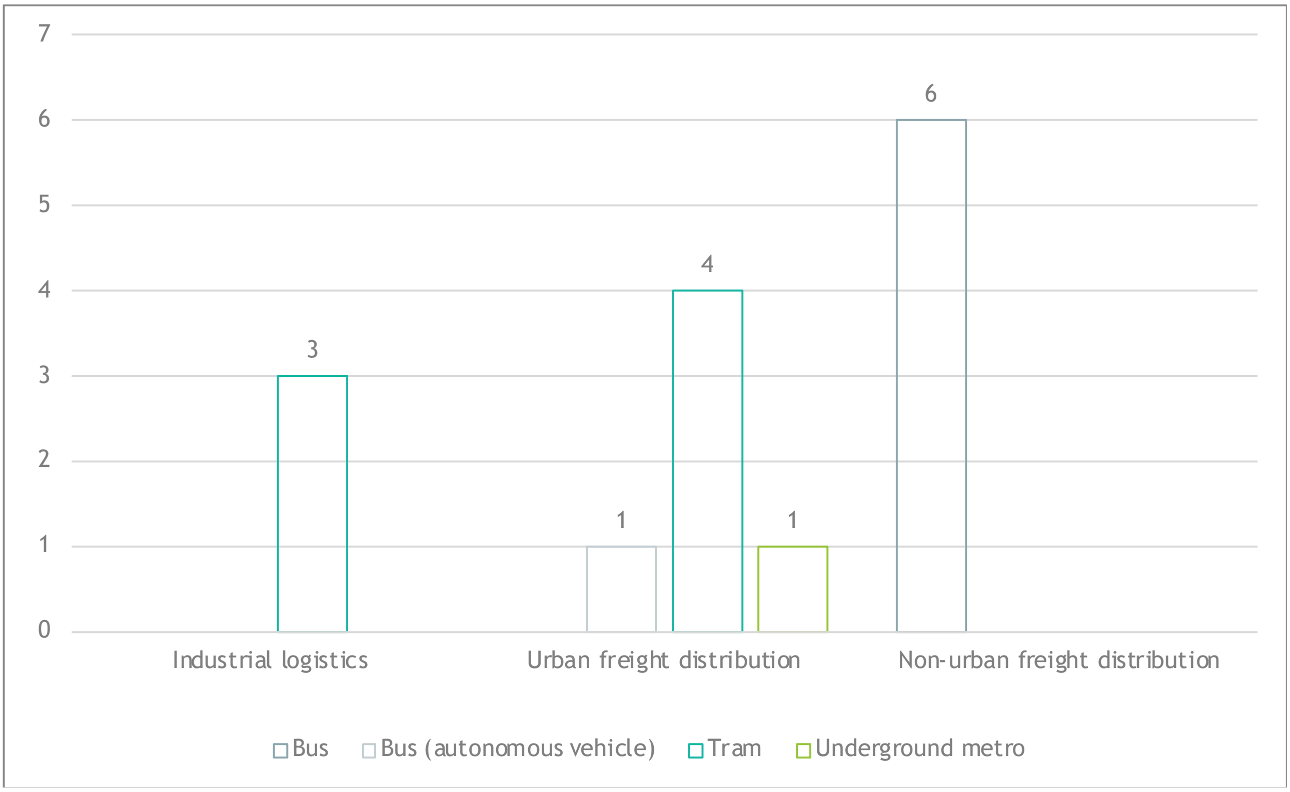
In the industrial logistics category, the use of shared infrastructure (SI) is definitely prominent, with 3 case studies implementing this approach. The reliance on shared infrastructure underscores the need for robust, dedicated systems to support continuous freight operations, whose need of frequency and space are not often compatible with a shared vehicle modality in which goods and passengers travel on the same conveyance.

Urban freight distribution exhibits a more balanced use of shared infrastructure (SI) and shared vehicle (SV) components, with 4 and 2 case studies, respectively. The mixed use of shared infrastructure and vehicles in urban freight distribution indicates that flexibility is key to addressing the dynamic nature of urban logistics. Developing adaptable and innovative solutions that can be integrated with existing passenger transport systems to address logistics needs while maintaining efficiency is crucial for the success of urban freight initiatives.

Finally, the figure underlines how, in non-urban contexts, leveraging the spare capacity of existing passenger transport vehicles (SV), such as inter-urban bus routes, proves to be a highly effective strategy, offering flexibility and cost savings, with all the case studies implementing this approach.

Last but not least, the distribution of case studies per means of transport involved is also presented below.

*Figure 8. Case studies distribution by category and means of transport*




*Source: own elaboration*

In the industrial logistics category, trams are the predominant mode of transportation, with three case studies utilizing this mode. This indicates a significant reliance on tram networks for freight operations supporting industrial activities. This might be due to several reasons, one of them being that trams operate on dedicated tracks, reducing interference with regular road traffic and ensuring timely deliveries. Moreover, trams can seamlessly integrate into urban infrastructure, facilitating efficient logistics within city environments.

On the other hand, urban freight distribution showcases a diverse utilization of transportation modes, with a notable presence of trams (four case studies) and a mix of buses (KombiBUS case study), autonomous buses (Mechelen trial), and underground metro systems (Sapporo case study). This diversity reflects the complex nature of urban logistics and the need for flexible and innovative solutions to manage first and last-mile deliveries.

Lastly, non-urban freight distribution is dominated by buses, which are highly utilized for their flexibility and cost-effectiveness in covering long distances in suburban and rural areas. The significant reliance on buses in these regions emphasizes the strategic advantage of using existing passenger transport networks for freight purposes, optimizing resource utilization, and ensuring operational sustainability.

The following table provides a comprehensive overview of the main features of the selected case studies, including the name, location, timeline, operator, and type of goods transported. Each case study is categorized according to its operational typology, showcasing the diversity and adaptability of cargo hitching solutions across different contexts.

*Table 3. Overview of case studies' main features*

| N. | NAME | CITY | COUNTRY | SHARED COMP. | TIMELINE | OPERATED BY | TYPOLOGY OF OPERATOR | MEANS OF TRANSPORT | GOODS TRANSPORTED |
|---|---|---|---|---|---|---|---|---|---|
| *INDUSTRIAL LOGISTICS* | | | | | | | | | |
| 1 | **CarGoTram** | Dresden | Germany | SI | Nov 2000-Dec 2020 | Partnership with Volkswagen | Public-private partnership | Tram | Volkswagen materials (automotive parts) and waste |
| 2 | **Monoprix Cargo Tram** | Paris | France | SI | Nov 2007-ongoing | Partnership with Monoprix | Public-private partnership | Tram | Different typologies of products for large-scale retail trade Monoprix |
| 3 | **TramFret** | Saint-Etienne | France | SI | Jun 2017-Jul 2017 | Partnership with Casino | Public-private partnership | Tram | Food products for large-scale retail trade Casino |

| URBAN FREIGHT DISTRIBUTION | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4 | **Cargo-Tram and E-Tram** | Zurich | Switzerland | SI | Apr 2003-ongoing | Partnership with Verkehrsbetriebe Zurich | Public operator | Tram | Electronic waste and large waste items |
| 5 | **CityCargo** | Amsterdam | The Netherlands | SI | Mar 2007-Apr 2007 | CityCargo Amsterdam | Private operator | Tram | Small and medium parcels to supply shops, restaurants and supermarkets |
| 6 | **GuterBim** | Wien | Austria | SI | May 2005-Jun 2007 | Partnership with Wiener Linien | Public operator | Tram | Industrial materials and goods (drivers' seats, bicycle tires, batteries, etc.) |
| 7 | **LastMileTram** | Frankfurt | Germany | SI | Oct 2018-Dec 2019 | Partnership with Hermes Germany GmbH | Public operator | Tram | Small and medium parcels |
| 8 | **Mechelen Trial (ULaaDS project)** | Mechelen | Belgium | SV | Jun 2022-Aug 2022 | Partnership with Belgian Post | Public operator | Bus (autonomous vehicle) | Postal packages and small parcels |
| 9 | **Sapporo Trial** | Sapporo | Japan | SV | Sept 2020 | Partnership with Yamato Transport Co | Public operator | Underground metro | Small and medium parcels |

| NON-URBAN FREIGHT DISTRIBUTION | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10 | **Greyhound Freight** | n.a. | Australia | SV | Jan 1985-ongoing | Greyhound Freight | Private operator | Bus | Small and medium parcels (except for prohibited items) of private individuals and commercial activities |
| 11 | **KombiBUS (Ucker Warentakt)** | Uckermark District | Germany | SV | Jan 2012-ongoing | Uckermärkische Verkehrsgesellschaft mbH | Public operator | Bus | Orders from retailers and producers consisting in small and medium parcels |
| 12 | **Maritime Bus** | n.a. | Canada | SV | Dec 2012-ongoing | Maritime Bus | Private operator | Bus | Small and medium parcels for both individuals and commercial activities |
| 13 | **Matkahuolto** | n.a. | Finland | SV | Unknown (estimated 2000s)-ongoing | Matkahuolto | Private operator | Bus | Parcels of all sizes for both individuals and commercial activities |
| 14 | **Millingen aan de Rijn Trial** | Millingen aan de Rijn | The Netherlands | SV | Mar 2017 | Partnership with Breng - Connexxion group | Public operator | Bus | Postal packages and small parcels deriving from e-commerce |
| 15 | **Sverigefrakt** | n.a. | Sweden | SV | Unknown (estimated 2000s)-ongoing | Bussgods | Private operator | Bus | Small and medium parcels for both individuals and commercial activities |

*Source: own elaboration on the basis of several sources (see bibliography)*

## 4.2. In-depth presentation of a case study: the Dutch experience and the Millingen aan de Rijn trial

The following section provides a more detailed presentation of one of the 15 case studies that have been identified as to provide a better insight and understanding of actual realisations in context which can be pertinent or at least assimilated to the key focus of the GRETA project.

In the Netherlands the development of cargo hitching was boosted by the Cargo Hitching (2012-2016) project financed at the national level by the TKI DINALOG (Dutch Institute for Advanced Logistics).

This initiative brought together different kinds of stakeholders, including universities, logistics companies, and local authorities, to design and implement this innovative approach. It encompassed both thorough theorical deepening and a real-life test. In particular, the test consisted of making use of the regular Public Transport line in a rural context for the delivery of parcels and

- **The testbed: Millingen aan de Rijn**

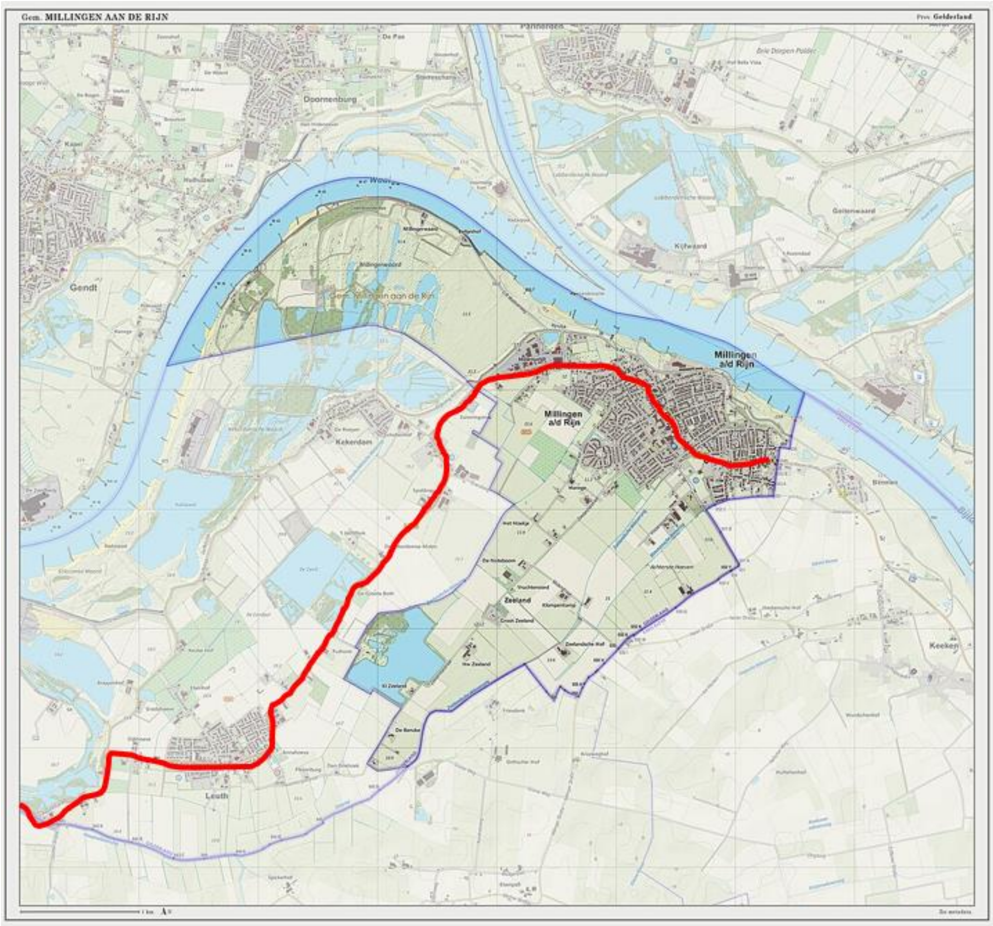
As testbed, the village of Millingen aan de Rijn (with fewer than 6,000 inhabitants) was chosen. It is located in Eastern Netherland (specifically, in the Gelderland province), approximately 17 km from the city of Nijmegen (around 170,000 inhabitants) and bordering with Germany.

*Figure 9. Millingen an de Rijn, testbed area of the cargo hitching project*


*Source: own elaboration on [Wikipedia source]*

The village is connected to Nijmegen through two public bus lines: Line 80 and Line 82. Line 80 runs every half hour throughout the day, while Line 82 operates on essentially the same route (especially within Millingen aan de Rijn) but with fewer stops and only during peak hours in the morning (06.00 - 08.30) and in the afternoon (14.45 - 18.00). However, utilization of these bus lines during off-peak hours is relatively low, and the same applies to taxis. Hence, also due to budget cuts, the local public transport company was eager to seek new opportunities to make the business more profitable.

*Figure 10. Detailed view of Millingen aan de Rijn with the route of the bus lines used for cargo hitching (in red)*




*Source: own elaboration on [Wikipedia source]*

Overall, the area is characterized as an "underserved urban municipality," with relatively low population density compared to major urban areas like the nearby Nijmegen.

- **The innovative proposal & the involved actors**

The proposed solution involved using the available space in public transport buses to deliver parcels from a main hub located near the center of Nijmegen to customers in Millingen aan de Rijn, where they are stored at a Cargo Hitching service desk. Eventually, final customers/receivers—usually, local residents and businesses—take their parcels from the depot according to predefined time windows. Additional customers can consist of carriers and shippers (e.g., DHL), looking for cost reductions deriving from the overall cooperative business model. Very last-mile deliveries (home deliveries) can also be made by cargo bike.

A pilot service was carried out starting in March 2017, thanks to the commitment of various actors described in the following table, encompassing both public passenger and freight transport. An important driver was the involvement of residents who agreed to receive their parcels through the new service.

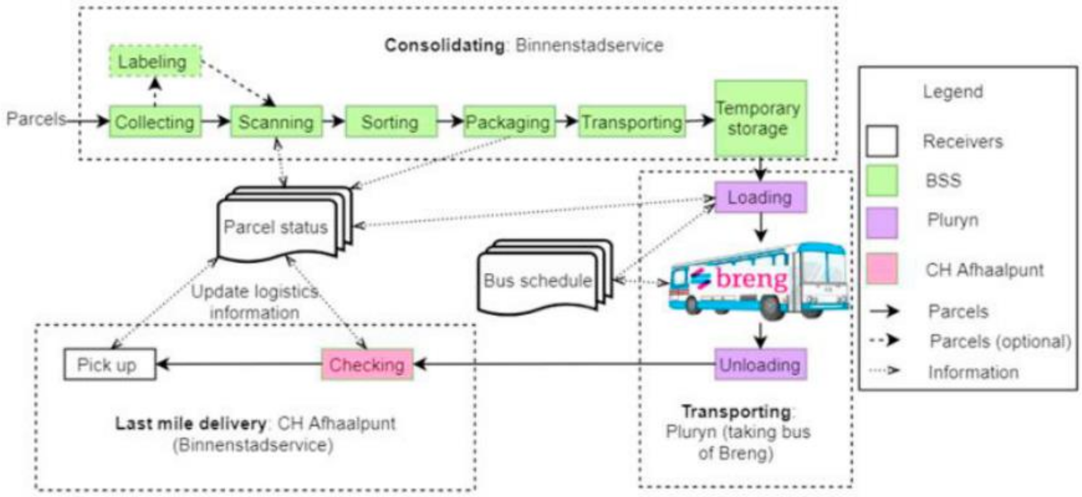
Below is a description of the main involved actors and their roles:

- **Binnenstadservice (BSS) Logistics Company** consolidated parcels from different carriers and Parcel Delivery Service Providers (PDSP) at their logistics hub close to the centre of Nijmegen; once sorted and packed the freight in a roller bag or a parcel trolley, they were transported to Nijmegen Central Station (in a small room for temporary storage of the parcels); moreover, BSS managed the local service point in Millingen, where the parcels were stored at for final distribution;

- **BRENG**, **Public Transport company**, allowed to transport a certain number of parcels, by means of trolleys or rolling containers, (especially during off-peak hours) from Nijmegen to Millingen;
- **Pluryn, social care organisation** (which provides treatment and support for disabled, child welfare and mental health), was responsible for actually transporting from Nijmegen Central Station to the local service point in Millingen. Its employees carried out the task taking parcels out of the storing room and traveling with the parcels as private luggage by the public bus;
- **Local Authorities** facilitated the necessary permits and supported the integration of the service.
- **Academic Institutions** conducted research and provided data analysis to optimize the service.
- **Local Residents/businesses**, about 100 households joined this project by agreeing to receive their parcels via the new service by making reference for their deliveries to the address of the logistics hub in Nijmegen when shopping online. Then deliveries could be received either at the local service point in Millingen.

The resulting collaborative effort made up the delivery process represented in the following figure.

*Figure 11. The delivery process of cargo hitching in Millingen aan de Rijn*




*Source: Van Duin et al., 2019*

- **Key takeaways**

This collaborative effort aimed to optimize the use of available transport capacity, reduce costs, and minimize environmental impact while improving the delivery service for residents in the area.

More specifically, on the basis of the research activity carried out, the following key finding can be outlined with reference to this specific case study:

- Current daily demand of 320 parcels can be delivered by both line buses and taxis towards the rural area of Nijmegen.
- Public transport is currently far from optimal. Two scenarios are appropriate to integrate passengers and freight flows. Both line buses and taxis independently have ample capacity to accommodate upcoming e-commerce. Independently, both transport modes have capacity up to 750 parcels a day.
- Around 250 euro per day is saved from the traditional system and is the margin in which the integrated system should work.

- Approximately 400 kilometers per day is eliminated which not only reduce congestion, but also reduces $CO_2$ emissions.
- The integrated passenger- and freight transport system keep public transport viable to the rural area of Nijmegen. This is essential for specific populations groups. Furthermore, it avoids further isolation of rural areas.

Moreover, the idea was to develop a scalable model that could be replicated in other regions, demonstrating the feasibility of integrated transport solutions for both urban and rural areas. However, in order to pave the way to further successful and viable implementation, it is important to outline the key drivers and to thoroughly elaborate on the business model analysis and to tailor it to each specific planned implementation.

In this regard, a set of key drivers for the successful implementation can be identified:

- **Improved Utilization of public transport**: The project effectively utilized available space on public buses for parcel delivery, particularly during off-peak hours, addressing low bus usage and enhancing transport efficiency.
- **Collaborative framework**: Successful implementation relied on the collaboration between the aforementioned actors, coming from different sectors. Each of them played a critical role, from transport to final parcel distribution.
- **Community participation**: The involvement of local residents who agreed to receive parcels via public buses was crucial. Their participation provided practical feedback, enhancing the service's effectiveness.
- **Technological integration**: Advanced scheduling algorithms and real-time data systems facilitated efficient logistics management, ensuring parcels were delivered on time and loads were distributed evenly.

With reference to this case study, it shall be mentioned that a dedicated analysis was carried out by Van Duin et al. (2019) on the application of the Osterwalder Business Model Canvas technique (Osterwalder & Pigneur, 2010), whose main outcomes are presented in chapter 6.1.

# 5. SWOT analysis

Based on the overall analysis of the selected case studies, a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis is proposed hereby to evaluate the cargo hitching concept from multiple dimensions, from its general application to the different typologies of potential cargo hitching services that have already been described in chapter 3.2.

Therefore, strengths and opportunities were identified to highlight the benefits and potential advantages of implementing cargo hitching, while weaknesses and threats were analyzed to acknowledge the challenges and risks involved, providing a balanced view of the concept's feasibility and overall sustainability.

## 5.1. SWOT on the general cargo hitching concept

The following table resumes the main aspects that have been highlighted when approaching the general concept of cargo hitching.

*Table 4. SWOT analysis on Cargo hitching concept*

| *CARGO HITCHING CONCEPT* | |
|---|---|
| STRENGHTS | WEAKNESSES |
| • Synergic use of resources (infrastructure, human and economic) in the transport of passengers and freight<br>• Enhanced efficiency of transport services that make use of existing spare capacities of both infrastructure and actual vehicles<br>• Environmental and social benefits, consisting in lower polluting emissions, lower use of public space and congestion, especially in urban areas<br>• Fostering of a sense of community among public and private players, promoting collaboration and mutual support<br>• Provision of a new revenue stream and branding opportunity for public transport operators | • Organizational challenges due to the need to reconcile different requirements and operational models for freight and passenger transport<br>• Financial sustainability still uncertain, to be verified on a case-by-case basis<br>• Security concerns related to unsecured cargo and potential damage or theft of freight during transit<br>• Need for substantial financial investments to equip vehicles and adapt infrastructures (for instance by installing lockers at certain stops or implementing a consolidation facility) to make them usable for quick and easy load/unload operations<br>• Increased travel time to perform both passenger and freight operations, mostly in urban contexts where stops and stations are closer |
| OPPORTUNITIES | THREATS |
| • Rising demand for cargo transport solutions due to increasing e-commerce and related home delivery services<br>• Diffusion and growing acceptance of sharing and collaborative approaches in the transport sector | • Lack of a conducive regulatory and normative framework, which often does not encourage the integration of freight- and passengers (e.g. due to the lack of possibility to extend the scope of operations managed by LPT drivers with additional activities) |

| | |
|---|---|
| • Advances of ICT technologies that can leverage and facilitate the cargo hitching concept<br>• Potential synergies to be further deployed in parallel with regulatory frameworks concerning local/urban transport planning (e.g. SULP etc.)<br>• Growing sensitivity to sustainability issues, also due to the strict target on emissions levels approved at the EU level that require a profound change in the transport sector.<br>• Possibility to explore niche markets such as perishable goods or specialized equipment transport<br>• Difficult financial balance for public transport services linking peripheral regions to urban areas and opportunities for improving it with cargo hitching services. | • Lack of generalized safety standards and insurance coverage, as well as data privacy rules to safeguard sensible information while still enabling data sharing<br>• Necessity to involve and engage different stakeholders, both from the public and private sector, who may show resistance to change<br>• Scarce interest of private companies (e.g. logistics operators) to adopt this solution<br>• Issues related to time, including the passengers' sensitivity to travel times, just-in-time deliveries and the limited availability of stores to receive delivery<br>• Difficulty and cost of implementing the necessary IT tools, which requires special expertise related to data analytics, software development, and cybersecurity<br>• Lack of familiarity to some customers, requiring education and marketing efforts to gain widespread acceptance, especially in the case of SV modality. |

*Source: own elaboration on the basis of several sources (see bibliography)*

Among the strengths, cargo hitching leverages the synergistic use of existing resources, including human capital and economic investments, to enhance the efficiency of transport services. This approach not only optimizes the use of vehicles and infrastructure but also generates significant environmental and social benefits by reducing emissions, congestion and the use of public space, particularly in urban areas. Furthermore, cargo hitching fosters a sense of community among public and private stakeholders, promoting collaboration and mutual support. It also opens up new revenue streams and branding opportunities for public transport operators as well as for market operators.

However, several weaknesses pose substantial challenges to its implementation. These include organizational difficulties in reconciling the diverse requirements of freight and passenger transport, uncertain financial sustainability that requires validation on a case-by-case basis and security concerns regarding cargo and passengers' safety during transit. Additionally, significant financial investments are needed to retrofit vehicles and adapt infrastructures to accommodate quick and easy load/unload operations. The increased travel time required to manage both passenger and freight operations, especially in urban areas, also presents a notable disadvantage.

On the opportunity front, the rising demand for cargo transport solutions driven by e-commerce and home delivery services creates a favorable environment for cargo hitching which should also be deployed in parallel with the development of new regulatory frameworks of urban transport (e.g. SULP etc.). The growing acceptance of sharing and collaborative approaches in the transport sector, along with advances in ICT technologies, can significantly facilitate the implementation of cargo hitching. The increasing awareness of sustainability issues and stringent emission targets set by the EU further underscore the need for innovative transport solutions like cargo hitching. Moreover, there is potential to explore niche markets such as the transport of perishable goods or specialized equipment, and to improve the financial balance of public transport services in peripheral regions through cargo hitching.

Despite these opportunities, several threats could impede the widespread adoption of cargo hitching. The lack of a supportive regulatory and normative framework often hinders the integration of freight and passenger transport. There are also gaps in safety standards, insurance coverage, and data privacy rules, which complicate the sharing of sensitive information necessary for operational efficiency. Engaging a diverse range of stakeholders, who may resist change, is another significant hurdle. Additionally, private companies, especially logistics operators, may show limited interest in adopting cargo hitching. Time-related issues, such as passenger sensitivity to travel times and the need for just-in-time deliveries, along with the complexity and cost of implementing necessary IT tools, further challenge the feasibility of cargo hitching. Finally, educating customers and gaining widespread acceptance for this relatively unfamiliar concept require considerable marketing efforts.

## 5.2. SWOT on the identified cargo hitching categories

### 5.2.1. Industrial logistics

The main strengths, weaknesses, opportunities and threats on the first category of potential cargo hitching services, namely industrial logistics, are provided below.

*Table 5. SWOT analysis on cargo hitching – Industrial logistics*

| *C1. INDUSTRIAL LOGISTICS* |
|---|
| STRENGHTS |
| • **Efficiency.** Cargo hitching for industrial logistics optimizes freight transportation within urban areas by implementing a synergic use of transport infrastructures, thus reducing congestion and pollution in densely populated areas which are more affected by these challenges.<br>• **Dedicated infrastructure.** Utilizing dedicated freight vehicles like cargo trams (SI modality) ensures reliable and secure transport of goods without direct interactions with passengers, who may be affected by the storage of freight directly in the same vehicle, resulting in less space for them.<br>• **Customized solutions.** Tailored freight handling at specific load and unload points, such as warehouses or factories, meets the unique needs of promoting entities.<br>• **Convenience.** It represents a cost-effective solution for dedicated companies with predictable freight movements. |
| WEAKNESSES |
| • **Limited interaction with passengers.** Lack of passenger interaction limits revenue opportunities compared to integrated passenger-freight services.<br>• **Infrastructure retrofitting.** Retrofitting existing infrastructure to accommodate cargo trams may require significant investment and time.<br>• **Limited flexibility.** The use of an existing physical transit network implies a lower level of flexibility compared to traditional methods for unexpected changes in freight schedules, both related to geographical location and timing, as it must respect also the timeline of passengers' services.<br>• **Infrastructure limitations.** This model relies on existing public transport routes (unless consistent financial resources are allocated), therefore it may not be suitable for all industrial locations/entities. |

| |
|---|
| • **First and last-mile deliveries.** Unless the service foresees specific load and unload points that corresponds to the original and final destinations (e.g. CargoTram in Dresden), an additional transport service for first and last mile must be organized and integrated within the model. |
| OPPORTUNITIES |
| • **Technology integration.** Integration of IT tools and ICT technologies can enhance operational efficiency, route planning, and real-time tracking of freight, thus fostering technological advancements.<br>• **Public-private partnerships.** Collaboration between public and private entities can unlock funding opportunities and streamline service implementation.<br>• **Sustainable solutions.** Promoting environmentally friendly delivery options, such as cargo trams, aligns with sustainability goals and enhances corporate social responsibility.<br>• **Use of public space.** This model allows to address the need to reduce the space occupied by urban logistics operations, thus leading to a better quality of life in the urban center. |
| THREATS |
| • **Regulatory challenges.** Regulatory constraints or lack of specific normative on safety, insurance and data protection may hinder the implementation of cargo hitching services for industrial logistics.<br>• **Competitive landscape.** Competition from traditional freight transport methods or emerging technologies could pose challenges to market expansion.<br>• **Infrastructure limitations.** Infrastructural barriers or limitations may restrict the scalability and effectiveness of cargo hitching solutions for industrial logistics.<br>• **Lack of collaboration.** The lack of an established dialogue between public and private transport operators and logistics providers – also due to the absence of substantial incentives to attract them – may hinder the potential of cargo hitching of attracting sufficient cargo volume to justify the service. |

*Source: own elaboration on the basis of several sources (see bibliography)*

In the context of industrial logistics, cargo hitching offers a promising avenue to optimize freight transportation within urban areas. By leveraging dedicated infrastructure and synergistic use of transport resources, it reduces congestion and pollution, addressing significant urban challenges. Utilizing dedicated freight vehicles, such as cargo trams, ensures reliable and secure transport of goods without affecting passenger space, providing a tailored solution for companies with predictable freight movements.

However, this model presents some limitations. The separation from passenger services restricts additional revenue opportunities. Retrofitting existing infrastructure to accommodate cargo trams demands considerable investment and time, and the model's reliance on the existing transit network reduces flexibility in responding to unexpected changes in freight schedules or geographical needs. Additionally, without specific load and unload points aligned with original and final destinations, first and last-mile delivery challenges arise, necessitating supplementary transport solutions.

Opportunities abound through the integration of advanced IT tools and ICT technologies, enhancing operational efficiency, route planning, and real-time freight tracking. Public-private partnerships can unlock funding and streamline implementation, promoting environmentally friendly delivery options that align with sustainability goals and corporate social responsibility. Moreover, this model can improve urban quality of life by reducing the space occupied by logistics operations.

Nevertheless, several threats could impede its success. Regulatory challenges, including constraints on safety, insurance and data protection, might hinder implementation. The competitive landscape, with traditional freight transport methods and emerging technologies, poses market expansion challenges.

Infrastructure limitations may restrict scalability and effectiveness, and a lack of collaboration between public and private entities, exacerbated by insufficient incentives, could prevent cargo hitching from attracting sufficient cargo volumes to justify the service.

### 5.2.2. Urban freight distribution

The following table presents the main elements that have emerged during the SWOT analysis of the second category of cargo hitching, which is urban freight distribution.

*Table 6. SWOT analysis on cargo hitching – Urban freight distribution*

| *C2. URBAN FREIGHT DISTRIBUTION* |
|---|
| STRENGHTS |
| • **Last-mile solutions.** Depending on how many and which points are used to load and unload freight, cargo hitching facilitates efficient first and last-mile deliveries of small to medium parcels in densely populated urban areas, thus addressing the increase of deliveries deriving from online shopping.<br>• **Enhanced efficiency.** Integration with public transit networks enables seamless passenger-freight transport, maximizing resource utilization and reducing vehicle congestion, therefore improving urban air quality and traffic flow in densely populated urban centres.<br>• **Flexible load and unload points.** Multiple load and unload points can be designated, including central distribution centres, lockers and micro-hubs, thus offering convenience, flexibility and accessibility for both shippers and recipients. |
| WEAKNESSES |
| • **Infrastructure constraints.** Limited space and capacity in urban environments, especially in the case of a SV service, may pose challenges for accommodating freight alongside passenger services.<br>• **Operational complexity.** Managing multiple load and unload points and coordinating schedules across passenger and freight services – which may not be perfectly aligned – requires efficient logistics and coordination.<br>• **Infrastructure and vehicles retrofitting.** This model requires infrastructure modifications (e.g., implementation of an additional platform or a micro-hub at selected stops) or vehicles adaptation (e.g. designated storage compartments).<br>• **Security concerns.** Integrating parcels with passenger belongings on public transport may raise security concerns for both passengers and goods, which might be stolen or damaged.<br>• **Impact on passengers' services.** The passengers may have to allow for longer waiting times while freight is loaded and unloaded from the vehicle at selected stops, thus resulting in an increased travel time and reduced reliability, which may have a wider impact during peak hours (e.g. commuters that need to reach their workplace at a certain time) and lower the appeal of the service for passengers. |
| OPPORTUNITIES |
| • **Public awareness.** Public promotional campaigns can promote the environmental and social benefits of cargo hitching services.<br>• **Collaborative partnerships.** Collaborating with e-commerce platforms, local businesses, and municipalities can expand service reach and enhance customer satisfaction.<br>• **Modal shifts.** Promoting modal shifts from traditional delivery methods to cargo hitching can reduce traffic congestion and environmental impact in urban areas. |

| |
|---|
| - **Connection to peri-urban areas**. The realisation of node and linear structures dedicated more to sustainable mobility, also in projection towards suburban areas could open up new possibilities for the implementation of cargo hitching services while promotion a deeper integration of the tram route into a more extensive network.<br>- **Technology adoption.** Adoption of advanced ICT technologies for the traceability of goods can enhance efficiency, reliability and accessibility of non-urban transport for passengers, who may benefit from real-time information on the status of their journey.<br>- **Use of public space.** This model allows to address the need to reduce the space occupied by urban logistics operations, thus leading to a better quality of life in the urban center. For some particular types/cases it could work especially in combination with policies for redesigning mobility infrastructure and space utilisation in urban areas. |
| THREATS |
| - **Regulatory challenges.** Regulatory constraints or lack of specific normative on safety, insurance and data protection may hinder the implementation of cargo hitching services of freight distribution in urban areas.<br>- **Customer awareness.** Public perception and acceptance of shared passenger-freight services may impact adoption rates and regulatory support, along with consumers' preference for fast and reliable delivery options.<br>- **Lack of collaboration.** The lack of an established dialogue between public and private transport operators and logistics providers – also due to the absence of substantial incentives to attract them – may hinder the potential of cargo hitching of attracting sufficient cargo volume to justify the service.<br>- **Competitive landscape.** Competition from established delivery services and emerging technologies could pose challenges to market expansion and revenue generation, also due to the resistance of the sector's stakeholders to change. |

*Source: own elaboration on the basis of several sources (see bibliography)*

By integrating freight transportation with existing public transit networks, this approach maximizes resource utilization and reduces vehicle congestion, leading to improved air quality and traffic flow in urban centers. A notable advantage is the flexibility it provides through multiple load and unload points, which enhances convenience and accessibility for shippers and costumers.

However, the model also encounters several challenges. Urban infrastructure constraints and the need for retrofitting existing facilities and vehicles can be substantial hurdles. Additionally, coordinating schedules between passenger and freight services introduces operational complexities, including security concerns about integrating parcels with passengers. There is also the potential impact on passenger services, with longer idling and travel times, which could reduce the appeal for passengers, particularly during peak hours.

Opportunities for cargo hitching in urban freight distribution are considerable. Public promotional campaigns can emphasize its environmental and social benefits, boosting public acceptance. Collaborating with e-commerce platforms, local businesses and municipalities can expand service reach and improve customer satisfaction. Encouraging modal shifts from traditional delivery methods to cargo hitching can alleviate traffic congestion and reduce environmental impact. The integration of advanced ICT technologies can foster efficiency, reliability and traceability of goods. Moreover, incorporating cargo hitching into broader urban mobility and space utilization strategies can significantly enhance urban quality of life.

At the same time, several threats are still present. Regulatory challenges and the lack of specific norms for safety, insurance and data protection may impede progress. Public perception and acceptance of shared passenger-freight services are crucial for adoption and regulatory support. The competitive landscape, including established delivery services and emerging technologies, presents significant challenges. Furthermore, insufficient collaboration between public and private transport operators and logistics providers, due to a lack of substantial incentives, could limit the service's ability to attract enough cargo volume to be viable.

### 5.2.3. Non-urban freight distribution

The third and last category of cargo hitching is the non-urban freight distribution, whose main strengths, weaknesses, opportunities and threats are collected in the following table.

*Table 7. SWOT analysis on cargo hitching – Non-urban freight distribution*

| *C3. NON-URBAN FREIGHT DISTRIBUTION* |
|---|
| STRENGHTS |
| • **Extended reach.** Cargo hitching extends freight distribution services to peri-urban, suburban, and rural areas, addressing first and last-mile delivery challenges in less densely populated regions which often lacks an adequate frequency of transport services, resulting in transport poverty.<br>• **Accessibility.** Utilizing existing bus stops and stations can improve accessibility for parcel pick-up and drop-off, especially in areas with limited delivery options.<br>• **Sustainability**. This model (SV) reduces reliance on dedicated delivery vehicles, leading to lower emissions and a smaller environmental footprint due to an overall mileage and fleet size reduction.<br>• **Improved financial sustainability**. The integration of freight handling on existing passengers services improves the financial sustainability of transport in non-urban areas by providing an additional revenues stream and expanding the customer base. |
| WEAKNESSES |
| • **Limited frequency of service.** The limited frequency of services in non-urban areas may pose challenges for scheduling and implementing freight deliveries services, as customers and businesses might need a faster service.<br>• **Impact on passengers' services.** The passengers may have to allow for longer waiting times while freight is loaded and unloaded from the vehicle at selected stops, thus resulting in an increased travel time and reduced reliability, which may have a wider impact during peak hours (e.g. commuters that need to reach their workplace at a certain time) and lower the appeal of the service for passengers.<br>• **Operational costs.** Operating over longer distances and serving dispersed populations may increase operational costs and logistical complexities.<br>• **Seasonal variability.** Seasonal variations in demand (e.g. due to tourism flows) and road conditions in rural areas (e.g. due to winter weather) may impact service reliability and profitability.<br>• **Security concerns**. Security concerns related to freight could be amplified with fewer passengers and longer transit times when goods are reachable by passengers and are not supervised. |
| OPPORTUNITIES |
| • **Rural development initiatives.** Collaboration with rural development agencies and local governments can unlock funding opportunities and support infrastructure development for cargo hitching services. |

| |
|---|
| • **Technology adoption.** Adoption of advanced ICT technologies for the traceability of goods can enhance efficiency, reliability and accessibility of non-urban transport for passengers, who may benefit from real-time information on the status of their journey.<br>• **Last-mile solutions.** Innovative last-mile delivery solutions, such as cargo bikes and e-trucks, can improve accessibility and convenience for rural recipients.<br>• **Added frequency of services.** In rural and peripheral areas, a reduction in overall operational costs could allow additional and more frequent transit or delivery services. This may relieve the isolation that is typical of rural areas and, in the long run, may contribute to a modal shift from private vehicles.<br>• **Flexible services.** Integration with demand-responsive transport models offer flexibility to meet specific delivery requirements in non-urban environments in terms of routes and destinations, thus implementing an almost door-to-door delivery system. |
| THREATS |
| • **Infrastructure limitations.** Inadequate road infrastructure and connectivity in remote areas may restrict the scalability and effectiveness of cargo hitching services.<br>• **Regulatory challenges.** Regulatory constraints or lack of specific normative on safety, insurance and data protection may hinder the implementation of cargo hitching services in non-urban regions.<br>• **Competitive challenges.** Competition from traditional delivery methods and existing logistics networks may pose challenges to market expansion and revenue generation in rural areas, also due to the fact that consumer expectations for fast delivery times might be difficult to be met in non-urban environments.<br>• **Customer awareness.** The concept of cargo hitching may be unfamiliar to some customers, requiring education and marketing efforts to gain widespread acceptance by underlining environmental and social benefits, also due to consumers' preference for fast and reliable delivery options.<br>• **Lack of collaboration.** The lack of an established dialogue between public and private transport operators and logistics providers may hinder the potential of cargo hitching of attracting sufficient cargo volume to justify the service. |

*Source: own elaboration on the basis of several sources (see bibliography)*

Cargo hitching for non-urban freight distribution addresses significant last-mile delivery challenges leverages existing transportation networks to extend parcel deliveries, particularly in regions with infrequent transport services, thus mitigating transport poverty. By reducing reliance on dedicated delivery vehicles, it promotes sustainability, leading to lower emissions and a smaller environmental footprint. Utilizing bus stops and stations for parcel pick-up and drop-off enhances accessibility in areas with limited delivery options, and integrating freight handling into passenger services improves financial sustainability by creating additional revenue streams.

However, the limited frequency of service in non-urban areas can complicate scheduling and reduce the attractiveness of freight deliveries for customers and businesses that demand faster services. Increased waiting times and reduced reliability for passengers, particularly during peak hours, pose significant concerns. Furthermore, operating over longer distances and serving dispersed populations increases operational costs and logistical complexities, and seasonal variations in demand and road conditions can impact service reliability and profitability. Security concerns related to parcels and passengers is also a point to be considered.

Despite these challenges, there are significant opportunities for cargo hitching in non-urban areas. Collaborations with rural development agencies and local governments can unlock funding and support infrastructure development. Advanced ICT technologies can enhance service efficiency and reliability, providing real-time information also to the benefit of passengers. Innovative last-mile delivery solutions, such as cargo bikes and e-trucks, can improve accessibility and convenience for customers in non-urban territories. Additionally, the potential to reduce overall operational costs could enable more frequent transit and delivery services in these areas, alleviating isolation and encouraging a shift from private vehicle use. Moreover, the integration with demand-responsive transport models offers interesting opportunities, combining the parcel distribution with the flexibility to meet specific delivery requirements, effectively implementing an almost door-to-door service.

However, inadequate road infrastructure and regulatory hurdles pose relevant threats to scalability and effectiveness. Moreover, competition from traditional delivery methods and consumer expectations for fast, reliable service may impede market expansion. Therefore, educating customers about cargo hitching's environmental and social benefits is crucial for widespread acceptance. Additionally, fostering collaboration between public and private stakeholders is essential to realize cargo volume viability and ensure service sustainability in non-urban areas.

# 6. Practical hints on the implementation of cargo hitching

## 6.1 Main factors to be considered in developing a cargo hitching business model

The Business Model Canvas is a strategic management tool that helps organizations visualize and design their business model. Comprising several components, it provides a clear, visual framework that facilitates a comprehensive understanding of the concept, enabling stakeholders to see how all aspects of the initiative interconnect, thus ensuring alignment and coherence. It also helps identify potential gaps and opportunities for innovation.

Moreover, it fosters collaboration among diverse stakeholders by providing a common language and structured approach to discussing and refining the business model. This structured approach ensures that all critical elements are considered, enhancing strategic planning and execution.

The classic version of the Business Model Canvas has been developed by Osterwalder & Pigneur in 2010 and comprises nine key components: Customer Segments, Value Propositions, Channels, Customer Relationships, Revenue Streams, Key Resources, Key Activities, Key Partnerships, and Cost Structure.

Indeed, additional variants of this Canvas have been proposed by several authors, among which the adaptation presented by Timeus et al. (2020), which proposes several additional components, for a total of 14 elements, among which are also the environment and societal risks and benefits.

This version of the Business Model Canvas has been adopted in the framework of the ULaaDS (*Urban Logistics as an on-Demand Service*) Project[6], a European initiative co-financed under the Horizon 2020 Programme that lasted until June 2023 and was aimed at developing and testing innovative solutions for urban logistics, including cargo hitching that was tested in Mechelen, whose trial is included in the list of case studies that have been presented in chapter 4.1.

In this framework, the Deliverable 3.1 (*Benchmarking business/operating models & best practices*)[7] delved into the discussion of the Business Model Canvas for the several logistics solution trialed in the project.

With relation to the integration of passenger and urban freight transport, a specific Canvas is proposed to provide an overview of the main implications deriving from the integration of passengers and freight transport from the point of view of a company (either public or private) that already operates a passengers' service and opens it to freight.

More specifically, it comprises some general elements that are applicable to the cargo hitching concept (in black), as well as a few specific aspects related to:

- a smaller and unscheduled service (in turquoise) – this could be associated with the third category identified in this document, namely the non-urban freight distribution, whose potentiality if associated to a demand-responsive transport service has already been underlined;
- a rather well-structured and larger service (in orange) -this, on the other hand, could be referred to the second category of urban freight distribution, as the authors have mainly considered the shared vehicle modality.

[6] More information on the project is available on the ULaaDS website, at the following link: https://ulaads.eu/

[7] The document is available at the following link: https://ulaads.eu/wp-content/uploads/2021/07/D3.1_Benchmark.pdf

*Figure 12. Business Model for cargo hitching, including smaller unscheduled services (in turquoise) and larger and structured services (in orange)*

<table>
<tr><td colspan="5">Mission statement: To reduce congestion and emission in busy areas and offer cost-effective transport of passengers and urban freight in less busy areas of a city</td></tr>
<tr><td rowspan="2">Key partnerships:<br>1. Passenger transport authority or company<br>2. Logistics providers involved with first and last mile</td><td>Key activities:<br>1. Schedule the integrated passenger and urban freight transportation services<br>2. Pick up, transport, and drop off parcels<br>3. Load, transport, and unload roll carriers or bags with parcels</td><td rowspan="5">Value proposition:<br>1. To provide a service for urban freight transport using passenger vehicles<br>2. Optimize load and vehicle usage</td><td>Buy-in & support:<br>1. Legislators writing rules and regulations or consider statutory exemptions for integrating urban freight transport in passenger vehicles<br>2. Passengers need to accept goods in vehicle</td><td rowspan="2">Beneficiaries:<br>1. Logistics service providers gain from cost-effective transportation of parcels to less busy areas of the city or its surroundings<br>2. Citizens and other people staying in the city benefit from improved efficiency (e.g., less vehicles) in busy areas of the city</td></tr>
<tr><td>Key infrastructure and resources:<br>1. Decision support for planning the operations<br>2. Mobile app to guide drivers to passenger and parcel pick-up and drop-off locations<br>3. Passenger vehicles that enable transport of multiple parcels at once<br>4. Roll containers or bags for parcels</td><td>Deployment:<br>1. Form an alliance of actors (e.g., logistics service provider, public transport authority, collection point operator) to initiate the service<br>2. Identify areas where service will run<br>3. Identify public transport lines on which goods will be transported</td></tr>
<tr><td colspan="2">Budget costs:<br>1. Developing decision support and app that helps drivers pick up and drop off passengers and parcels<br>2. Transportation costs, or costs for detours needed to pick up and drop off parcels.<br>3. Designing or retrofitting vehicles that can carry both parcels and passengers<br>(4. Lost-sales due to reduced capacity for passengers)</td><td colspan="2">Revenue streams:<br>1. Fee per parcel transported<br>2. Cost saving from optimised routes and optimisation of vehicle capacity</td></tr>
<tr><td colspan="2">Environmental costs:<br>1. Greenhouse gas emissions involved with detours to pick up and drop off parcels<br>2. Greenhouse gas involved with first and last mile, depending on the vehicle used</td><td colspan="2">Environmental benefits:<br>1. Reduced greenhouse gas emissions from better utilization of existing vehicles</td></tr>
<tr><td colspan="2">Social risks:<br>1. Passengers are exposed to potential dangers with parcels, such as dangerous goods (low probability).<br>2. Increased traffic due to inefficient transport of individual parcels by individual vehicles</td><td colspan="2">Social benefits:<br>1. Additional income or work for drivers<br>2. A reduced number of vehicles operating in the city<br>3. More public transport services in less busy areas of the city due to increased cost-effectiveness</td></tr>
</table>

*Source: ULaaDS- Deliverable 3.1 (2020)*

The mission statement of this business model emphasizes the dual goal of cargo hitching, which are reducing congestion and emissions in busy urban areas while offering cost-effective transport for passengers and urban freight. This dual focus ensures that the initiative aligns with broader urban sustainability goals and enhances the livability of cities.

Key partnerships are fundamental for the successful integration of passenger transport authorities or companies with logistics providers involved in the first and last mile of delivery, both in the non-urban and urban contexts. These partnerships are strategic as they bring together different expertise and resources, enabling a seamless integration of passenger and freight services. For instance, passenger transport authorities can provide access to extensive transit networks, while logistics providers bring expertise in parcel handling and delivery optimization.

Key activities include scheduling the integrated services and managing the logistics of picking up, transporting and delivering parcels. This involves not only operational logistics but also strategic planning to ensure that the integration of services does not disrupt passenger transport schedules. Therefore, efficient scheduling and route planning are crucial to minimize delays and ensure timely deliveries.

The key infrastructure and resources needed for cargo hitching include solid decision-support systems, mobile apps to guide drivers, as well as passenger vehicles provided with the adequate capacity to transport multiple parcels, in a dedicate compartment or in the same area of passengers. Additionally, tools like roll containers or bags for efficient handling of goods during load and unload operations are essential. Investing in these technologies and resources is a strategic move to enhance operational efficiency and reliability of an integrated passengers-freight service, especially for shared vehicles services in which freight handling can potentially delay passengers' services.

The value proposition centers on providing a service for freight distribution that exploits synergies with passenger transport. This approach leverages existing passenger transport infrastructure, reducing the need for additional and more polluting vehicles (i.e. road trucks) and thereby cutting costs and emissions. Strategically, this value proposition aligns with the broader goals of sustainable urban development and resource optimization.

However, a successful implementation requires the full support of both legislators and passengers. Legislators need to adapt regulations or provide exemptions to facilitate the integration of urban freight into passenger transport, which is crucial to overcome legal and bureaucratic hurdles. Passengers, on the other hand, must accept the presence of goods in their vehicles. Effective communication and engagement strategies are needed to gain passenger acceptance, emphasizing the environmental and societal benefits of the initiative.

Deployment involves forming alliances with key actors, such as logistics service providers, public transport authorities and first and last mile operators. Identifying service areas and public transport lines for goods transport are essential steps in the deployment process. Strategically, forming these alliances can create synergies and shared value among the stakeholders, enhancing the overall viability and scalability of the service.

The budget costs associated with this model include developing decision support systems, transportation costs for detours to pick up and drop off parcels and designing dedicated vehicles or retrofitting existing ones. Strategic investment in these areas can lead to long-term savings and efficiency gains. For instance, advanced decision support systems can optimize routes and schedules, thus reducing operational costs.

Environmental costs are considered, noting emissions from detours and the first and last mile logistics, depending on the vehicle used. Strategically, mitigating these costs through the use of low-emission or electric vehicles can enhance the environmental sustainability of the initiative.

Social risks involve potential dangers to passengers from goods and increased traffic due to inefficient transport. However, strategic risk management measures, such as stringent safety protocols and efficient scheduling, can definitely mitigate these risks.

Despite the costs and risks, the model presents several benefits. Environmental benefits include reduced greenhouse gas emissions through better vehicle utilization. This aligns with strategic environmental goals and can attract support from environmental advocacy groups and policymakers.

Social benefits include additional income revenue streams for transport companies (both public and private), and therefore for drivers, as well as less congestion in urban areas and more cost-effective public transport services in less densely populated areas. These benefits can generate broad-based support for the initiative, creating a positive feedback loop that enhances its long-term sustainability.

Revenue streams are derived from additional fees collected through the parcel transported and cost savings from optimized routes and vehicle capacity. However, the financial profitability of implementing a cargo hitching service is still unsure and should be evaluated on a case-by-case basis.

Beneficiaries of this model include logistics service providers, who gain from cost-effective transportation, and – most importantly – citizens, who benefit from reduced traffic and emissions. Strategically, demonstrating these benefits can help build a coalition of support among diverse stakeholders, ensuring the initiative's success and longevity.

In summary, this Business Model Canvas for integrating passenger and urban freight transport provides a comprehensive and structured approach to implementing cargo hitching. It highlights the critical aspects necessary for successful integration, balancing costs, environmental and social impacts, and providing clear value propositions and benefits to stakeholders.

When looking to concrete applications of the Business Model to cargo hitching, the study by Van Duin et al. (2019) – mentioned already in chapter 4.2 – is particularly relevant, as it elaborated on the implementation of the Osterwalder Business Model Canvas technique (Osterwalder & Pigneur, 2010) to the Millingen aan den Rijn trial, thus mapping each component to specific aspects of the project, as represented in the figure below.

*Figure 13. Business Model for the Millingen aan den Rijn trial*

<table>
<tr><th>Key Partners</th><th>Key Activities</th><th rowspan="3">Value Proposition<br>1. Parcel delivery service<br>2. Making use of unused capacity of public bus and combining passengers and parcels and reducing transporting cost.<br>3. Providing job opportunities for people with poor job prospects<br>4. Environmental benefits (reducing $CO_2$ emission)<br>5. Higher efficiency and utilization of rural public buses<br>6. Traffic safety (fewer vehicles in the village)</th><th>Customer relationships</th><th>Customer Segments</th></tr>
<tr><td rowspan="2">1. Receivers<br>2. Breng<br>3. Pluryn<br>4. PDSPs and carriers<br>5. Shippers<br>6. BSS</td><td>1. Collecting and sorting parcels<br>2. Transporting parcels to the village by public buses<br>3. Logistics information tracking<br>4. Operating the local service point<br>5. Expected societal and environmental benefits</td><td>Customers (receivers) use the address of BSS with an identification code when do shopping online</td><td rowspan="2">Receivers of parcels (residents of Millingen aan de Rijn)</td></tr>
<tr><td>Key Resources<br>1. Warehouse space<br>2. Public bus (Line 80 & 82)<br>3. IT platform<br>4. Organizational capacity<br>5. Personnel</td><td>Channels<br>1. Unique codes for customers (Online orders)<br>2. Tracking information to customers<br>3. Local service point</td></tr>
<tr><td colspan="3">Cost Structure<br>1. Rent<br>2. Personnel<br>3. Management & maintenance of vehicles equipment and infrastructure<br>4. IT platform (SaaS)</td><td colspan="2">Revenue Streams<br>Governmental funding</td></tr>
</table>

*Source: Van Duin et al., 2019*

In the case of the Millingen aan den Rijn trial, the components are as follows:

- Customer segments: Local residents and businesses in Millingen aan de Rijn who need parcel delivery services within the area.
- Value propositions: Efficient, cost-effective, and environmentally friendly parcel delivery using existing public transport infrastructure.
- Channels: Public buses, local distribution centres, and digital platforms for scheduling and tracking.
- Customer relationships: Community engagement through feedback loops and customers service desks dealing with requests and complaints.
- Revenue streams: Service fees from parcel delivery and potential subsidies from environmental programs, as well as regional , national and European funding.
- Key resources: Public buses, logistics hubs, real-time scheduling software, and human resources from partnering organizations.
- Key activities: Coordinating logistics, managing schedules, maintaining relationships with stakeholders, and continuous service improvement.
- Key partnerships: Public transport companies, logistics operators, local authorities, and community organizations.
- Cost structure: Operational costs of buses, salaries for personnel, software maintenance, and community engagement activities.

Therefore, a range of several strategic and operational aspects must be taken into account when evaluating the design of a cargo hitching service. In this purpose, the study by Van Duin et al. (2019) provides a practical framework for understanding these elements through a set of key operational and practical questions that must be addressed in the planning phase.

**a. Who are the customers?**

One of the first steps in designing a cargo hitching service is to identify the potential customers. These typically include local residents and businesses (consumers), shippers (B2B and B2C businesses), and carriers or parcel delivery service providers (PDSPs) to cover the first and last mile. Understanding the diverse needs and priorities of these customer segments is essential. For example, while consumers may have an interest in the environmental and social impacts of the service, shippers and PDSPs are likely to prioritize cost reductions and financial efficiency while still maintaining speed and high reliability. Recognizing these different motivations can help tailor the service to meet their various expectations effectively.

**b. Who can do the interfacing to the customers?**

Determining who will interface with customers is another critical aspect. The customer-facing company is responsible for direct interactions and can be any entity within the cargo hitching group, or even a dedicated service desk. For instance, this role could be entrusted to the local public transport operator, which could leverage its existing infrastructure and customer service capabilities. Effective customer interfacing ensures clear communication, smooth service operations and the resolution of any issues that may arise throughout the delivery process, thus contributing to building trust and public support for the service.

**c. Who can do the consolidation of the parcels?**

Consolidating parcels efficiently is fundamental to unlock the potential of the cargo hitching concept. Consolidation involves gathering parcels at a central location before distributing them to their final destinations. Potential consolidation points include:

- Logistics centres, that are existing facilities equipped to handle large volumes of parcels and streamline the sorting and dispatching process.
- Transport hubs, which can facilitate the easy transfer of parcels onto public transport, optimizing the use of existing infrastructure.
- Lockers, which can provide additional flexibility and convenience, especially in urban areas.
- Other strategic locations with sufficient space and access to transport networks, which can serve as a consolidation point, especially in the case of dedicated urban logistics services.

Strategically placing these consolidation points can optimize logistics, reduce transit times and enhance overall efficiency. Moreover, the use of small cargo units allows to entrust load and unload of parcels to relatively unskilled workers, as these operations can be done by hand directly at platforms (e.g. transport hubs and stops).

**d. Who is responsible for transporting and supervising the parcels?**

Post-consolidation, it is crucial to manage the transportation and supervision of parcels. On the basis of the service implemented, several entities can undertake these responsibilities, including either private or public transport operators, as well as carriers or parcel delivery service providers (PDSPs) that might be entrusted with the first and last mile leg of deliveries. Moreover, in the case of shared vehicles services, the personnel already present on-board can supervise the parcels to ensure that both goods and passengers are safe during transit.

**e. Who is responsible for the service points/pick up locations?**

Service points for parcel collection and delivery also play a crucial role in the cargo hitching model. These points can be integrated into local shops, thus providing convenient access for customers and supporting local businesses. In alternative, dedicated service desks can be implemented to serve this function, while the use of lockers located at the main public transit stops or significant locations is also a viable option, offering a secure and automated solution that allow customers to pick up their parcels at their convenience and eliminating, at the same time, the need to address the last mile delivery of parcels. Choosing the right service point configuration can enhance customer convenience and streamline the logistics process.

**f. Who is responsible for the final home delivery?**

The final delivery of parcels is a critical component that might be overlooked but that could pose significant operational difficulties, and therefore that needs a clear assignment, as efficient scheduling and route planning are essential to ensure timely deliveries and customer satisfaction. A smart way to solve this issue would be to implement a system that relies on lockers, or even on costumers' pick up directly at transport stops, which could be viable in the case of non-urban freight distribution but would impact users' range of choices of pick up time and location.

In alternative, a last mile distribution system could be managed by:

- Logistics operators, which could leverage public transport to cover the middle part of deliveries while completing the last mile through light vehicles such as cargo bike.
- Public transport operator, which could offer this paid service by leveraging the infrastructure and part of the personnel to deliver parcels to their final costumers. : They can integrate last-mile delivery into their existing transport services, leveraging their infrastructure.
- External delivery companies/operators that could be subcontracted to carry out the final leg of the delivery process.

Indeed, utilizing small and sustainable vehicles for the last mile delivery still contribute to reducing emissions and mitigating congestion in urban areas.

In conclusion, implementing a cargo hitching service demands a holistic approach that integrates multiple facets of logistics and transportation. The Business Model Canvas provides a structured framework to visualize and strategize this integration, ensuring all critical elements are addressed. Overall, the successful implementation of a cargo hitching service relies on a collaborative effort between various stakeholders, strategic planning, and continuous adaptation to emerging challenges and opportunities. By addressing each component thoughtfully and strategically, cargo hitching can become a viable and sustainable solution for urban freight distribution, contributing to more liveable and efficient urban environments.

However, not all urban areas or enlarged suburban territories might be suitable to implement such services. The following section is designed to provide a valuable tool to be implemented during the phase of feasibility evaluation of potential implementation of cargo hitching by local authorities.

## 6.2 Proposal for the self-assessment of desirability and compatibility of implementing a cargo hitching service

As a result of the presented analysis, in order to further support a factual evaluation of the feasibility of implementing a cargo hitching service, a sort of questionnaire was designed, thus guiding local and regional authorities. In this purpose, the following guiding questions were drafted with the aim of identifying the main topics to be considered when evaluating the potential feasibility of cargo hitching services within the targeted territorial level (i.e. including either densely populated urban area or rather a non-urban as well as less densely populated territory, including a suburban and rural area). Therefore, in order to address this dual nature, the questionnaire presents two versions tailored to address the urban and suburban/rural territorial scales, respectively.

The two questionnaires consist of 13 questions each that address a specific aspect of the business and operational model for cargo hitching. Each question should be answered on a Likert scale from 1 to 3, where:

- 1 indicates disagreement or poor suitability,
- 2 indicates neutrality or moderate suitability, and
- 3 indicates agreement or high suitability.

After completing the questionnaire, the scores have to be summed to determine the area' potential propensity towards cargo hitching, which can fall into one of the three scoring categories.

Obviously, this questionnaire represents a proposed potential approach for a preliminary assessment of the key factors that influence the overall suitability and appeal of implementing of a cargo hitching service, guiding authorities in making informed decisions and identifying areas for improvement. Therefore, results should be considered as a general indication on the feasibility and not as a conclusive evaluation of the opportunity to activate cargo hitching in the area which, evidently, need to be appropriately evaluated trough dedicated studies and analysis.

### 6.2.1 Self-assessment for the URBAN territorial scale

| n. | QUESTION | POSSIBLE ANSWERS |
|---|---|---|
| 1 | **Transportation network development**<br>Is the city provided with a wide and highly developed transportation network - including different means of transport - which can be easily used for freight transportation? | - **1 point**: The transportation network is underdeveloped and not suitable for implementing CH.<br>- **2 points**: The transportation network is moderately developed and could be adapted for freight and CH with some modifications.<br>- **3 points**: The transportation network is highly developed and can easily support the enhancement of freight transportation through CH. |
| 2 | **Traffic congestion**<br>Does the current urban traffic situation allow for additional freight transport without causing significant congestion? | - **1 point**: The city has low congestion levels, and additional freight transport would not cause significant issues, thus CH would not be significant.<br>- **2 points**: The city experiences moderate congestion; additional freight transport may be feasible in a BAU situation with proper management. |

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| | | - **3 points**: The city already faces severe congestion, making freight transport problematic, thus requiring an innovative solution like CH. |
| 3 | **Freight flows**<br>Is the urban centre invested by significant flows of goods, underlining a high supply and demand of goods' deliveries? | - **1 point:** The urban centre has low freight flows, indicating limited desirability for CH.<br>- **2 points:** The urban centre has moderate freight flows, suggesting desirability for CH with proper planning.<br>- **3 points:** The urban centre has high freight flows, indicating strong desirability for CH. |
| 4 | **Presence of POIs**<br>Within a short distance from the urban area, are there multiple industrial/logistics POI (e.g. factories, depot, warehouses, UCCs, shopping malls) that could benefit from a more efficient/sustainable transport of freight/parcels - for instance, by delivering to retailers in the city? | - **1 point:** There are few or no significant POIs nearby.<br>- **2 points:** There are some POIs that could benefit from CH.<br>- **3 points:** There are multiple POIs that would significantly benefit from CH. |
| 5 | **Space availability**<br>At the POIs identified above, is there adequate space for the temporary storage, consolidation and handling of freight? If not, are there any significant locations that can be converted to this purpose (e.g. convenient space at transport stops)? | - **1 point:** There is no adequate space available for freight handling.<br>- **2 points:** There is some space available, but it may be limited or need modifications.<br>- **3 points:** There is ample space available for temporary storage, consolidation and handling of freight. |
| 6 | **Private companies/operators**<br>Are there any important factory or warehouse of a specific individual company/operator located in the periphery of the dense urban area that could benefit from a CH service (e.g. from a factory to a warehouse and vice versa)? | - **1 point:** There are no significant companies/operators that could benefit from CH.<br>- **2 points:** There are a few companies/operators that might benefit from CH.<br>- **3 points:** There are several key companies/operators that would significantly benefit from CH. |
| 7 | **Consolidation of freight/parcels**<br>Is there a clear plan or entity (either private or public) responsible for consolidating freight/parcels before they are loaded onto the transportation network? | - **1 point:** No clear plan or entity for parcel consolidation.<br>- **2 points:** Some plans or entities for parcel consolidation, but it needs development.<br>- **3 points:** A clear and effective plan or entity is in place for parcel consolidation. |
| 8 | **Operational flexibility**<br>Can the current public transport transit schedules accommodate additional stops or slight modifications for freight purposes without significantly affecting passenger service? | - **1 point:** Public transport schedules are rigid and cannot accommodate any changes.<br>- **2 points:** Schedules are moderately flexible and could accommodate some changes.<br>- **3 points:** Schedules are highly flexible and can easily accommodate additional stops for freight. |

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| 9 | **Stakeholders' engagement**<br>Is there an established and ongoing dialogue at the local level between authorities, providers and stakeholders of the transport sector, which can be leveraged to foster cooperation? | - **1 point:** There is little to no engagement between authorities and stakeholders.<br>- **2 points:** There is some engagement, but it is not well-established.<br>- **3 points:** There is strong and ongoing engagement that can be leveraged. |
| 10 | **Financial resources**<br>Are there financial resources and funding available to potentially support the initial setup and operational costs of a cargo hitching service? | - **1 point:** Financial resources are very limited or non-existent.<br>- **2 points:** Some financial resources are available, but they may not be sufficient.<br>- **3 points:** Adequate financial resources and funding are available to support the initiative. |
| 11 | **Regulatory framework**<br>Is the regulatory environment favorable for introducing new urban logistics solutions such as cargo hitching? | - **1 point:** The regulatory environment is restrictive and does not support new logistics solutions.<br>- **2 points:** The regulatory environment is somewhat supportive, with some barriers to be addressed.<br>- **3 points:** The regulatory environment is very supportive and facilitates the introduction of new logistics solutions. |
| 12 | **Environmental concerns**<br>Is there a strong local policy and related regulatory constraints for reducing urban freight-related pollution and noise? | - **1 point:** There is little to no policy constraints or public support for reducing freight-related pollution and noise.<br>- **2 points:** There is moderate policy constraints and public support for these environmental concerns.<br>- **3 points:** There is strong policy constraints and public support for initiatives that reduce freight-related pollution and noise. |
| 13 | **Public support and community engagement**<br>Is there public awareness and support by the civic associations and citizens for integrating passenger and freight transport to reduce environmental impact?[8] | - **1 point:** There is little public awareness or support for integrating passenger and freight transport.<br>- **2 points:** There is moderate public awareness and support for such initiatives.<br>- **3 points:** There is high public awareness and strong support for integrating passenger and freight transport. |

As mentioned above, the points allocated to each parameter should be summed to allow the categorization in one of the following levels of potential desirability of a cargo hitching service.

- **0-13 points: Low desirability.** The conditions are generally unfavourable for the implementation of a cargo hitching service. Significant improvement and considerations are necessary.
- **14-26 points: Moderate desirability**. There is potential for a cargo hitching service, but several areas need further development and support to improve the suitability of the area towards cargo hitching.

[8] For instance, this factor could be assessed by means of a simple online survey prepared by local authorities to be filled in by a sample of citizens.

- **27-39 points: High desirability.** The conditions are highly potentially favorable for implementing a cargo hitching service. There is a strong foundation to build upon and likely to achieve success.

The following questionnaire, on the other hand, is designated to assess the desirability of implementing a cargo hitching service at the non-urban territorial scale, including suburban and rural areas.

### 6.2.2 Self-assessment for the NON-URBAN territorial scale

| n. | QUESTION | POSSIBLE ANSWERS |
|---|---|---|
| 1 | **Transportation network connectivity**<br>How well-connected is the suburban/rural area to major transportation hubs or urban centres that are the origin and destination of freight flows? | - **1 point:** Poor connectivity, limited transport options to be leveraged for a CH service.<br>- **2 points:** Moderate connectivity, with some transport options to be leveraged for a CH service.<br>- **3 points:** High connectivity, with multiple transport options to be leveraged for a CH service. |
| 2 | **Freight flows**<br>Are there significant flows of goods through the area, indicating a high supply and demand for deliveries? | - **1 point:** Minimal freight flow, indicating limited demand and desirability for a CH service.<br>- **2 points:** Moderate freight flow, suggesting desirability for CH with proper planning.<br>- **3 points:** High freight flow, indicating strong desirability for CH. |
| 3 | **Presence of POIs**<br>Are there significant industrial/logistics POI (e.g. factories, depot, warehouses, UCCs, shopping malls, lockers) that could benefit from a more efficient/sustainable transport of freight/parcels - for instance, by delivering to costumers in non-urban area? | - **1 point:** There are few or no significant POIs nearby.<br>- **2 points:** There are some POIs that could benefit from CH.<br>- **3 points:** There are multiple POIs that would significantly benefit from CH. |
| 4 | **Space availability**<br>At the POIs identified above, is there adequate space for the temporary storage, consolidation and handling of freight? If not, are there any significant locations that can be converted to this purpose (e.g. convenient space at transport stops)? | - **1 point:** There is no adequate space available for freight handling.<br>- **2 points:** There is some space available, but it may be limited or need modifications.<br>- **3 points:** There is ample space available for temporary storage, consolidation and handling of freight. |
| 5 | **Private companies/operators**<br>Are there any important factory or warehouse of a specific individual company/operator located in the suburban and rural area that could benefit from a CH service (e.g. from a factory to a warehouse and vice versa)? | - **1 point:** There are no significant companies/operators that could benefit from CH.<br>- **2 points:** There are a few companies/operators that might benefit from CH.<br>- **3 points:** There are several key companies/operators that would significantly benefit from CH. |
| 6 | **Existing passengers' services**<br>Are there existing medium and long-haul passenger services (e.g., interurban lines, demand-responsive | - **1 point:** No medium and long-haul passenger services available.<br>- **2 points:** Some medium and long-haul passenger services that could be adapted. |

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| | transport services) that could be easily adapted to implement cargo hitching? | - **3 points:** Several medium and long-haul passenger services that could easily be adapted. |
| 7 | **Customer base identification**<br>Is there a clear identification of potential customers who would use the cargo hitching service (e.g., local businesses, e-commerce, residents)? | - **1 point:** There is no clear identification of potential customers.<br>- **2 points:** There is some identification of potential customers, but it is incomplete.<br>- **3 points:** There is a clear and well-defined identification of potential customers. |
| 8 | **Consolidation of parcels**<br>Is there a clear plan or entity (either private or public) responsible for consolidating parcels before they are loaded onto the transportation network? | - **1 point:** No clear plan or entity for parcel consolidation.<br>- **2 points:** Some plans or entities for parcel consolidation, but it needs development.<br>- **3 points:** A clear and effective plan or entity is in place for parcel consolidation. |
| 9 | **Stakeholders' engagement**<br>Is there an established and ongoing dialogue at the local and regional level between authorities, providers and stakeholders of the transport sector, which can be leveraged to foster cooperation? | - **1 point:** There is little to no engagement between authorities and stakeholders.<br>- **2 points:** There is some engagement, but it is not well-established.<br>- **3 points:** There is strong and ongoing engagement that can be leveraged. |
| 10 | **Financial resources**<br>Are there sufficient financial resources and potential funding available to support the initial setup and operational costs of a cargo hitching service? | - **1 point:** Financial resources are very limited or non-existent.<br>- **2 points:** Some financial resources are available, but they may not be sufficient.<br>- **3 points:** Adequate financial resources and funding are available to support the initiative. |
| 11 | **Regulatory framework**<br>Is the regulatory environment favorable for introducing new urban logistics solutions such as cargo hitching? | - **1 point:** The regulatory environment is restrictive and does not support new logistics solutions.<br>- **2 points:** The regulatory environment is somewhat supportive, with some barriers to be addressed.<br>- **3 points:** The regulatory environment is very supportive and facilitates the introduction of new logistics solutions. |
| 12 | **Environmental concerns**<br>Is there a strong local policy and related regulatory constraints for reducing urban freight-related pollution and noise? | - **1 point:** There is little to no policy constraints or public support for reducing freight-related pollution and noise.<br>- **2 points:** There is moderate policy constraints and public support for these environmental concerns.<br>- **3 points:** There is strong policy constraints and public support for initiatives that reduce freight-related pollution and noise. |
| 13 | **Public support and community engagement**<br>Is there public awareness and support by the civic associations and citizens for integrating passenger and freight | - **1 point:** There is little public awareness or support for integrating passenger and freight transport.<br>- **2 points:** There is moderate public awareness and support for such initiatives. |

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| | transport to reduce environmental impact?[9] | - **3 points:** There is high public awareness and strong support for integrating passenger and freight transport. |

As in the case of the previous questionnaire, the points allocated to each parameter should be summed to allow the categorization in one of the following levels of potential desirability of a cargo hitching service.

- **0-13 points: Low desirability.** The conditions are generally unfavourable for the implementation of a cargo hitching service. Significant improvement and considerations are necessary.
- **14-26 points: Moderate desirability**. There is potential for a cargo hitching service, but several areas need further development and support to improve the suitability of the area towards cargo hitching.
- **27-39 points: High desirability**. The conditions are highly potentially favorable for implementing a cargo hitching service. There is a strong foundation to build upon and likely to achieve success.

[9] For instance, this factor could be assessed by means of a simple online survey prepared by local authorities to be filled in by a sample of citizens.

# 7. Conclusions

The concept of outsourcing parts of the delivery process by utilizing public transport with excess capacity has been around for decades, particularly in long-haul air and rail operations, where it is common to use the same aircraft or train for multiple purposes. Following that, cargo hitching has emerged as a promising model for shared transportation of goods and passengers, especially for short and medium-haul operations.

The literature, though still developing and definitively not so wide, has consistently underlined the advantages of cargo hitching for various stakeholders, showing how load consolidation and shared transport capacities can lead to cost savings and increased operational efficiency.

Moreover, while its benefits in urban areas are well-documented, including reduced pollution and congestion, in suburban and rural areas, it offers an additional, critical benefit represented by an enhanced social value. Indeed, by reducing costs for transit services and goods deliveries, cargo hitching can enable the provision of otherwise unprofitable services, such as more frequent public transport journeys or postal services. This can mitigate the isolation often experienced in less densely populated areas, improving their attractiveness and potentially retaining population levels.

Despite its potential, cargo hitching still faces significant challenges, primarily due to regulatory and operational constraints. Current legislative frameworks at all levels generally treat cargo and passenger transport as separate entities, subject to different rules and legislation, including – for instance – work contracts and insurance rules. This separation further complicates its implementation, elevating costs and slowing down cooperation among stakeholders, which often show resistance to change.

As a matter of fact, this kind of services often involve multiple stakeholders, each with distinct interests and operational requirements. Then, an effective collaboration between these stakeholders is crucial for the success of cargo hitching. However, achieving this cooperation is time-consuming and requires significant political and organizational effort.

Additional operational constraints include the complexity of consolidating parcels and integrating deliveries - or even vehicles entirely dedicated to freight – with passenger transport schedules, as well as time-related constraints that include the importance for passengers of a reliable schedule that is not affected by delays due to load and unload operations. ICT technologies and real-time monitoring system are also needed to ensure an efficient and functional system.

Furthermore, the need for new infrastructure, such as consolidation facilities, retrofitting of vehicles and facilities and/or light and sustainable conveyances for the last mile, often results in the need of substantial investments from both public and private entities, which is in contrast with the relatively limited revenue streams available.

At the same time, the availability of real trials and projects implementing this concept is still quite limited and often concerns case studies that vary greatly from one another in terms of type of goods involved and mode of operation. Despite the fact that this first critical set of practical applications can provide a layering foundation for the testing of theoretical models, additional pilot projects funded by public authorities - if necessary- are essential to provide critical data and further insights. This would allow researchers and stakeholders to build a reliable set of indicators and operational models to facilitate a broader diffusion of cargo hitching.

As already mentioned, the logic behind cargo hitching is not new, but its practical applications have not been as successful and widespread. Consequently, it seems that the concept may not be sufficiently attractive to many stakeholders in its current form, which is due to many reasons, including the uncertain financial profitability and the regulatory and operational challenges that come with it.

Therefore, to enhance the attractiveness of cargo hitching services, it is crucial to focus on synergies: cargo hitching, by nature, is already a form of synergy, combining different transportation flows and resources. To further enhance its appeal, synergies shall be further emphasized in several key areas:

- Vehicles and infrastructure: Efficiently utilizing existing transportation infrastructure and vehicles to accommodate both passengers and cargo has the potential to optimize resource use and, therefore, reduce costs. This involves retrofitting current transport systems and designing multi-purpose facilities that can handle both passengers and freight seamlessly. Additionally, leveraging technology for better route planning, real-time tracking and efficient load management can further enhance resource efficiency and reduce operational costs.
- Human resources (onboard staff and personnel at load and unload platforms): Training and employing staff who can manage both passenger and cargo needs can streamline operations and improve service quality. This dual-function workforce can enhance operational efficiency and reduce labour costs.
- Economic resources: Pooling financial resources from different stakeholders, including public funding, private investments, and possibly new business models such as cooperative funding, can help bridge the funding gap often associated with the implementation of cargo hitching projects.

Indeed, a strong focus on resource efficiency and finding ways to address the funding gap is essential for the success of cargo hitching initiatives. This includes exploring innovative funding mechanisms and public-private partnerships to secure the necessary investments.

Additionally, to make cargo hitching more attractive, it is also important to implement concepts of reward and valorization. The synergy between passenger and cargo transport offers significant environmental and social benefits, which are primarily for the community of people living in these areas. For this reasons, the financial gap should also be bridged by public resources, considering the substantial environmental and societal advantages generated, similarly to what is already done for local public transport aimed at passengers. In this purpose, public local authorities could provide incentives for companies that participate in cargo hitching schemes, such as tax breaks, grants, or subsidies, thus further valorising the broader societal benefits.

In light of these considerations, the questions provided in chapter 6 for the self-assessment of the desirability of a cargo hitching service, directed at local authorities, are relevant (despite being still broad and somewhat generic) as they can help initiate dialogue on this topic and promote the potential application of cargo hitching services by ensuring that benefits and feasibility of such initiatives are thoroughly evaluated. By considering factors such as community needs, environmental impact, economic viability and stakeholder collaboration, local authorities can make informed decisions about implementing cargo hitching services.

Furthermore, creating a supportive regulatory environment that facilitates the integration of passenger and cargo transport can significantly boost the attractiveness and feasibility of cargo hitching. This may involve revising existing regulations to allow for mixed-use transportation systems (including rules on insurance) and ensuring that policies support innovation and collaboration among stakeholders.

By focusing on these strategies and addressing the challenges outlined, cargo hitching can become a more viable and attractive solution for shared transportation. This would lead to a more sustainable and efficient logistics network, capable of reducing costs, minimizing environmental impact and enhancing service provision in both urban and rural areas, fostering a more interconnected and resilient transportation system.

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