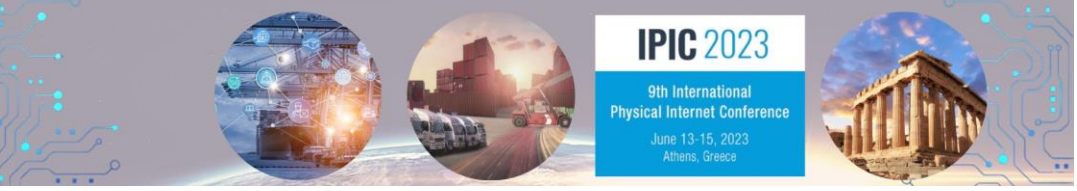

New business models for last mile delivery in city centres

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Abstract: *In urban regions, freight transportation is crucial for replenishing stores and markets' inventories as well as for transporting packages, parcels and goods to citizens' homes. However, urban freight transportation generates a number of negative effects, such as increased air and noise pollution, disturbance of traffic flow, and traffic congestion. We wish to address a particular aspect of today's cities: the commercial traffic which enters cities daily and occupies the public space. We aim to reduce several of the nuisance sources of this activity. By reducing the traffic, we would obtain a lower carbon footprint of the commercial vehicles which come into cities to deliver e-commerce parcels to residents as well as reduced traffic and reduced noise. We present in this paper three possible templates to be implemented in cities which will have both positive attractiveness for logistic service providers, satisfy end-customers and yet reduce traffic and CO2 emission.*

Keywords: *Last mile delivery, city logistics, business models, regulatory framework, URBANE Project.*

Conference Topic(s): *business models & use cases; last mile & city logistics; logistics and supply networks; omnichannel & e-commerce logistics;*

Physical Internet Roadmap *(Link): Select the most relevant area for your paper: ☐ PI Nodes, ☐ PI Networks, ☒ System of Logistics Networks, ☐ Access and Adoption, ☐ Governance.*

1 Introduction

The purpose of the URBANE project is to help cities in Europe in increasing social welfare for their residents. To this end we are dependent upon other partners in the project to provide a set of objectives and the Key Performance Indicators (KPIs) which would have to be tracked to monitor the performance of the solutions which we wish to provide. Since such KPIs have not yet been defined, we shall only describe in a general way how the proposed framework, business models, policies, and Incentive schemes would provide some of the necessary impetus to improve such KPIs and succeed in achieving the targets. In urban regions, freight transportation is crucial for replenishing stores and markets' inventories as well as for transporting packages, parcels and goods to citizens' homes. However, urban freight transportation generates a number of negative effects, such as increased air and noise pollution, disturbance of traffic flow, and traffic congestion.

We address the e-commerce generated traffic which enters cities daily and occupies the public space. By reducing the traffic, we would obtain a lower carbon footprint of the commercial vehicles which come into cities to deliver e-commerce parcels to residents as well as reduced traffic and reduced noise.

We must indicate here that the task covered by this report only includes the traffic generated by the delivery of orders placed by residents through phone or e-commerce (ie, the 6% that have

been identified as such in the study on urban logistics in the city of Vienna, 2019, see Figure 1).

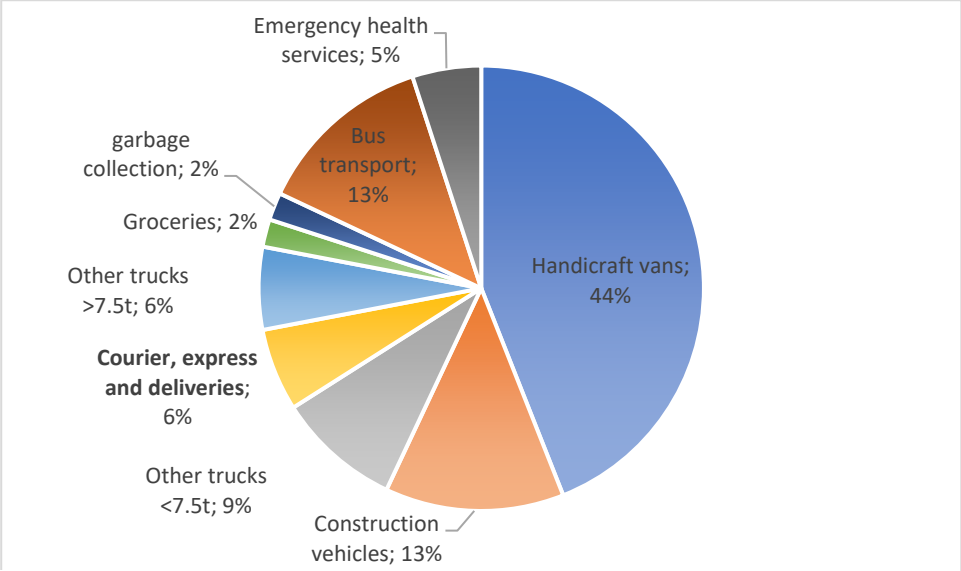

Figure 1: Urban logistics, distribution by type, Vienna 2019 (Mobilität mit Zukunft, VCO)

This means that we do not take into account the traffic due to public services such as waste collection, ambulance or other health services, police, firefighting services. We do not take into account either the traffic due to construction and other building services which have to enter the city to deliver building materials or take out rubble or other building waste. Commercial transportation regarding the replenishment of shops, deliveries from shops to customers or the traffic due to artisans on their regular installation works in the city are not included here either. Finally, we do not consider people mobility services.

In the remainder of this paper, we present the various stakeholders that we have identified and their characteristics in terms of sensitivity to the e-commerce last mile delivery services. We then define the governance and regulatory models which should be set up to frame the way each of the stakeholders would develop their activities before presenting the three operating models that could be set up to for the last mile delivery of goods ordered online in city centres.

2 Stakeholders

We present below those stakeholders and describe how they will interact with each other and with the organizations which will be carrying forward the job of reducing the carbon footprint of the last mile delivery of parcels in city centres when the necessary regulatory framework will have been defined and set up.

2.1 City authorities

City authorities are the de jure representatives of the residents. As such they are responsible for their wellbeing and echo their preoccupations. Over the years city authorities have developed and implemented several types of regulatory frameworks for the usage of public space and roads such as parking space, traffic control, etc. In that capacity some are now trying various policies to reduce the various types of pollution such as noise, fine particles, and CO2. we will presume that city authorities have the power to define under which conditions parcels can be delivered to residents. That presumption involves political power and a political will to do so.

2.2 Third party logistic service providers (3PL)

The number of 3PLs delivering e-commerce parcels in a city are usually limited in number and remain the same firms over a long period of time. In the project, we expect to observe approximately four to five large 3PLs and a limited number of local operators with fleets of environmentally friendly delivery vehicles such as bikes, cargobikes, electric scooters and the like.

For the major 3PLs such as DHL, Fedex, UPS, DPD, Chronopost, Die Post and other local post parcel delivery providers, the cost of delivering in a city centre with its high density of deliveries means that the cost per drop is low. It is reckoned that 3PL make a profit on deliveries inside cities with dense population but a loss on deliveries to residential and rural addresses. The plan presented here would be to maintain their commercial and logistic presence in the market of city deliveries while controlling or reducing costs. These stakeholders are key to the success of the project.

2.3 Microhub and locker owner-operators

Microhubs are logistics facilities for micro-consolidation, which is the bundling of goods at a location near the final delivery point (e.g. within 1 to 5 km from the final destination)(Janjevic & Ndiaye, 2014).

Microhub operations may use a permanent building or a mobile structure, operate on a permanent or temporary basis, and may be operated by one or more businesses in parallel. In general, though, microhub operations have five common characteristics (Janjevic & Ndiaye, 2014):

- Intend to reduce the number of vehicle trips in an urban area
- Focus on the delivery of smaller and lighter loads
- Allow goods to be transferred to a cleaner mode of transport, such as cycling or walking, for the last mile of delivery
- Are typically operated by privately owned transportation companies
- Facilities are located within an urban area near the final delivery point

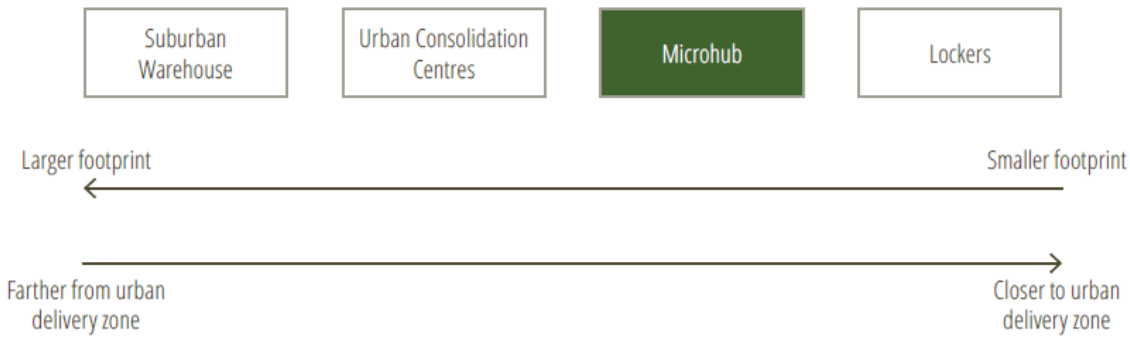

Figure 2: Types of urban logistics spaces (Janjevic & Ndiaye, 2014)

Single-carrier microhubs are typically private-led initiatives. Transport companies can use these microhubs as additional transhipment platforms within their existing and exclusive delivery networks and build them to be either stationary or mobile (Katsela et al., 2022). The position and corresponding authorization by the city authorities must be related to delivery volumes and frequencies. As those change in time, so the lockers and microhubs must be eventually repositioned to different locations.

2.4 Residents

Residents are interested in obtaining their deliveries on time and in full at the desired delivery spot (drop-off point or home). They consider that their welfare is improved if traffic on the streets, pollution, and noise are reduced.

We expect to define within the URBANE project the variables to be monitored which take all these aspects into consideration and establish the corresponding KPIs. This category of stakeholders will not object to the plan we propose given that the outcome will be improved welfare.

2.5 Cargobikes and other small electric vehicle operators

This category of stakeholders includes various types of firms: some large, others small, some privately owned or in partnership with a city. We consider here that their preoccupation is to ensure commercial viability and acceptance by the other stakeholders.

2.6 Parcel exchange platform

This type of stakeholder is necessary in the proposed solutions which are to be contemplated in this report and in the upcoming work in the course of the URBANE project. There already exist a stream of literature on such platforms with some proposing white label ones (Pufahl et al., 2020). This platform would be created jointly with city authorities and 3PL participation to ensure success. Such a platform will provide the following services to the 3PL and to the city.

To the 3PL:

- On a real-time basis evaluate and present each 3PL with a set of routes combining the available parcels to be delivered or picked up inside the city in such a way as to optimize the number of stops, kilometres, and time of the appropriate delivery vehicle.
- Present updated quality metrics (on time delivery) for parcels delivered the preceding business day for all parcels offered in the platform. These metrics will be the basis for quality reports for each 3PL about the deliveries performed by the assigned 3PL of the parcels originally entrusted to them. For example, if DHL has 300 parcels to deliver or pick up daily and these are shared between DPD, UPS, FedEx as well as DHL, then DHL will be informed of the quality of the service provided by the others as well as its own vehicles.
- Define periodically the bonuses and penalties shared out between the 3PL according to their quality of service over the considered period. This will ensure that all 3PL will strive to provide the highest possible service over time.

To the city:

- Periodic reports about the number of parcels delivered by period and neighbourhood.
- Periodic reports about the market share of the various 3PL active in the city. These will have to include all 3PL which participate in the parcel exchange platform.
- Periodic reports about the overall quality of delivery service provided by the 3PL in the platform. These reports might help the city in vetting the 3PL active in the delivery service provided to citizens.
- Periodic reports about the emissions generated by the traffic of delivery vehicles inside the city as well as an estimate of the traffic generated in terms of road and parking occupancy.

To be able to deliver those services, a number of information systems are required. The type and form of those systems are detailed elsewhere in the project.

Information from the 3PL

- Parcels to be delivered or picked up in real-time by the 3PL with the corresponding logistic information such as origin and destination, size and weight of the parcel, time widow in which the parcel must be delivered or picked up. This information will serve as the basis for the optimization of the PUDO routes which will then be assigned to a particular vehicle.
- Geographic position in real time of the fleet of delivery vehicles operating. In this way the system will assign a PUDO route to the optimally available vehicle in real time.

Information from the microhub operators

- Information about parcels received for each microhub so that they be assigned to a vehicle for delivery in real time.
- Information about parcels returned because of missed deliveries in real time. In this way, a new delivery may be planned in a new time window.

Information from the city:

- Planned works in the city such as road closures, restrictions, parking availabilities etc. This information will be used by the exchange to evaluate the optimal PUDO routes.
- City plan of roads, parking spaces, traffic lights, etc.

Various economic models can be applied. In the following some of the most important by their expected consequences. Others could eventually be implemented.

3 Governance and regulatory models

3.1 City regulatory authority

We describe briefly the framework of rules which the city authorities would set to the 3PLs as well as the locker and microhub operators who which to provide their services to the residents. Such an entity would issue the regulatory framework needed for the operation of 3PL in the city centres. Such a framework would be necessary so as to ensure that all commercial entities which operate in the city be included and that the “playing field” be made level. For example, if a city wishes to reduce the pollution and other sources of Green House Gas (GHG) emissions, then the maximum level of emissions per vehicle/km will have to be provided by type of vehicle. In the same way, some cities prohibit the entrance to city centres at some hours of the day or days in the week. These restrictions should be made mandatory for all operators in the same way. The city regulatory framework should be made visible and its evolution in time (towards stricter limits) be made clear and sufficiently in advance so that the commercial operators have the time to adjust their operations. It appears also evident that some form of consultation and recourse should also be provide so that the necessary debate and information exchange can take place in the best interests of all parties.

3.2 Third party logistic service providers

The 3PLs who wish to participate in the PUDO of parcels in the city would have to adhere to the regulatory framework. This includes all 3PLs whatever their nature, public or private, and whether they operate with their own fleets of vehicles or through third party fleet owners as well as other transport service providers such as cargobike, electric vehicle, delivery robots or bicycle operators.

As participants, 3PLs would have to link up their information services to the parcel exchange platform of the city through the corresponding APIs. They would also agree to participate in

the financial incentive schemes provided by the parcel exchange in such a way that bonuses or penalties could be perceived or paid up. The incentive scheme would involve also sharing some information about previous periods activities and costs. These will be described later.

3.3 Microhub and locker owner operators

These actors own some real estate in the city on which certain infrastructure has been built. They would need to be involved in obtaining some synergy by consolidating flows from distinct 3PLs in a micro-consolidating of parcels in local microhubs. They might be incentivized into setting up hubs or lockers in public places through favourable treatment of permits or even subsidized rent by the city authorities. Sharing of resources is a way of collaboration in last mile delivery. Urban consolidation centres are a typical example of this (Marcucci & Danielis, 2008). A white-label pickup station follows the idea of sharing logistics resources to improve performance and decrease environmental impact. The particularity of a white-label pickup station lies in its openness to all (or at least a group of) parcel delivery companies as delivery point. A white-label pickup station may be operated by a logistics company, any other company or the public sector. Independent of its operator, it potentially offers various benefits (Schodl et al., 2020).

In return for placing such logistic warehousing capacity, the 3PLs would be invoiced according to the usage done. The usage would be calculated as the number of lockers in time or the square meters in time being occupied by parcels or other forms of cargo.

3.4 City residents

The city residents are interested in getting the deliveries of their e-commerce orders on time. They are also highly aware of the traffic, noise, and pollution generated by the 3PLs and other cargobike services. Their behaviour may generate further disturbance and extra costs in terms of the above because of missed deliveries due to absence.

4 Operating models

There are several PPP operating models with varying degrees of participation, from almost total public sector control (i.e. city) to almost total private sector control (i.e. 3PL). Basically, the following forms of PPP operating models can be distinguished:

- The Build-Operate-Transfer (BOT) model assumes that construction and financing are private. After construction, ownership is transferred to the public sector. Operations can then be carried out by the public sector or by a private operator. As a rule, the latter will then be granted an operating license for a limited period.
- Build-Own-Operate-Transfer (BOOT). In contrast to the BOT model, here the private investor temporarily receives the ownership rights, which pass to the public sector at the end of the contract period.
- The Lease-Develop-Operate (LDO) is the form of a leasing contract. The construction, financing and operation are private, but the ownership remains in public hands.
- In Build-Own-Operate and Buy-Own-Operate (BOO), all criteria are organized in the private sector. Since these are public tasks, the state will secure itself via contracts or public regulation.

Table 1: operating model types

Operating Model		**Administrative fiat**	**Provision of Infrastructure**	**Market regulated**
Owner		Public Sector	Public / Private Sectors	Private Sector
Operator	Package Exchange	City	City	Neutral Third Party
	Microhub	City	City	3PL
	Last Mile	City	3PL	3PL
White Label		Yes	Yes/No	No

4.1 Administrative model: administrative fiat

In this model, the city assumes the operation of the package exchange, microhubs and the last mile. It owns the microhub real estate.

4.2 Provision of infrastructure

Here the city assumes the operation of the package exchange and the microhubs. It also owns the microhub real estate. Similarly, as in the first Operating Model, the activity of 3PLs regarding parcel delivery within city limits is restricted due to environmental or transport regulation. However, the last mile is carried out by 3PLs, who either closely cooperate within a white label framework or do not cooperate with each other, being parcels sorted on the basis of the respective 3PL and fed into their respective routes. Here the delivery vehicles (incl. cargo bikes and others) are provided, operated and maintained by the respective 3PL.

4.3 Market regulated

This model describes a variant in which a neutral third party assumes the operation of the package exchange, while 3PLs operate microhubs and last mile deliveries. Ownership of the microhub real estate is in private hands, who rents it to the 3PLs. There is no city environmental or transport regulation. Here the operation of the microhubs and the delivery of parcels within their respective zones of influence are allocated to individual 3PLs. Since this model is not a white label approach, there is only limited cooperation within the 3PLs. The delivery vehicles (incl. cargobikes and others) are provided, operated and maintained by the respective 3PL.

5 Business Models

Here we will only present for the three operating models the key activities, cost structure and revenue sources to conserve space.

Table 2: key activities for each operating model

Key Partner	**Administrative fiat**	**Provision of Infrastructure**	**Market regulated**
City	Regulate parcel deliveries in the inner-city Operate the package	Regulate parcel deliveries in the inner-city	Ensure Neutral Operator and 3PL

	exchange Buy / build and operate microhubs Buy and operate last mile equipment Debit 3PL for parcel deliveries in the inner city	Operate the package exchange Buy / build and operate microhubs Debit 3PL for parcel deliveries in the inner city	performances through service contracts
3PL	Transfer parcel data to package exchange Deliver parcels to microhubs	Transfer parcel data to package exchange Deliver parcels to microhubs Buy and operate last mile equipment	Transfer parcel data to package exchange Deliver parcels to microhubs Rent and operate microhubs Buy and operate last mile equipment
Neutral Operator	None	None	Operate the package exchange
Real Estate Developer	None	None	Buy / build microhubs

Table 3: Cost and revenue sources for the three operating models

Key Partner	**Administrative fiat**		**Provision of Infrastructure**	**Market regulated**
City	**Cost structure**	Investments in microhubs and last mile equipment Costs of operation of microhubs and last mile delivery Costs of operation of package exchange	Investments in microhubs Costs of operation of microhubs Costs of operation of package exchange	Service invoice from the Neutral Operator
	Revenue sources	Service invoice to 3PLs	Service invoice to 3PLs	Service invoice to 3PLs
3PL	**Cost structure**	Reduction of last mile delivery costs Service invoice from the city	Investments in last mile equipment Last mile delivery marginal cost Service invoice from the city	Costs of rental of microhubs Last mile delivery marginal cost Service invoice from the city
	Revenue sources	None	None	None
Neutral Operator	**Cost structure**	None	None	Costs of operation of package exchange
	Revenue sources	None	None	Service invoice to the city

Real Estate Developer	**Cost structure**	None	None	Investment in microhubs
	Revenue sources	None	None	Rental fee from 3PLs

6 Incentive schemes in each operating model

6.1 For administrative fiat

To ensure the success of this model, the city must make participation compulsory. If, as has happened in some cities, the 3PL can withdraw from this operating model, they will do so and that will lead to the failure of the model and a return to the previous undesirable situation. Given the above, the city authorities will need to establish a very strong and clear regulatory and governance framework establishing clearly the roles, expected performance metrics and regulatory regimes for all of the actors involved: the 3PL, parcel exchange platform, and real estate developers of the microhubs.

The 3PL only deliver to the microhubs and no longer have the commercial contact with the end-customer. Given the importance of this continued contact, they are expected to refuse to participate in such an operating model. In this model, the cargobike operators take over that role. It is to be expected that 3PL will resist this change. Only if participation is compulsory under the threat of exclusion from operating in the city will they agree.

As the cargobike operators will deliver, they are entitled to a share of the fee that 3PL receive for the delivery (or collection) from the end-customer. There is a risk that this fee will not be shared as it should be since the city has effectively a monopole on the contracting of the cargobike operator. The neutral operator of the last mile PUDO service inside the city centre limits is a de facto monopolist. As such, she has to report quality of service metrics such as percentage of parcels delivered within the time slot which the end-customer booked. To ensure that the neutral operator does not engage in opportunistic behaviour, proof of delivery (POD) data about the final delivery would be collected and made available to the 3PL whose parcels are thus being manipulated.

6.2 Provision of infrastructure

In this model, the 3PL has to invest in the ecologically friendly transport equipment to deliver themselves the parcels retrieved from the microhubs to the end-customers. In this case, the 3PL do keep the commercial contact with the end-customers. The investments in the microhubs and the package exchange platform have to be borne by the city. The cost of using such infrastructure shall be paid by the 3PL. The necessary incentive to ensure adoption of this model by all 3PL delivering in the city is equivalent to the difference between these costs and those supported by them in the anterior situation. This difference is expected to be negative (ie, the cost will be higher in this operating model because of the cost of investment in the ecologically friendly delivery vehicles, probably electric vehicles). Again, to ensure that all 3PL comply, the city will have to make the subscription to the parcel exchange platform compulsory.

6.3 Market regulated with private operators

The cities will have an important role, we propose that cities must agree to a common set of dispositions which would be adopted across Europe. The logistic service provider is the owner and operator of the fleet of inner-city delivery vehicles (eg, cargobikes, electric delivery vans) will perform PUDO operations along optimized tours provided by the parcel exchange platform. This means perfect coordination through the exchange platform between the three

actors: the 3PL, the microhub and the final delivery service. The parcel exchange service has the duty to transparently inform all parties about the position of parcels, position of delivery vehicles and the messages that need to be transmitted to the right parties. Only if the whole information system including the 3PL, the last-mile delivery vehicles and the end-customers works seamlessly can the value be unlocked.

7 Conclusion and possible evolution between models

As we have seen, all the above operating models have widely different implications for the delivery and collection of parcels in city centre. City authorities have an important role to play. According to their political will and the availability of city officials to take on many duties, they can engage in centralizing the logistics of deliveries or let the market take on that responsibility. What is evident is that if cities intend to follow up on citizens demands on clean air, unclogged roads and high-quality service for last mile delivery, they must take action. This action mostly turns on setting a regulatory framework which will foster the development of electric delivery vehicles in dense city centres. Cities must also help in presenting clear and well-defined rules for the investment in microhubs and lockers. It is the recommendation of this work that beyond the initial investment, cities should not subsidize neither of the delivery or storing services. We could have a city start with a laissez faire policy change as technology evolves and citizens behaviours change. For example, if citizens can be convinced to pick and drop off their internet orders at lockers or specially equipped stores, that in itself might reduce traffic as there would be less PUDO. If electric delivery vehicles become cheaper, there might be more.

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