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# ULaaS: Urban Logistics as a Service – a conceptual platform for digital transformation of logistics services in urban areas

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**Abstract**

Due to the rapid growth of cities, in addition to high urban flow of goods in cities, aggravated by problems of congestion and air pollution in urban areas, there is a growing need for logistics services to be operated in a digital platform environment. This paper proposes the concept of a collaborative platform for Urban Logistics as a Service (ULaaS) and validates it through a literature review and field research based on primary databases, in-depth interviews, and surveys conducted in the Campinas city, Brazil. The analysis of collected data contributed to the validation of the proposed concept and identified modules that can generate value for the stockholders in the Campinas city: parking space reservations, shared warehousing, e-commerce deliveries and logistics services. Even though the concept is not entirely new, and some similar initiatives are found in the literature, the contribution of this work is to provide a comprehensive conceptual view of the platform. The paper also discusses a possible business model for its implementation and a preliminary canvas for a minimum viable product (MVP).



*Keywords:* Sharing economy, Collaborative Digital Platform, Logistics as a Services, Urban Logistics

## 1. Introduction

The COVID-19 pandemic accelerated the pace of the on-demand economy. Consumers are increasingly making small orders each day, while expecting immediate or next day deliveries, increasing the number of vehicles in urban areas with severe impact on cities' quality of life. Freight transport makes up about 25 percent of traffic in cities but takes up 40 percent of road space and creates 40 percent of transport-related emissions (Frischtak et al., 2015) as it involves trucks (Diziain et al., 2014, MTPA, 2017). According to the World Economic Forum (World Bank, 2017), urban last-mile delivery emissions are on track to increase by more than 30 per cent by 2030 in the top 100 cities globally (by population). Without intervention, these cities' emissions could reach 25 million tons of $CO_2$ annually by 2030.

The combination of optimizing urban goods flow and minimizing the adverse social and environmental effects is the cornerstone of City or Urban Logistics concept (Taniguchi and Thompson, 2007; Taniguchi et al. 2007; Dablanc, 2017).

On the supply side, innovations and digital technologies are contributing to make it possible: home deliveries and pick-ups done by individual drivers, for example, usually the same drivers working for the Transportation Network

Companies (TNCs) like Uber, are making same day deliveries a reality. Tracking capabilities provided by cell phones and GPSs are providing more visibility for truckers and clients, enabling better planning for orders and deliveries. It is not without consequences though, that the last mile logistics is getting more active and important. The transportation of small units more frequently is increasing the number of vehicles in the streets and so congestion and emissions. These trends probably will not be reverted as customer behavior might have changed permanently, however, the same digital technologies that create these problems can make the management of urban logistics more efficient.

According to IDC (International Data Corporation), global spending on digital transformation is expected to reach $3.4 trillion by 2026, with a five-year annual growth rate of 16.3%. On the other hand, it also mentions that 38% of all technology spending is on digital transformation, and two-thirds of all companies have implemented IT (initiatives supporting digital transformation, starting towards the evolution to autonomy process).

On the other side, the logistics industry is experiencing a massive transformation with innovations from crowd-shipping to drones. The "uberfication" of logistics is an example of how private companies use crowdsourcing and shared economy to improve logistics efficiency. In addition, some companies are focusing their work on optimizing transportation — there are many startups centered on express deliveries using scooters and bikes. Nevertheless, in many cases, the challenges are in another part of the logistics processes, for example, in finding a load/unloading area or integrating long-haul transportation with local last-mile delivery.

The different challenges faced by urban logistics presents an enormous opportunity a new technology such as the Internet of Things (IoT) to track the use of infrastructure and vehicles in real-time (Montoya et al., 2018; Zhang and Yu, 2013; Zhou et al., 2012), artificial intelligence (AI) to improve and accelerate decision making (Giret, 2019; Jucha, 2021), implementation of blockchain to improve security (Dutta et al., 2020); applications on the cloud (Lin et al., 2021) and data science (Pan et al., 2021) among others.

In this context, this paper proposes the innovative concept of Urban Logistics as a Service (ULaaS), expanding the concept of Mobility as a Service (MaaS) to the urban logistics space (Holmberg et al., 2016; Becker et al., 2020; Smith and Hensher, 2020; Wong et al., 2020). The proposed value proposition for ULaaS is the integration of various forms of logistics services and assets into a single platform accessible on-demand. The integration of the different services and stakeholders of Urban Logistics in a single platform allows the provision of service on demand and, at the same time, constitutes a control tower for traffic authorities, policymakers, logistics providers, carriers, and shippers themselves, improving the efficiency of logistics movements, reducing congestion and emissions.

First, this paper aims to define the ULaaS concept and its business ecosystem and explore the value proposition in the Campinas city, Brazil, examining the importance of the different ULaaS users and their role in creating value within the platform. For this purpose, stakeholder data was obtained through interviews and surveys with 161 individuals and firms from the wholesale and retail sectors, including 18 in-depth interviews.

The contribution of this work including a conceptual proposal for a digital platform, a comprehensive review of the literature and review practical cases in different regions of the world; a methodology for data collection and analysis based on interviews and surveys, and finally, the paper discusses business model for its implementation and a preliminary canvas for a minimum viable product (MVP). The work can provide insights to various stakeholders in the urban logistics ecosystem, including potential private operators for the platform, and policymakers interested in improving the governance of urban logistics.

## 2. Literature review

The evolution of different models of service-oriented architectures and cloud computing, such as Infrastructure as a Service – IaaS, Platform as a Service – PaaS, Software as a Service – SaaS provide a solid foundation for the development of a new generation of decentralized and interoperable IT services for logistics (Klingebiel and Wagenitz, 2013). As is the case of platforms based on the concept of Logistics as a Service (LaaS), with the function of supporting design, planning and operation tasks in supply chains; different authors present different architectures that support this concept (Table 1).

On the other hand, in the urban transport setting, historically, the implementation of digital platforms has been focused on the movement of passengers, whether by car, metro, train, tram, bicycle, public transportation, etc. The concept of Mobility-as-a-Service (MaaS), for example, is an integrated system for distributing and administering intelligent and user-centered mobility, bringing together the offers of multiple providers of mobility services through

a digital interface and enabling end-users to seamlessly plan and pay for mobility (MaaSLab, 2018). Another concept used in this space is the Collaborative as a Service (CaaS): this structure is based on incorporating operators more completely and uses its commercial interest to offer integrated public transport solutions that are commercially viable and attractive to consumers (Merkert et al., 2020).

Table 1 presents a literature review on the different variations (called "X") of service-oriented architectures (XaaS).

Table 1. XaaS variation

| XaaS variation | Objectives | Findings |
|---|---|---|
| Logistic as a Service - LaaS | This paper-based on projects of the Effizienz Cluster Logistik Ruhr, introduces the respective main concepts and guiding thoughts. To handle the growing need for flexibility and changeability in the supply chain, and thus to manage complexity and dynamics (Klingebiel and Wagenitz, 2013). | "Logistics as a service" contributes to the cluster strategy with advanced design instruments (Design Services), structures, processes, resources, and systems in supply chains that can be designed efficiently and sustainably (Klingebiel and Wagenitz, 2013). |
| | The article proposes a generic architecture for LaaS, based on elements of logistics networks as services (Lin et al., 2021). | Shared service platforms and traditional institutions confirm that the sharing economy positively impacts caregiver earnings and client surplus for government and social welfare (Lin et al., 2021). |
| Infrastructure as a Service – IaaS<br>Platform as a Service - PaaS | Infrastructure as a Service, Platform as a Service, and Software as a Service were identified for use to examine automation issues in customer relationship management by introducing a CRM (Customer Relationship Management) system to improve transportation support and logistics services (Zolkin et al., 2021). | Modern intelligent transport systems can solve problems like managing traffic flows and improving road safety. And its implementation is possible only in case of interaction of a whole set of technologies (Zolkin et al., 2021). |
| | Proposes a cloud-enabled platform in a multi-layer cyber-physical system achieving virtualization of logistics assets and real-time control, execution, and reconfiguration (Kong et al., 2020). | The platform can realize the modulation of technology applications with sufficient productivity improvement and generate a paradigm shift for e-commerce logistics (Kong et al., 2020). |
| Software as a Service - SaaS | This article aims to study the intelligent cold chain logistics distribution optimization algorithm based on big data cloud computing analysis (Chen et al., 2020). | With the application of technology such as big data in the cold chain logistics industry, it can be challenging to integrate information resources and requires considerable human and material resources to cooperate (Chen et al., 2020). |
| Collaboration as a Service-CaaS | This paper reviews the literature and current public transport governance frameworks of transport operators on a macro and micro spectrum (Merkert et al., 2020). | CaaS incorporates operators more fully and uses their commercial interest to offer consumers commercially viable and attractive integrated public-private transport solutions (Merkert et al., 2020). |
| Mobility as a Service - MaaS | This article presents an empirical analysis of the Transport for New South Wales MaaS policy program, based on a political analysis of MaaS, by introducing a framework that identifies the issues such policies should address (Smith and Hensher, 2020). | MaaS is a deliberate attempt to gradually transform the personal mobility system towards greater alignment between service regimes (Smith and Hensher, 2020). |
| | The objective was to develop a new service model to access transportation based on a critical analysis of the concept's rhetoric (Pangbourne et al., 2020). | A set of social effects are identified that affect urban planning and transport governance. Based on this, a range of possible unintended consequences and risks require public intervention (i.e., management) for both efficiency and equity (Pangbourne et al., 2020). |
| | This paper aims to investigate the business outlook for MaaS by collecting qualitative data from workshops and interviews in Budapest, Greater Manchester, and Luxembourg City (Polydoropoulou et al., 2020). | MaaS is viewed as a system-based innovation approach. The analysis indicates that the regulatory framework of cities, the lack of standardization and openness of application programming interfaces, and the need for investments related to transportation constitute risks for the successful implementation of MaaS in the study areas (Polydoropoulou et al., 2020). |

| | | |
|---|---|---|
| Delivery as a Service - DaaS | Delivers an industry report based on the evidence collected in various exploratory European projects that integrate ambitious and strategic findings on the Internet of Things, urban planning, consolidation centers, transportation optimization, and clean vehicle use (Huschebeck and Leonardi, 2020). | Contribute to the future scenario of urban logistics business models, based on that collected in multiple European exploratory projects that integrate ambitious and strategic findings on the Internet of Things, urban planning, consolidation centers, transport optimization and use of clean vehicles. |
| Supply Chain as a Service- SCaaS | This document presents a network-based business model for the cloud to design and manage the supply chain based on physical and digital assets (Ivanov et al., 2022). | The cloud supply chain was conceptualized as a new and distinct research area based on formalizing the supply chain's multi-structural dynamics and the service's dynamic composition (Ivanov et al., 2022). |

In this context, considering attention has been put on proposing platforms focused on the logistics and movement of goods in urban areas, this paper proposes the concept of ULaaS.

Some pilot projects have been created in Europe and the United States that include some of the concepts of ULaaS, though not in a comprehensive manner, such as Urban Logistics as an on-Demand Service (ULaaDS) (CIVITAS, 2022), Alliance for Logistics Innovation through Collaboration in Europe (ALICE) (Entrance-platform, 2021), Last mile delivery and logistics orchestration platform for your Enterprise - UrbanTZ (Urbant, 2022), Airmee (Airme, 2021), PTV software (PTV Group, 2022) and Lead Project (LEAD, 2022).

Some practical cases have also been written that have establishing the basis for creating the ULaaS platform. Table 2 list some of the literature case in this topic.

Table 2. Literature Cases

| Objective | Methodology and Technology |
|---|---|
| Develop a service application prototype based on information and communication (technologies for transport companies and end customers (Azab et al., 2021). | 1. Adopting a design thinking.<br>2. Practical ICT-based solution.<br>3. Software components: smart mobile application. |
| Explore the mechanisms that support collection and delivery points (CDP) as sustainable urban logistics innovations, providing viable market offers (Vural and Aktepe, 2021). | 1. Consumer survey and interviews.<br>2. Secondary data. |
| Reduce traffic flows within regional traffic systems as only one regional logistics service (Wagner vom Berg et al., 2020). | 1. SusCRM approach is a CRM-system that integrates sustainability into the customer relationship.<br>2. Hardware: MOVR, HUB and BOXES.<br>3. Software components: customer app, a disposition for order processing, a tour and route planning for the realization. |
| Develop a cooperative strategy for the sustainability of the urban last mile delivery (Siegfried and Zhang, 2020) | 1. Data collection from long-term empirical research and a survey of e-commerce users in Germany and China. |
| Analyze the combination of goods and cars through people to match the vehicle so that "urban cargo taxis" make reasonable planning development (Gao et al., 2018). | 1. Design of matching system algorithm for urban goods.<br>2. The system uses O2O design concept.<br>3. Software components: Google Android system, Apple System, Microsoft Windows phone system APP client. |

## 3. Methodology approach

To achieve the objectives of this research, the Design Science Research methodology was used based on the proposal Dresch (2015) of as illustrated in Figure 1.

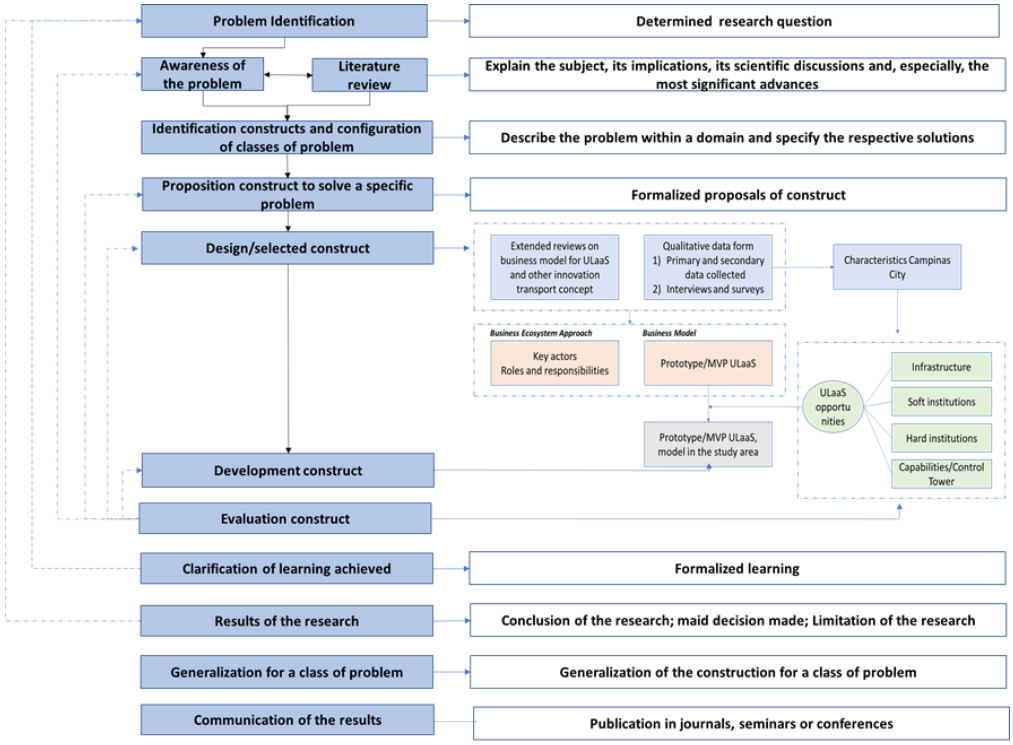


Fig. 1. Design Science Research adapted of Dresch (2015)

In the first place, the problem identification was carried out, and subsequently, a literature review was conducted on the concept of logistics or shared mobility, new technologies, the business perspective of ULaaS, and other innovative transport concepts. The information acquired by this review was then supplemented with qualitative data collected from stakeholders in Campinas city based on surveys and interviews. The analysis of these data allowed (i) to identify the essential ULaaS actors and their roles (business ecosystem approach), (ii) the mapping of unique characteristics and challenges of each area (innovation systems approach), and (iii) the development of a prototype/MVP business model for ULaaS.

### *3.1 Proposed construct - Urban Logistic as a Service*

The proposed construct of ULaaS (Urban Logistics as a Service) is the integration of various forms of urban logistics services and assets into a single digital shared platform accessible on-demand and based on the concept of sharing economy. The platform needs to provide service on demand and, at the same time, provide a “control tower” for traffic authorities, policymakers, and the shippers. The main goals are optimized resources, reduce congestion and emissions, improve safety and security, and improve integration of service.

The ULaaS provider business ecosystem comprises several actors, including 1. Shippers, 2. End consumers, 3. Retailers, 4. External platforms, 5. Independent truckers, 6. Carriers, 7. Local government research centers, and 8. Bank Developers. As the ULaaS ecosystem evolves, other players could also be added, such as media, marketing,

advertising companies, trade unions, and other standards bodies. However, this report focuses only on those actors who could enable or disable the concept in its early stages.

The concept of ULaaS includes several dimensions. It can prioritize each one according to the needs of a city or area, namely: i) the main goals of the urban logistics system (for example: reducing congestion or increasing safety), ii) the stakeholders, iii) the processes to be managed, and iv) the technology to be applied.

The dimensions are grouped in two levels, strategic and system components. The strategic level has a link to policies and regulations and the system/components level to the different activities (Figure 2).

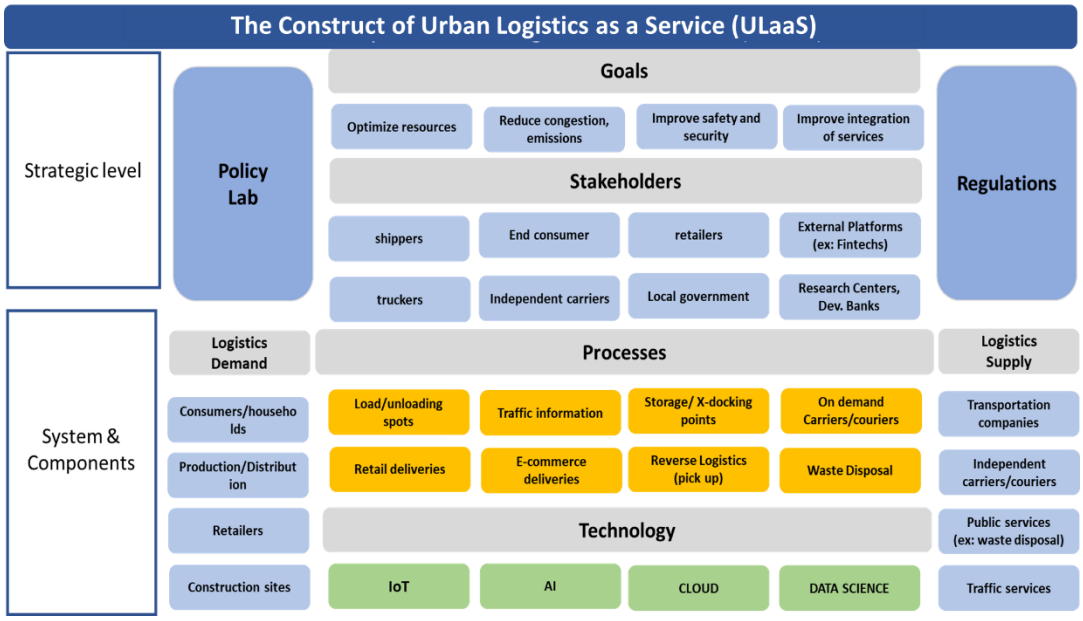


Fig. 2. A conceptual view of the main elements of the ULaaS platform

The value proposition of ULaaS revisit the biggest challenges of the last mile and how our solution solves that:

- Variety of stakeholders and interests (everybody meets at the last mile), including shippers, carriers, retailers, and the population that consumes the products and uses the transportation system.
- ULaaS will constitute a digital platform to integrate urban logistics stakeholders (shippers, carriers, retailers).
- Scarcity of space and infrastructure in urban areas: IoT components are implemented in the infrastructure, vehicles, and cargo (when applicable) to synchronize the deliveries and enable real-time planning and adjustment.
- Poor vehicle capacity utilization: manage carriers ‘on demand’ including not only truck drivers but ridesharing drivers and independent couriers using scooters, bikes, or other means of transportation.
- Complex decisions in a short period: utilization of data science concepts and AI to guide decisions by policymakers and stakeholders.
- Lack in sustainability solutions in Urban Logistics: funded by the public sector and developed with local startups, ideally integrated with traffic management activities in the city to guarantee sustainability and, in the medium term, exploring public-private partnerships.
- The disconnect between policies and implementations of solutions: to use Policy Labs to transform information into Policies and Regulations.
- Urban Logistics environmental externalities: the ULaaS platform allows non-motorized transportation to be incorporated into the portfolio of on-demand services, using the available infrastructure, and leveraging the sharing economy while reducing the carbon footprint of logistics movements in the city.

### *3.2 Proposed construct - Urban Logistic as a Service – ULaaS construct proposed structure*

The paper discusses a possible business model for its implementation and a preliminary canvas for a minimum viable product (MVP), providing a generic framework and set of guiding principles for developing a business model. The potential scope of services that create value for stakeholders is significant.

The MVP is a set of preliminary tests designed to validate the viability of the business. Several practical experiments will be carried out in bringing the product to a select group of customers without being the final product. We are talking about a product with the minimum possible resources if (in its entirety) they maintain its function of solving the problem for which it was created (being within a functional system, regardless of whether it is only the prototype). The entrepreneur will offer the minimum of functionalities to know in practice the reaction of the market, the client's understanding of his product and if this —in fact— solves the consumer's problem.

The proposal for mapping the different market levels of ULaaS as a product, the core is presented, where the movement of physical goods in the city is generated; the basic shared goods are analyzed; the expected reliability and safety of the product are shown in the different processes of the chain; in the expanded one, it is based on support services, transport, and storage, in addition to infrastructure and information support and remote monitoring of the system; and finally the potential shows the exchange of orders, capacity, and information. As a way of monetizing the ULaaS platform, there are different possibilities:

1. Membership-based self-service: repeat customer base, where customers can often access the product or service. As a result, the customer may benefit from the service without owning the underlying asset held by the company running the subscription-based business (i.e., roundtrip, one-way stationed, one-way free-floating).

2. Peer-to-Peer (P2P) Service: is a decentralized network formed by two or more people with computer equipment aligned within the same communication protocol (i.e., online platform, customer support, driver vehicle safety certification, auto insurance, and technology).

3. Non-Membership Self-Service: a service or business without membership and renting cars or vans. Also, carpooling, and other forms of transportation. (i.e., rental cars and carpooling);

4. For-Hire Service Models: include trikes, rideshares, taxis, limousines or liveries carrying passengers, with dynamic pricing based on a meter or similar technology.

Figure 3 presents a proposed canvas for the business model for ULaaS.

| Problem | Solution | Unique Value Prop. | Unfair Advantage | Customer Segments |
|---|---|---|---|---|
| • Trucks have no space for loading/unloading, and park on streets interfering with pedestrian and private vehicles<br>• Large trucks in urban roads increase congestion and pollution | • Online platform to control and give visibility of load/unloading space<br>• Sharing of private space dropoff/load/unload space<br>• Sharing of personal vehicles/spaces | • One stop shop for urban logistics info, services<br>• Control tower for city management<br>• End to End solution for shippers, carriers, receivers | • Supported by Government<br>• Honest Broker | • Shippers<br>• Carriers<br>• Retailers<br>• Independent truckers<br>• Service providers (lockers, UDC)<br>• Government |
| **Existing Alternatives** | **Key Metrics** | **High-Level Concept** | **Channels** | **Early Adopters** |
| • Blue Zone Parking<br>• Private unload/load areas | • % space used by trucks<br>• # irregular parking<br>• Emissions generated<br>• Volume of shared space | • Mobility as a Service (MaaS) | • City Administrators<br>• City web portal<br>• Cell Phone APP | • City Administrators<br>• Independent truckers<br>• Carriers |
| **Existing Alternatives** | | **Revenue Streams** | | |
| • Software Development<br>• Software and Hardware Maintenance<br>• User Support<br>• Data Analysis/Reporting | | • City Subsidies<br>• Sponsorship/merchandise<br>• Transaction fees<br>• Subscription | | |

Fig. 3. Canvas of ULaaS Business Model

## 4. Construct design

A questionnaire-type survey was designed for data collection, and we used the "Google Forms" tool. The target groups of the study were formulated according to the two categories of stakeholders, therefore: Shipper sectors and Transport sector.

### *4.1 Data Collection*

In data collection, each block of questions is different and is related to the stakeholder category. i.e., each block pursued different objectives in terms of obtaining information.

*4.1.1. Based on the Shipper Information Sector*

- Block 1 aimed at collecting information on the company's functional situation/processes (seven question).
- Block 2 collected information on the company's infrastructure situation (one question).
- Block 3 contained questions to obtain information on opinions related to the situation, legislation, and public sector initiatives in the sector under study (three questions).
- Block 4 refers to the studied sector's innovation and information technology sector (one question).

*4.1.2. Focused on the Transport Sector*

- Block 1 aimed at collecting information on the company's functional situation/processes (eight questions).
- Block 2 contained questions to obtain information on opinions related to the situation, legislation, and public sector initiatives in the sector under study (five questions).
- Block 3 is aimed at finding information about assets and information sharing (four questions).
- Block 4 collected information on the company's infrastructure situation (two questions).
- Block 5 opinion on a neutral governance body that manages city traffic (one question).
- Block 6 refers to the studied sector's innovation and information technology sector (one question).

To collect the data from the interested parties, 161 interviews were conducted for the wholesale and retail sectors. Thirty-three of these were applied virtually, and the rest were in person. And for the transportation sector were involved 18 in their entirety virtually in the Campinas city.

We applied the 33 interviews conducted by wholesalers and retailers' sectors on the following web page: https://forms.gle/A62U1UqW9M41s2bd8. And the 18 interviews the transport sector conducted virtually were involved in the following web page https://forms.gle/t2MGLh6Nva3bYnEn7.

The report was prepared in primary databases and interviews and surveys conducted in the Campinas city, Brazil. A total of 179 stakeholders were interviewed, of which 128 interviews were conducted in person and 51 remotely, conducted by transport, wholesalers, and retailers' sectors. The data exposed from the results of the interviews are analyzed in the work of Fioravanti et al. (2022).

### *4.2 General Characterization of Campinas City*

The Campinas region contains 19 municipalities. The city has a GDP per capita (2018) estimated at 10,052.09 US$, including 6% of industrial activities, 47.5% of commerce, and 46.6% of services (IBGE, 2021). The city has a strategic location, being a logistical hub due to its characteristics. Campinas is also close to the Port of Santos (172 km), the largest port in Latin America. In 2019, according to the IBGE (Instituto Brasileiro de Geografia e Estatística) statistics, Campinas had 46979 companies. With specific information on wholesale, retail, transport, and logistical services, according to IBGE statistics in 2019, a total of 21288 companies.

### *4.3 Analysis Shipper and Transport Sectors*

The current state of freight mobility in the Campinas city was analyzed using the SWOT analysis of challenges tool based on interviews. Its aim was to clarify the strengths, weaknesses, opportunities, threats, and challenges of

today's cargo services and to organize them. To clarify the analysis, the results were divided into four categories: operational environment context, public policy, infrastructure, and innovation and technology.

Tables 3 to 6 show the main SWOT results in these categories.

Table 3. SWOT Operational Environment Context

| **SWOT Analysis of Operational Environment Context** | |
|---|---|
| **Strengths** | **Weaknesses** |
| • Decision-makers are aware of development needs solutions based in the cargo traceability.<br>• Sharing economy: Information and cargo sharing in all city zone.<br>• Control tower for traffic authorities, policymakers, and the shippers.<br>• Integrations transportation: creates basic transport load for the integration of other transportation.<br>• Stable situation regarding population and services, good predictability of demand. | • Cargo inefficiency: long distances, low occupancy rates, cargo mobility based on personal cars, thin flows.<br>• Maintain the quality of products in the cold chain.<br>• Traffic congestion.<br>• Communication with the client (absent client).<br>• Lack of resources and expensive current system: subsidized transportation. |
| **Opportunities** | **Threats** |
| •Possibility of an existing cargo network, which could be better used for organizing travel chains to urban and rural areas. | • High insecurity.<br>• Condition and maintenance of the road network deteriorate.<br>• No new market-based cargo services.<br>• Confidence in the application and entities that manage it. |

Table 4. SWOT Public Policy

| **SWOT Analysis of Public Policy** | |
|---|---|
| **Strengths** | **Weaknesses** |
| • Policy makers to plan for transportation and loading infrastructure down to the block level in a city based on demand of application users.<br>• Possibility governmental subsidized sharing freight transportation creates basic transport load for the integration of other transportation. | • Incompetence governmental entities: lack of expertise in organizing and planning cargo mobility.<br>• Stakeholders do not trust public policies for cargo mobility. |
| **Opportunities** | **Threats** |
| • Collaboration of municipalities, universities, and/or government research centers.<br>• Combining rides and creating travel chains: mobility goods, postal delivery, sharing services; combining stakeholders in social and health services/care, municipality. | • Remarkable rise in costs (new taxes).<br>• New politics about cargo mobility.<br>• The Transport Code will benefit large companies and small ones will lose out. |

Table 5. SWOT Infrastructure

| **SWOT Analysis of Infrastructure** | |
|---|---|
| **Strengths** | **Weaknesses** |
| • Brazil postal service and Pick-up points: distribution network during weekdays covering the whole country.<br>• Collaborative platform that works as a marketplace.<br>• Future research to explore the challenges of this model in the context of various business and government norms outside of Campinas city. | • Limited infrastructure: poor state of the road network and easy accessibility of air traffic and ports.<br>• Vehicles do not have space for loading/unloading.<br>•Large trucks in urban roads increase congestion and pollutants. |
| **Opportunities** | **Threats** |
| • Savings in future infrastructure investments required (e.g., 5G). | • Inflation, High gasoline costs.<br>• Inefficiency in the application of public policies. |

| |
|---|
| • Agility in deliveries. |

Table 6. SWOT Innovation and Technology

| **SWOT Analysis of Innovation and Technology** | |
|---|---|
| **Strengths** | **Weaknesses** |
| • Extensive technology infrastructure: road network.<br>• Central tower.<br>• Digitization services.<br>• Cloud data (information on-time).<br>• Real time tradability. | • Data security.<br>• Lack of IT systems and information, accessibility, and usability (broadband blind spots, communication between the public sector and consumer). |
| **Opportunities** | **Threats** |
| • Availability of technologies and continuous development.<br>• Open data connection, use in decision making.<br>• News startups in new technologies. | • Public policies for cargo mobility and technological applications.<br>• Patent delays. |

Since the Covid 19 pandemic, the increase in demand for online purchases in countries such as Brazil, Colombia, and Chile have led to the need to expand the range of delivery solutions, both in time slots and in places where the transport company can deposit the package. Also, it eliminates problems such as loading and unloading within urban centers and reduces congestion, air pollution, and noise pollution.

Thus, the ULaaS platform, acting as a marketing place, brings together several benefits in a single digital platform, is therefore that the table 7 describes solutions based on specific problems raised in the interviews and the SWOT analysis.

Table 7. ULaaS Impact

| **ULaaS Impact** | **Importance** | **Solution** |
|---|---|---|
| Congestion | To impact and translate the findings into open decision support tools and guidelines that other urban areas can adopt to identify, explore, and assess different sets of intervention measures to deal with the requirements of congestion in the city urban. | • Base in route planning and optimization, Geocoding, digital maps, and data.<br>• Vehicles space sharing.<br>• Communication «Vehicle to Vehicle» to «Vehicle to Infrastructure»; real-time data capture and management. |
| Pollution | Employs machine-learning technologies or other technologies, and AI algorithms to fully optimize logistics in the last-mile in cities to make it more efficient and environmentally friendly. | |
| Noise | To know the exact scope of the impact of noise in the main environments of the city by evaluating the acoustic impact. | Based on the implementation of IoT, sound environments can be evaluated, allowing the creation of remote and autonomous equipment (acoustic nodes), independent or interrelated, that would enable monitoring of the environment with almost no human action. |
| Consolidation centers | To facilitate loading and unloading operations (reducing illegal parking) and can offer stock services to merchants. | Being a collaborative platform that works as a marketplace in an ecosystem of logistics service providers and consumers, it can offer its spaces as urban centers for loading and unloading products. |
| Parcel lockers & Pick-up points | To link to a system of non-home delivery networks, combining Collection Points and Lockers, to offer them the possibility of receiving | In addition, offering on the ULaaS platform spaces associated with Parcel lockers & Pick-up points. This service depends on the volume of products and number of users to be served, in any case they are small spaces that can be exclusive or that can be integrated into other spaces. |

| | | |
|---|---|---|
| | purchases online other types of deliveries. | |
| Sharing economy platforms | Sharing Economy Platform for on-demand freight city logistics.<br>A city-wide platform for integrated management of urban logistics will support the management of the integrated system built as in a Physical Internet (PI) | Using a control tower with a procedural view of the entire life cycle of an order in a company brings many benefits. Among them are:<br>• Reduction of return fees and delays;<br>• Improved punctuality in deliveries and fluidity in the operation;<br>• Risk management;<br>• Definition of safer routes;<br>• Increase in fleet productivity;<br>• Real-time information;<br>• Expanding the flexibility of a logistics operation;<br>• Cost reduction;<br>• Greater efficiency;<br>• Creation of a competitive differential. |
| Unloading booking systems | Develop a framework to support the design and implementation of cost-effective sustainable integrated city logistics systems, by involving stakeholders in the co-creation of innovative last mile solutions and services that address the needs of the on-demand economy. | Use of the Internet of Things (IoT) to track in real-time the infrastructure, vehicles, and packages, lead us to propose an innovative concept of Urban Logistics as a Service (ULaaS), which is in essence like Mobility as a Service (MaaS), the only difference is that focuses on the cargo transportation. |
| Vehicles space & warehouses sharing | Cluster the merchandise of several clients in a single shipment or warehouse so that each of them can save time and money. | • Companies that are starting to outsource: groupage is a way to save costs on small shipments;<br>• Small and medium-sized companies: with shared transport, they have access to quality and economical logistics services;<br>• Shared transport guarantees on-time delivery of goods;<br>• Small shipments are much more efficient if they are sent by groupage;<br>• Savings are achieved in logistics and transport costs;<br>• Groupage makes it possible to offer more competitive prices to customers. |
| Responsible for the platform | Manage the ULaaS platform through a public initiative (EMDEC) | Based on traffic management in the Campinas city. The best option to manage the platform with drop-off/pick-up points for cargo with the possibility of integration with a marketplace for hiring individual couriers to carry out last-mile deliveries to their customers would be a public initiative. |

The platform is expected to create positive externalities in terms of public policy and public good as it will enable a direct communication channel between different stakeholders in the urban logistics space and will create more efficiency and use of vehicles and space in urban areas.

There is a direct impact in reducing environmental externalities like pollution and $CO_2$ emissions. Also, data collected in the platform can be shared with policymakers to improve traffic management and infrastructure investment.

Applying technologies such as Big Data, 5G, or machine learning can multiply IoT applications in transport used within a digital platform such as ULaaS. By combining increased speed and bandwidth with AI, more possibilities arise with greater control and load tracking. In addition, this also impacts improving the working conditions of the entire team.

The combination and application of these technologies make the success and positioning of companies possible. The transport sector cannot be left out of the opportunities offered by a ULaaS platform based on IoT applications.

However, the correct implementation and the best way to add these benefits is probably through the support and advice of specialized companies to incorporate digitized solutions. Thus, the authors created four modules to address different logistics problems, to offer you help and intelligent solutions that businesses such as e-commerce need, providing a specialized platform from which to carry out all the management.

### *4.4 Identified modules by interviews*

In addition to validating the proposed construct, the research contributed to the identification of modules that generate value for the stockholders discussed below: Parking space reservation, warehousing spaces, e-commerce, and logistics service. Which allowed the expansion of the proposed construct to a second level of detail incorporating the desired modules as illustrated in the following figure as an expansion of Figure 4.

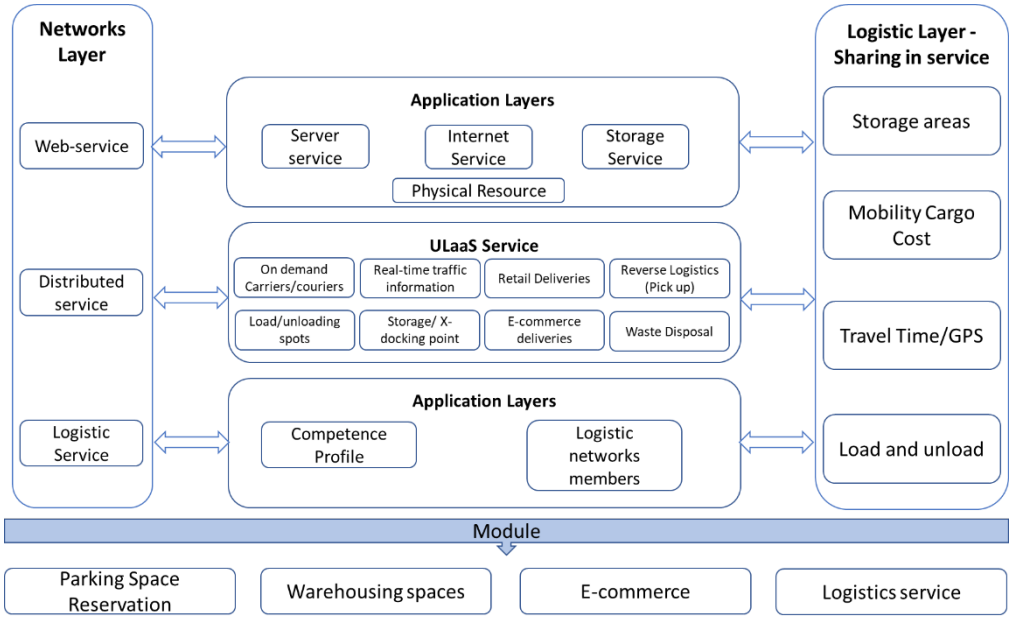


Fig. 4. Architecture diagram ULaaS of the approach with four Modules

- Parking Space reservation module: it will address the delivery companies' concerns about the missing available parking areas for delivery vehicles in cities. On the demand side, the module will allow delivery companies to reserve spaces ahead of time and on-demand, knowing the spot is guaranteed at arrival time.

To access the available parking spaces, first, the user will enter the pick/up delivery information such as a pickup/delivery address, the vehicle size, and the date and time of arrival. Second, the user will define the search criteria, such as Map-area (based on the Mobile GPS information), address or region, suggested route, or performance rating. After completing this step, the module will show the closest available parking locations.

On the Supply Side, both Public Companies and Private Companies can offer parking spaces to be reserved. The module should use geo-intelligence to show the closest location, based on the information entered, and will suggest the best route to the available parking space, helping delivery companies to save cost and time and reduce the urban logistics externalities in cities.

All the suppliers who desire to include their services or goods in this module must be approved in a previous background check.

- Warehousing spaces module: it will allow warehouse companies to share available formal/informal spaces to maximize warehouse utilization and help businesses expand their storage capacity.

On the Demand side, the app will allow businesses to look for available spaces in warehouses. To access the public warehouse spaces, the user will enter information such as the location, the number of volumes or pallet positions required, the rental date and period, and some specific details on the items to be stored, such as restrictions, cold storage, etc.

Then, the user will select the criteria used in the search. For example, the search can be based on the user's mobile GPS information, the user can search for the warehousing spaces in a specific address or region, or the user can consider the performance rating as a criterion for the search.

On the Supply Side, companies such as warehousing companies, pickup/delivery companies, dark-warehouse companies, and even individuals can offer spaces to be rented. All the suppliers who desire to include their services or goods in this module must be approved in a previous background check.

- E-commerce module: it will allow stores, businesses, and individuals to search/offer pickup, drop-off, or storage services. To access the offered services, the user will enter information such as the location, the number of parcel volumes to be delivered or stored, the pickup, delivery, or warehousing date and period, and some specific information or requisites required.

Then, the user will select the criteria used in the search. For example, the search can be based on the user's GPS information, or the user can search for the service type, search for the service in a specific address or region, or the user can consider the performance rating as criteria for the search.

On the Supply Side, private companies such as moto boy's companies, uber and other delivery companies, warehousing companies, pickup/delivery companies, e-commerce parcel lockers companies, and even individuals, such as moto boys and personal vehicle drivers; can offer their delivery/warehousing services in the module.

All the suppliers who desire to include their services or goods in this module must be approved in a previous Background check.

- Logistics Service module : it will allow the search for goods (new or used) that are on sales, such as vehicles, forklifts, and equipment. The user can also search for maintenance services for these goods, or some supplies, such as gas/diesel, lubricants, etc.

To access the goods or services, the user will enter information such as the service type, the location, or the user can look at some web databases that will link to the service platform. Also, the user can consider the performance rating criteria for the search.

On the Supply Side, private companies, drop shipping companies, or other marketplaces can offer their goods or services in the service marketplace.

All the suppliers who desire to include their services or goods in this module must be approved in a previous background check.

## 5. Conclusion

The research carried out allowed, from the theoretical framework, to build a conceptual proposal for ULaaS and from the interviews, to identify the four main modules with potential for use, namely: parking space reservation module, warehouse space module, e-commerce module, and logistics services module. In many aspects, the prioritization of these functionalities, highlights the need of sharing logistics assets that are scarce in urban areas.

In addition, the interviews pointed that an area that is still very little explored is the exchange of logistics data between companies and municipal authorities to improve operations, regulations, guide investments, and improve the economic and environmental sustainability of logistics operations in urban areas.

In this context, the ULaaS platform can contribute to these aspects, increasing efficiency in using assets and improving the quantity and quality of data available to authorities, private companies, and the population.

The results of interviews and surveys conducted in the Campinas city provided key insights for the development of the platform, which can be summarized as following:

- Loading/Unloading in commercial areas is one the biggest issue (all interviewers).
- Some carriers must have two drivers in the same vehicle to coordinate deliveries.
- Drop-off directly in stores causes disruptions in the operation.
- Carriers and 3PLs (Third Party Logistics) are willing to participate in future pilots.

- Most logistics actors feel comfortable with public sector ownership of the product, but there is a strong resistance in some groups.
- Some interviewers will require freemium model (not transactional costs for carriers).
- There are opportunities to offer additional services in the platform.
- Barriers to the implementation of ULaaS was also identified in the study area.
- Internet quality: in some areas, users may not have enough Internet coverage or resources.
- Privacy: privacy concerns may prevent some carriers/drivers/service providers from uploading your information to the platform. The privacy policy and features must be well established, and a clear communication plan must be in place.

In summary, the concept of ULaaS was well received by the stakeholders involved in the operation of urban logistics in the Campinas city and some of the challenges could be tackled successful by the platform. The benchmarking of similar platforms such as MaaS and LaaS are good indication for a road map that could be followed by ULaaS. Nevertheless, due to the complexity of the urban logistics setting, the successful implementation of ULaaS will require a strong coordination among all the stakeholders, including authorities, legislators, operators, and civil society.

The preliminary analysis of possible business models indicates potential for a public-private participation in the operation of the platform, but further detail financial and economic analysis will be required.

The ULaaS platform can help policymakers to leverage technology to organize the urban logistics system while accelerating the engagement of small firms and startups in this task. In addition, by using the principles of sharing economy, the platform will increase efficiency while generating new businesses opportunities.

Finally, the analysis presented here was carried out in a Brazilian metropolitan area. Therefore, it could be interesting to explore the business models of ULaaS in cities with similar cultures, transport environments, and economies.

This paper sets the base for pursuing a service-oriented platform for urban logistics. Future work could be focused on exploring the different monetization models and investments required, what will be critical to assess potential private participation, as well as further analysis could be done to determine the economic benefits generated by ULaaS, what will be essential to get public sector involvement.

## References

Airme. Perfecting the Delivery Experience. https://airmee.com/platform/ Accessed 01 November 2021.

Azab, A., Park, J., Mostafa, N. A., 2021. Smart mobile application for short-haul cargo transportation. Logistics, 5.2, 36.

Becker, H., Balac, M., Ciari, F., Axhausen, K. W., 2020. Assessing the welfare impacts of Shared Mobility and Mobility as a Service (MaaS). Transportation Research Part A: Policy and Practice, 131, 228-243.

Chen, Y. H.,2020. Intelligent algorithms for cold chain logistics distribution optimization based on big data cloud computing analysis. Journal of Cloud Computing, 9.1, 1-12.

CIVITAS. Urban Logistics as an on-Demand Service. https://civitas.eu/news/new-ulaads-project-deliver-solutions-urban-logistics-demand-economy. Accessed 01 January, 2022.

Dablanc, L., 2007. Goods transport in large European cities: Difficult to organize, difficult to modernize. Transportation Research Part A: Policy and Practice, 41.3, 280-285.

Diziain, D., Taniguchi, E., & Dablanc, L., 2014. Urban logistics by rail and waterways in France and Japan. Procedia-Social and Behavioral Sciences, 125, 159-170.

Dresch, A., Lacerda, D. P., Antunes, J. A. V.,2015. Proposal for the conduct of design science research. In Design Science Research (pp. 117-127). Springer, Cham.

Dutta, P., Choi, T. M., Somani, S., Butala, R., 2020. Blockchain technology in supply chain operations: Applications, challenges and research opportunities. Transportation research part e: Logistics and transportation review, 142, 102067.

Entrance-platform. Alliance for Logistics Innovation through Collaboration in Europe – ALICE. https://www.entrance-platform.eu/constortium/alliance-for-logistics-innovation-through-collaboration-in-europe/ Accessed 01 November 2021. 2021.

Fioravanti, R., Fontes Lima, O., Montoya, G., 2022. Logística urbana como serviço (ULaaS): um teste de conceito. Anais do 36º Congresso de Pesquisa e Ensino em Transportes. ISSN: 2237-1346.

Frischtak, C. R., Davies, K., Noronha, J., 2015. O financiamento do investimento em infraestrutura no Brasil: uma agenda para sua expansão sustentada. Econômica, 17, 2.

Gao, C., Yang, J., Xu, J., Chu, P., Zhang, L., 2018. The design and analysis of the matching system for the urban freight taxis. In CICTP 2017: Transportation Reform and Change—Equity, Inclusiveness, Sharing, and Innovation Reston, VA: American Society of Civil Engineers. 1447-1452.

Giret, A., 2019. Smart and sustainable urban logistic applications aided by intelligent techniques. Service Oriented Computing and Applications, 13.3, 185-186.

Holmberg, P. E., Collado, M., Sarasini, S., Williander, M., 2016. Mobility as a Service-MaaS: Describing the framework. In Tuesday, February 16, 2016.

Huschebeck, M., Leonardi, J., 2020. Approaching delivery as a service. Transportation Research Procedia, 46, 61-68.

Ivanov, D., Dolgui, A., Sokolov, B., 2022. Cloud supply chain: Integrating industry 4.0 and digital platforms in the "Supply Chain-as-a-Service". Transportation Research Part E: Logistics and Transportation Review, 160, 102676.

Jucha, P., 2021. Use of artificial intelligence in last mile delivery. In SHS Web of Conferences EDP Sciences. 92, 04011.

Klingebiel, K., Wagenitz, A., 2013. An introduction to logistics as a service. In Efficiency and logistics. Springer, Berlin, Heidelberg. 209-216.

Kong, X. T., Zhong, R. Y., Zhao, Z., Shao, S., Li, M., Lin, P., Huang, G. Q., 2020. Cyber physical ecommerce logistics system: An implementation case in Hong Kong. Computers & Industrial Engineering, 139, 106170.

LEAD, 2022. LEAD Strategies for shared-connected and low-emission logistics operations. Accessed 23 July 2021: https://www.leadproject.eu/

Lin, M., Ma, L., Ying, C., 2021. Matching daily home health-care demands with supply in service-sharing platforms. Transportation Research Part E: Logistics and Transportation Review, 145, 102177.

MaaSLab, 2018. The MaaS Dictionary. https://www.maaslab.org/_files/ugd/a2135d_d6ffa2fee2834782b4ec9a75c1957f55.pdf. Accessed 15 June 2021.

Merkert, R., Bushell, J., Beck, M. J., 2020. Collaboration as a service (CaaS) to fully integrate public transportation–Lessons from long distance travel to reimagine mobility as a service. Transportation Research Part A: Policy and Practice, 131, 267-282.

Montoya, G. N., Santos Junior, J. B. S., Novaes, A. G., Lima, O. F., 2018, February. Internet of Things and the risk management approach in the pharmaceutical supply chain. In International Conference on Dynamics in Logistics, Springer, Cham, 284-288.

MTPA, 2017. Anuário Estatístico de Transportes 2010-2016 (Statistical Yearbook of Transport 2010-2016), Ministry of Transport, Ports and Civil Aviation, Brasilia.

Pan, S., Zhou, W., Piramuthu, S., Giannikas, V., Chen, C., 2021. Smart city for sustainable urban freight logistics. International Journal of Production Research, 59.7, 2079-2089.

Pangbourne, K., Mladenović, M. N., Stead, D., Milakis, D., 2020. Questioning mobility as a service: Unanticipated implications for society and governance. Transportation research part A: policy and practice, 131, 35-49.

Polydoropoulou, A., Pagoni, I., Tsirimpa, A., Roumboutsos, A., Kamargianni, M., Tsouros, I., 2020. Prototype business models for Mobility-as-a-Service. Transportation Research Part A: Policy and Practice, 131, 149-162.

PTV Group. 2022. Soluciones de software para la movilidad. Accessed 15 November 2021: https://company.ptvgroup.com/es/productos.

Siegfried, P., 2021. Developing a sustainable concept for the urban lastmile delivery. Open Journal of Business and Management, 9.1, 268-287.

Smith, G., Hensher, D. A., 2020. Towards a framework for Mobility-as-a-Service policies. Transport policy, 89, 54-65.

Taniguchi, E., Thompson, R. G., Yamada, T., 2014. Recent trends and innovations in modelling city logistics. Procedia-Social and Behavioral Sciences, 125, 4-14.

Taniguchi, E., Thompson, R. G., Yamada, T., 2008. Modelling the behaviour of stakeholders in city logistics. In International Conference on City Logistics, 5th, 2007, Crete, Greece.

Urbantz, 2022. Empresas de logística. https://urbantz.com/es/solutions/logistics/ Accessed 15 July 2021.

Vural, C. A., Aktepe, Ç., 2021. Why do some sustainable urban logistics innovations fail? The case of collection and delivery points. Research in Transportation Business & Management, 100690.

Wagner vom Berg, B., Hanneken, F., Reiß, N., Schopka, K., Oetjen, N., Hollmann, R., 2020. Platform Sustainable Last-Mile-Logistics—One for ALL (14ALL). In Advances and New Trends in Environmental Informatics Springer, Cham. 67-78

Wong, Y. Z., Hensher, D. A., Mulley, C., 2020. Mobility as a service (MaaS): Charting a future context. Transportation Research Part A: Policy and Practice, 131, 5-19.

World Bank. https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html#:~:text=News-,68%25%20of%20the%20world%20population%20projected%20to%20live%20in,areas%20by%202050%2C%20says%20UN&text=Today%2C%2055%25%20of%20the%20world's,increase%20to%2068%25%20by%202050. Accessed 15 January 2021, 2017.

Zhang, Y. C., & Yu, J., 2013. A study on the fire IOT development strategy. Procedia Engineering, 52, 314-319.

Zhou, H., Liu, B., & Wang, D., 2012. Design and research of urban intelligent transportation system based on the internet of things. In Internet of Things, Springer, Berlin, Heidelberg. 572-580.

Zolkin, A. L., Domracheva, E. A., Losev, A. N., Avdeev, Y. M., 2021, February. Use of the modern information technologies for continuous monitoring of transport infrastructure. In IOP Conference Series: Materials Science and Engineering IOP Publishing. 1047. 1, 012094