

**LAST MILE TRIPS:
Logistics distribution infrastructure in smart cities and the experiences of
service provision in the Metropolitan Region of Recife - PE**

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SUMMARY

The present research aims to explore the main technologies added in the last mile logistics distribution infrastructure models used in smart cities, as well as relate them to the experiences of companies that provide these services in the Metropolitan Region of Recife (MRR). In order to do so, a case study is presented on the logistics distribution system used by a company that performs last mile delivery in the MRR. The data were collected through the application of a questionnaire to the manager of the company in question. Considering the studies analyzed on the subject, the implementation of new models of last mile logistics distribution in smart cities around the world, such as pick-up points, lockers, crowdsourcing and crowdshipping, was evident. Regarding the logistics distribution infrastructure used in the MRR, the results obtained showed that the application of the new models is still limited. It is concluded that the existence of public/private partnerships is essential for the introduction and strengthening of new last mile logistics distribution systems used in cities, whether they are considered smart or not.

KEYWORDS: Smart cities. Last mile. Logistics.

INTRODUCTION

For the development of smart cities, regarding to the urban mobility axis, it is not limited to solving the inefficiency of the public transport system and/or the emission of polluting gases by combustion vehicles. In fact, solving the complexity of problems arising from urbano mobility in large cities also depends on the use of technological instruments to create intelligent service delivery models.

Souza et al. (2020, p. 02) draws attention to urban freight transport (UFT), considering it “an important source of employment and a facilitator of economic growth in cities”, which is justified by changes in consumer habits and consequent expansion of e-commerce, particularly due to e-commerce amenities and logistical practices.

Behind this appearance of facilities provided to consumers by the commerce in general, of receiving the purchased goods in the comfort of home, there are the economic, social and environmental impacts generated by traffic jams, noise pollution, consumption of non-renewable energy, emissions of polluting gases and risk of accidents, which are already a concern, especially regarding to the last mile, that is, the last stage of the delivery of the goods to the final consumer. (MCKINNON et al., 2015; MUÑOZ-VILLAMIZAR et al., 2017; SOUZA et al., 2020).

According to Roumboutsos et al. (2014), the last mile represents approximately 50% of the total cost of deliveries. Joerss et al. (2016) states that the global logistics cost corresponding to the last mile is 70 billion euros per year. In Brazil, logistics costs reach 12.2% of GDP (ILOS, 2019). Oliveira (2020) also reveals that expenses from the last mile represent 7.6% of the companies’ net revenue, when expenses with transport, inventory and storage are considered.

Oliveira (2020, p. 01) cites a survey carried out by the Brazilian Association of Electronic Commerce (ABComm, 2020), which found that “expenses with carriers (freight) are equivalent to 58% of logistics costs, followed by expenses with storage (21.5%) and handling expenses (20.5%)”.

In this sense, considering that information and communication technology tools (ICTs) are used to promote problem solutions also in the context of urban mobility, which last mile logistical distribution infrastructure models are used in cities considered smart? From such questioning, the present study aims to explore the main technologies added in the last mile

logistics distribution infrastructure models used in smart cities, as well as relate them to the experiences of companies that provide these services in the city of Recife - PE.

In the knowledge that the traditional model of home delivery of goods is still used by many companies, the new models, such as pick-up points, lockers, crowdsourcing and crowdshipping, are already part of the reality in many cities and several countries on the planet. There are even researches, case studies, on the aforementioned last mile logistics models. However, the present research intends to obtain results concerning even more advanced models, with technologies used in cities considered smart.

Thus, from the last mile logistics models implemented in smart cities, it will be possible to stimulate reflections on the operationalization of such models in cities where traditional last mile logistics distribution systems are still predominantly used, even with the known disadvantages that an economic impact by raising the cost of providing this delivery service to the final receiver.

THEORETICAL FOUNDATION

Preliminary notions about new logistical distribution models in smart cities

The amount and diversity of harm involving the UFT, especially regarding to the last mile, is quite significant. Through new distribution systems associated with ICTs, however, cities considered smart have created and implemented models of logistics distribution infrastructure in order to fix the problems related to the last stage of goods delivery to the final consumer.

Vieira, Carvalho and Yoshizaki (2016) refer to the decrease in delivery time when performed at night. Bertazzo et al. (2015) also reinforce the potential of overnight delivery as a solution for companies that use transporters and logistics operators. Among the benefits, the authors mention the increase in the speed of the transport vehicle, ease of parking, reduction of time at each stop, reduction of traffic fines and a lower level of stress.

The aforementioned deliveries, in the traditional model, in the other hand, increase the value of nighttime labor, the distribution of the goods to final consumers' houses takes more time on the part of the employees, which would impact the payroll, as well as they can find restrictions regarding to schedules and certain city locations or areas, depending on municipal legislation (BERTAZZO et al., 2015). In this sense, in the face of these obstacles, it appears that associating overnight deliveries with traditional models is not a viable solution. However, it is believed that overnight deliveries combined with new models, which make use of ICTs for the distribution of last mile goods, can provide more advantages to those involved.

Among the best-known models today and already implemented by several companies, it is worth mentioning, by way of example, pick-up points, lockers, crowdsourcing and crowdshipping. All of them are used as last mile models, aiming at the effective delivery of the goods to the consumer, with the lowest cost with logistics for the company, but in a different way from the traditional delivery.

Pick-up points is a system that is used in physical partner stores or in a stand-alone collection facility, such as a locker or box, for example (SILVA et al., 2020). Generally, local entrepreneurs take advantage of the physical space of the establishment itself, as a source of

income, and partner with other businesses to receive and store orders, so that final consumers can collect the goods acquired using distance selling. The products must be withdrawn during business hours, defined by the establishment which receives the goods (AUGEREAU; DABLANCE, 2008).

Lavado (2018) reports how pick-up points have become a successful model in India due to the notoriously poor infrastructure there. According to the author, large retailers have partnered with small neighborhood stores, called “kiranas”, known for selling different products, turning them into pick-up points for goods purchased online. Lavado (2018) says that in addition to improving the final logistics of delivery, the distribution network “helped small businesses to survive and pleased the government, which feared the extinction of the “kiranas” and talked about strong regulations”.

The locker, which also functions as a pick-up point, is a locker usually located in shopping malls, gas stations, train stations or on the street, where people can pick up their orders (AUGEREAU; DABLANCE, 2008). As a rule, automatic delivery terminals are open 24 hours a day. Araújo, Reis and Correia (2019) explain that in Europe, 54% of all online consumers already benefit from this modality that uses a delivery terminal as a destination (final). Furthermore, it is worth noting that while a delivery team in the traditional model has the capacity to deliver 100 orders at home, in the locker model they carry out 700 per day with the same operating cost (MUNDO LOGÍSTICA, 2017).

Crowdsourcing is structured by means of a network of drivers, that is, any qualified person can participate as long as they register themselves on a certain platform to make deliveries. Among the advantages of this model, it is worth mentioning the low initial investment, since the drivers are the owners of the vehicles (SOUZA et al., 2020). The crowdshipping, on the other hand, although similar to the previous model, differs by making use of ordinary citizens, who can perform the deliveries on foot, by bike or by means of transport they have, such as scooters (OLIVEIRA, 2020).

The truth is that the models illustrated here can and are used in smart cities, but even though in an incipient or experimental basis, they are also being introduced in developing countries, such as Brazil. The alternatives described here present advantages in several aspects in terms of promoting intelligent logistics, not only in relation to the delivery of the goods to the final consumer, but also regarding to the return of the product or even to implement reverse logistics.

As for the ICTs used for self-service models, these vary from company to company. The consumer who purchases products on Amazon becomes aware that the order is already available in the locker through email/message, and to withdraw the product, the one receives a code sent, also by email/message, or by scanning the barcode sent by email using the reader available in the locker (OLIVEIRA, 2020). The MeuLocker company, by application, informs the arrival of the goods in the locker and with a password provided, the consumer withdraws his/her purchase on the day and time that is most convenient (OLIVEIRA, 2020).

Experiments on last mile logistic distribution models in smart cities

The city of Singapore in Asia is popularly known, and recognized by several rankings, as the number one (01) smart city in various segments. This is due to the track record of Singapore, well remembered by Souza et al. (2014, p. 423), due to the “adoption of cutting-edge technology and inter/intra collaborative ventures between regulatory agencies and companies – in public/private partnerships”.

As far as distribution of goods to the (final) recipient in the city center is concerned, Singapore, as in so many others, faces the problem of widespread fragmentation of last mile freight logistics, because, as a rule, shippers hire different logistics service providers and carriers for deliveries to retailers in the cities, which makes this model inefficient and unproductive, since it has as a consequence low truck utilization, excessive truck maneuvers, higher system-wide costs and negative environmental impacts (SOUZA et al., 2014).

Amid the known and possible technological solutions to solve the problem at hand, the Singapore government announced its project to implement a locker system as part of its smart nation vision (SINGAPORE'S, 2016). The locker system, as mentioned earlier, allows the collection of orders and returns to be performed without face-to-face contact with the carriers. Instead, according to the Singapore government's project, customers can interact directly with the locker system through a digital interface (SINGAPORE'S, 2016).

In some cities today, we can see that the lockers have been installed by the companies themselves, in places considered strategic, such as in public places, where consumers gather. Amazon, for example, has placed its lockers in underground stations in London which is not allowed in Singapore since the government prohibits the installation of commercial lockers in train stations or crowded public areas, for security reasons (LYU; TEO, 2021).

On the other hand, the Singapore government, through automated infrastructure, intends to build a society of digitally responsive delivery companies and customers in order to provide more convenient, cost-effective and faster order delivery services and thereby simplify the delivery flows in densely populated neighborhoods. To understand the concept, the locker system would be installed 250 meters from each public housing unit to attract the customer use of the service. Furthermore, as the project will be open to all parcel delivery companies, Singapore will be the first country to do “large-scale roll-out of common parcel lockers” on a national level (LYU; TEO, 2021).

Europe, considered the cradle of civilization, faces very similar issues to Singapore when it comes to planning and managing the logistics of last mile goods, among others. The European Commission predicts that the urbanization process will reach 82% by 2050 or more than 90% by 2050 in countries such as Denmark, Sweden, Belgium, Luxembourg, Malta and the Netherlands (EUROPEAN COMMISSION, 2013). As it is known, as the amount of population in cities increases, economic activities also increase, and, consequently, the number of problems of all kinds grows, which require effective solutions from governments, particularly in the transport sector, since, according to Slabinac (2015) the effectiveness and sustainability of this segment are increasingly important to perform all the specific functions of the city and promote its economic prosperity and welfare (economic) of its residents.

In this sense, the effectiveness and sustainability of goods deliveries to customers in the urban areas of European cities is among the concerns of their rulers, because, as Visser (2005) rightly recalls, the presence and operation of goods transport vehicles in urban areas,

especially in small and large European cities with historic cores, are often considered more of a nuisance than an essential service.

Thus, considering this and other issues, the European Union (EU) signed the Green Deal on sustainable and smart mobility strategies for EU transport (EUROPEAN COMMISSION, 2020). As part of the Green Deal, city logistics strategies that focus on zero-emission vehicles, smart delivery projects, and freight logistics planning and management have been included. A promising solution to reduce traffic in cities is the use of a hub that allows trucks to unload goods, which are then grouped together so that efficient and emission-free last mile logistics can be carried out. City hubs have proven to be economical - saving time and fuel, and contributing to CO₂ reduction (TOLENTINO-ZONDERVAN; BOGERS; VAN DE SANDE, 2021).

For a better understanding of the hub model, Tolentino-Zondervan, Bogers and van de Sande conducted research at the Heijendaal Living Lab, an urban logistics project that aims to improve the sustainability of goods delivery using city and campus hubs, in Nijmegen, in the Netherlands, one of the countries where a large increase in urbanization is expected by 2050, as mentioned above.

It is worth clarifying that the Heijendaal campus is home to three organizations: a hospital, a university and a university of applied sciences. And according to the authors, the Heijendaal campus is characterized by a considerable flow of students, patients, visitors and staff, and supplies needed for research, treatment and teaching for each of these organizations, which causes traffic jam and, consequently, the negative impacts on the environment and life quality (TOLENTINO-ZONDERVAN; BOGERS; VAN DE SANDE, 2021).

Tolentino-Zondervan, Bogers and van de Sande (2021) explain that to reduce the aforementioned negative consequences, the three organizations decided to collaborate on a long-term living lab Project with the aim of gradually learning by doing. According to the authors, as an initial solution for the campus, a new concept was proposed consisting of newly established city and campus hubs where shipments are packaged and delivered with zero emission vehicles to organizations, which resembles the crowdsourcing. Thus, there is a pilot implementation of the association of two strategies, which are hubs and zero emission vehicles. Depending on the location of the hub in the city, the positive result will be the reduction of large vehicles traveling throughout the neighborhoods, which would reduce the disturbance for the residents, as well as the costs for suppliers. With the use of zero-emission vehicles, the positive effect is focused on delivering the goods to consumers' homes in a sustainable way.

Following this path related to the concern to adhere to sustainable last mile logistical distribution models, it is worth mentioning the case study carried out by researchers Simić, Lazarević and Dobrodolac (2021), in Belgrade, capital of Serbia (southeast Europe). The motivation to introduce a more sustainable last mile model is due to the fact that Belgrade was declared the 9th (ninth) city with the most polluted air in the world on several occasions throughout 2019 and 2020, according to the Quality Ranking of air and city pollution (IQAir, 2020).

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been declared the 9th (ninth) city with the most polluted air in the world on several occasions throughout 2019 and 2020, according to the City Air Quality and Pollution Ranking (IQAir, 2020). Considering the exposed, added to the increasing number of users and traffic problems in the city, the research aimed to determine the best last mile logistics distribution model in Belgrade. Therefore, the researchers interviewed 05 (five) relevant experts to collect assessments of linguistic importance in relation to criteria, sub-criteria and alternatives. Four of them from the private sector and one employee from the public postal operator (SIMIĆ; LAZAREVIĆ; DOBRODOLAC, 2021).

In summary, the experts evaluated the following models: (1) traditional, operated by postal companies, which use a diesel engine vehicle, and the delivery process basically involves the activities of loading shipments into a vehicle, driving to last mile locations, and delivering a package; (2) autonomous vehicle, where packages are loaded into the storage space of the vehicle, which visits users' locations; (3) a cargo bicycle, driven by a courier, which is environmentally convenient because it does not use any artificial energy sources; (4) drone, which accompanied a shipment departs from a suitable station, which can be a fixed infrastructure object or a mobile station within a suitable means of transport, located on the ground close to the delivery location. When it flies to the delivery location, it lands, recognizes the appropriate landing tag or by pre-defined coordinates, and leaves the shipment; (5) postomate, which resembles lockers, which are installed in places such as gas stations, shopping malls, etc, and provide easy access authorization and quick collection of a shipment, in addition the service is available to users 24 hours a day, 7 days a week; (6) tube transport, which has an infrastructure consisting of pipelines and specialized packaging for shipments. Packages are transported via tubes to the appropriate stations where users pick them up (SIMIĆ; LAZAREVIĆ; DOBRODOLAC, 2021).

From the analysis, the experts have drawn the following ranking of the mentioned models: in first place, the postomate/locker or lockers, considered the best last mile distribution system to be implemented in Belgrade. The cargo bike model would be the second best alternative. Drones and self-driving vehicles would represent the future of last mile distribution. In the last positions were the traditional model and the tube transport (SIMIĆ; LAZAREVIĆ; DOBRODOLAC, 2021).

It is easy to understand that the availability of the 24/7 service offered by the postomate/locker makes it a customer favorite. The system in question has other advantages, including environmental sustainability (HOFER, et al. 2020) and the credibility of the system (LACHAPELLE, 2018). In the literature, however, it is possible to find studies that point out the need to implement certain improvements to the locker system, such as locating it closer to the consumer and the sharing the locker system by several delivery companies (DEUTSCH; GOLANY, 2018; ZUREL. , et al. 2018). Nevertheless, these improvements are possible, according to the outlines of the project presented by the Singapore government, described earlier.

In fact, each city requires its own last mile logistics distribution infrastructure model, which will require a prior study of all the factors involved in the specific case, as well as the participation of several specialists from different areas of knowledge. The city of Santiago, Chile (Latin America) presents itself as a good example to exemplify the importance of thinking last mile logistic distribution models based on the place where they will be implemented. In research

conducted by Urzúa-Morales et al. (2020), the authors proposed a new goods distribution system in the historic center of Santiago city. They first considered the following specificities of that historic center: the existence of 1419 stores in km²; 04 bicycle lanes in total; 08 vehicle parking lots in total; 15 lanes for public transport in total; the sum of 7648 vehicles during a working day; the total sum of 6.7 hours per day of interruptions; the total sum of 601 agents affected by interruptions; the total sum of 78 deliveries per schedule, per critical point, per vehicle, per equipment used and frequency of deliveries; the total daily sum of 1459.56 g/km and CO₂ emitted by ICE (internal combustion engines/diesel and gasoline) and 4,419,606g CO₂ /km only from cargot vehicles per month. (URZÚA-MORALES et al. 2020).

Therefore, the researchers thought of a last mile logistic distribution model, as well as the best vehicle to deliver the shipments, depending on the infrastructure of the urban environment. As for the logistical distribution model, they concluded for the implementation, at the edge of the historic center, of the Cross-Docking platform, a kind of hub, where the distribution processes of products will be done towards the historic center. Regarding the vehicle, one of the alternatives considered was the use of bikes, however, they observed the existence of only four avenues with bicycle lanes and nine avenues that require the incorporation of bike lanes. In view of this, they also found it possible to make deliveries by means of small vehicles (URZÚA-MORALES et al. 2020).

Amid the annual benefits for reducing the factors that determine the costs of negative externalities in the historic center of Santiago, the research found a reduction of 53 tons of carbon dioxide per square kilometer (CO₂/km²) and a reduction of 1103 hours of interruptions per year in traffic congestion in the sector, which means reduced time spent by ICE vehicles in the sector's distribution logistics (URZÚA-MORALES et al. 2020).

METHODOLOGY

The study starts from a literature review (LAKATOS; MARCONI, 2003), utilizing descriptors: logistics, last mile, smart city. Considering that new last mile logistics distribution models, currently known, such as the previously described examples, are already being implemented in cities in general, a case study methodology was employed to explore the last mile logistics distribution infrastructure model used in the Metropolitan Region of Recife (MRR), State of Pernambuco.

In this way, preliminarily, scientific articles were selected that were developed as from the application of the case study methodology on last mile logistics in smart cities, such as Singapore, Nijmegen (Netherlands), Belgrade (Serbia) and Santiago (Chile). Next, the models adopted in the places where the researches took place were studied, to then analyze the positive and negative impacts identified with the research, and the aspects related to the development of smart cities.

Hence, with the literature review of the selected articles, considering the application of the case study methodology on last mile logistics in smart cities, it was possible to explore new models of last mile logistics in smart cities, and consequently, identify the main variables and restrictions, without the obligation of studying the same model in different cities.

Regarding the case study methodology, Yin (2003) teaches that there is the single case study type, in which the unit of analysis is limited to one case, and there is the multicase study type, where several cases are analyzed, allowing comparisons to be made. In this sense, the case study type was adopted with the intention of applying a qualitative approach to understand the processes that constitute the last mile logistics distribution model used by a company that provides the service in question in the MRR.

For this purpose, a company in the last mile logistics delivery business that provides the service under examination in the MRR was selected, identified here with the initial "L". The data were collected by means of a questionnaire applied to the Company's respondent, hereinafter referred to as "respondent". The questionnaire was prepared with semi-structured questions, via Google forms, and sent by the professional social network LinkedIn. The questionnaire focuses on the perception of the traditional models and the possibilities of implementing new last mile delivery models in the capital city, and was divided into two sections: part 1, which presents 05 (five) questions about the current operation developed by the company; and part 2, with 04 (four) questions about the operation intended for the company's future.

Characterization of the case study object

The Company "L" is an online platform, available through the URL, which started offering delivery service in 2013. Initially, the Company "L" was created to serve fast and local deliveries to offices, but in 2015 it expanded nationwide with deliveries to several e-commerce companies in the five regions of Brazil. Since 2019, due to the investments received, Company "L" joined the list of Brazilian unicorns, with a capital of approximately US\$ 1 billion dollars.

Currently, the Company "L" is present in all Brazilian capitals, including the city of Recife-PE, and has a virtual platform, which aims to offer registered users ("User") services that intend to make available to the User a virtual environment that brings them closer to independent providers ("Self-Employed Drivers") of transportation services of small loads, documents and products ("freight"), through the technologies and tools made available by the company.

RESULTS AND DISCUSSION

The metropolitan region of Recife (MRR) has approximately a resident population of 4,054,866 inhabitants, which corresponds to 42.7% of the total population of the State of Pernambuco (FNEM, 2018), spread across the 14 cities that constitute the MRR, here identified in alphabetical order: Abreu e Lima, Araçoiaba, Cabo de Santo Agostinho, Camaragibe, Igarassu, Ilha de Itamaracá, Ipojuca, Itapissuma, Jaboatão dos Guararapes, Moreno, Olinda, Paulista, Recife, São Lourenço da Mata (IBGE, 2020).

It is worth highlighting that the city of Recife is the municipality in the State of Pernambuco with the greatest number of public streets with adequate urbanization (presence of culverts, sidewalks, paving and curbs), which corresponds to 49.6% of urban households in the state capital of Pernambuco (IBGE, 2010). Therefore, the other cities in Pernambuco have a

lower percentage of public roads with adequate urbanization when compared to the capital. In addition, Recife is also known for traffic jams, so much so that, even in the pandemic, in 2021, the capital was considered the most congested in Brazil (SOARES, 2021), a title already received in years preceding the pandemic.

This initial information, about the geographical dimension of the MRR, as well as the poor adequate paving of public roads for urban households in the cities of Pernambuco, and the high level of congestion in Recife, highlight some of the challenges that are faced by the last mile distribution sector in the MRR.

Despite this, systems such as pick-up points and, particularly, the lockers system, praised for the excellent results resulting from the implementation in smart cities, are still virtually unknown to consumers in Recife. Currently, there are two shopping malls in the MRR that offer locker service, here called Shopping mall 1 and Shopping mall 2.

Shopping mall 1 is located in the city of Recife, and provides 24 lockers of different sizes, free of charge. The dynamic is limited to purchases made in the stores of Shopping mall 1 - so the store makes the reservation of the rental on the day and time agreed with the consumer, who receives a QR Code to open the compartment door for withdrawal the product (ABRACE, 2022).

Shopping mall 2, located in the city of Jaboatão dos Guararapes, MRR, uses a similar system, where the consumer can make purchases through the website (guararapesonline.com.br) and pick up the products in the locker inside the mall. After receiving the email, the consumer has up to 24 hours to withdraw his or her order. If the consumer does not pick up the products within this period, they will be returned to the store. If the goods are food products, the deadline is reduced to 2 hours (SHOPPING GUARARAPES, 2022). Although the other malls in the MRR do not offer the service, it is known that large retailers with stores in malls, such as Renner, Riachuelo and C&A already use the "click and collect" system in their stores, using lockers to make deliveries inside the stores, in cases of online purchases (INTERMODAL, 2022).

Excluding the limited experience with lockers in shopping malls, and despite the difficulties with traffic in the MRR, the traditional last mile distribution model and the crowdsourcing and crowdshipping systems are the most used in the MRR. It is still quite common for companies located in the MRR to deliver their goods by road transport, such as container trucks, for example. By using self-employed drivers of cars and motorcycles registered in the platform it owns, Company "L" practices the crowdsourcing system, since through this platform Company "L" provides, through the registration of autonomous drivers, a variety of motor vehicles to provide the service. As for the crowdshipping model, it is safe to say that it is generally used throughout Brazil by the Ifood, Uber Eats, and Rappi platforms, mainly to deliver food.

It should be considered that the traditional system still offers some advantages such as agility and mobility in the provision of the service, depending on the location where the delivery will be made. It is worth considering, however, the disadvantage related to fuel expenses, which consequently impacts the cost of last mile distribution. According to the National Agency of Petroleum, Gas and Biofuels (ANP) the price of gasoline increased 46% in 2021 (PODER 380, 2021). In this sense, the performance of public management for the

improvement of public roads is fundamental, since adequate urbanization could collaborate with the reduction of the last mile logistics cost in the MRR.

The respondent from Company “L” cites as an advantage of the model used by the company the predictability of available vehicles registered on the platform, and mentions the increase in the volume of deliveries as a way of reducing logistics costs. And as Company “L” uses a more modern model, called crowdsourcing system, it allows it to exclude from the cost spreadsheet all expenses and responsibilities related to vehicles owned by the Self-Employed Drivers, among them, breakdowns, fines, vehicle maintenance, and others.

Regarding the ICTs used by the company under examination, as mentioned previously, besides using a platform that intermediates the contact between the Self-Employed Driver and the User, it also has an internal routing system, with suggestions for the best route to be adopted, based on distance and time, and on the number of packages to be delivered, dimensioned, when offering freights, according to the number compatible with the load compartment of the Self-Employed Driver.

But, curiously, the answer of the respondent from Company “L” to the question about which technologies could be applied in order to facilitate the last mile activities in the MRR, considering improvements for the future of the service offer, shows a satisfaction with the ICTs already used by the company, since the answer is limited to the systems already used by the company itself. In fact, the respondent from company “L” informs, in addition, the existence of several improvement projects in progress, without presenting details, since the sectors in each area would be, respectively, focused on the elaboration of projects.

Regarding government action, the respondent from Company “L” states that he is not aware of the existence of legislation applicable in the MRR that reduces the competitiveness of last mile operations. In fact, the legislation on loading and unloading is little restrictive, but it does exist, for such, Law n. 18.133/2015 and Decree no. 17.562/97 are cited, both in force in the municipality of Recife. The respondent from Company “L”, however, mentions some actions that the local government could take in order to facilitate last mile activities in the MRR, among them: the adequate paving of roads and corridors with greater circulation, and the correct organization of the numbering of residences and buildings, as well as prohibiting the same name for more than one street/avenue in the same city.

FINAL CONSIDERATIONS

E-commerce is a globally consolidated fact, and its expansion is a phenomenon that has been accelerated in recent years by the Covid-19 pandemic. Indeed, such operations of buying and selling products and services through virtual channels have repercussions in the urban cargo transport sector, more specifically in the last stage of the delivery of the goods to the final consumer.

While urban freight becomes a source of employment and a facilitator of economic growth in cities, it also needs the right management and technological resources to offer the last mile delivery service in order to overcome the challenges imposed by the city infrastructure and makes it cost-effective for the transport company and the consumer.

In this regard, when exploring the main technologies added to last mile logistics distribution infrastructure models used in smart cities such as Singapore (Asia), Nijmegen (Netherlands), Belgrade (Serbia), and Santiago (Chile), one verifies public/private partnership actions for the implementation of pick-up points, lockers, crowdsourcing, crowdshipping, hubs and zero-emission vehicles.

Thus, it is worth noting the active participation of the government in referred cities, as well as that the projects and actions of those cities governments were not restricted to a single technology. On the contrary, the association between more than a technology was identified in the effective offer of the service so as to overcome the obstacles of cities with touristic importante infrastructures and that were declared part of the historical and cultural heritage of humanity.

Concerning the experiences of the companies that provide this last mile logistics distribution service in MRR - PE, they can be defined as timid, besides being absent from governmental initiatives. Immediately, one can observe the maintenance of the traditional model of delivery of goods at the final consumer's residence by cargo vehicles, or combustion passenger vehicles.

Some companies operating in the MRR, such as the one in the case study, already use a system that has more advanced technological tools, like the crowdsourcing system via digital platforms. It is worth pointing that the Self-Employed Drivers registered in the digital platform are owners of combustion vehicles, unlike what is already a reality in smart cities, where zero-emission vehicles have been introduced.

It is appropriate to clarify that in Brazil and in the state of Pernambuco there are still no public policies that encourage the sale of hybrid and electric vehicles to accelerate decarbonization. Likewise, there is no concern on the part of the local government to implemente a plan to provide a last mile logistic distribution infrastructure in the MRR.

In fact, all initiatives for improvements and technological advances in this segment come exclusively from the private sector, as demonstrated in the two shopping malls in the MRR, by offering delivery services in pick-up points and lockers models, which, as previously observed in smart cities, are the systems that presente the best advantages, and have started to receive government investment for the expansion of these systems. It is clear that the existence of public/private partnerships is essential for the introduction and strengthening of new last mile logistics distribution systems used in cities, whether they are considered smart or not.

Therefore, while in MRR Company "L" demands from local authorities a better paving of roads and corridors for greater circulation of combustion vehicles, governments in other countries are more concerned about adding new technologies to smart cities, with the installation of lockers system approximately 250 meters away from each public housing, so that in this way consumers can interact directly with the cabinet system through a digital interface.

BIBLIOGRAPHICAL REFERENCES

ABCOMM - Associação Brasileira de Comércio Eletrônico. **Logística no e-commerce brasileiro**. 2020. Disponível em <https://bit.ly/2YDNKbi> Acesso em: 21 julho 2021.

ABRASCE. **E-commerce**: lockers para retirada de compras é novidade no shopping recife. Espaço do associado. <https://abrasce.com.br/espaco-do-associado/inauguracoes/e-commerce-lockers-para-retirada-de-compras-e-novidade-no-shopping-recife/> Acesso em: 10 abril 2022.

ARAÚJO, F. A.; REIS, J. G. M.; CORREIA, P. F. C. Uso de lockers como melhoria e redução do last mile no e-commerce. In: **XXXIX Encontro Nacional de Engenharia de Produção: “Os desafios da engenharia de produção para uma gestão inovadora da Logística e Operações”** Santos, São Paulo, Brasil, 15 a 18 de outubro de 2019.

AUGEREAU, V.; DABLANC, L. An evaluation of recent pick-up point experiments in European cities: The rise of two competing models. *Innov. City Log.*, p. 303-320, 2008.

BERTAZZO, T. R.; HINO, C.; TACLA, D.; YOSHIZAKI, H. T. Y. Estudo de caso: entregas noturnas em São Paulo. In: **XXIX Congresso Nacional de Pesquisa em Transporte da ANPET, Ouro Preto, 9 a 13 de novembro de 2015**. Logística Urbana II, p. 557-568, 2015.

DEUTSCH, Y.; GOLANY, B. A parcel locker network as a solution to the logistics last mile problem. *International Journal of Production Research*, 56(1-2), p. 251-261, 2018. Disponível em: <https://doi.org/10.1080/00207543.2017.1395490>. Acesso em: 20 jan. 2022

ESALES. **Sistema TMS**: o que é e qual sua importância para a logística? Disponível em: <https://esales.com.br/blog/sistema-tms-o-que-e-e-qual-sua-importancia-para-logistica/> Acesso em: 10 abril 2022.

EUROPEAN COMMISSION. **Commission staff working document**. 2013. Disponível em: [http://ec.europa.eu/transport/themes/urban/doc/ump/swd\(2013\)524-communication.pdf](http://ec.europa.eu/transport/themes/urban/doc/ump/swd(2013)524-communication.pdf). Acesso em: 20 jan. 2022

EUROPEAN COMMISSION. **Sustainable & Smart Mobility Strategy**. European Commission: Brussels, Belgium, 2020.

FNEM. Fórum Nacional de Entidades Metropolitanas. **Região Metropolitana de Recife (PE)**. Disponível em: <https://fnembrasil.org/regiao-metropolitana-de-recife-pe/> Acesso em: 10 abril 2022.

HOFER, K.; FLUCHER, S.; FELLENDORF, M.; SCHADLER, M.; HAFNER, N. Estimation of changes in customer's mobility behaviour by the use of parcel lockers. *Transportation Research Procedia*, 47, p. 425-432, 2020. Disponível em: <https://doi.org/10.1016/j.trpro.2020.03.118>. Acesso em: 20 jan. 2022

IBGE atualiza lista de municípios e deixa goiana fora da região metropolitana do recife. **TV Jornal**, 2020. Disponível em: <https://tvjornal.ne10.uol.com.br/noticias/2020/11/17/ibge-atualiza-lista-de-municipios-e-deixa-goiana-fora-da-regiao-metropolitana-do-recife-198919/index.html> Acesso em: 10 abril 2022.

IBGE. **Recife**, 2010. Disponível em: <https://cidades.ibge.gov.br/brasil/pe/recife/panorama> Acesso em: 10 abril 2022.

ILOS - Instituto de Logística e Supply Chain. **Custos logísticos no Brasil**. Disponível em <https://bit.ly/2Qerq5a> Acesso em 01/02/2019 Acesso em: 27 julh 2021.

IQAir. **Air quality and pollution city ranking from 2019 to 2020**. Disponível em: <https://www.iqair.com/world-air-quality-ranking>. Acesso em: 01 set. 2021.

INTERMODAL Plataforma de Negócios do Setor de Logística. **Tudo sobre Lockers, os armários inteligentes**. Disponível em: <https://www.intermodal.com.br/pt/noticias-e-conteudos-exclusivos-intermodal/tudo-sobre-lockers-os-armarios-inteligentes.html> Acesso em: 10 abril 2022.

JOERSS, M.; SCHRÖDER, J.; NEUHAUS, F.; KLINK, C.; MANN, F. **Parcel delivery**: the future of last mile. New York: McKinsey & Company, 2016. Disponível em: <http://www.mckinsey.com/industries/travel-transport-and-logistics/our-insights/how-customerdemands-are-reshaping-last-mile-delivery> Acesso em: 27 julho 2021.

LACHAPPELLE, U.; BURKE, M.; BROTHERTON, A.; LEUNG, A. Parcel locker systems in a car dominant city: Location, characterisation and potential impacts on city planning and consumer travel access. *Journal of Transport Geography*, 71, p. 1-14, 2018. Disponível em: <https://doi.org/10.1016/j.jtrangeo.2018.06.022>. Acesso em: 20 jan. 2022

LAKATOS, E. M; MARCONI, M. A. **Fundamentos de metodologia científica**. 5a ed. São Paulo: Atlas, 2003.

LAVADO, T. Pegaki: o e-commerce vai tirar você de casa. **Exame**. 12/04/2018. Disponível em <https://bit.ly/2VOR7yX> Acesso em: 27 julho 2021.

LYU, G.; TEO, C-P. Last Mile Innovation: The Case of the Locker Alliance Network (October 17, 2019). Guodong Lyu, Chung-Piaw Teo. 2021. Last Mile Innovation: The Case of the Locker Alliance Network. **Manufacturing & Service Operations Management** (Forthcoming). Disponível em: <http://dx.doi.org/10.2139/ssrn.3471166> Acesso em: 20 jan. 2022.

MCKINNON, A. C.; BROWNE, M.; WHITEING, A. E. **Green logistics: improving the environmental sustainability of logistics**. London: Kogan Page Publishers, 2015.

MUNDO LOGÍSTICA. **Lockers InPost são lançados no Brasil**. 03/02/2017. Disponível em: <https://www.revistamundologistica.com.br/noticias/lockers-inpost-sao-lancados-no-brasil> Acesso em: 4 agosto 2021.

MUÑOZ-VILLAMIZAR, A.; MONTOYA-TORRES, J. R.; FAULIN, J. Impact of the use of electric vehicles in collaborative urban transport networks: a case study. **Transportation Research Part D**, Transport and Environment, 50, p. 40-54, 2017. <https://doi.org/10.1016/j.trd.2016.10.018> Acesso em: 25 junho 2020.

OLIVEIRA, L. H. Caso Pegaki: Melhorando a Experiência de Quem Compra pela Internet. In: **XLIV encontro da ANPAD - EnANPAD 2020**. Evento on-line - 14 a 16 de outubro de 2020, p. 2177-2576 (versão online).

PODER 360. **Gasolina subiu cerca de 46% nos postos em 2021, diz ANP**. <https://www.poder360.com.br/economia/gasolina-subiu-cerca-de-46-nos-postos-em-2021-diz-anp/> Acesso em: 07 maio 2022.

ROUMBOUTSOS, A.; KAPROS, S.; VANELSLANDER, T. Green city logistics: systems of innovation to assess the potential of E-vehicles. **Research in Transportation Business & Management**, 11, 43-52, 2014. <https://doi.org/10.1016/j.rtbm.2014.06.005> Acesso em: 27 junho 2020.

SHOPPING GUARARAPES. **Confira como usar o serviço de Locker do Guararapes Online**. Notícias, 2022. Disponível em: <https://www.shopping-guararapes.com/eventos-e-novidades/confira-como-usar-o-servico-de-locker-do-guararapes-online> Acesso em: 10 abril 2022.

SILVA, J. V. S.; SOUZA, N. R.; RODRIGUES, A. P.; SILVA, A. S. Avaliação da Viabilidade dos Pick-Up Points na Cadeia de Suprimentos de Medicamentos. **Rev. Cienc. Gerenc.**, v. 24, n. 40, p. 99-104, 2020. <https://doi.org/10.17921/1415-6571.2020v24n40p99-104> Acesso em: 27 junho 2020.

SIMIĆ, V.; LAZAREVIĆ, D.; DOBRODOLAC, M. Picture fuzzy WASPAS method for selecting last-mile delivery mode: a case study of Belgrade. **European Transport Research Review**, 13:43, 2021. Disponível em: <https://doi.org/10.1186/s12544-021-00501-6> Acesso em: 20 jan. 2022

SINGAPORE'S SMART NATION INITIATIVE. Retrieved from the Keynote talk of the "Smart Libraries for Tomorrow" Conference. Disponível em: <http://www.las.org.sg/wp/lft/files/0910-TKY-Smart-Libraries-for-Tomorrow-20-Sep-Final.pdf> Acesso em: 20 jan. 2022

SLABINAC, M. Innovative solutions - a European experience. In: **15th international scientific conference Business Logistics in Modern Management**. Osijek, Croatia. October 15, p. 111-129, 2015.

SOARES, Roberta. Recife, mesmo com a pandemia, é a capital mais congestionada do Brasil. De novo. **JC NE**, 2022. Disponível em: <https://jc.ne10.uol.com.br/colunas/mobilidade/2022/03/14959182-recife-mesmo-com-a-pandemia-e-a-capital-mais-congestionada-do-brasil-de-novo.html> Acesso em: 10 abril 2022

SOUZA, C. O.; D'AGOSTO, M. A.; BANDEIRA, R. A. M.; ALMEIDA, I. R. P. L. Soluções para o transporte urbano de cargas na etapa de última milha. urbe. **Revista Brasileira de Gestão Urbana**, 12, e20190138, 2020. <https://doi.org/10.1590/2175-3369.012.e20190138> Acesso em: 27 junho 2020.

SOUZA, R.; GOH, M.; LAU, H.-C.; NG, W.-S.; TAN, P.-S. Collaborative Urban Logistics – Synchronizing the Last Mile a Singapore Research Perspective. **Procedia - Social and Behavioral Sciences**, v. 125, p 422-431, 2014. Disponível em: <https://doi.org/10.1016/j.sbspro.2014.01.1485>. Acesso em: 20 jan. 2022

TOLENTINO-ZONDERVAN, F.; BOGERS, E.; VAN DE SANDE, L. A Managerial and Behavioral Approach in Aligning Stakeholder Goals in Sustainable Last Mile Logistics: A Case Study in the Netherlands. **Sustainability**, 13, 4434, 2021. Disponível em: <https://doi.org/10.3390/su13084434> Acesso em: 20 jan. 2022.

URZÚA-MORALES, J. G.; SEPULVEDA-ROJAS, J. P.; ALFARO, M.; FUERTES, G.; TERNERO, R.; VARGAS, M. Logistic Modeling of the Last Mile: Case Study Santiago, Chile. **Sustainability**, 12 (2), 648, 2020. Disponível em: <https://doi.org/10.3390/su12020648> Acesso em: 20 jan. 2022.

VIEIRA, J. G. V.; CARVALHO, C. D.; YOSHIZAKI, H. T. Y. Atributos da distribuição de carga e indicadores de desempenho logístico: pesquisa com empresas que atuam na região metropolitana de São Paulo. **Transportes**, v. 24, n. 4, p. 10-21, 2016.

VISSER, J.G.S.N. **Urban freight transport policies and planning in Europe**: an overview and classification of policy measures, 2005. Disponível em: http://www.johanvisser.nl/mediapool/51/519305/data/Microsoft_Word_paperNUFCjvisser.pdf, access June 27, 2021]. Acesso em: 20 jan. 2022

YIN, R. K. **Case study research**: design and methods. 3rd ed. Califórnia: Sage Publications, 2003.

ZUREL, Ö.; VAN HOYWEGHEN, L.; BRAES, S.; SEGHERS, A. Parcel lockers, an answer to the pressure on the last mile delivery? In New business and regulatory strategies in the postal sector. **Springer**, p. 299–312, 2018. Disponível em: https://doi.org/10.1007/978-3-030-02937-1_22. Acesso em: 20 jan. 2022