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LAST-MILE DELIVERY: E-COMMERCE PARCEL DISTRIBUTION CHALLENGES IN URBAN CENTERS

FERNANDA ALVES DE ARAÚJO

SÃO PAULO

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Master's thesis presented to Postgraduated Program in Production Engineering of Universidade Paulista – UNIP as requirement for obtain Master's of Science Degree in Production Engineering

Orientador: Prof. Dr. João Gilberto Mendes dos Reis

Main Subject: Operations Systems Management

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Approved in:_____

Examiners:

_____

Prof. Dr. João Gilberto Mendes dos Reis

Universidade Paulista - UNIP

_____

Prof. Dr. Márcia Terra da Silva

Universidade Paulista - UNIP

_____

Prof. Dr. Emel Aktas

Cranfield School of Management

Inscription

For all the dreamers around the world.

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Epigraph

"Tell me and I forget. Teach me and I remember. Involve me and I learn."

Benjamin Franklin

ABSTRACT

Last-mile delivery has attracted considerable interest from the logistics suppliers and retail industry in the past few years. New technologies and approaches are being discussed from experts' to scholar's sides. These trends should not stop, and the reason is the increase of electronic commerce and app-based ordering of almost everything, from a pen to a car. Therefore, e-commerce requires a large capacity, speed, and flexibility in all its processes and operations. This study aims to investigate the literature and expectations of consumers and logistics providers in last-mile delivery regarding the alternative technologies available on the market. Hence, we conducted research structured in three papers to identify the main gaps found in the literature so far, aiming to extend the current literature and explore new alternatives. Our results showed that advances in last-mile delivery will depend on the capacity of logistics providers, retail companies, and consumers to align their expectations. It also observed the impact of COVID-19 on last-mile delivery services, revealing that do not cost does not showcase as a priority in the current scenario, indicating a possible new bias.

Keywords: Last-mile logistics · City logistics · Urban freight · Parcel freight distribution · Electronic commerce · COVID-19.

RESUMO

O *last-mile* (entrega na última milha) atraiu um interesse considerável dos provedores de logística e do setor de varejo nos últimos anos. Novas tecnologias e abordagens estão sendo discutidas por especialistas e acadêmicos. Essas tendências não devem parar, e o motivo é o aumento do comércio eletrônico e da compra de quase tudo por aplicativos, de uma caneta a um carro. Portanto, o e-commerce exige grande capacidade, velocidade e flexibilidade em todos os seus processos e operações. Este estudo pretende investigar a literatura e as expectativas dos consumidores e fornecedores de logística na entrega de última milha em relação às tecnologias alternativas disponíveis no mercado. Para tanto, realizamos uma pesquisa estruturada em quatro artigos para identificar as principais lacunas encontradas na literatura até o momento, com o objetivo de ampliar a literatura atual e explorar novas alternativas. Nossos resultados mostraram que os avanços na entrega na última milha dependerão da capacidade dos fornecedores de logística, empresas de varejo e consumidores em alinhar suas expectativas. Também observou o impacto do COVID-19 nos serviços de entrega de última milha, revelando que o custo não se apresenta como prioridade no cenário atual, indicando um possível novo viés.

Palavras-chave: Logística de Última Milha · Cidades Logísticas · Frete Urbano · Distribuição de Frete de Encomendas · Comércio Eletrônico · COVID-19.

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ABBREVIATIONS AND ACRONYMS LIST

AHP Analytic Hierarchy Process

APMS Advances in Production Management Systems

B2C Business to Consumer

CET Companhia de Engenharia e Tráfego

CHE Switzerland

CHN China

CL Chile

CNT Confederação Nacional do Transporte

COVID Corona Virus Disease

CSSE Center for Systems Science and Engineering

D2C Direct to Consumer

DEU Deuteland

ENEGEP Encontro Nacional de Engenharia de Produção

FIN Finland

GDP/GNP Gross Domestic Product

HKG Hong Kong

IBGE Instituto Brasileiro de Geografia e Estatística

IBRD International Bank of Reconstruction and Development

ICT Information and Communication Technology

IDA International Development Association

IFLOG Congresso Internacional de Logística e Operações do IFSP

KOR Korea

LAC Latin American and The Carribbean

LMD Last Mile Delivery

NETLOG Internacional Conference on Network Enterprises & Logistics Management

PWC PricewaterhouseCoopers

SETRANS Sindicato das Empresas de Transporte de Carga do ABC

SGP Singapure

SLR Sistematic Literature Review

UN United Nations

UNESCO United Nations Educational, Scientific and Cultural Organization

UNIP Universidade Paulista

UPS United Parcel Service

USA United States of America

WEF World Economic Forum

SUMMARY

1 Introduction

1.1 Background and statement of the problem

In the new global economy, it is fair to say that logistics moves the world that is connected but at the same time it's full of contrasts. Therefore, logistics has the role of making distances shorten to offer well-being to society. In this sense, Werner-Lewandowska & Kosacka-Olejnik (2018) emphasize that logistics has become a critical success factor for enterprises.

Since ancient times logistics is critical. Ballou (2004) contextualizes that at the beginning of mankind the most necessary goods usually were not made close to the places where they were consumed, turning transportation of goods (part of logistics) essential ever since. Ballou (2004) states that logistics is the essence of commerce and contributes decisively to improving the general economic standard of living.

Logistics has evolved from the original understanding of transportation, handling, and storage to an integrated approach, where it influences various areas of a company as well as the current cross-company perspective of managing supply chains, which also includes the last-mile delivery. Moreover, the trend of new technologies developed for transportation is growing exponentially due to the increase of online commerce and app-based ordering requiring a large capacity, speed, and flexibility from last-mile delivery providers.

Urban and metropolitan development face well known challenges, such as congestions, mobility, access to urban roads, capillarity of transport, among others. In this context, the logistics of all types of flows is extremely necessary to avoid the interruption of basic services that depend on it. COVID-19, for instance, opened the way for the need for essential services, with the "stay home" behavior being the new modus operandi, hence, logistics services providers are struggling to meet consumers' expectations.

The concept of Logistics is academically broadcasted, nevertheless, its evolution of city logistics is not so much explored. Uckelmann (2008) says that it is reasonable to group the corresponding research and realize a common understanding, the definition must be flexible and adaptive, to incorporate future technological developments. Within the context of city logistics, a fundamental concern has been the last-mile delivery.

Chen & Pan (2016) justify that the increase in consumption and the expansion of e-commerce made last-mile delivery a problem of transport and planning from the traditional retailers and to the so-called e-retailers. They also point out that two factors are crucial to the success of last-mile: fast delivery and low-cost. However, e-commerce

stakeholders are complex and usually do not share the same interests causing an enormous challenge for city logistics operations.

Faccio & Gamberi (2015) argue that part of city logistics' aims is to identify ways to regulate access, circulation, and parking of private and commercial vehicles in urban centers. In addition to implementing unrestricted policies that may harm the prosperity of the city, economy, and local society. They point out that "harmonious growth" should be formed in urban areas.

Despite the fact of Harrington et al. (2016) highlight that the network of key actors in the process is critical to the development of the entire network, the role of each one must be understood and taken into consideration from development to implementation of a better last-mile system. Their research confirms that these actors will have prospects, requirements, and different objectives besides having to relate to government structures to evaluate a solution of the last mile.

The world is dramatically changing, the implications of the pandemic are far-reaching and signal a watershed moment for e-commerce, specially in Latin America. eMarketer (2020) estimates that 10.8 million consumers will make a digital purchase for the first time in 2021. This will bring the total digital buyer count to 191.7 million, or 38.4% of the region's population ages 14 and older. It demands a robust last-mile delivery network.

The challenges encountered open the door to new opportunities and innovation in the last mile sector. According to Meyer-Larsen et al. (2014), innovation is not just about daring business models or high technologies, but of efficient practices. Anchored on this concept, this research sheds light on the study of models and effective practices, capable of adding value to last-mile focused to the e-commerce sector.

There is a gap in the literature concerning last-mile providers' expectations, being difficult to understand the combined actions to solve the "last-mile issue" reported in the literature. Viu-Roig & Alvarez-Palau (2020) indicate that all this means that freight distribution and transportation companies have seen a sharp increase in their activities. However, they have found a serious obstacle along the way: the "last-mile".

For Shao et al. (2019) earlier efforts are devoted to city logistics and consequently last-mile, mainly because it is one of the costliest, least efficient and most polluting activities in the e-commerce economy according to previous literature. Cárdenas et al. (2017) explore the relevance of this discussion, by saying that the last-mile is a trade-off between internal costs, externalities, and the density of the deliveries. On the one hand, customer density is essential for achieving efficiency in the last-mile. In the urban areas, the density is higher and logistics carriers benefit from lower costs. However, the residents undergo more negative impacts such as congestion, noise, and emissions. Groß et al. (2017) highlighted that to perform cost-efficient and reliable deliveries poses a major challenge to city logistics LMD, due to the varying travel times in urban areas.

Aiming to contribute with the literature and explore the last-mile providers perspective, integrating with current literature, this study is composed of several reviews on city logistics, last-mile, urban freight distribution, and e-commerce concepts, trying to focus on Brazilian scenario, distributed in four articles to support literature expansion.

This study is composed as follow: This brief introduction including the research problem, objectives (general and specifics), justification, and research structure; the next section will cover the literature review focusing on the last-mile, city logistics, Brazil overview, and e-commerce, followed by the presentation of methodology and results, finalizing with final considerations and future research proposal.

1.2 Research questions

This master-thesis raised five research questions, that aim to decompose the so called "last-mile issue" reported on the literature. For Moroz & Polkowski (2016) cities are created by clusters of people, which, on the one hand, promotes the development of transport infrastructure and communication network. On the other hand, placing numerous residents with the entire "life" infrastructure (jobs, transportation, commerce etc.) within limited space causes air pollution, noise, and other negative effects on the environment. The development of e-commerce also contributes to increasing the burden on the environment, in this sense, a delivery of a parcel to a recipient's address results in high costs of logistics service (extended car route of a courier) and greater environmental pollution (higher emissions from the cars of transportation companies). This problem is referred to as "the last-mile issue".

Logistics problems of e-commerce directed towards retail recipients are concentrated on the last stage of the delivery, causing problems known as last mile issue. Geographical dispersion of recipients demands the need to organize supplies in practically every place of residence of the prospective customer. For the logistic operator it is related to the optimization of the place, the mode and the time of receipt of the parcel, the lead time, the average cost of delivery (de Souza et al., 2014; Moroz & Polkowski, 2016).

In this context this research presents the following questions:

1. What are the last-mile stakeholders expectations?
2. Is there a disproportional gap among last-mile stakeholders expectations? How do they compare?
3. What operational challenges does the last-mile delivery impose on e-commerce retailers and last-mile logistics service providers?
4. How many available technologies are connected with the last-mile delivery?

5. Is Last-mile delivery in urban centers a concern for logistics providers and e-commerce retailers?

1.3 Objectives

1.3.1 General objective

The general aim of this study is to investigate last-mile delivery challenges in an urban center focused on retail e-commerce channels, also analyze the available solutions and technologies that can support improvements in this final stage of the supply chain from the point of view of last-mile delivery providers.

1.3.2 Specific objectives

This contribution adopts four specific objectives:

1. To identify stakeholders of last-mile delivery;
2. To explore the expectations gap between stakeholders;
3. To investigate the challenges for last-mile delivery providers in urban centers and;
4. To organize information about last-mile delivery technologies, allowing providers to choose the best alternative for e-commerce LMD in Brazil.

1.4 Justification of the study

The study is relevant due to the overload that the current models and systems of urban logistics, mainly last-mile delivery, are facing in urban centers. Looking at the city of São Paulo as our greatest example of a mega city. According to data from the Traffic Engineering Company (CET), the city of São Paulo has 7.4 motor vehicles for every 10 inhabitants, 8.6 million cars, motorbikes, buses, or trucks (CET, 2019).

According to Junior (2008) due to the deficiency of the road system, urban movements have encountered great economic losses that reached BRL 500 million a year. Considering only the additional fuel expense and the waste of workers' time urban cargo transportation represents one-quarter of the total traffic in a city. It is a reality that most societies have to deal with, otherwise economic activities would not exist.

Therefore, the study of new approaches, technologies, and innovation that supports urban centers' growth is needed to ensure a harmonious development without disruption of the system.

1.5 Conceptual framework

The master's thesis structure is presented in Figure 1.

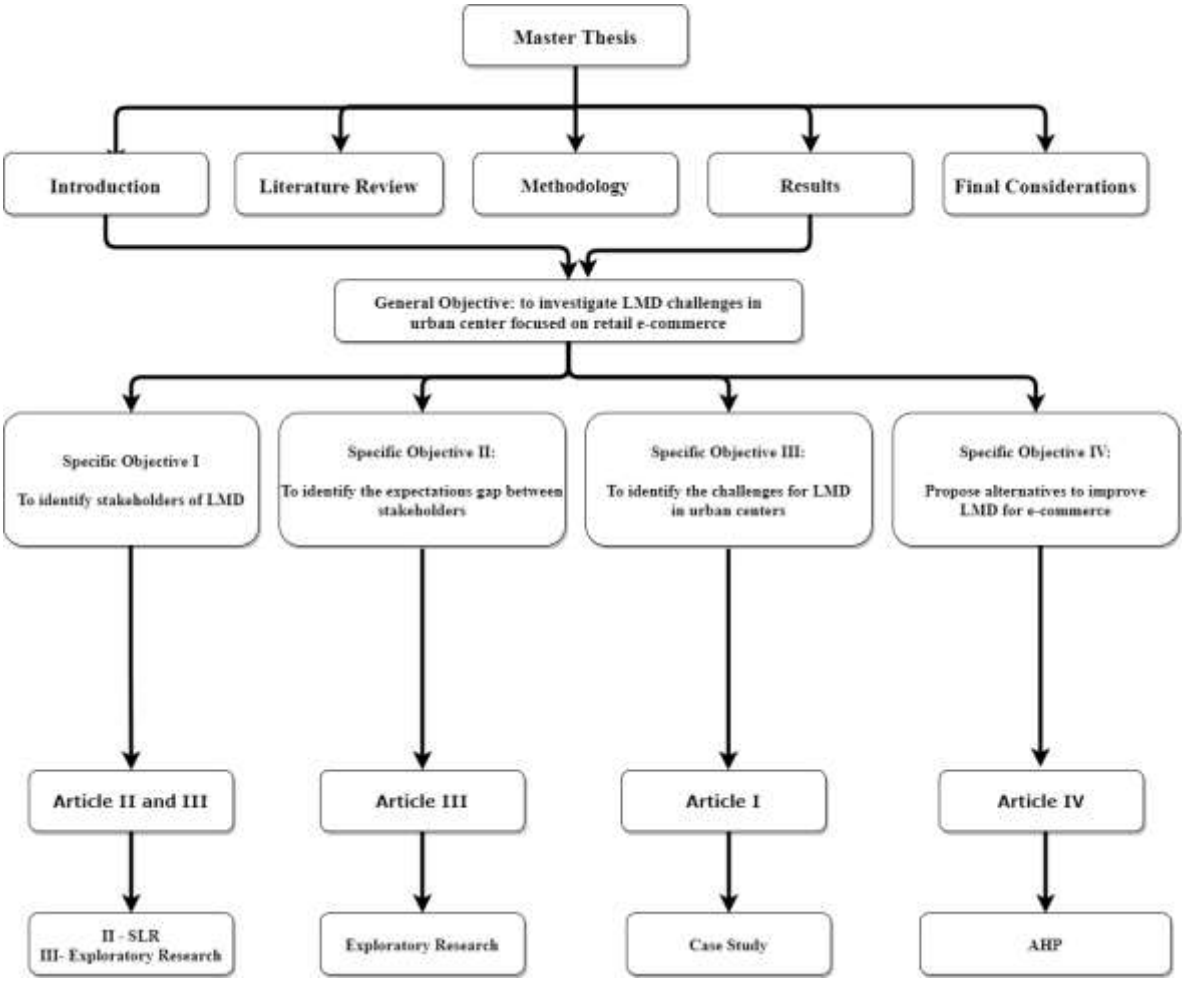


Figure 1: Research structure

References regarding this master thesis are cited at the end of the text and followed the Elsevier / APA (*model5-names*) adapted to the thesis model of the Universidade Paulista - UNIP in Latex2e. The article's references can be found themselves. These articles, as well as their references, are presented in the format of the congress, journal or submission format and they were produced using Latex2e or Microsoft Word.

2 Literature Review

2.1 Last-mile logistics

By definition, the last-mile is the last stretch of a business-to-consumer (B2C) parcel delivery to the final consignee who has to take reception of the goods at home or a cluster/collection point (Macharis & Melo, 2011). The last-mile delivery (LMD) is one of the most crucial steps of a successful supply chain. Everything leads to this moment – when the end consumer receives their product or service. Kull et al. (2007) argue that the past decade has seen a number of firms seeking to extend their supply chains directly to the end customer. Managing this portion of the supply chain – home delivery service for the customer – it has coined the "last mile" issue.

Today, last-mile logistics denotes the last segment of a delivery process, which is often regarded as the most expensive, least efficient aspect of a supply chain and with the most worrysome environmental concerns. Order fulfillment can be the most expensive and critical operation for both the online and offline businesses of companies engaged in e-commerce (Lim & Srai, 2018; Xu et al., 2008). Commonly LMD is linked to online sales (e-commerce) concerns.

Macharis & Melo (2011) identified five main problems related to LMD: (I) for home deliveries, the "not-at-home" syndrome is an important problem, which implies extra costs per extra kilometers and gas emissions; (II) door-to-door deliveries can create a high degree of "empty running"; (III) related to security when delivering a parcel if a signature is needed - This security problem can result in discussions between supplier and consignee; (IV) for some regions, the critical mass of goods is too small to generate a profitable and efficient routing plan; and (V) the fact that most of the door-to-door deliveries are done by small vans implies that the carbon footprint per kg is higher than that of transport by a bigger truck.

Gevaers (2013) explains that the term "urban logistics" or "city logistics" are not the same as B2C last-mile logistics. The LMD of the B2C logistics chain can take place everywhere: at an urban environment, but also at rural areas. The difference is very significant. A brief review of city logistics is presented in the next section.

2.1.1 Innovation on last-mile delivery

According to Macharis & Melo (2011) when companies want to optimize their last mile by implementing innovative concepts, the most effective ideas will be those that focus/anticipate one of the five characteristics as follows: (I) Consumer service levels; (II) Security & type of delivery/reception; (III) Geographical area & market penetration;

(IV) Fleet & technology and (V) Environment.

Some of recent innovative practices explore collect points, smart lockers, drones, and customized vehicles. Morganti et al. (2014) say that e-retailers consider that delivery services are one of the fundamental factors that determine a consumer's decision to shop with them and they have developed a wide range of services that offer, flexible hours, reduced prices, and fast deliveries. It justifies some of the new technologies and alternatives applied to LMD.

Apart from home delivery services, automated parcel stations equipped with smart lockers, and pick-up points, which are stores providing parcel drop-off and pick-up services, are fast-growing solutions. The costs of those deliveries are lower than for home deliveries, and the risk of missed deliveries is avoided. These alternatives are offered by online retailers and provided by LMD providers, combining both consumer demand for flexibility and firms' needs to optimize parcel distribution through consolidated shipments (Morganti et al., 2014).

A more innovative option is starting to raise companies' and researcher's attention: delivery robots. Chen et al. (2021) explain that the self-driving delivery robot is a promising kind of autonomous delivery mode, which can cover limited areas. Before the COVID-19 pandemic, the sight of robots delivering customers' parcels would have seemed futuristic. However, Starship Technologies, the San Francisco based firm, is currently running a delivery robot service in the north of London. Earlier in 2020, the company has also launched this new delivery system in six new cities, including a grocery delivery service in Washington, D.C. The features of these robots are best suited for the last mile delivery in the context of city logistics, moreover, as robots may be a slow option to drive all the way from a distribution hub, it can be a good substitute of bike couriers, being used for instant deliveries in urban areas where delivery vans are inefficient. For Pani et al. (2020) the ongoing COVID-19 pandemic has created a surge in the public interest and demand for autonomous delivery robot, since it can provide contactless delivery, a highly sought-after service under the directives of social distancing. As a result, consumers, businesses, and governments have switched from being cautious beta testers into eager early adepts.

On the other hand, Wang et al. (2014) argue that different last-mile delivery modes have different delivery efficiencies. Measuring the operation efficiency of each mode is fundamental for calculating its total cost. Hübner et al. (2016) discuss that innovative operational and logistical solutions must be developed to make home delivery and click & collect not only possible but profitable.

2.2 City logistics

City Logistics (CL) is directed connected to urban center freight distribution challenges. Taniguchi et al. (2001) recognized that urban freight transport plays a vital role in the sustainable development of cities. However, urban freight transport currently face many challenging problems, including high levels of traffic congestion, negative environmental impacts, high energy consumption, and a shortage of labor. Within these difficult conditions, freight carriers are also requested to provide higher levels of service with lower costs. For the authors, in response to these problems, a new area of transport planning has emerged called city logistics. CL is the process of totally optimizing urban logistics activities by considering the social, environmental, economic, financial, and energy impacts of urban freight movement.

Bozzo et al. (2014) say that literature analysis of ex-ante models in city logistics showed a certain lack of detailed studies characterized by integrated approaches. For Rao et al. (2015) an advanced and well-developed city logistics system can hasten the rate of economic growth, reduce unnecessary transaction costs, enhance economic efficiency, improve the investment horizon, increase foreign direct investment, solve urban unemployment, and promote the development of the regional economy.

Crainic et al. (2004) summarize CL goals as: (I) To reduce congestion and increase mobility, (II) To reduce pollution and noise; Contribute reaching the Kyoto targets; Improve living conditions of city inhabitants; and (III) Avoid unduly penalizing the city center commercial activities such as not “deflating” them. In addition, Faccio & Gamberi (2015) say that city logistics identify ways to regulate access, circulation, and the parking of commercial vehicles in urban centers and to implement policies without restrictions that harm economic and social prosperity and are conducive to the relocation of economic activities and population.

According to Taniguchi et al. (2001), the recent development of e-commerce also makes CL more important. There are two points to discuss the impacts on CL by the development of e-commerce: (I) E-commerce changes logistics activities by gi- ving a high priority to the demands of customers or consumers; (II) Logistics activities themselves incorporate e-commerce for matching the demand and supply of goods movement. The authors identified the Stakeholders, Figure 2, where a combination of private and public initiatives are necessary to achieve CL goals. Those different stakeholders are one of the main challenges in accomplish CL goals, mostly because they diverge in their expectations not having a common ground.

Anand et al. (2012) reinforce by saying these stakeholders belong to different parts of the CL domain and are closely connected to at least one component, but loosely connected to the whole domain. Although action by one stakeholder affects the whole domain, a stakeholder can influence only that part to which it is closely connected.

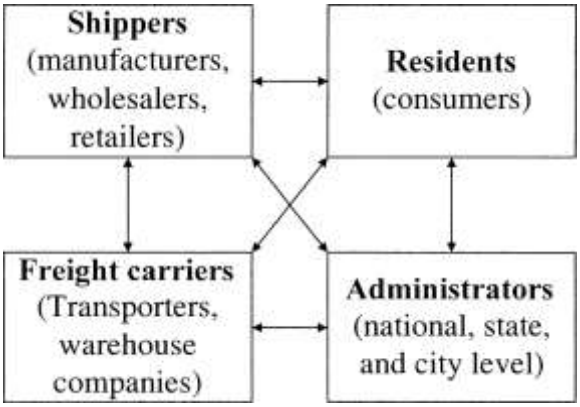


Figure 2: City logistics stakeholders. Source: Taniguchi et al. (2001)

Despite all research in this field, the CL concept is far from reality. For van Duin & Quak (2007) the lack of national or regional bodies dealing with city logistics, as there exist for urban passenger traffic, is significant. Some scholars believe that CL is an utopia considering the real conditions of most urban centers around the world.

2.2.1 Urban centers & urban distribution

The urbanization process has been intensified in the twentieth century impacting both corporations' strategies and population routine. According to Freitas & Martins (2018) in 1950, approximately 30% of the global population lived in cities. In 2007, for the first time in history, the urban population surpassed the rural population in the world. This means creating a structure capable of producing, storing, transporting, and maintaining the service level efficiently worldwide. Therefore, businesses neededto boost their logistic capabilities development, enhancing the coordination with their partners.

Nonetheless, predictions indicate that more than two-thirds of mankind will be residing in urban areas by 2050. By 2018, 55% population residing in urban areas and this number is expected to increase 68% in 2050 (United Nations et al., 2019). Therefore, managing urban areas has become one of the most important development challenges of the 21st century. Our success or failure in building sustainable cities will be a major factor in the success of the United Nations (UN) development agenda. (United Nations et al., 2019) The report notes that in 1990, there were ten mega-cities while in 2018, there were 33 mega-cities across the globe, with more than 10 million inhabitants, two of them located in Brazil - São Paulo and Rio de Janeiro. Of today's as per WorldData (2020) presents Megacities in 2018 and predict a scenario for 2030, Figure 3.

There is an ongoing trend towards urbanization in the world. For Taniguchi et al. (2001) cities provide more attractive opportunities for employment, education, cultural and sports activities, etc. However, this leads to expanding urban areas and often ge-

nerates freight transport problems, due to a lack of appropriate urban logistics policies.

Figure 3: Megacities in the world. Source: UNESCO (2021)

It's undeniable the concern with the urban center for logistics services providers, Meryem et al. (2019) emphasize that urban freight transport is a major challenge for transport companies as well as for local authorities. However, it generates several problems such as congestion, noise, and atmospheric pollution, which harm the quality of life of citizens and the performance of stakeholders. The authors point out that urban freight transport represents about 20% of the overall cost of the supply chain and about 15% to 20% of the vehicles circulating in the city.

For Crainic et al. (2004) the already significant volume of freight vehicles moving within city limits is growing and is expected to continue growing at a fast rate. Major contributing factors to this phenomenon are the current production and distribution practices based on low inventories and timely deliveries (the much talked about "just-in-time" paradigm) as well as the explosive growth of business-to-customer electronic activities that generate significant volumes of personal deliveries. The number of vehicles of all types is increasing fast and, therefore, congestion and pollution levels are increasing as well.

Bozzo et al. (2014) understand that urban distribution is a complex system in which freight is moved on the same transportation infrastructure on which passengers travel. The complete problem of CL, from the end-consumer to the producer, has been rarely

addressed. In their analysis of urban freight transportation, two main freight movements were identified: end-consumer movements and logistic movements. Several actors are (directly or indirectly) involved in urban goods transportation, such as end-consumers, logistics, transport operators, and public administration.

Cossu (2016) endorses the importance of urban freight transport role in the development of cities representing an element of great importance for the economic system, mainly distributing goods to retail, commercial establishments, offices, as well as homes urban freight transport, cannot be seen separately from other parts of the transportation chain.

2.3 Brazil market overview

Brazil is a continental dimension country, being the largest country in Latin America and the Caribbean (LAC). With a population over 209 million people in 2018, more than 87% is located in urban areas (The World Bank, 2021).

Brazil ranks 71st/ 141 globally in the last published Global Competitiveness Report by The World Economic Forum (WEF) - one position higher than the last assessment - and 8th / 22 in the LAC region. Economic growth is slowly picking up (2%) after the 2015-2016 recession; Brazil also fights against a high unemployment rate - 11.4% before COVID-19. According to Stankiewicz Serra et al. (2021), Brazil is also characterized by extreme regional inequalities, which remind us the differences between developed and developing countries. Deprivations persist and remain substantially larger in rural areas and the North and North-East regions of the country.

Despite those non-encouraging figures, Brazil is considered an important emergent market. The competitiveness performance of the country is highlighted from a relatively high innovation capability level (40th/141) and the size of its market (10th/141). On the other hand, regarding its macroeconomic stability Brazil fills position (115th/141), driven by applied tariffs (128th/141) and non-tariff barriers (135th/141); better security (132nd/141); excessively distortive taxation (136th/141) and sounder government stability (130th/141) (Schwab & Forum, 2019). LAC countries are among the most required to develop pillars of Infrastructure, Information and Communications Technology (ICT), and Innovation capacity, however, represents a substantial portion of the market size, Figure 4.

Regarding logistics infrastructure, the last logistic performance index (LPI) from World Bank Arvis et al. (2018) ranked Brazil as position 56th/160th, with a 2.99 score. Getting attention among other LAC countries for a reasonable logistics and quality competence (46th/160th) and a good track and tracing rank (51st/160th), on the other hand customs has a very poor rank (102nd/160th) which implies directly in cross-border e-commerce aspects.

Region (alphabetic order)	Enabling Environment				Human Capital		Markets				Innovation Ecosystem	
	Institutions	Infrastructure	ICT adoption	Macroeconomic	Health	Skills	Product Market	Labour Market	Financial System	Market Size	Business dynamism	Innovation Capacity
East Asia and the Pacifc	61.6	74.8	70.3	89.6	83.8	67.3	62.2	66.6	74.3	67.9	66.1	54.0
Eurasia	53.8	67.7	59.5	74.9	71.3	66.1	56.1	63.5	52.0	50.3	61.9	35.5
Europe and North America	64.7	79.7	70.4	92.6	89.1	74.6	60.0	66.4	70.9	60.1	68.3	58.1
Latin America and the Caribbean	47.1	61.3	50.9	73.7	82.2	58.7	51.6	55.9	60.3	51.2	53.8	34.3
Middle East and North Africa	55.5	70.5	57.6	75.3	80.8	62.9	56.7	54.8	63.7	59.9	58.2	41.3
South Asia	50.0	59.2	35.1	74.7	68.4	50.1	45.8	51.5	30.0	67.7	57.8	36.3
Sub-Saharan Africa	46.9	45.0	34.3	69.4	50.8	44.3	49.3	54.6	50.8	40.4	51.8	29.4

Figure 4: Region Performance by Pillar (0-100). Source: Adapted from World Economic Forum Analysis Schwab & Forum (2019)

Analyzing Brazil's data, Table 1, infrastructure score is slightly higher than the LAC average (61.3), differently, Innovation capacity is 43% higher than the LAC average, same for Market Size, where it is 80% bigger than other LAC countries, affirming that its market should be more broade, in terms of investment and research.

Table 1: Brazil performance overview 2019.

Pillar	Brazil Rank	Brazil Score	LAC Avg Score	Best Score Country
Overall	71	61	57	SGP
Institutions	99	48	47	FIN
Infrastructure	78	65	61	SGP
ICT Adoption	67	58	51	KOR
Macroeconomic Stability	115	69	74	33 countries
Health	75	79	82	4 countries
Skills	96	56	59	CHE
Product Market	124	46	52	HKG
Labour Market	105	53	56	SGP
Financial System	55	65	60	HKG
Market Size	10	81	51	CHN
Business Dynamism	67	60	54	USA
Innovation Capacity	40	49	34	DEU

Source: Adapted from World Economic Forum Analysis (Schwab & Forum, 2019).

In addition, dos Santos (2011) explains that in the next 20 years, the world's economy will undergo enormous changes. Brazil has timidly and hesitantly begun its march toward economic development and global economic competitiveness.

2.4 E-commerce

2.4.1 Historic evolution

Mendes (2013) points out that the effective start of e-commerce became possible in 1991 when the Internet was opened for commercial use. The Internet is a network connected to other networks that are present all over the world. It is not managed by any organization or government; however, it operates within technical standards and protocols that enable it to operate with a global infrastructure.

The Internet was the XX century most disruptive innovation that changed the world the most, in a glance (Mendonça, 2016). Table 2 summarizes the Internet history since 1970 and is possible to notice that only between 1995-2000 Brazil steps into the Internet, with some pioneer companies launching their online commerce.

Electronic commerce is only possible due to Internet development. Adam & Yesha (1996) initially defined electronic commerce (e-commerce) as the process of conducting commercial transactions, which were done through various media such as paper, phone, and fax, electronically without prior arrangements. However, as the world was brought closer together by the Internet, more information becomes available in an online manner Adam & Yesha (1996) updated their concept, by saying that consumers were spending more time in the electronic medium, hence, e-commerce supports traditional commercial models in which consumers acquire, analyze, and decide on their commercial actions as in the traditional case when certain aspects of their commercial decisions are supported electronically. Later, Hsu & Pant (2000) simplified the concept of business-to-customer, affirming that is essentially retailing on the Internet.

May (2000) argue that e-commerce is a compact word for a wide array of interconnected business concepts, technologies, and cultural phenomena. Poong et al. (2006) reflect that the term “electronic commerce” carries different meanings to different people. For Turban et al. (2008) the meaning of the e-commerce concept has been changed. Initially, it was seen as a process of executing commercial transactionsmade in an electronic environment. But, with its development, the term e-commerce has come to be defined as the process of buying goods and services available over the internet, using secure connections and electronic payment services.

Regarding Brazil, there is uncertainty about the first official e-commerce store. Nevertheless, some specialized websites referred to something between 1995-1996 as the first online sale, it was a book store called Book Net (ComSchool, 2017). The commercial internet has been approved in 1995 by the Ministry of Communications - at that time the only government company and their subsidiaries - TELEBRAS. In 1998 occurred the privatization process of the company, bringing new investments to expand Internet infrastructure services. Tigre (2003) points out that a poor telecommunication infrastructure was considered an important barrier for e-business diffusion. However,

Table 2: Internet history

Year	Event
1970	EDI and EFT transactions were used by the banking sec-tor.
1979	Michael Aldrich (1941 2014) invents the first online mall allowing electronic transactions with B2B and B2C.
1981	British tourism company Thomson Holidays makes its first online transaction.
1982	France Telecom invents Minitel, considered the most successful online service before the world wide web, users could make online purchases, train reservations and more through the Videotext service.
1984	Jane Snowball, 72, Using the Gateshead SIS / Tesco System to become the first person to shop online from her own home.
1987	First electronic commercial account. Swreg creates the first electronic business account that allows software developers to sell online.
1990	Tim Berners Lee writes the first internet browser using a NeXT NeXT3 computer, thus creating the World Wide Web.
1991	The National Science Foundation (NSF) removes restric-tions on commercial use of the internet, paving the way for E commerce.
1994	The first Netscape browser opens; New security means are implemented for online transactions called SSLSSL; Pizza Hut makes the first registered sale on the internet.
1995-2000	The first product on Ebay is announced; Amazon starts its activities; Livraria Cultura, Lojas Americanas, Maga- zine Luiza were the pioneers in Brazil; Dell was the first company to earn USD 1,000,000 in online sales; Google is born.
2002	eBay and Niche Retail begin the first duel between online stores
2003	Facebook is born; eBay buys PayPal
2006	Google buys YouTube
2007	The internet reaches 1,018,057,389 of internet users in the world. Google Adwords surpassed 21 billion dollars.
2008	Andrew Mason creates Groupon, the first collective purchasing site that became a fever years later.
2009	Facebook surpasses the number of accesses by Google.2010 Mobile commerce appears.
2012	Social commerce becomes a market trend.

Source: Adapted from Mendonça (2016).

from 1998, when the telecom system was privatized, to 2000, telecom investments boosted to an average of 1.36% of Gross Domestic Product (GDP) a year, a percentage well above both Brazilian and Latin American historical levels back then.

The World Wide Web technology enables people around the globe to engage in commercial activities without temporal and physical boundaries. Consumers prefer e-shopping towards in-store shopping due to the higher convenience that it offers them, such as more product information and choices, the ability to compare products and prices, and the potential to shop from any place at any time avoiding shopping trips. An important factor that determines the choice of e-shopping towards in-store shoppingis the product type and value (Irakleous, 2018)

2.4.2 Types of e-commerce

E-commerce has other types of transactions besides business-to-consumer, Table 3 summarizes the typical transactions, depending on the business model implemented, Mendes (2013) points out that types of e-commerce are a developing field, following market trends and new demands. Due to its relevance to this research, we will limit to shortly explain two types: business-to-business and business-to-consumer.

Jovarauskienė & Pilinkienė (2009) define the business-to-business model as a process of bargaining between enterprises' bodies by Internet or other technologies. In other words, it is a model which business processes take place between two companies. Therefore, performing operations standard business models can be improved due to new technologies to reach higher efficiency. Assessing the application of new technologies (Internet) to trade business-to-business is defined as a deal between two parts, which is realized by Internet.

Table 3: E-commerce types

	Business	Consumer	Government	Peer
Business	B2B	B2C	B2G	B2P
Consumer	C2B	C2C	-	C2P
Government	G2B	G2C	G2C	-
Peer	P2B	P2C	-	P2P

Source: Adapted from Mendes (2013).

Nemat (2011) affirms that the "business-to-business"term was originally coined to describe the electronic communications between businesses or enterprises in order to distinguish it from the communications between businesses and consumers (B2C). It eventually came to be used in marketing as well, initially describing only industrial or capital goods marketing. Today it is widely used to describe all products and services used by enterprises. Mendes (2013) highlights that the use of electronic means, such

as the internet and e-commerce, between companies is a natural tendency since it brings benefits, such as costs reduction in orders placement and price of raw materials, greater agility in the selection procedures of suppliers and buyers and, therefore, allows the reduction of errors in these processes, among other benefits.

Business-to-consumer (B2C) is defined by Jovarauskienė & Pilinkienė (2009) as

bargains between business organizations and individual consumers, which are made directly or invoking information nets. The main principle of this business model is connected with the efforts, which the company makes in order to give complete necessary information about its products or services to present or potential consumers, allowing them to order goods, pay for them, and expect future services. This model is used by traditional and electronic businesses and is usually connected with retail trade. Mendes (2013) explains that in this e-commerce model, interaction is established between the organization (business) and the final customer (consumer). They are online companies selling services, products, and information directly to the final consumer.

2.4.3 Current and future scenario

In 2020, worldwide retail e-commerce sales were responsible for USD 4.208 trillion and it is expected to reach USD 6.388 trillion in 2024. Despite the fact of a challenging year for retail in 2020, worldwide retail e-commerce sales grew 27.6% (eMarketer, 2020). Figure 5 illustrates the percentage of e-commerce sales growth, where the LAC region stands out, with 36.7% growth in 2020.

LAC led the world in retail e-commerce sales growth in 2020 (36.7%) and it was in second place in digital buyer growth (7.3%). For 2021 it is expected to ascend to No. 1 in digital buyer growth and remain among the fastest-growing markets for retail e-commerce sales (eMarketer, 2020). It endorses the huge economic impact of e-commerce in LAC, demanding other areas (such as LMD) to grow in concordance.

Allagiannis et al. (2021) discuss that the advent of technology has affected every industry in some way and retail is one of the industries that has been heavily affected by innovative digital technologies. These technologies have blurred the lines between physical and digital retail channels, presented the integration of online and offline channels in retail. As a consequence, e-commerce is drawing a new chapter: the omnichannel concept. Arslan et al. (2020) define omnichannel as the integration of online and offline channels in retail.

Moreover, Allagiannis et al. (2021) highlight that the COVID-19 pandemic has forced many retailers to go digital due to European countries have been forced to go under lockdown for months. This situation has made the digitalization of retail even more urgent. During this shutdown, small and medium retailers who do not have an online presence suffered the most as all the shops and markets were closed for months.

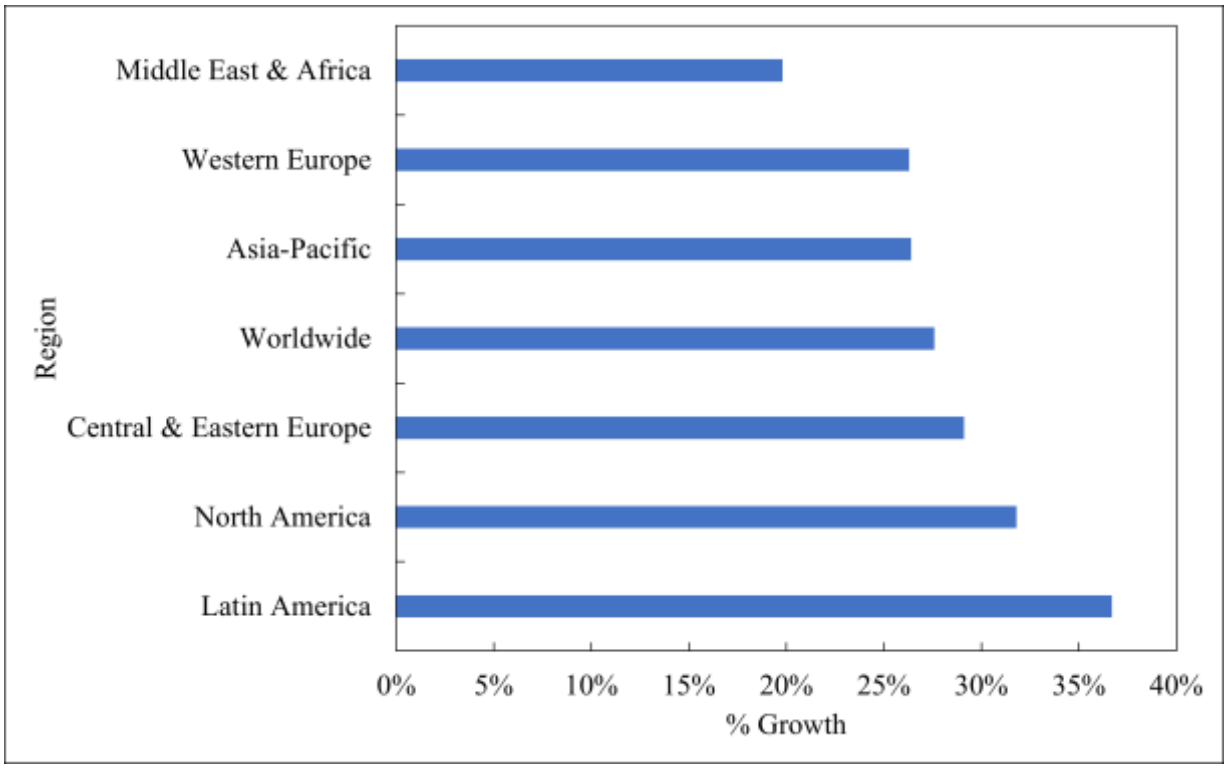


Figure 5: Retail E-commerce Sales Growth Worldwide, by Region, 2020 (% change) Source: Adapted from eMarketer (2020)

In agreement, e-commerce adoption has been growing rapidly in recent years, and in some advanced economies (as well as in China) its penetration could be approaching the saturation point among internet users. Thus, the surge in it generated by the pandemic served mainly to keep user growth rates and may create new trends.

3 Methodology

The present study consists of exploratory and descriptive research of the last-mile delivery chain and it unfolds, through a qualitative and quantitative approach. It embraces different methods of research and analysis, which directs to the characterization of the LMD scenario and collaborates to explore solutions for the e-commerce segment considering the available alternatives in place. As per Morabito et al. (2021), the combination of methods allows the benefits of one technique to mitigate the disadvantages of the other, offering a more complete study. In addition, the exploratory research intends to investigate the subject to provide familiarization with the study problem, in this research e-commerce last-mile delivery challenges in urban distribution.

3.1 Literature review

For the literature review, scientific articles indexed in databases such as Scopus – Elsevier, Science Direct, Emerald, Wiley, Francis & Taylor, and others were used. Books, theses were also used, different data were collected in Brazilian and International databases Brazilian Federal Government (IBGE, CNT, Johns Hopkins Coronavirus Resource Center, UNESCO) and other national and international association bases (eBIT-Nielsen, eMarketer, WEF). These data materials were incorporated in the articles that compose this dissertation, connecting all content on the studied subjects.

A detailed reading of the selected material was carried out, looking for similari- ties and relevance in the literature related to the project such as historical evolution, processes, approaches, and innovations proposed to the sector. For the research, a qualitative and quantitative methodology was adopted aiming to answer the research problem.

3.2 Results and discussion

We adopted articles to composed the results and discussion section. Here in this section, we include a summary of the articles' methodology.

3.2.1 Article I- Lockers as enhancement and reduction of last-mile risk on e-commerce

The methodology of this article consists of a case study, based on the observation of the volume obtained from a Brazilian e-commerce company.

For this case study, 2018 sales data were analyzed with Microsoft Excel ©as it follows:

- Firstly, the database was cataloged by monthly volume;
- After analyzing the seasonality, the database was cataloged by delivery zip code destinations;
- Based on the cataloged zip code deliveries database, the suggested areas for setting up the lockers for customer withdrawal was defined, considering the places with biggest pedestrian flow and using subway lines and urban buses terminals that connect all areas of São Paulo City;
- Then, to measure the number of lockers required for the project, the volume company's' basis was used, considering a percentage of deliveries using the Click & Collect, by its use in Europe as reference.

Finally, after analyzing all information, a proposal was made to set up lockers in order to reduce the risks of distributing e-commerce products.

The article was published at ENEGEP conference, Santos - SP, on October 2019, an event promoted by ABEPRO - Brazilian Association of Industrial Engineering and had the purpose to meet the specific objective III.

3.2.2 Article II- Connecting city logistics to smart cities: A literature review and future research agenda

For this paper, was chosen a systematic literature review (SLR) to track and understand the evolution of city logistics and smart city concepts throughout the years in academia.

We focused on papers published in refereed journals in the field of logistics, production engineering, and transportation, from 2000 to 2019. These criteria lead us to the first amount of more than 700 articles of "City Logistics". The same criteria was used to research articles of "Smart City", returning more than 15,000 articles. Due to the large number of articles published on those topics, this paper focused on the most cited in an academic area and most representative authors to do the SLR.

The article was published at International Conference of Logistics from Federal Institute of São Paulo - IFLOG conference, Suzano-SP, on October 2019. The paper had the purpose to meet the specific objective I.

3.2.3 Article III- The role of the last-mile delivery in the future of e-commerce

For this paper, a literature review was conducted to analyze and understand the literature implications on Stakeholders' expectations regarding last-mile logistics in e-commerce.

The research conducted a discussion over literature and summarized the findings in a graphic representation, comparing logistics providers' desires with e-commerce consumer's desires.

The article was published as a Springer book chapter at Advances Management Production Systems - APMS conference, Novi Sad - Serbia, on August 2020. The paper had the purpose to meet the specific objectives I e II.

3.2.4 Article IV- Alternatives for Brazilian E-Commerce Last-Mile Delivery Based On Service Expectations Evaluated By 3PL Providers: A Multi-Criteria Decision Analysis Using Analytic Hierarchy Process

The methodology of this paper consists of an Analytic Hierarchy Process (AHP) approach to investigate the impact of last-mile delivery methods from the point of view of Logistics providers considering the e-commerce sector in Brazil. The AHP is a multicriteria method widely adopted for decision-making developed by Tomas L. Saaty. The objective is to solve problems with the multiple criteria technique (Maletič et al., 2014). This methodology consists of the comparison of criteria, in this research, criteria related to LMD services. The paper had the purpose to meet the specific objective IV.

The motivations for carrying out each work, as well as their relation with the present study, are described in Table 4.

Table 4: Article summary

#	Title	Objective	Conclusions	Conference/ Year
I	Lockers as Enhancement and Reduction of Last-Mile Risk on e-commerce	Analyze the volume of distribution of an e-commerce company and propose the feasibility of using these lockers to improve the distribution process in the Last-Mile and reduce the losses arising from cargo theft.	It was concluded that the alternative of using lockers in the observed scenario, would be extremely relevant in terms of cost-efficiency, risk reduction, and positive perception of the final consumer.	ENEGEP/2019
II	Connecting City Logistics to Smart Cities: A Literature Review and future research agenda	This paper had a twofold aim: first is to present a systematic review of city logistics and smart city, summarizing and describing its main elements; second is to conjoin those models analyzing their connection in the Transportation Science	The question of this paper was answered, regarding CL is connected moreover; coexists with SC models, they are co-dependents in a certain way. A future question of research could analyze this codependency and more possible frameworks embracing all active stakeholders.	IFLOG/2019
III	The Role of the Last-Mile Delivery in the Future of the E-commerce	This paper intended to identify the expectations of logistics parcel providers and consumers and discuss the implications of e-commerce marketing. To this end, a literature review was conducted.	The research allows us to conclude that there is a gap among logistics parcel providers, e-Shops, and e-Consumer's expectations. The limited delivery options and affordable technologies are dominated by standard home delivery methods. Solutions such as autonomous drones and sharing mobility are embryonic; still, need clear regulation and investments to make it feasible for most parcel delivery companies in last-mile logistics	APMS/2020
IV	Alternatives of Brazilian e-commerce Last-Mile Delivery Based on Service Expectations Evaluated by 3PL Providers: A Multi-Criteria Decision Analysis Using Analytic Hierarchy Process	This paper aims to delve LMD regarding the e-commerce sector in Brazil considering the expectations of service providers in face of available logistics solutions. To do so, the Analytic Hierarchic Process (AHP) approach is used contextualizing with the logistics solutions presented in the literature.	The results indicated a potential statement change. The unprecedented AHP outcome, prioritizing Security over Costs, shed the light for new perspectives in this field. These results could suggest a desire of LMD providers to consider innovative e-commerce solutions and may lead the Industry to draw a new chapter of Brazilian LMD.	Journal Undefined

4 Results and Discussions

Four articles were developed, three of them have been published and the last was completed waiting for considerations and remarks before finding a suitable journal to submit it.

4.1 Article I - Lockers as enhancement and reduction of last-mile risk on e-commerce

This article was published in Portuguese and translate to English to contemplate this master thesis. Some minor adaptations were necessary to be presented in this format. The original version can be consulted at:

Link: http://www.abepro.org.br/publicacoes/artigo.asp?e=enegep&a=2019&c=38633

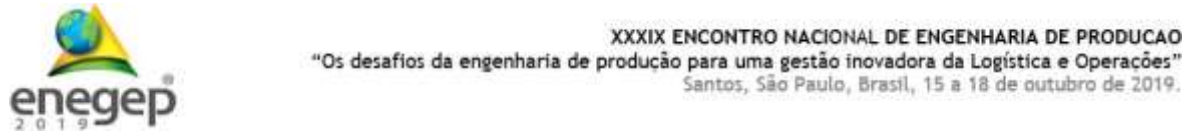


Figure 6: ENEGEP 2019

LOCKERS AS ENHANCEMENT AND REDUCTION OF LAST-MILE RISK ON E-COMMERCE

Fernanda Alves de Araujo
fernanda.araujo@stricto.unip.br
João Gilberto Mendes dos Reis
joao.reis@docente.unip.br
Paula Ferreira da Cruz Correia
paulafecruz@gmail.com

Summary:

With the ongoing growth of e-commerce, comes big challenges for logistics providers, especially in the so-called Last-Mile Delivery, which besides representing a large portion of transportation costs, raises a red flag in regards to claims of cargo theft, with a higher incidence and constant concern for customers and providers. This article aims to propose the use of lockers as an alternative in distribution for e-commerce companies. For that matter, it presents a case study from a computer products distributor and projects the advantages of using the option. The conclusion is that the alternative of using lockers in this e-commerce would be extremely valuable in terms of cost, risk reduction and positive experience from consumers.

Keywords: Last-Mile Distribution, E-commerce, Cargo Theft, Delivery Terminals, Click & Collect.

1. Introduction

Over the years, the purchasing habits of consumers have been changing at a fast pace. This change in behavior is perceived by the speed at which technological platforms develop and by the constant innovation in offering products for consumption in different areas. Regular retail, through a physical point of sale, still responds for a big portion in sales in developing countries, such as Brazil, but they are losing more and more ground for electronic commerce. This paradigm shift has influenced the way logistics operators distribute their products. If previously the distribution was done directly to the store, nowadays there can be different ways, either at the consumer's residence or point of contact, either directly from the distributor or through the store, creating a huge logistical challenge.

In Latin America, e-commerce represents more than US$ 61 billion, led by the giants Mercado Livre and Amazon. Just in Brazil in 2018, about 74% of the population had internet access, this represents more than 156 million people, an increase of 6% compared to the previous year, 2017; therefore, more than USD 60 million were handled through internet purchases in Brazil, led by electronic products and clothing (E-COMMERCE FOUNDATION, 2018).

This shift in consumption habits brings logistical infrastructure challenges, especially in the so-called Last-Mile or "leg" of delivery (Last-mile Delivery), which has become more challenging in terms of cost and efficiency for transportation companies. According to data from NTC & Logística (2018) the index of cargo theft in the country increases by the year, in 2017 there were almost 26,000 reported case in highways and urban areas, losses worth BRL1.6 billion, the southeast region weighing 85.53% of the claims, with prominence for the States of São Paulo and Rio de Janeiro with 40.75% and 40.81%, respectively. Also, according to data from this industry, the most targeted items are electronics and pharmaceutical products.

The majority of cargo theft claims occur precisely in the Last-Mile, which is the moment of distribution to the final consumer, where vehicles become more vulnerable to this type of action, as it is directly in touch with urban and considered to be risk areas.

In this scenario, logistics providers and e-commerce retailers have been looking for solutions to enable the delivery of products to consumers and to prevent theft and cargo loss. One of the potential solutions is the use of lockers at strategic points for the withdrawal of goods. This solution has several advantages, such as: (i) avoiding wasted efforts for delivery in the absence of the consumer; (ii) reduces risks in the traffic of high-value goods in unsafe areas of the city; (iii) it allows the consumer to pick up the merchandise in a convenient place whenever they wish to.

Given this scenario, the goal of this article is to analyze the volume of distribution of an e-commerce company and propose the feasibility of using these lockers to improve the distribution process in the Last-Mile and reduce the losses arising from cargo theft. For this matter, a case study of a leading Brazilian e-commerce company specialized in computers, electronic products and smartphones is used.

This article is divided as it follows: in addition to this introduction, it presents the fundamental concepts in section two, section three presents the methodology, part four presents the case study and analysis, and at last, section five presents the final considerations.

2. Literature review

2.1 Last-Mile Logistics

The Last-Mile concept is recent in the literature of logistics. Lim *et al.* (2018) states that Last-Mile logistics is the last stretch of a B2C (business-to-consumer) parcel delivery service. It occurs from the order entry to the final customer's destination point. According to Manerba (2018), Last-Mile delivery is currently considered to be one of the most expensive, least efficient and most polluting steps in the entire supply chain.

Schwab (2018) believes that solving our common challenges requires radical ways of thinking. Because of technologies that replace human labor, severe climate change, major concerns about inequality and the prospects for economic insecurity are undermining the models and paradigms in which our societies rest.

Therefore, the Last-Mile also presents today a great challenge within the transportation sector, mainly for e-commerce, demanding technological developments to enlighten the current and future problems.

Another issue that increases costs and is a Last-Mile concern in e-commerce logistics are returns. Besides usual returns for fault and missing items, the Buyer's Remorse Rule is supported by legislation on the Consumer's Protection Code (Código de Defesa do Consumidor), Rule 49 Law Nº 8,078 of September 11, 1990, which ensures the right to regret purchases carried out other than the physical marketplace, such as on the Internet, brochures, telephone, among others. Thus, the consumer has a seven-day span from the receiving of the product to regret and have the money returned, with monetary compensation. However, this is not a strict problem of Brazilian e-commerce, countries like the United States have even greater

return policies, which can reach 30 days, guaranteeing 100% financial refund, according to data from Findlaw (2019).

Whenever a product has to be returned, two things may happen: (i) the costs related to reverse flows are added; (ii) the returned products, when remarketed, will have their turnover reduced [...]. (CORRÊA, 2010).

Liu (2014) points out that product returns are considered an inevitable cost for online sales, with no use for cost reduction. As competition pressure continues to increase in e-commerce, B2B or B2C, companies have begun to consider the possibility of managing product returns in a more cost-effective way.

2.2 Distribution Technologies

The Last-Mile relies directly on distribution technologies. Reis *et al.* (2015) states that the technological revolutions that have taken place in the last 60 years have transformed the way in which these relationships are established and managed. If before, it depended exclusively on geographical proximity to establish some kind of relationship, today these barriers have been eliminated by information technology.

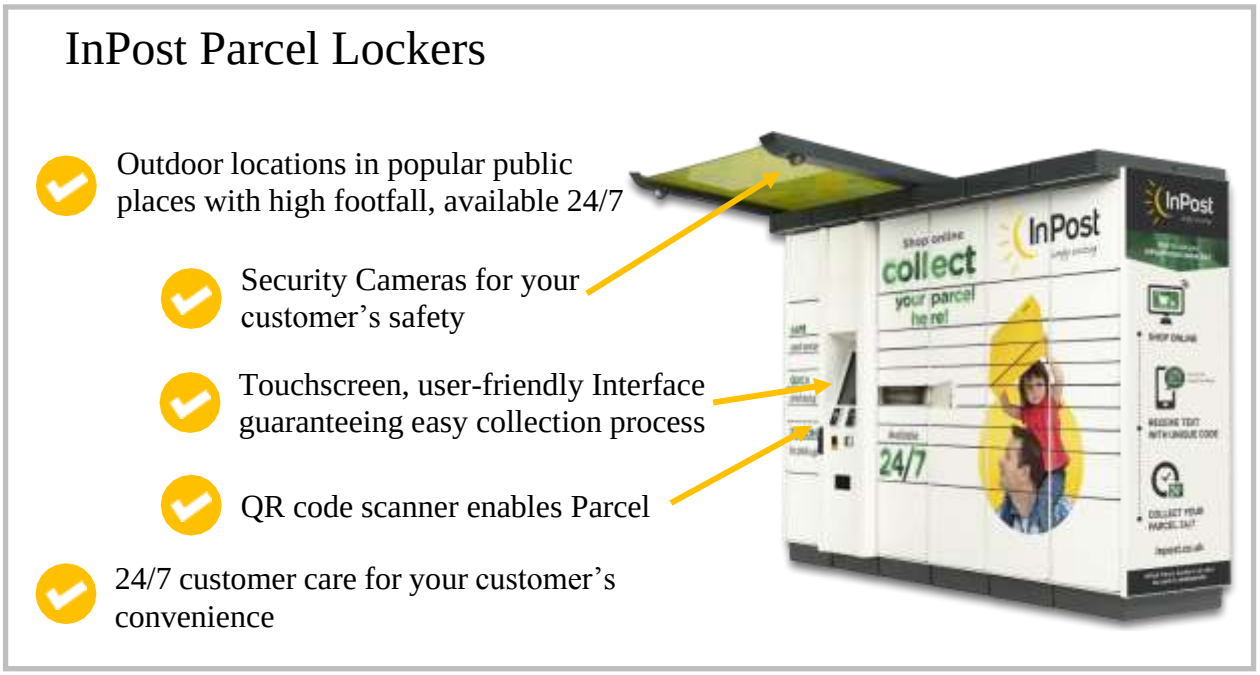
This technology surpasses regular computing, with the so-called Smart products, using IoT (Internet of Things). Schwab (2018) points out that in a recent study, IHS, a London company that analyzes market data, predicts that the number of devices with IoT will grow by an estimated 15.4 billion devices in 2015, to 75.4 billion, in 2025. The author further reveals that this five-fold increase will result in deeper connectivity in all areas of life, interconnected global economies in innovative ways, and likely to enfold a flourishing machine-to-machine economy.

Despite these technologies linked to communication, an important technology to be implemented is the use of lockers as delivery terminals. This type of technology combined with the Last-Mile was used in a breakthrough manner by the American company Amazon in the United States, at first. This technology is still embryonic in developing countries, such as Brazil, but in the United States and Europe, delivery terminals are already a reality that has been reducing costs and ensuring greater convenience and safety for end consumers.

In Europe, 54% of all online consumers use "Click & Collect" delivery method, which would be the method using a delivery terminal as the final destination; while a delivery crew has an operational capacity of 100 home orders, lockers can carry out 700 orders per day at the same operating cost (REVISTA MUNDO LOGÍSTICA, 2017). Figure 1 depicts a delivery terminal by the English company InPost, which is expanding its business to Latin America, with some

models already set up in Brazil with lesser technology, as can be seen in Figure 2, already in operation as a pilot project.

Figure 1 – InPost Parcel Lockers



Source: InPost UK. https://inpost.co.uk/

Figure 1 - InPost Locker in Rio de Janeiro

Source: InPost BR. https://inpost.com.br/

As potential advantages of this delivery device we may highlight:

- Greater convenience for the final consumer;
- 24/7 Withdrawal
- More access for people with no Zip Code or living in remote/risk areas;
- Reduces delivery time from the perspective of the final consumer;
- Lower costs to the final consumer;
- No need for a carrier to receive the order;
- Can be used as a Drop-off point for reverse logistics;
- Confidentiality when receiving;
- Safety, as it can be set up in places of high footfall and using the existing structures;
- Cost reduction in the Last-Mile delivery;

The withdrawal from the lockers are through a code sent to the final consumer, who receives a message with the tracking code via email or text and the date the item will be available for withdrawal, once at the delivery terminal, a QR-Code is sent to the consumer by Application or Text, the terminals are equipped with a scanner to read the QR-Code, either from a cell phone screen or printed material, after reading and confirming the QR-Code the compartment that holds the package is automatically released. Then the terminal sends the electronic information about the withdrawal and informs the compartment is once again available to receive a new package.

When it comes to technology, decisions usually have a high cost and, therefore, require enormous precautions in order to reduce risks. In addition to the high-cost equipment, it almost always brings with it the need for changes in the setup [...]. (COSTA NETO, 2007)

On the opposite side to the advantages, the risks and costs associated with investing in new technologies, since at first there will be a need to invest in the setup and maintenance of structures, but an alternative are the models used in Europe as outsource, leasing the lockers and leaving a third-party company in charge of maintenance and update of the delivery terminals.

2.3 Cargo Theft in Brazil

Cargo theft is a broad issue to be faced by logistical operations, especially in regards to road transportation. According to data from the National Transport Confederation - CNT (2009) 61% of all cargo in Brazil were carried on road modal.

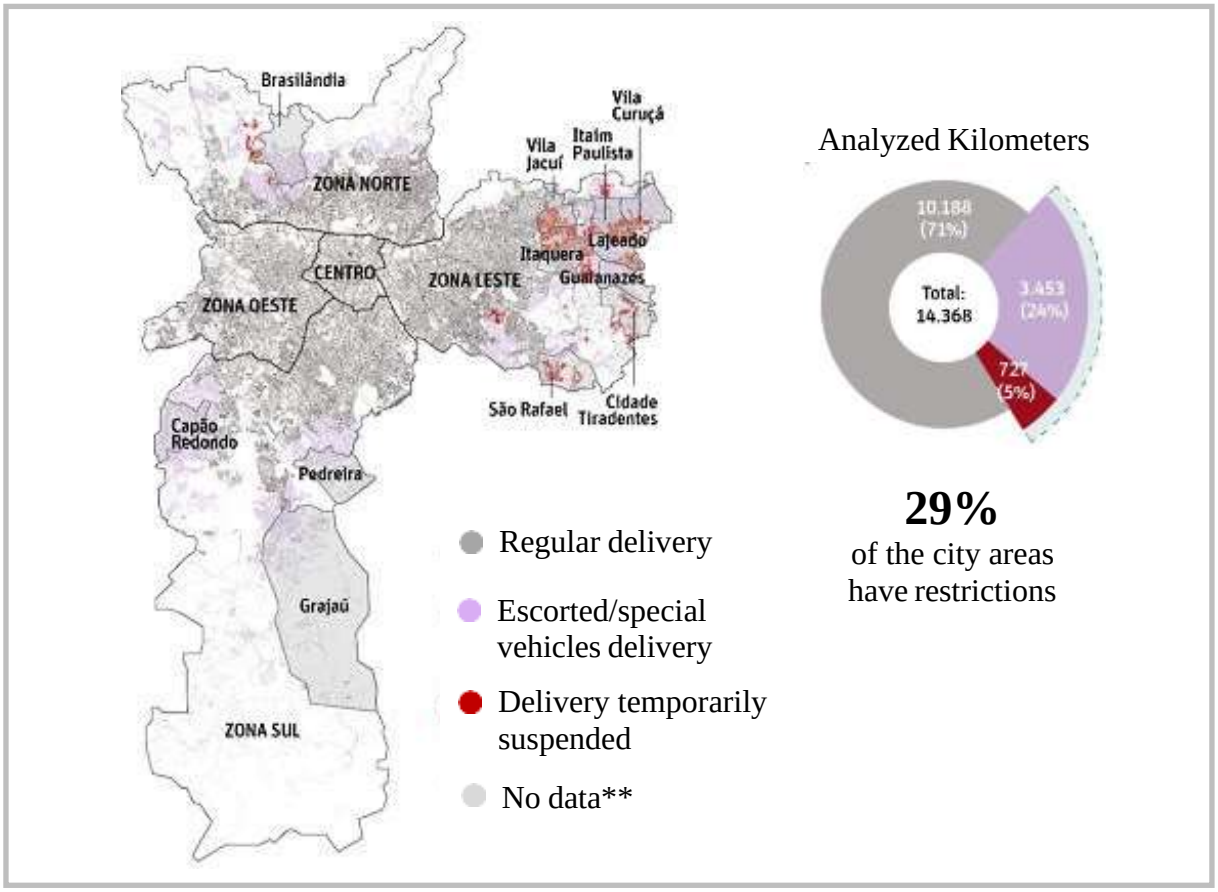
Cargo theft in Brazil increased considerably in the years from 2015 to 2017 (Union of Transport Companies of São Paulo - SETCESP, 2017). Just this period alone, almost 70.000 claims were reported, resulting in a BRL4 billion loss (NTC & Logística, 2018). The roads with the highest

number of thefts are: Presidente Dutra, Anhanguera, BR-116, Fernão Dias, Castelo Branco, among others (Cargo Transport Companies Union - SETRANS, 2011).

As mentioned in the previous sections, São Paulo accounts for more than 40% of cargo theft claims in the country, as this State will be the focus of this study, more information was sought regarding the restrictions of deliveries on considered risk areas. A report published by Folha de São Paulo (2017), brings data from the Correios where the restriction or lack of delivery reaches up to a third of São Paulo City, affecting more than 4.5 million people. Still according to this report 57 of the 96 total districts in the city face distribution problems in risk areas, and on the outskirts, restrictions can affect 99.96% of all streets, for instance the district of Itaim Paulista in the eastmost of the state's capital.

According to the Correios database (2019) in São Paulo, there are more than 13,400 zip codes with complete and/or partial restrictions for deliveries. Figure 3 shows the regions where there are restrictions due to be considered risk areas in the metropolitan São Paulo until 2017.

Figure 3 – Risk map of São Paulo City



Source: Folha de São Paulo – Adapted from Correios (2017)

The city outskirts, considered to be commuter towns, are the most affected areas in terms of Last-Mile delivery restrictions, where deliveries may have a much higher cost due to security protocols, such as escort service or special vehicles, that carriers are expected to put in practice in order to avoid incidents.

3. Methodology

The methodology of this article consists of a case study, based on the observation of the volume obtained from a Brazilian e-commerce company. Founded in 2003 and with 100% online sales, its two main distribution centers are located in countryside areas in the states of São Paulo and Espírito Santo. The company resells and distributes computer products, electronics and smartphones.

For this case study, 2018 sales data were analyzed with Microsoft Excel® as it follows:

• First, the database was cataloged by monthly volume, in order to observe the trend of seasonality of deliveries, to identify if there would be any impact on the distribution process.

• After analyzing the seasonality, the database was cataloged by delivery destinations, through volume and invoice amount (Nota Fiscal).

• Based on the cataloged database, the suggested area for setting up the lockers for customer withdrawal was defined.

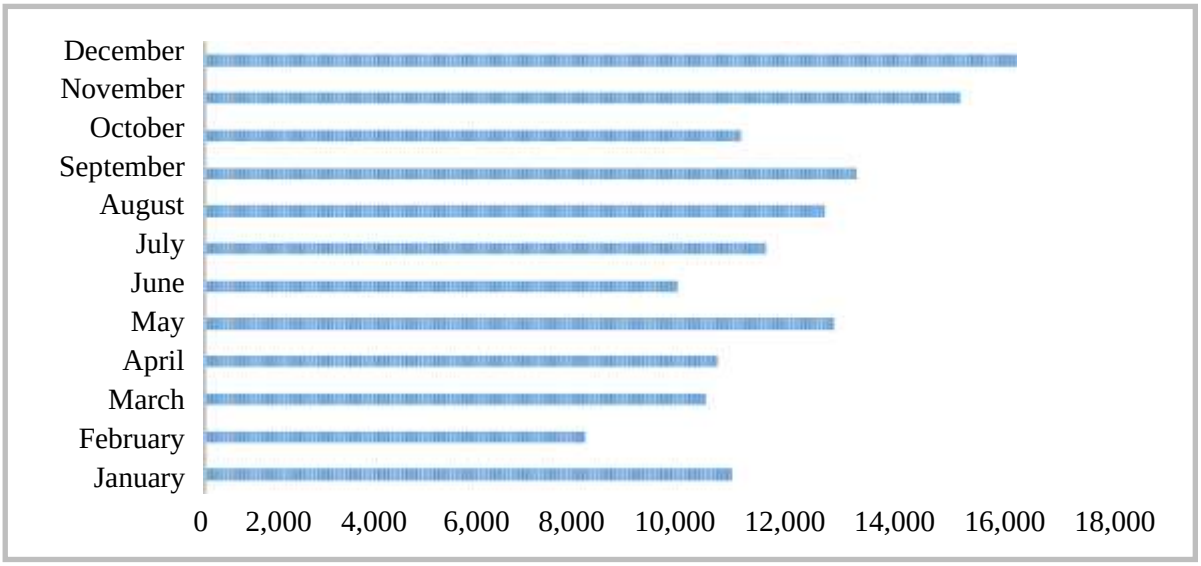
• Then, to measure the number of lockers required for project, the company's volume basis was used, considering a percentage of deliveries using the Click & Collect mechanism of the Last-Mile, considering the receiving capacity of the lockers and the point of access.

Ultimately, after analyzing all information, a proposal was made to set up lockers in order to reduce risks of distributing e-commerce products.

4. Results

The results imply that in the analyzed period there were 146,222 orders, with an average of 12,000 monthly or 400 daily orders. The months with highest seasonality indexes are December, November and September, driven respectively by Christmas, Black Friday and Children's Day, as per Figure 3.

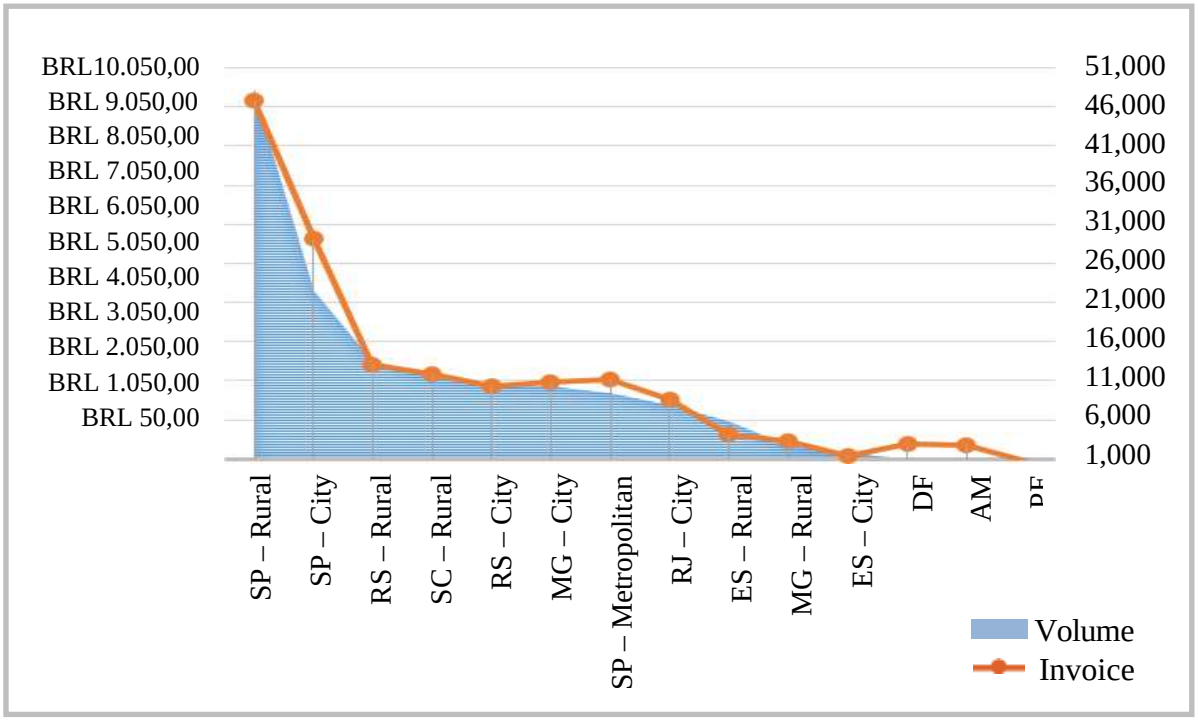
Figure 2 – Monthly orders



Source: The authors, 2019.

99% of the deliveries are dispatched from the company's distribution center in Viana, ES due to tax purposes and then headed, mainly for the downtown of São Paulo, Figure 4. The cargo is sent to São Paulo by air, with arrival at Viracopos, SP airport. Then it is carried out to other locations within the country, by air or road.

Figure 3 - Volume x Invoice Amount



Source: The authors, 2019

As per Figure 5, the highest concentration of deliveries is for countryside of the State of São Paulo, followed by the City of São Paulo. Due to this concentration and its complexity, it was decided to analyze just the City of São Paulo. The average invoice amount (Nota Fiscal) presented is BRL200,00, but some purchases may reach BRL2.000 per invoice (Nota Fiscal).

Considering more than 13,000 Zip Codes with potential delivery restrictions in the City of Sao Paulo, the risks and costs associated with these locations can make the Last-Mile even more challenging. It is noted that there are almost 23,000 B2C deliveries destined in the City of São Paulo, a daily average of 91 deliveries.

The districts that are restricted, are called "commuter towns", according to Ojima *et al.* (2010) there is an almost immediate association between the urbanization process and the rising of "commuter towns" based on the dichotomous "center-periphery" model, which means that the majority of this population/consumers during the day are in the urban centers, performing professional activities, and the living address starts to play a secondary role in terms of convenience when it comes to Last-Mile.

Ojima *et al.* (2010) also pointed out that another source for the stigma built around the commuter-towns principle is the poverty associated with the metropolitan peripheries that were formed during the accelerated urbanization process experienced in Brazil until the 80's. This anthropological factor can "justify" the higher rates of robbery and theft, that also affects cargo, and concerns residents/consumers about receiving their orders directly at home, often rented, shared with others or simply by the lack of safety receiving their purchases.

The considered models of lockers by the company InPost have the capacity to receive up to 70 orders at the same time. Considering that the volume of e-commerce observed is 91 deliveries per day just in the City of São Paulo, the disposition proposed as a pilot project would be the setup of three lockers (represented by red arrows on Figure 6).

These are neighborhoods considered to have easy access and high footfall:

• Barra Funda (East Side/Downtown)

• Republica (East Side/Downtown)

• Consolação (South Side/Downtown)

Figure 4 – Proposed Locker's disposition

Source: The authors, 2019.

In order to optimize the "Click & Collect" service through delivery terminals, the proposed scenario would be to consolidate deliveries with the delivery schedules three times a week, at first, but with merchandise available for withdrawal 24/7.

Table 1, represents the estimated quantity of deliveries through the Lockers, based on the study carried out in the European market by InPost (2017), but considering a smaller percentage in the Brazilian market (40%), due to being an unusual modal for Brazilian consumers.

Table 1: Estimates

Characteristics	Quantity
General delivery	91/day
"Click&Collect"[1] Estimate	36/day
Consolidated 3 times/week	108/week
"Click & Collect" by terminal/delivery	12/day

Source: The authors, 2019

[1]Based in an InPost study (2017) – Europe counts 55% of deliveries via "Click&Collect". For the study a 40% estimate was considered.

As seen in the previous sections Lim *et al.* (2018) and Manerba (2018) reinforce the challenges of the Last-Mile, both in regards to costs and to infrastructure, the mentioned results pointed the effectiveness that lockers can represent in contrast to those aforementioned concerns.

The capacity, at first idle, of the lockers of 34 daily deliveries can address the points of returns and/or reverse logistics, as previously stated by Corrêa (2010) and Liu (2014).

Thus, the mentioned results point out that the use of this technology has great potential for consolidation of deliveries and returns, reducing the risks associated with distribution. In addition, there would still be idle capacity that could expand the capacity of e-commerce deliveries via this modality by up to 50%.

5. Final Considerations

The conclusion of this study is that Last-Mile risk can be reduced and its efficiency, increased through the implementation of lockers. However, it is understood that the observed data are still a starting point for a more in-depth discussion of the topic.

The advantages that this type of delivery represents in the context of the Last-Mile in e-commerce, reduces the cost of final distribution with the possibility of using a single channel for direct delivery and returns in reverse logistics. In addition, it presents convenience and a solution to the final consumer, especially those affected in the outskirts of the City of São Paulo, which are in need of more effective and low-cost solutions.

Currently, the reasonable solution for these consumers is withdrawal at a Post Office branch linked to their Zip Code, which does not add up in terms of convenience, as the opening hours of the branches are strict and do not meet the routine of this consumer who is outside the residential area for the most part of their day, as noted in previous sections.

Of course, it is necessary to consider the costs of setup and maintenance of delivery terminals - lockers, but there are business models that can be optimized through splitting the costs, such as partnerships with more than one e-commerce, in addition to possible partnerships with existing retails, such as: Shopping Malls, Gas Stations, Convenience Stores; 24/7 Drugstores; 24/7 fast-food restaurants, among many others; lockers can also bring new customers and increase income in those marketplaces.

Another interesting point, from the perspective of the carriers, is that responsibility is passed to the final consumer in an unnoticed way, since the moment the merchandise arrives at the terminal, the responsibility of the withdrawal (with pre-defined deadline), depends 100% on the final consumer.

Thus, it is concluded that the alternative of using lockers in the observed scenario, would be extremely relevant in terms of cost-efficiency, risk reduction and positive perception of the final consumer.

6. Acknowledgements

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4.2 Article II - Connecting city logistics to smart cities: A literature review and future research agenda

This article was published originally in English in accordance to conference parameters. Under ISSN 2596-2914. The original version can be consulted at:

Link: http://www.iflog.net.br/expediente-e-edicoes/edicoes-anteriores/

This article was part of initial research, that use to consider Smart Cities (broader scope), at the same time relevant to introduce the City Logistics concept for this research, the following articles were more focused on the last-mile, once the scope was properly defined.

Figure 7: IFLOG 2019

ISSN 2596-2914

Connecting City Logistics to Smart Cities: A Literature Review and future research agenda

Conectando o conceito de "*City Logistics*" as Cidades Inteligentes: Uma Revisão da Literatura e agenda futura

De Araujo, Fernanda A[1]. Universidade Paulista - UNIP,
fernanda.logistica@gmail.com
Reis, João Gilberto M[2], Universidade Paulista - UNIP,
joao.reis@docente.unip.br
Correia, Paula Ferreira da Cruz[3], Universidade Paulista - UNIP,
paulafecruz@gmail.com

Abstract: This paper presents a systematic literature review of city logistics and smart city concepts reported in the literature for a transportation science analysis. This research has a twofold aim; first to present a systematic review of city logistics and smart city, summarizing and describing its main elements from the most relevant and high-cited articles in the Academia; second to conjoin those models analyzing their connection in the Transportation Science. This review argues that city logistics may be connected to a smart city model through an initial framework, filling the expectations from different stakeholders. Next, it opens a dialogue to identify current gaps and propose a future research agenda.

Key Words: Smart City, Last Mile, Urban Freight, Smart Logistics, Stakeholders.

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1 INTRODUCTION

Due global economy and technology changes, cities are facing fierce competition for investors, tourists, international events, and market share. Currently more than 50% of global population lives in urban areas; by 2050, 79% of the total population will reside in urban centers. (Lagorio *et al*., 2015; Savelsbergh & VanWoensel, 2016). In this context, many challenges have been raised, requiring efficient and innovative modern cities.

Looking deeper in how those challenges affect urban freight distribution we can highlight the consumer behavior change from traditional retail to e-commerce retail. Bektas, Crainic and Van Woensel (2015) mention that substantial growth and new business models are expected following the increasing freight volumes due to the Internet shopping growth and improved mode utilization. As a response to those concerns, emerge the concept of smart city and city logistics that encompasses the idea of efficiency and technology working together to solvethose future and existing issues. The initial dialogue among smart cities, centeredon Information and Communication Technologies-related topics (ICT), therefore it has evolved into concepts that tend to a holistic view, considering three main factors: technology (hardware and software infrastructure), people (creativity, diversity, education) and institutions (politics and governance) (Nam & Pardo, 2011; Lee et *al*., 2013).

Urban and metropolitan development has their challenges itself such as traffic jam, mobility, access to urban roads, energy, transportation capillarity, etc.; in this context logistics of all kind of flows are extremely necessary to avoid disruption of basic services. The concept of logistics is well-known, but an evolution is the concept of City Logistics, Uckelmann (2008) says that is reasonable to group the corresponding research and to accomplish a common understanding, the definition has to be flexible and adaptive though, to incorporate future technology developments. New technologies are emerging all the time, IoT (Internet of Things) and IoS (Internet of Services) are now a reality for most different areas that are taking advantage of it, such as logistics.

City management deals with plenty issues related to the economy, spatial planning, and environmental protection. Smart cities mostly requires the transfer

and diffusion of knowledge, innovation and technology, between tasks carried by government also include topics related to city logistics (HAJDUK, 2017).

In this context, how the city logistics can connect to a smart city model?

This paper has a twofold aim: first is to present a systematic review of city logistics and smart city, summarizing and describing its main elements; second is to conjoin those models analyzing their connection in the Transportation Science. This research combines papers published from 1997 to 2019, showing the evolution of concepts and what are their focuses providing a correlation between them, also revealing the uppermost relevant and widespread ideas from academics all over the world. Additionally open a dialogue for the future research agenda.

The article is structured as follows. Section 2 we provide details regarding systematic literature review protocol as methodology. Section 3 brings a city logistics and smart city review, highlighting the evolution from basic transportation to city logistics - a much more connected and embracing concept that rise from modern society needs and exploring smart city model, analyzing different definitions since the term appeared in an academic context, identifying their focus. Section 4 associates a Smart City Model to a City Logistics framework, trying to establish their connection. Last section correlates previous sections to urban mobility needs and closes with an initial discussion and suggestion for a future agenda, relating all literature review, organizing researches into areas of focus to come up with a list of current gaps and needs.

2 THE RESEARCH METHOLODOGY

For this paper, was chosen a systematic literature review (SLR) to track and understand the evolution of city logistics and smart city concepts thought the years in academia. According to Kitchenham (2007) a SLR is a research methodology to identifying, evaluating and interpreting all available research relevant to a particular research question, or topic area, or phenomenon of interest.

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There are three main reasons for performing an SLR: (i) to summarize the existing evidence concerning a treatment or technology; (ii) to identify any gaps in current research in order to suggest areas for further investigation; (iii) to provide a framework/ background in order to appropriately position new researchactivity. (Kitchenham, 2007). For Lagorio *et al*. (2015) a SLR provides a repeatable research method which, when applied properly, should provide sufficient detail to be replicated by other researchers.

Based on available tools was opted for SLR as a research method because of the structure of research questions, which aims to understand the evolution of concepts and find out existing gaps for scientific academia. In this paper, a SLR has been used to summarize city logistics and smart city main definitions, trends and possible gaps. To endorse our research were focused on papers published in refereed journals in the field of logistics, production engineering, and transportation, from 2000 to 2019. The starting year has been chosen due city logistics as a term has been introduced formally in an International Conference for the first time, according to Taniguchi *et al.* (1999).

A guide proposed by Kitchenham (2007) was used to escort this systematic review as described in the following section.

2.1 DRAFT OF SYSTEMATIC LITERATURE REVIEW

Based on the guide proposed, was taken 4 steps: Planning, Selection, Extraction, and Execution as illustrated in Figure 1.

The success of SLR is the quality of results, to assure it a very critical part is to select the database for the research. So we went thought the most renowned publishers and library services such as Scopus, Emerald, ScienceDirect, and Wiley.

Keywords combinations including terms “City logistics”, “Smart City,” “Last mile”, “Urban Logistics”, “Literature Review” were used in the field – “Article Title” sorting by “higher citation” in order to capture the most relevant ones. To guarantee a fresh review, it was also mixed most-cited with new researches in the last two years, to ensure a contemporary landscape of those concepts.

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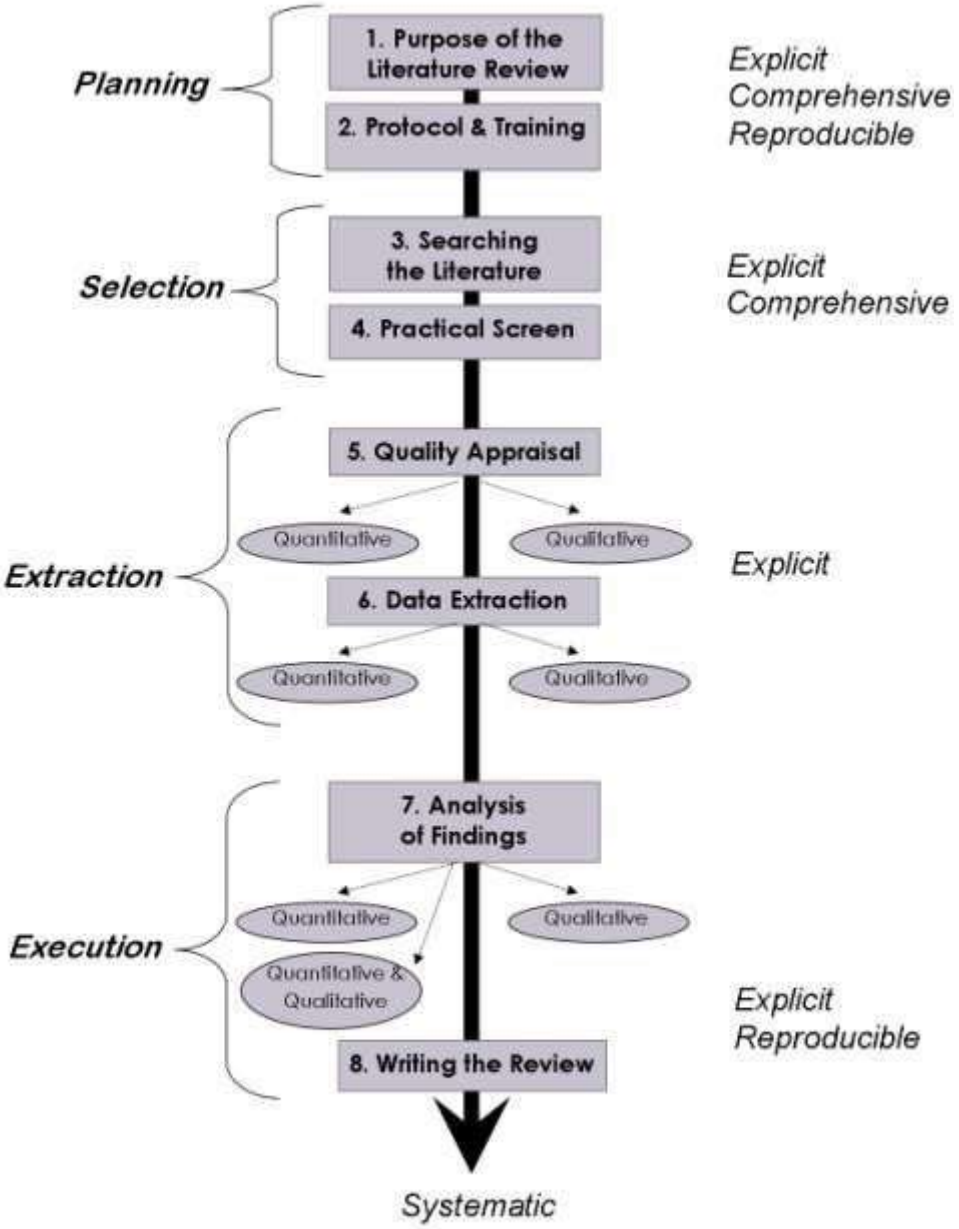
Figure 1 - A systematic guide to literature review development



Source: Okoli & Schabram (2010, p. 9)

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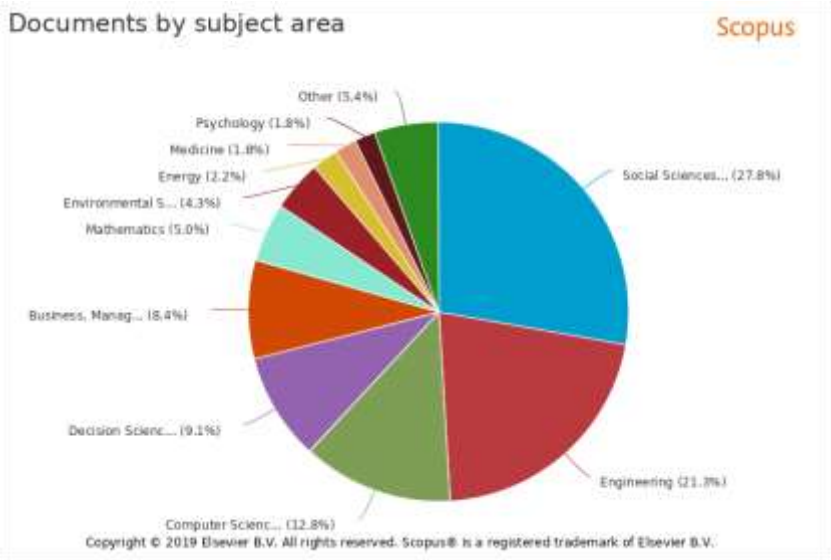
These criteria lead us to the first amount of more than 700 articles of “City Logistics” distributed in areas as below, figure 2, being the Social Sciences and Engineering segments the ones care most about this refereed subject.

Figure 2 - City Logistics documents by subject area



Source: Scopus, 2019

The peak of “City Logistics” discussions in the academic field was in 2016, with 125 articles published that appeared in our research, as represented in figure 3.

Figure 3 - City Logistics documents by Year

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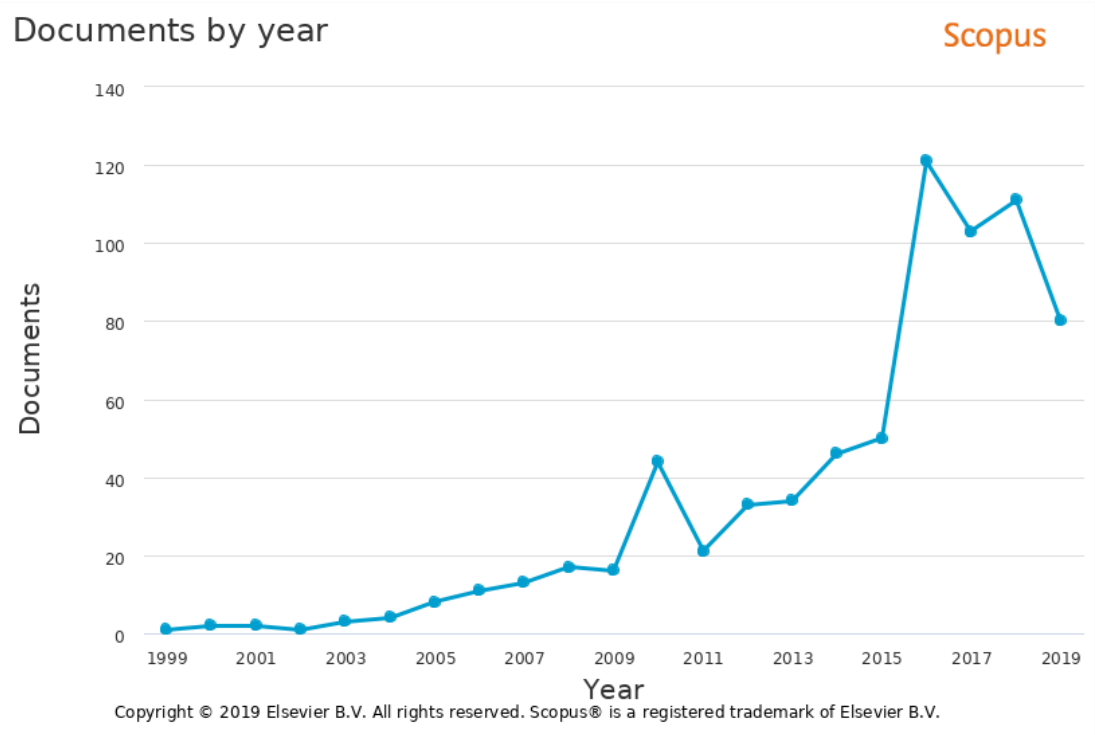
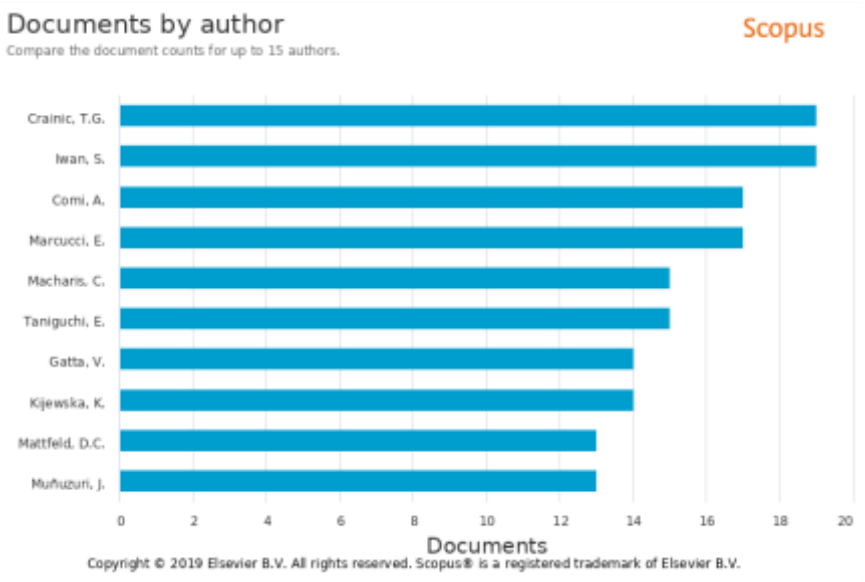


Source: Scopus, 2019

In figure 4 we can notice the top 15 most engaged authors, in City Logistics area, being Iwan, S. the most representative author among this selection.

Figure 4 - City Logistics documents by Author



Source: Scopus, 2019

The same criteria lead was used to research articles of “Smart City”, returning more than 15,000 articles, distributed in areas as below, figure 5, being the

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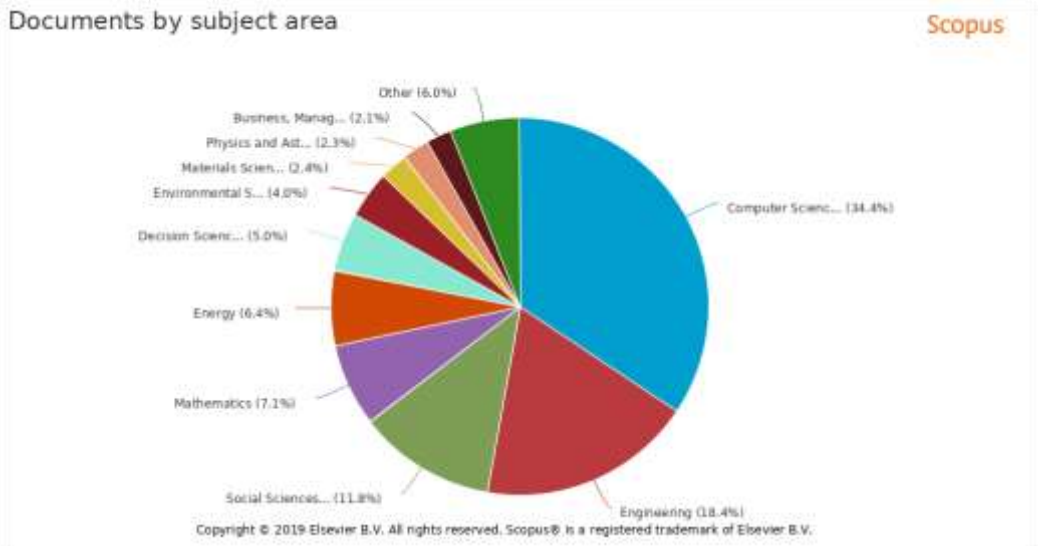
Computer Sciences and Engineering segments the ones discuss most thismatter.

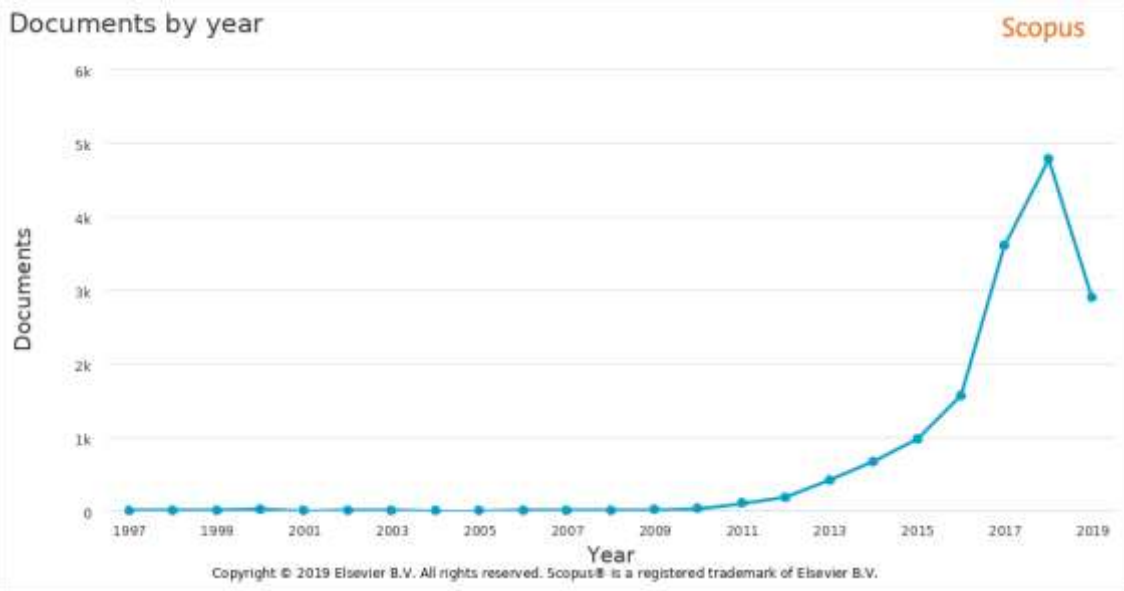
Figure 5 - Smart City by area



Source: Scopus, 2019

The highlighted year of “Smart City”, discussions in academic field were last year (2018), with almost 5,000 articles published that appeared in our research, as figure 6.

Figure 6 - Smart City by year



Source: Scopus, 2019

In figure 7 we can notice the top 15 most engaged authors, in Smart City articles, being Nesi, P, the main publisher with 34 publications so far.

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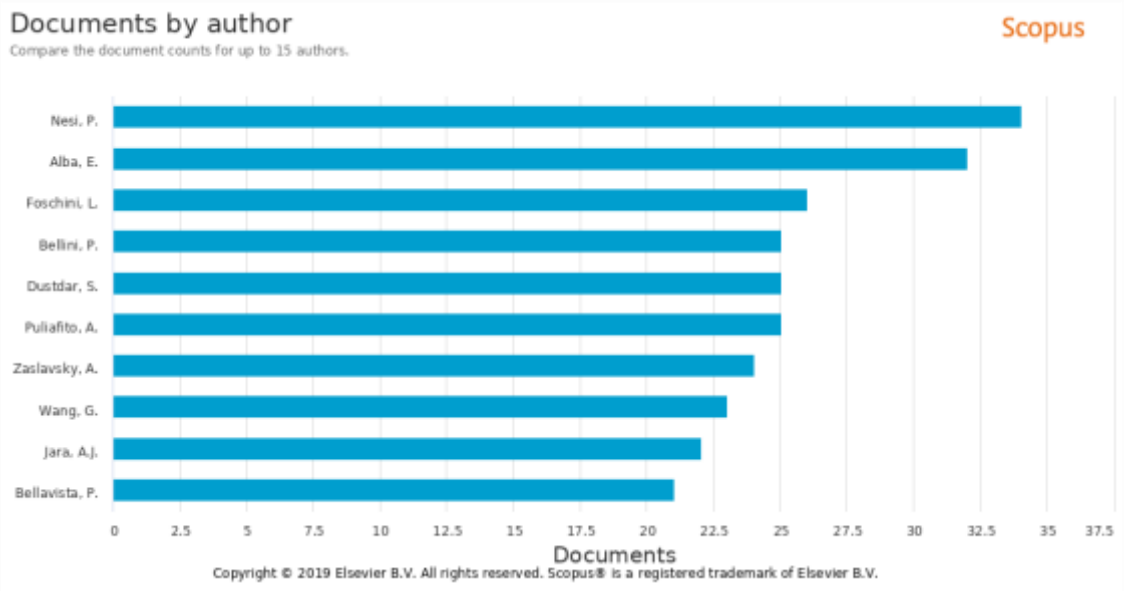
Figure 7 - Smart City by author



Source: Scopus, 2019

Due to a large number of articles published in those topics, this paper focused on the highest cited in academic area and most representative authors to do the SLR.

3 LITERATURE REVIEW

3.1 CITY LOGISTICS

The concept of city logistics (CL) came as an evolution of logistics itself. Savelsbergh & Van Woensel (2016) explain that there many definitions of CL, but common to all is that city logistics is about finding efficient and effective ways to transport goods in urban areas while taking into account the negative effects on congestion, safety, and environment.

Other names can be found to describe CL such as Urban Freight, Urban Logistics and in some cases Last Mile Logistics as well. The principal definitions founded in this SLR are presented as follow in Table 1.

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Table 1. City Logistics Definitions

Author (Year)	Definition	Focus of Definition
Crainic, T.G. et al. (2009)	City Logistics has been coined to emphasize the need for an optimized consolidation of loads of different shippers and carriers within the same delivery vehicle and coordination of freight transportation activities within the city.	Optimization
Iwan, S. (2016)	Last mile deliveries are one of the major effectors of heavy traffic of commercial vehicles in the whole city area. Their essential features, significantly lowering the rational functioning of the transport system, include high degree of fragmentation and low range of use of the cargo load compartment of vehicles.	Efficiency
Savelsbergh, M.& Van Woensel, T. (2016)	There are many definitions of city logistics, but common to all is that city logistics is about finding efficient and effective ways to transport goods in urban areas while taking into account the negative effects on congestion, safety, and environment.	Efficiency
Marcucci, E. & Daniels, R. (2008)	City administrators have designed and implemented a wide array of policies to tackle the urban goods transport issue. Some of the implemented policies are regulatory in nature and comprise dedicated parking bays for loading/unloading trucks, access restrictions to some areas of the city centre, time restrictions, vehicle restrictions according to the size of the vehicles, fuel used, fuel efficiency, and minimum load factor required. A second set of policies affects the costs of distributing goods within the city centre, e.g. by requiring the acquisition of time-based access permits or use of vehicles with low environmental impact.	Regulation policy
Dablanc, L. (2007)	Urban logistics can be defined as any service provision contributing to an optimized management of the movement of goods in cities.	Optimization
Taniguchi, E.& Shimamoto, H. (2004)	City logistics has been defined as the process for totally optimizing the logistics and transport activities by private companies with the support of advanced information systems in urban areas considering the traffic environment, its congestion, safety and energy savings within the framework of a market economy	Optimization

As previous section points, first time CL as a transportation science appeared was at the beginning of 21st century, presented by Taniguchi (1999), since that the world has been change, with more challenges and needs, in this context the concept still evolving and adapting to fill modern society demands. In general, authors agreed with a central idea of CL that combines transport and technology optimization for urban areas. Table 2 summarizes CL focus of research by relevance established in this SLR.

Table 2 – CL focuses

Focus	% of Relevance
Optimization	42%
Efficiency	30%
Sustainability	14%
Regulation policy	14%

3.2 SMART CITY

Smart City (SC) as terminology used for the first time in the nineties, mainly to describe application and use of Information and Communication Technologies (ICTs) in different areas of urban spaces. Due to their strong relationship with technology, in constant improvement, SC terminologies still an open- developing concept making it difficult to characterize in one single way. Prove of it are the huge amount of articles that cover this topic in the academic landscape in the past few years, being an ascending topic of interest from many scholars.

Table 3 compiles some concepts of SC definitions and bring their focus to attention, in order to correlate them, to see the most widespread concept between researchers all over the world.

Table 3 - Smart City Definitions

Author (Year)	Definition	Focus of Definition
Giffinger R. et al. (2007)	A Smart City is a city well performing in a forward-looking way in these six characteristics, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens.	People and Communication

Washburn et al. (2009)	The use of Intelligent computing technologies to make components and critical infrastructure services of a city - which include city administration, education, health, public safety, real estate, transport and public services - smarter, interconnected and efficient	Technology
Harrison et al. (2010)	A city that connects the physical infrastructure, the IT infrastructure, the social infrastructure and the business infrastructure to leverage the collective intelligence of the city	Infrastructure
Caragliu et al. (2011)	[…] a city to be smart when exist investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance.	People and Communication
Schaffers et al. (2011)	The concept of smart cities seen from the perspective of technologies and components has some specific properties within the wider cyber, digital, smart, intelligent cities literatures. It focuses on the latest advancements in mobile and pervasive computing, wireless networks, and middleware and agent technologies as they become embedded into the physical spaces of cities.	Technology
Komninos (2011)	Cities (smart) as territories with great capacity of learning and innovation, built on the creativity of its population. Their knowledge creation institutions and their infrastructure-communication and knowledge management.	People and Innovation
Nam e Pardo (2011)	A smart city infuses information into its infrastructure improve convenience, facilitate mobility, efficiency, conserve energy, improve air quality and water, identify problems and correct them quickly, recover quickly from disasters, collect data to make better decisions, distribute resources effectively and share data to enable collaboration in entities and domains.	Infrastructure
Barrionuevo et al. (2012)	Being a smart city means using all the technology and resources available in an intelligent and coordinated way with the objective of develop integrated, sustainable and sustainable urban centers	Technology
Lombardi et al.	The application of information and communication technologies (ICT) with its effects on human capital / education, social and	Technology and

Zanela (2014)	Although there is still no formal and widely accepted definition of "Smart City", the ultimate goal is to make better use of increase the quality of services offered while at the same time reducing operational costs of general government	People and Economy
Rizzon et al. (2017)	Despite all the investment in technologies to become a smart city, if there is no participation and if social learning of these changes is not observed, they may not achieve the purpose of integration and interconnection of the different systems governing life in society. Governments and businesses can be influenced by interests other than the collective benefit of the community / city where they are inserted.	People and Innovation
Ferreira (2017)	[...] the concept of Smart City goes beyond an infrastructure with information and communication technologies, but that it plays an important role in the construction and evolution of cities.	People and Innovation
Anthopoulos et al. (2019)	This term has been adopted by businesses, where an “ecosystem” describes the relationships between economic entities (i.e., producers, distributors, intermediaries, consumers etc.). Moreover, information and communication technologies (ICT) industry uses the term of digital ecosystems, which are focused on interactions among technological agents (devices, databases, programs, etc.) and respective information flows and form the infrastructure for digital business ecosystem	Economy and Technology

In the last 12 years of research (2007-2019), there is some similarity on ideas leading us to 4 main focuses that appears more than once in this research: Technology; People & Communication; People & Innovation and Infrastructure. The relevance were demonstrated in table 4, despite all new approaches trying to unlink SC concepts to ICTs only; this review shows that it still the most correlated focus when it comes to SC idea.

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Table 4. Smart City definitions focuses

Focus	% of Relevance
Technology	27%
People and Communication	20%
People and Innovation	20%
Infrastructure	13%
Economy and Technology	7%
People and Economy	7%
Technology and Communication	7%

4 CONNECTING A SMART CITY MODEL TO A CITY LOGISTICS FRAMEWORK

A research made by Vienna University of Technology dedicated to Smart City laboratories identified six main 'axes' (dimensions) along which a ranking of 70 European middle-sized cities can be made. The six dimensions are represented in Figure 8.

Figure. 8. Smart City Model

Source: Adapted by GIFFINGER, Rudolf, e Haindlmaier GUDRUN. (2010)

Each one of those areas has some key indicators, figure 9, sometimes with different stakeholders, but Giffinger & Gudrun (2010), believes that the combination of them will indicate how "Smart" a city can be.

Figure 9 – SC Key Indicadors

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Smart economy	Smart governance	Smart living	Smart people	Smart environment	Smart mobility
Innovative spirit	Political awareness	Cultural and leisure facilities	Education	Air quality	Local Transport system
Entrepreneurship	Public and social services	Health conditions	Lifelong learning	Ecological awareness	(Inter)national accessibility
City image	Efficient and transparent administration	Individual security	Ethnic plurality	Sustainability resource management	ICT-Infrastructure
Productivity		Housing quality	Open-mindedness		Sustainability of transport system
Labour market		Education facilities			
International integration		Touristic attractions			
Social cohesion					

Source: Adapted by GIFFINGER, Rudolf, e Haindlmaier GUDRUN. (2010)

All those key indicators in Figure 9 are directed or undirected related to a CL efficient model. The urban freight or last-mile logistics is a huge challenge for medium and large cities, according to Savelsbergh & Van Woensel (2016) population in developing economies is thus moving rapidly into cities, and mega-cities (having more than 10 million inhabitants) are becoming a (more) common phenomenon in many countries. Related to population growth rises new barriers for logistics, Dablanc (2007) says that in general logistic decisions are closely related to land issues, however, within cities, land is not an issue anymore, it's because urban land simply does not exist anymore for logistics activities, urban centers are more restricted than ever.

One of the forerunners of CL science, Taniguchi *et al.* (2004) has identified three main objectives of CL: (i) to improve the quality of life; (ii) to improve the flow of people and freight; (iii) to protect the environment. In this sense, to achieve those objectives is mandatory the commitment of different stakeholders who have different needs and wishes about CL model. With a broad vision of the whole panorama is possible to synchronize CL objectives into the SC key indicators.

Perboli *et al*. (2018) worked on a CL Framework, figure 10, based on operational optimization, which matches with evidenced SLR in this paper, where 42% of main authors are highlighting optimization as a current need in CL.

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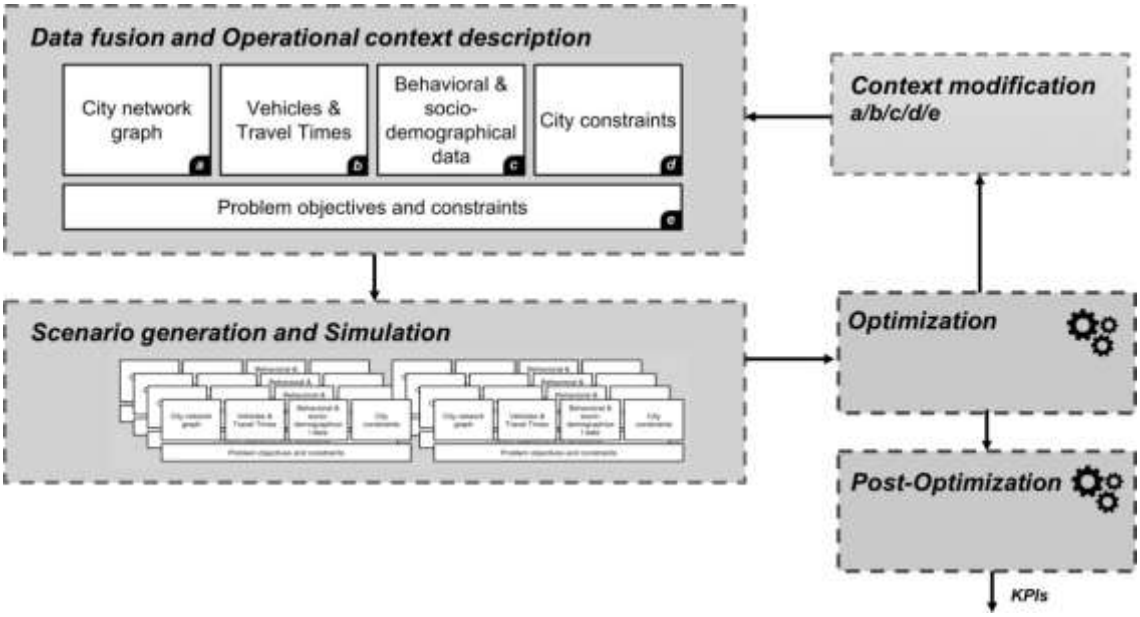
Figure 10 - CL Framework



Source: Perboli *et al*. (2018)

Perboli *et al* (2018) built this framework based on gathering data from 5 sources: (i) City network graph and maps; (ii) Vehicle fleet and travel times; (iii) Behavioral and socio-demographic; (iv) City constraints; (v) Problem objectives and constraints. They justify those sources affirming that with data of five distinct types allows to easily study the impact of modifying a specific aspect of the operational context.

A second phase – scenario generation and simulation – is required, according to Perboli *et al* (2018) once both the problem and the operational context are well defined; a broad set of scenarios is generated by using a scenario generator, which allows the researchers to develop specific scenarios for different frameworks. The aim of this paper is not to indicate a simulation process, so the paper will not deepen in this topic, a simulation method that fits most can be used in future research.

The intend is indicate a framework that can be modified according researcher needs, in this point that is the beauty of Perboli's *et al.* model, to be adaptable for different cities and contexts regardless simulation method or software.

Moving forward the five data sources from CL framework can easily permeate among six axes from SC model, as following section.

5 DISCUSSIONS AND FUTURE AGENDA DIRECTION

The SLR covering the state of art in those ascending topics, this paper could identify that Technology, People, Communication and Innovation are the focuses for SC presented by the Academia, as Table 4 - section 3; on the other hand, Optimization and Efficiency are the main areas of interest from CL researchers, as Table 2 - section 3. Beyond SLR a widespread model of SC was presented and related to an available CL framework, proving that there is a connection between both concepts, even merging their areas of focus and interest.

Most attention so far was paid to SC, as a more examined concept through the past year from scholars, but is undeniable the rising of CL awareness, part due to environmental and sustainability issues and part due economic matters. In this context we can build a scenario where Optimization in CL could come from established Technology, Communication and Innovation in SC and the Efficiency will have as main stakeholder People & Government that has the responsibility to keep and expand it.

Table 5 below compiles presented SC key indicators to the CL framework, in order to relate them. As observed some key indicators from SC appears more than once, connecting with more than a CL source, as highlighted. This characteristic evidences how connected and depended on those concepts can be.

Table 5 – CL Framework x SC Key Indicators

Smart City Key Indicators	City Logistics Framework Sources				
	City Network	**Vehicle and Travel Time**	**Behavior/ Socio-Demo**	**City Constraints**	**Problem Objectives & Constraints**
	International Integration	Productivity	Innovative Spirit	Political	City Image
	Touristic	Air Quality	Entrepreneurship	Housing	Efficient and Transparent Adm
	Accessibility	Ecological	Labour	Accessibility	Security
	ICT Infrastructure	Local Transport	Public and Social Services	ICT Infrastructure	Air Quality
					Ecological
		Accessibility	Culture & Leisure		
		ICT Infrastructure	Health		Sustainability
		Sustainability of Transport	Housing		Accessibility
			Education		ICT Infrastructure
			Learning		
			Plurarity		
			Open Mindedness		

Source: Author, 2019

In addition, those components match the identified areas of focus in the SLR. Being People, Efficiency and Technology the fundamental ones.

For future research agenda, there is an opportunity to dig deeper into CL and Urban Freight modeling, in order to understand this niche, their issues, and demands. There is a gap between understanding and analyzing inputs for active stakeholders, according to Anand *et al.* (2012) they are only a few models available in which all stakeholders and their influence in urban freight domain are included. Another dilemma could be observed is the necessity to align government and private companies into an acceptable CL framework in SC projects, considering restriction policies and transport efficiency.

The question of this paper was answered, regarding CL is connected moreover; coexist with SC models, they are co-dependents in a certain way. A future question of research could analyze this codependency and more possible frameworks embracing all active stakeholders.

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4.3 Article III - The role of the last-mile delivery in the future of e-commerce

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Figure 8: APMS 2020

The Role of Last-Mile Delivery in the Future of E-Commerce

Fernanda Alves de Araújo[1(✉)],
João Gilberto Mendes dos Reis[1,2],
and Paula Ferreira da Cruz Correia[1]

[1] RESUP/PPGEP - Universidade Paulista, São Paulo, Brazil
fernanda.logistica@gmail.com,
joao.reis@docente.unip.br, paulafecruz@gmail.com
[2] Postgraduate Program in Agribusiness, Universidade Federal da Grande Dourados, Dourados, Brazil

Abstract. Last-Mile delivery has attracted considerable interest from the logistics suppliers and retail industry in the last few years. New technologies and approaches are being discussed both professional and academic side. The trend of new technologies developed for transportation will not stop and the reason is not hard to explain: The increase of online commerce and app-based ordering of almost everything from books to food, requires a large capacity, speed, and flexibility. Following the importance of last-mile delivery, this paper intends to investigate the expectations of consumers and parcel logistics provides regarding last- mile delivery. To do so, we conducted a literature review of last-mile to identify the main gaps found in the literature so far, aiming to extend the current literature. Our results showed that advances in last-mile delivery will depend on the capacity of logistics parcel services and consumers to align their expectations.

Keywords: City logistics · Urban freight · Parcel freight distribution

1 Introduction

In the last few decades, the future of transportation has been revolving around science fiction ideas such as flying cars, floating bridges, teleportation. However, although our transport systems are a little bit far from this futuristic world, nowadays there is much more technology applied to the transport segment than ever before.

The most recent innovation in urban transportation is autonomy Drones. The first official tests with Drones started in 2013, performed by Amazon. According to the CEO company, the Drones could deliver packages weighing up to 2,3 kg to customers within 30 min of them placing order [1]. In the following year, DHL launched its initial operation for research purposes with Drones focused in remote areas with restricted access [2].

Currently, drone delivery is a reality. The "Prime Air" Amazon service is available in the US where drones cover up to 15 miles and delivery packages less than 30 min counting with the FAA (Federal Aviation Administration) approval and certification

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[3]. The German company DHL also launched in May 2019 their first regular service of Drones delivery in China, with a partnership with EHang an autonomous aerial vehicle company [4]. Another American parcel company – UPS – also performs Drone delivery for medical samples, but is going to expand the service for regular operations pushed by the competition and for the growth of online shopping [5]. Floreano and Wood [6] estimated that Drones will have an important socio-economic impact in society in many areas such as: Volumetric data collection; Inspection; Humanitarian Organizations, Transportation and others. In addition, they pointed out the Transport application affirming that Drones will also help developed countries to improve the quality of service in congested or remote areas and will enable rescue organizations to quickly deliver medical supplies in the field and on demand.

The trend of new technologies developed for transportation will not stop and the reason is the increase of online commerce and app-based ordering of almost everything from books to food, requires a large capacity, speed, and flexibility. In this context, last-mile delivery has grown exponentially in importance globally and is getting attention from the biggest companies around the world.

Besides drones, another trend for last-mile is shared mobility, Shaheen and Chan [7] explain that it will be possible in the future including the use of trip planning mobile apps, multi-modal integration, and potential opportunities with automation applied to last-mile delivery and not only for people mobility.

In this context, note that logistics service providers, who used to be almost invisible to final consumers, are now the first physical contact on the sales experience that consumers have. Moreover, more than ever, logistics and last-mile delivery are an active part of the whole customer experience journey. For Rai et al. [8] in the omnichannel environment, where products are delivered to the store and to the home, logistics service providers have become important links between retailers and their customers.

Indeed, the e-commerce sector was the first to realize the importance of last- mile delivery, nonetheless, the growth of sector create a gap between consumers and logistics parcel services companies. While the former are seeking alternatives to cost reduction and increase of the delivery efficiency, the latter are interested in more convenience to receive their products.

With those ideas in mind, this work intents to identify the expectations of logistics parcel providers and consumers and discuss the implications from e- commerce marketing. To this end, a literature review was conducted.

This paper is organized as follows. Section 2 represents the fundamental concepts for last-mile. Section 3 we delve into discussions considering expectations and implications of the last mile delivery in e-commerce. The last section closes with an initial conclusion and wonders for future researches.

2 Last-Mile

In recent years, logistics evolve from supporting role to the protagonist in the management scenario, replacing the notion that transportation is a necessity following production. Logistics turns out a paradigm referring to the integrated management of

the whole supply chain, encompassing the entire cycle of production, circulation and, increasingly, consumption as something to be planned and analyzed [9].

Logistics always pursue the development from industry and market trends, emerging from a cost center to an innovative player, being crucial for the success of any retail company. Competitiveness can be improved through better management of logistics networks and can lead to the development of new models for different sectors [10].

Regarding last-mile delivery, it is necessary an overview of City Logistics topic. Taniguchi and Shimamoto [11] define city logistics as the process for totally optimizing the logistics and transport activities by private companies with the support of advanced information systems in urban areas considering the traffic environment, its congestion, safety, and energy savings within the framework of a market economy. In addition, Savelsbergh and Woensel [12] explain there are many definitions of city logistics, but common to all of them is that city logistics is about finding efficient and effective ways to transport goods in urban areas while taking into account the negative effects on congestion, safety, and environment.

Another important aspect of city logistics, it has been coined to emphasize the need for an optimized consolidation of loads of different shippers and carriers within the same delivery vehicle and coordination of freight transportation activities within the city [13].

Part of city Logistics' concerns is last-mile delivery. Lim and Srai [14] explains that the term "last-mile" originated in the telecommunications industry and refers to the final leg of a network. Today, last-mile logistics denotes the last segment of a delivery process, which is often regarded as the most expensive, least efficient aspect of a supply chain and with the most pressing environmental concerns.

Last-mile deliveries are one of the major effectors of heavy traffic on commercial vehicles in the whole city area. Their essential features, significantly lowering the rational functioning of the transport system, include a high degree of fragmentation and a low range of use of the cargo load compartment of vehicles [15]. Boysen et al. [16] brings to light that traditional last-mile delivery by trucks faces several problems, due of the human driver and the large fraction of unproductive work (e.g., due to absent customers or traffic holdups), truck deliveries are costly and, furthermore, seen as a major source of negative effects on congestion, safety, and environment in large city centers. However, according to Mackinnon [17] the amount and efficiency of freight movement in urban areas will be influenced more strongly by wider technological and business trends than by the localized actions of government agencies. One such trend is the growth of online retailing.

In the environment of e-commerce, Irakleous [18] says that although the provision of delivery service for e-shopping is an issue between e-retailer and transport service provider, the services to be developed need to identify consumers' demand and especially under what conditions a customer is willing to pay for these services.

It is a complex chain, to meet expectations from different stakeholders, such as consumers, retailers, parcel service companies among others. According to Irakleous [18], e-shopping can be fulfilled by a delivery system that can satisfy both consumers' and retailers' needs.

Consumers care about last-mile delivery because it offers convenience and flexibility. For those reasons, same-day and on-demand delivery services are gaining traction for groceries (e.g. Deliv Fresh, Instacart), pre-prepared meals (e.g. Sun Basket).

3 Results and Discussion

3.1 Last-Mile Expectations

Based on the literature review was possible to identify five aspects of interest from the e-commerce consumer perspective: (1) Delivery point; (2) Delivery time and speed; (3) Track and trace; (4) Value-added services and (5) Delivery Price:

- **Delivery point:** is the first thing that consumers will determine after purchase something online. There are two main obvious options: at home or at the workplace or if available pick-up in a point provided by the e-retailer.
- **Delivery time and speed:** are regarding the total time between order confirmation and final delivery, as mentioned previously is the main factor that impacts on the choice of delivery services attribute.
- **Track and trace:** are services based automatic communication between parcel providers and e-shoppers, thought RFID bar codes or number of orders, guarantee end-to-end tracker is very important for the final consumer has the feeling of control of their package.
- **Value-added:** is difficult to measure, because depends on consumer perception, can be a different package, an electric vehicle, a bike delivery, a call from provider among others. The price of delivery is the most sensitive aspect of this relationship, preferably should be lower than product price, but also cover all transportation and information costs, some companies still offering "free shipment" sometimes absorbing part of freight cost, sometimes embedding in the final cost [18].

Each one of those five attributes above are connected more to the consumer perspective, but online retailers are striving to offer consumers evermore responsive (and costly) last-mile delivery services in their efforts to increase sales and gain market share from their competitors, and as a result, often fail to cover the costs of these operations. The most significant impact of e-commerce on freight transportation is the increase in direct home delivery of smaller shipments, which may stimulate greater complexity in distribution system management, potentially causing higher costs in carrier's fleet operations [19, 20].

On the other hand, three aspects from parcel service providers were also identified, being: (1) the "not at home" problem; (2) Unattended delivery and (3) Last-mile collection. From the last-mile provider side, we can summarize those three aspects in one unique concern: Operational Cost.

- **The not at home:** issue is a growing concern for logistics providers, the rise of home deliveries of very small packages, increases the freight cost and makes the flow more complex. When the customer is not at home at the time of delivery, it generates a future attempt and a lower satisfaction from the consumer as well.

- **Unattended delivery** may offer an option for not at home situation, is cheaper and no need a person to receive the package, leaving the package in the doorstep, garden shed, concierge; but it can cause some security implications mostly when are high-value packages.
- **last-mile collection** consists in giving the consumer the option to pick-up their package at some convenient location, such as retail shops, petrol stations, etc., but this option is only reasonable if the pick-up point concentrates a certain number of orders to justify the cost transportation, even though is the same cost as home delivery [20]. Endorsing those challenges Wang et al. [21] argues that in urban logistics, the last-mile delivery from the warehouse to the consumer's home has become more and more challenging with the continuous growth of E-commerce. It requires elaborate planning and scheduling to minimize the global traveling cost but often results in unattended delivery as most consumers are away from home.

Figure 1 summarizes the disproportional scale between parcel service providers and final consumers, in the middle is the online companies that must administrate and balance the operational costs of delivery with the final price of their products.

Fig. 1. Logistics desires × consumer desires

3.2 Last-Mile Implications

According to our research is possible to infer that there is a saturation of urban centers in terms of logistics flows, but there is a lack of an efficient and sustainable framework to deal with many challenges and expectations from different stakeholders along the last-mile in e-commerce supply chains.

Altenried [9] argues that the rise of logistics to a position in which it has become a central discipline of contemporary capitalism and sketches its digitally- driven saturation of urban spaces as the expression of new logistical urbanism.

Lim and Srai [14] endorse this idea saying that the development of these experimental last-mile logistics models, not surprisingly, created uncertainty within increasingly complicated and fragmented distribution networks. Without sustainable delivery economics, last-mile service provision will struggle to survive retailers increasingly challenged to find an optimal balance between pricing, consumer expectations for innovative new channels, and service levels.

Furthermore, is important to note that last-mile itself is a challenge for the majority of urban territories nowadays. Altenried [9] brings a reflection that with a glance at the streets of most cities brings to light the ubiquity of logistical operations: These streets are swarming with delivery vans of all sorts, bicycle messengers, food delivery drivers on scooters and many others trying to deliver all kinds of products to customers with maximum speed. Contemporary cities can no longer be understood primarily in relation to static objects, but increasingly through their logistical systems and procedural flows, claiming that time is now 'the most critical attribute of city making'.

In this sense logistics, cannot be apart from city development, must be an essential part of any discussions among stakeholders. To endorse this complexity Bjerkan et al. [22] conclude that so far research on e-commerce and transport can be characterized as diverse and inconsistent, both in terms of theoretical approaches, definitions, data, methodologies and findings. It is difficult to identify an obvious, overall direction, and existing research does not allow a definitive conclusion on the relationship between e-commerce and transport.

4 Conclusions

The research allow us to initially conclude that there is a gap among logistics parcel providers, e-Shops and e-Consumers expectations.

The limited delivery options and affordable technologies are dominated by standard home delivery methods.

Solutions such as autonomous drones and sharing mobility are embryonic; still, need a clear regulation and investments to make it feasible for most parcel delivery companies in last-mile logistics.

Finally, this study is relevant to the e-commerce sector, first because brings light that last-mile delivery is becoming a more significant factor that may affect online sales expansion in the future.

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4.4 Article IV - Alternatives Of Brazilian E-Commerce Last-Mile Delivery Based On Service Expectations Evaluated By 3PL Providers: A Multi-Criteria Decision Analysis Using Analytic Hierarchy Process

The article was not published and it is waiting for remarks of Examination Board to be submited for a suitable journal.

ALTERNATIVES FOR BRAZILIAN E-COMMERCE LAST-MILE DELIVERY BASED ON SERVICE EXPECTATIONS EVALUATED BY 3PL PROVIDERS: A MULTI-CRITERIA DECISION ANALYSIS USING ANALYTIC HIERARCHY PROCESS

Abstract

The remarkable growth of e-commerce is undeniable and has transformed the retail market. The unpredictable pandemic crisis of COVID-19 impacts the sector even more where the demand was to stay at home and have all supplies delivered at the door. Indeed, the growing flow of e-commerce orders continue to generate exponential e-retail annual revenues, and Last-Mile Delivery (LMD) is one of the most challenging logistics issues due to the high demand, small dimension of packages, and transportation volume. This paper analyzes LMD alternatives for Brazilian e-commerce based on service expectations from point of view of third-party logistics (3PL) providers. To do so, a multi-criteria decision analysis was conducted using the analytic hierarchy process approach. The data to establish the weights were obtained from a survey with 27 professionals from local and multinational companies. The results indicate that small trucks and motorcycle remain as the main options for 3PL providers in the country, but the smart lockers, despite the low availability, are indicated as a fair option for e-commerce deliveries. Moreover, security as a service expectation, surpasses cost concerns in our model based on 3PL providers' view.

Keywords: Last-Mile Delivery; B2C; Small Parcels; Brazilian e-commerce.

1 Introduction

Business–to–Customer (B2C) e-commerce is responsible for one of the most challenging logistics processes due to the high operational costs, insecurity, service level requirement, time window demand, and CO^2 emissions (Allen et al., 2018; Bjerkan et al., 2020; Shao et al., 2019; Trott et al., 2021; Zhang et al., 2020) . Compared to traditional offline retailing, B2C has brought new challenges for companies (Seghezzi et al., 2020). In this sense, the complexities of the physical distribution of products should not be underestimated and logistics need to find a way to obtain a competitive advantage.

Many scholars agree that Last-Mile Delivery (LMD) is the most critical and expensive logistics process regarding business to consumer orders (Lim & Srai, 2018; Mangiaracina et al., 2019; Seghezzi et al., 2020; Wang et al., 2016). Therefore, there is a gap between consumer's desires (service level and quality) and logistics companies' concerns (to reduce costs, to stay competitive). Mangiaracina et al. (2019) point out that in the online market, companies usually consider service level targets as constraints that they necessarily must meet to remain competitive. Given that, they aim at finding ways to minimize costs.

Until 2016 LMD literature was focused on three perspectives: (1) Environmental sustainability; (2) Effectiveness-Customer service level and (3) Efficiency – Costs (Mangiaracina et al., 2019). After 2016, the concerns were directed to innovative perspectives and new technologies/solutions applied to the LMD, such as parcel lockers (Iwan et al., 2016; Lin et al., 2016; Vakulenko et al., 2019) delivery point and pick-up design (Aljohani & Thompson, 2020; Bjerkan et al., 2020; Gonzalez-R et al., 2020; Lu & Yang, 2019); city logistics and urban distribution alternatives (Allen et al., 2018; Altenried, 2019; Balm et al., 2016; Caragliu & Del Bo, 2018; Crainic & Montreuil, 2016; Savelsbergh & Van Woensel, 2016) and drone delivery (Boysen et al., 2018; El-Adle et al., 2021; Giones & Brem, 2017; Kellermann et al., 2020; Watkins et al., 2020).

The pressure to innovate and optimize the process in LMD is a consequence of home delivery largely motivated by e-commerce sales. According to the Americas Market Intelligence (AMI) B2C e-commerce report, only LAC represented a market of USD 148 billion in 2019 and USD 166 billion in 2020. A growth of 12%, driven mainly by the Brazilian market (USD 95 billion in 2019 versus USD 105 billion in 2020) (Latin America E-commerce 2020, 2021)(e-Markerter - InsiderIntelligence, 2021)

We noted that the literature revolved around the consumer experience perspective rather than the challenges of 3PL providers showing a gap to be explored. One study by De Araújo et al. (2020) identified a gap between e-consumer's desires (low-cost freight; faster delivery) versus LMD service providers' desires (cost reduction; delivery optimization), becoming evident a disproportional scale in face of urban logistics centers saturation and lack of an efficient framework to deal with challenges and expectations from different stakeholders. These results confirmed the need to address the LMD in e-commerce from 3PL providers' perspective.

This paper aims to delve into Brazilian e-commerce last-mile delivery service expectations and alternatives based on a point of view of third-party logistics providers. To do so, the multi-

criteria method of the Analytic Hierarchic Process (AHP) was adopted. Using the literature review a decision tree was created and the weights in pairwise comparison were established based on a survey with 27 professionals of 3PL providers.

This paper is structured as follows: This introduction, a literature review with a brief overview on last-mile delivery literature, followed by the current situation of Brazil regarding urban freight focused on LMD, followed by Brazilian and LAC e-commerce markets. Then, the objectives are presented and the interviews and AHP methodology applied, explained, followed by the findings and discussion, closing with conclusions and possibilities for future research.

2 Literature review

2.1 Brazilian e-commerce market

E-commerce activities in Brazil are monitored by Ebit/Nielsen. The most recent report analyzes data from the 2020-1st semester and reveals a growth of 39%, driven by the number of new digital consumers(Ebit-Nielsen, 2021). Moreover, Brazil experienced 40% more online shoppers in 2020 than in 2019, totalizing 41 million online shoppers (Ebit-Nielsen, 2021), Table 1.

Table 1 - Var.% No. Consumers 1'sem 20 vs. ’19.

Consumer Type	% Growth
Recurrent	40
New	38
Total	40

Source: Adapted from (Ebit-Nielsen, 2021)

Figure 1 shows the contribution and importance of growth, highlighting the recurrent and new consumers.

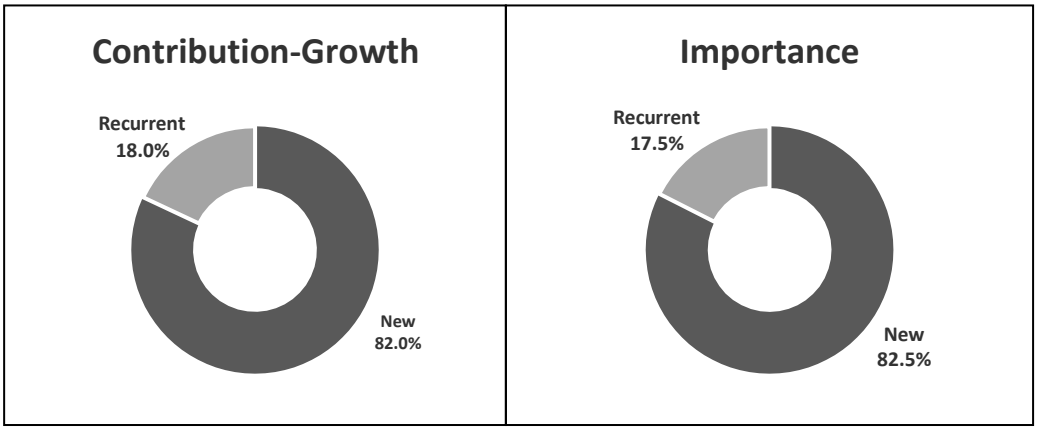

Figure 1 - Contribution, Growth, and Importance. Source: Adapted from (Ebit-Nielsen, 2021)

Driven by the COVID-19 pandemic, more consumers in Brazil are willing to buy more non-essential items from the internet, changing their behavior and feeling more comfortable to change their way to buy. Table 2 presents how the consumers in LAC feel regarding internet sales in comparison to Brazil.

Table 2 - Level of Comfort in Purchasing Non-essential Products During the Coronavirus Pandemic.

Country	**1-2 - Comfortable/Very comfortable %**	**3 – Neutral %**	**4-5 - Very uncomfortable/Uncomfortable %**
Argentina	29.50	22.20	48.30
Brazil	20.50	14.20	65.20
Chile	24.00	13.80	62.20
Colombia	24.00	13.80	57.00
Peru	30.80	13.40	55.80
Total	**25.70**	**16.40**	**7.90**

Source: Adapted from e-Markerter (2021)

Regardless of the increasing numbers induced by COVID-19 pandemic, e-commerce remains a challenge, The World Economic Forum measures the technology governance adaptability, evaluating the capacity of a country to develop and use technology (Schwab, 2019). In this context, Brazil ranks a poor global position - below the global average, ranked as 111th, Figure 3.

Figure 2 allows us to infer that the larger portionof the Brazilian population still feels uncomfortable buying online, due to the slow insertion of new digital business models. On the other hand, it could indicate a huge potential for improvement and investment, as a result of Brazil's dimension and potential for new markets.

Online sales growth has intensified from April 2020 on, during the pandemic scenario. Table 3 summarizes percent variation pre-COVID-19 and during COVID-19, where is possible to notice the growth impact in revenue, number of orders, and average ticket increase, as below.

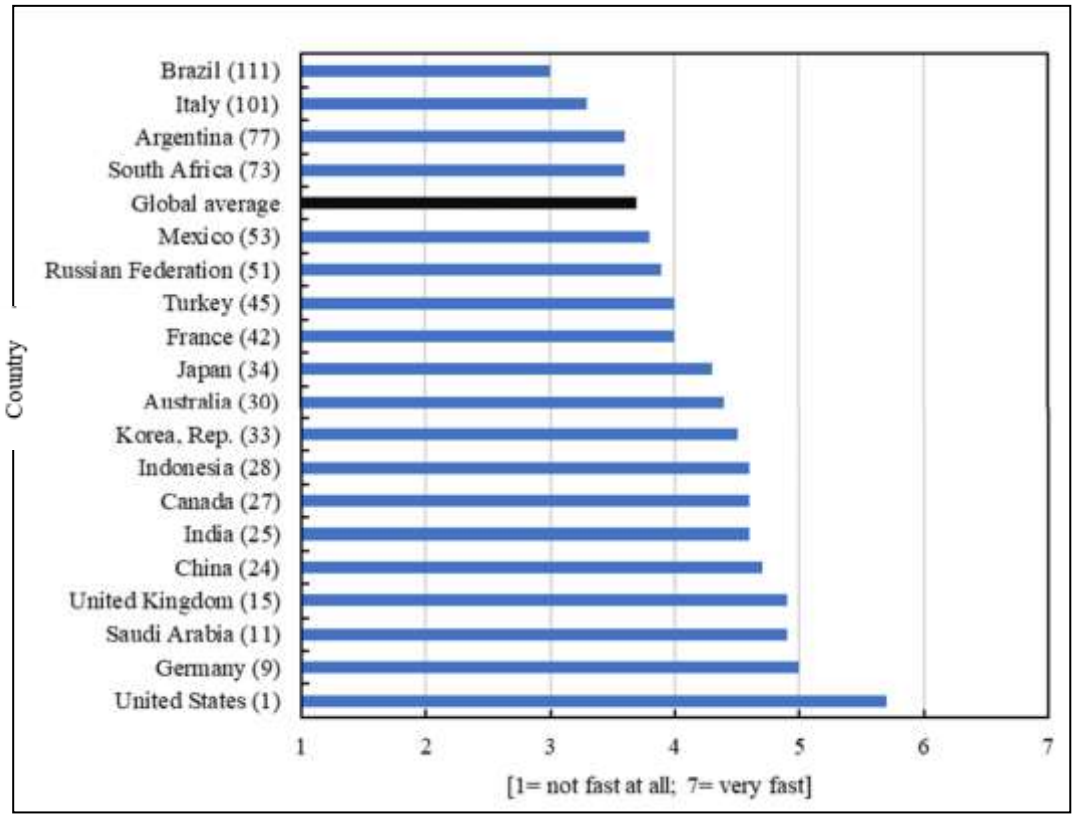

Figure 2 – Technology Governance. Source: (Schwab, 2019)

Triggered by COVID-19 in 2020, B2C online shipments delayed 3% more against in comparison with 2019. In Brazil, around 15% had LMD postponed, with an average of 11.8 days. This time in transit average is far from the ideal in comparison with developed countries such as the United States in which the average is less than 3 days (Ebit-Nielsen, 2021).

Table 3. Variation in percent Pre and During COVID-19

	% Before Pandemic (Jan/Mar)	**% During Pandemic (Apr/Jun)**	**% Year to Date (Jan/Jun)**
USD Revenue	19	70	47
Number of Orders	16	57	39
Average Ticket	3	8	6

Source: Adapted from (Ebit-Nielsen, 2021)

The market outlook after the COVID-19 crisis started to be discussed among business leaders, Schwab & Zahidi (2020) argue that in G20 economies, new exports “non-tariff barriers” emerged since last year drawn by the pandemic, as protection for internal demand. Therefore,

some specialists expect that value chains to be less globalized than today in developed countries. On the other hand, Brazil is forecasted to be more globalized for almost 80% of business specialists, indicating a positive market perspective in the future, above all in e-commerce.

2.1 Last-Mile Delivery

Early definitions of the last mile were narrowly stated as the "extension of supply chains connected to the end consumer" - a home delivery service for consumers. LMD has been termed as a delivery issue and has been a particular issue from a logistics infrastructure standpoint, most notably because of trade-offs between routing efficiency and customer convenience (Kull et al., 2007).

Gevaers et al. (2011) define the last mile as the final leg in a business-to-consumer service whereby the consignment is delivered to the recipient, either at the recipient's home or at a collection point. Besides that, Gevaers (2013) expands the idea and explains that a standard logistics chain, may be organized as follows: raw materials are supplied to the processing/ manufacturing industry, from where finished products are shipped to the storage facilities.

From this point onwards, they are mainly tree distribution (selling) options: either through traditional outlets such as stores or supermarkets, or through direct sales (D2C) to consumers, or a combination of these two. Therefore, the term "last-mile" in a B2C environment refers specifically to the final leg in a system involving business-to-consumer deliveries. Lim and Srai (2018) agree that the last mile refers to the final leg of a network and established its origin in the telecommunications industry.

Lim and Srai (2018) also pointed out that although several contributions have been made in the last mile logistics domain, the literature models remain relatively fragmented hindering a comprehensive and holistic understanding of the topic to direct research efforts.

Eventually, Lim and Srai (2018) believe that existing last-mile logistics definitions converge on a common understanding that refers to the last part of a delivery process. However, existing definitions appear incomplete in capturing the complexities driven by e-commerce, so in their vision, synthetized a more accurate definition: "Last-mile logistics is the last stretch of a business-to-consumer (B2C) parcel delivery service. It takes place from the order penetration point to the final consignee's preferred destination point."

It is a common ground in literature linked LMD to City Logistics research. Dating back to the 2000's when e-commerce was emerging, Taniguchi et al. (2001) advised that the development of e-commerce makes City Logistics more important. The authors identified two points to discuss the impacts on City Logistics by the development of e-commerce: (I) changes in the logistics activities by giving a high priority to the demands of customers or consumers; (II) Logistics activities themselves incorporate e-commerce by matching the demand and supply of goods movement.

Nowadays, e-commerce and logistics are bonded, being difficult to imagine our world without one of them. Gevaers et al. (2011) built a LMD typology and explored the delivery methods, in order to able interpretation of the typical characteristics of the last mile concept, differentiating among various types of LMD, Figure 3.

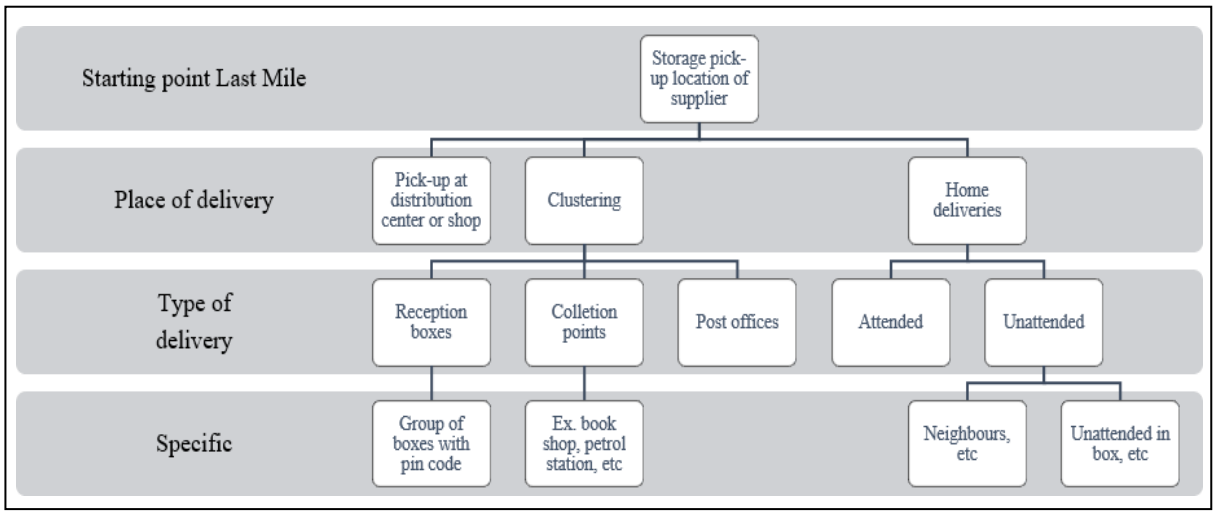

Figure 3 - Last-mile delivery methods. Source: Adapted from (Macharis & Melo, 2011)

According to Macharis & Melo (2011) the nature of the last mile is determined mainly by six fundamental aspects: (1) the level of consumer service; (2) security and delivery type; (3) the geographical area; (4) the degree of market penetration and density; (5) the vehicle fleet and technology employed and (6) the environmental impact. Some of those aspects we will discuss on the decision tree criteria selection in the next section.

2.3 Brazil's last-mile delivery landscape

Brazil is the largest country in LAC. In 2018, its population was over 209 million people being more than 87% located in urban areas (The World Bank , 2021). Making it a very complex

country in terms of logistics, taking into account its continental dimension and poor infrastructure.

The urban population is a global concern, Ranieri et al. (2018) emphasized that about 54% of the population live in the cities today, and around 66% are expected in 2050. Urban areas require a massive quantity of goods, services, and resources causing many troubles for citizens.

Ranieri et al. (2018) reinforced that in LMD, the most widespread transportation mode adopted is road freight transportation. In urban areas, it is the dominant mode responsible for the externalities related to delivery. In Brazil, road transportation is the dominant modal adopted and responsible for several externalities.

Brazil has 109 thousand kilometers of trafficable roadways, but they are not adequate. Only 12.4% of them are paved and around 59% are considered regular/poor. Table 4 (CNT - Confederação Nacional do Transporte, 2021)

Table 4 - Classification of highways evaluated in the CNT Highway Survey by type of variable and measured in kilometers extension, 2019

Variable	Excellent %	Good %	Regular %	Poor %	Very Poor %
General conditions	11.90	29.13	34.56	17.49	6.92
Paving quality	38.59	8.97	34.96	13.75	3.72
Signaling quality	13.96	37.89	26.14	11.64	10.36
Geometry quality	5.74	17.99	26.64	20.69	28.94

Source: Adapted from CNT (2021)

Despite the infrastructure issues, the logistics providers' competition in Brazil is fierce. There are at least 220 thousand transport companies officially registered and more than 724 thousand autonomous carriers. To follow those numbers the vehicle fleet also increased. In 2019, Brazil counted 103 million registered vehicles. The biggest growth in ten years was for motorcycles, with a 64% increase between 2009-2019, trucks grew 30.9% in the same period (Confederação Nacional do Transporte - CNT, 2021).

All those Brazilian characteristics have their unfoldings for the main stakeholders, being the main ones: Infrastructure, quality, and competitiveness. According to Brazil Infrastructure Ministry (Ministério da Infraestrutura, 2020) in 2020, Federal Government invested BRL 133 billion in infrastructure, corresponding to 1.8% of Gross Domestic Product (GDP), but some specialists say that it was not enough and it should be the double of this amount (PWC, 2019).

The e-commerce growth brought opportunities to innovate the LMD sector in Brazil, Reuters (2020) published that until 2024 there is a forecast of USD 3.6 billion investment in Transportation Management Systems (TMS), representing an increase of 14.8%. In thiscontext, the rise of Logistics Startups and Logitech's seems to be a way out to overcome highcosts and infrastructure issues, using technology as the main differentiator. Today there is an average of 280 Logistics startups in Brazil, 50% of them were founded between 2015-2020 andattracted more than USD 186 million in investment only in 2020 (Peña, 2021). The top 5 Logitech's in Brazil are iFood, Loggi, Mandaê, Clique Retire, and FreteBras, also big retail companies are acquiring small Logitech's, thinking in merging their business and staying morecompetitive in the near future (Revista Mundo Logística, 2020). Of all the LAC Venture Capital investments in 2019 (USD 4,6 billion), 26% were in logistics and distribution companies. (Peña, 2021)

(Souza et al. (2020) explored some solutions for Brazil LMD in urban centers, not focusing on the e-commerce industry. The authors' objective was to understand from retail companies what types of innovative LMD practices they were willing to use. This research is also interesting to add a counterpoint comparing LMD providers' results on this research with retail companies' results on theirs.

Table 5 presents that the most innovative practices were pick-up point/locker solution and the least innovative were tied between drones and car drops. In their research, they judged to be viable in Brazil all innovative practices, despite car drops, but only considering the companies answers, not external factors and other barriers.

Table 5 – Solutions for LMD.

Innovative practice	**% Yes**	**% No**	**% Maybe**	**% The product does not allow**
Bicycle/ Electric Scooter	44	22	17	17
Pick-up point/ Locker	50	0	28	22
Crowdsourcing	22	22	34	22
Semi-autonomous/ autonomous vehicles	33	17	28	22
Drones	34	33	11	22
Car Drops	17	33	39	11

Souce: Adapted from Souza et al. (2020)

Souza et al. (2020) concluded that developed countries tend to have more sophisticated solutions for the LMD such as the use of innovative vehicles to reduce the labor cost, environmental impacts, and to improve efficiency. On the flipside, the developing countries are betting on solutions with a lower level of technology, easier to adopt, and with a lower investment, as they still have to face other recurring challenges.

3 Methodology

3.1 Analytic Hierarchy Process

To investigate the impact of service expectations and alternatives for Brazilian e-commerce LMD, we adopted the multi-criteria method of the Analytic Hierarchy Process (AHP) (Saaty, 1980). It is commonly adopted for decision-making, supported by the AHP tool developed by Tomas L. Saaty and the objective is to solve problems with the multiple criteria technique (Maletič et al., 2014).

The first step of the method is a definition of decision tree containing the problem (goal), criteria of evaluation, and alternatives. Based on the literature presented in Table 8 we defined these parameters considering the different methods of delivery and service expectations.

Regarding the literature implication for the LMD services expectations, we found ground in several papers, that were able to better explore the practical implications covering the consumer's expectations and the logistics service provider, to cite some used in the literature review related to each selected expectation we can find: Delivery Point (Bjerkan et al., 2020; Hübner et al., 2016; Irakleous, 2018); Time and Speed (Allen et al., 2018; Devari et al., 2017; Murray & Chu, 2015; Shao et al., 2019); Track and Trace (Altenried, 2019; Groß et al., 2017; Papoutsis & Nathanail, 2016; Roque-Cilia et al., 2019); Value-Added (Hübner et al., 2016; Wang et al., 2016); Security (M. Xu et al., 2008) and Cost ((Bhutta & Huq, 2002; Cárdenas et al., 2017; Gevaers et al., 2014; Lin et al., 2016; Ranieri et al., 2018). For the alternatives, Table 6 summarizes the main authors used to determine it.

Table 6 - Description of the literature used to assist in assigning the weights of the *alternatives* in the parity *comparisons.*

Author (Alphabetic order)	**Parcel Locker**	**Delivery point & Pick-up design**	**Urban distribution alternatives (multimodal, small truck, motorcycle)**	**Drone**
Aljohani & Thompson, 2020		x		
Allen et al., 2018			x	
Altenried, 2019			x	
Balm et al., 2016			x	
Bjerkan et al., 2020		x		
Boysen et al., 2018				x
Caragliu & Del Bo, 2018			x	
Crainic & Montreuil, 2016			x	
El-Adle et al., 2019				x
Giones & Brem, 2017				x
Gonzalez-R et al., 2020		x		
Iwan et al., 2016	x			
Kellermann et al., 2020				x
Lin et al., 2020	x			
Lu & Yang, 2019		x		
Savelsbergh & Van Woensel, 2016			x	
Vakulenko et al., 2018	x			
Watkins et al., 2020				x
Experts			x	

The LMD services expectations established were: (1) Delivery Point; (2) Time and Speed; (3) Track and Trace; (4) Value-Added; (5) Security; and (6) Cost, and five alternatives: (1) Small Truck; (2) Motorcycle; (3) Smart Lockers; (4) Drones; and (5) Multi-Modal. Figure 7 presents the decision tree of the problem.

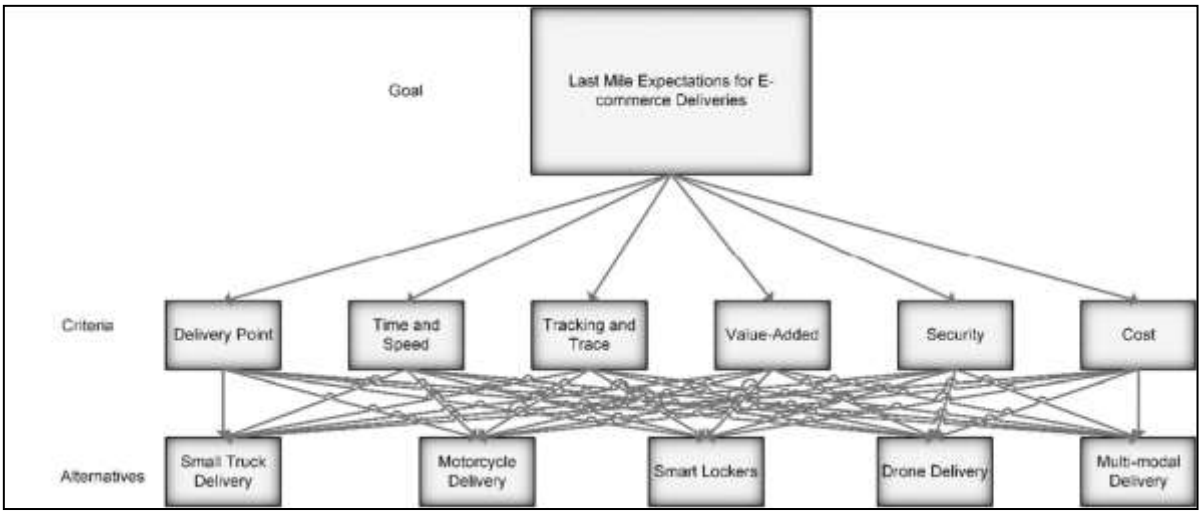

Figure 7 - Decision Tree. Source: Authors, 2021

Afterward, we performed the judgments of the pairwise comparison using data collected from a survey conducted as can be seen in the next section. This step in AHP means to align the criteria and alternatives using a scale of importance numbered 1-9, where (1) is considered the least important and (9) (the most) important, Table 9.

Table 9 - Parity comparison scale.

Scale	Meaning
1	Equally important
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extremely important
2.4.6.8	Intermediate values

Source: Adapted from (Saaty & Sagir, 2009)

The AHP tool converts comparisons into fractions where the weight of each element in the decision model is established (Saaty & Sagir, 2009). The comparisons consider relative weights among the criteria that must be evaluated. It only remains to calculate the statistical probability of each of the alternatives. Thus, the probability of an alternative reaching the previously established objectives is determined (Wollmann, 2017).

The final step is to check the consistency of the model using the Consistency Index (CI), Random Consistency Index (RCI), and Consistency Ratio (CR). L. Xu et al. (2013) explained that in Professor Saaty methodology if the CR < 0.1, then the decision can be considered

acceptable, if not the pairwise comparison matrix should be adjusted to remove the inconsistency.

The consistency is checked using the following parameters:

1. Finding the relative weights and λ_{max} for each pairwise comparison matrix of order *n*,
2. Finding the consistency index for each matrix of order *n* by Equation 1:

$$CI = (\lambda_{max} - n) / (n-1) \quad (1)$$

3. Then, calculating the consistency ratio using Equation 2:

$$CR = CI/RCI \quad (2)$$

4. Determining the global weight of each criterion and rank them accordingly.

The decision model variables were calculated as well as the consistency index using the software SuperDecisions® v 2.10.0.

3.1 Data collection

The data were obtained using an online survey (Google Forms®). We sent it to 57 logistics specialists from the LMD Market. Both local and multinational companies in March 2021. The questionnaires had a response rate of 47%, the majority of respondents were from multinational companies with active last mile operations in Brazil, Table 10.

Table 10 - Questionaries Summary

Company Type	Amount	%
Brazilian Local Provider	12	44
Multinational Company	15	56
Total Answered	27	100

Source: Authors, 2021

The survey was composed of seven sections and fifty questions to establish the pairwise importance of each criterion and alternative presented, being six criteria and five alternatives for evaluation. Due to the fact of the use of electronic form it was necessary to define two

questions per comparison. Firstly, what was the best option in the respondent's view, and secondly how much more on a parity comparison scale. The participation of specialists to judge is fundamental for the decision tree construction in the Analytic Hierarchy Process - AHP (Reis et al., 2016).

Using the pair-comparison tabulated values from the specialist's responses an overall response was established using geometric average (Ishizaka e Labib, 2011), this step aimed at obtaining the respondents' knowledge in aggregation to achieve greater generalizability of results, Equation 3.

$$\left(\mathop{\mathbf{G}}_{i=1}^{n} a_i\right) = \sqrt[n]{a_1\, a_2 \ldots a_n} \tag{3}$$

4 Results and Discussion

Our results were divided into two scenarios: (i) including cost criterion, and (ii) removing cost criterion, to identify the best alternative besides cost-relation. We assume at the beginning of the research that the cost could lead the decisions affecting other facts (Saaty, 1980). Therefore, we structured the analysis based on that. However, the results indicated that this assumption was not confirmed as can be seen in the results of Table 11. Bhutta & Huq (2002) point out that the AHP approach can consider cost criterion and be used as a multifactor decision-making environment, where subjective and/or intuitive consideration has to be incorporated.

Table 11 - Criteria Ranking

Scenario I - Cost Included			**Scenario II - Cost Removed**		
Criteria	% Cost Included	Priority	Criteria	% Cost Removed	Priority
Security	35.90	1	Security	42.07	1
Cost	24.75	2	Time and Speed	24.91	2
Time and Speed	15.87	3	Tracking and Trace	15.22	3
Tracking and Trace	10.48	4	Delivery Point	11.17	4
Delivery Point	8.17	5	Value-Added	6.62	5
Value-Added	4.83	6	Cost	-	-
Inconsistency (CR)		**9.67%**	**Inconsistency (CR)**		**9.99%**

Based on methodology limits acceptance, both scenarios can be considered acceptable due to the CR < 0.1 (Saaty & Sagir, 2009; L. Xu et al., 2013).

Note that security is the central criterion priority in both scenarios. This reveals that security brought a more holistic role for LMD, encompassing not only cargo-risk related but also health-risk. Schwab et al. (2021) alerts that manifested through persistent and emerging risks to human health, rising unemployment, widening digital divides, and youth disillusionment can have severe consequences in an era of compounded economic, environmental, geopolitical, and technological risks.

Certainly, costs are still a huge concern, especially for LMD companies. Manners-Bell, (2019) highlights that the express parcels industry has undergone a critical transformation over years. At the outset, it was far from certain that many of the major express players, such as UPS, FedEx, or DHL would embrace home delivery due to the high costs involved in the number of undelivered parcels caused by “not-at-home” end-recipients. Nowadays, B2C is an important part of the major players’ thinking and revenues. The criteria results presented in this research, merge those major international players, with local players, giving a more realistic perspective from Brazil.

Both scenarios indicate that value-added is the least relevant index according to experts, this could be a reflection of the shift in the retail market, where businesses are adapting to the new scenarios and trying to figure out the contemporary concept of value-added at this point. Lipsman et al. (2020) suggests that the destruction of old retail will provide openings for the green shoots of modern concepts to emerge; new flagships, store-of-the-future concepts, small-footprint D2C locations, click-and-collect hubs, and dark stores will begin to dot the brick-and-mortar landscape, giving us a glimpse of what next-generation retail has in store.

Tracking and trace become more relevant without costs involved because the tracking integration depends on ICT technologies. Delfmann et al. (2018) say that ICT solutions permit common access to data by business partners, e.g. logistics service providers, shippers, subcontractors via the cloud in real-time; this data can include sender-related and recipient-related order statuses as well as available resources – the challenge in Brazil due to its dimension, as discussed in section 2. There are more than 724 thousand autonomous carriers and 103 million registered cargo vehicles (CNT, 2021). So, how to connect all subcontractors under a real-time cloud at a low cost? This question remains unanswered.

The criterion time and speed is the one that suffers the highest variation in percentage, 9.04% between both scenarios leading us to assume that if the cost was not so relevant the time and speed may increase its importance. At this point, we can't compare those results with the United States Market, for instance, where Manners-Bell (2019) points out that delivery timesare getting ever-faster, with the number of same-day and one-or two-hour delivery services rising, which is having a knock-on effect on customer expectations. As we saw in the previoussections, the average delivery time in Brazil is 11.8 days (Ebit-Nielsen, 2021), hence, the costsrelated to shortening for same day delivery, would be huge and impracticable for Brazil, shortly.

From a delivery point perspective, a lower interest prioritizing it was noted, once this criterion used to be a huge concern and considered a cost center. As described by Kedia et al. (2019) Kedia et al. (2019), customers missing home deliveries have increased and they mentioned the example of New Zeland that over 10% of home deliveries fail during the first attempt. One of the possible reasons for that is the work-from-home culture established during the pandemic, addressing not at home issues for now. PWC (2021) highlights that remote work has been an overwhelming success for both employees and employers. Around 83% of US employers say the shift to remote work has been successful for their company, which may indicate a trend post-COVID-19.

Analyzing the presented alternatives, the priorities revealed a difference between both scenarios, probably influenced by the cost relevance on their implementation and maintenance, Table 12.

Table 12 - Alternatives Ranking

Scenario I - Cost Included			**Scenario II - Cost Removed**		
Alternatives	% Cost Included	Priority	Alternatives	% Cost Removed	Priority
Smart Locker	28.83	1	Small Truck	26.42	1
Motorcycle	24.70	2	Smart Locker	25.64	2
Small Truck	24.27	3	Motorcycle	24.22	3
Drone Delivery	11.98	4	Drone Delivery	13.70	4
Multi-Modal	10.22	5	Multi-Modal	10.02	5

Smart locker alternative results show an alignment from LMD providers in Brazil with World's trend, even before the pandemic. Click and collect was a growing trend in the United States, as consumers found they enjoyed the convenience and cost-savings of purchasing online and

picking up their order on the way home from work or while running errands (Lipsman et al., 2020). In Brazil, apart from the convenience, lockers are considered also a secure alternative, matching with security criterion priority. A refresh finding for the Brazilian market since smart lockers are not a complete reality in the country.

Even though small trucks are the current most common alternative in Brazil, as a result of its transport matrix; the maintenance costs, oil & gas, and labor costs related impact directly LMD providers. The regulatory Oil & Gas Company – Petrobras boosted the price of wholesale diesel 5% to USD 0.48/liter - it was the fourth increase to domestic diesel prices since the start of 2021; Gasoline was elevated 4.8% to USD 0.46/l - was the fifth increase to gasoline prices so far in 2021 (S&P Global Platts, 2021), this is one of the reasons for small truck increasing its priority without costs included.

For drones, there are non-costs barriers related to regulation that is not approved in Brazil for commercial delivery use. Even in other countries, this alternative is still embryonic, (Tang & Veelenturf (2019) point out that this alternative is part of Logistics 4.0, but only develop countries such as the United States, China, Australia, and Germany have successful examples so far, but those countries pave the way for such emerging technologies applies to LMD.

Motorcycles could be considered the lowest cost alternative for fast delivery, especially in urban centers. This alternative is not mentioned in any of the papers consulted in this research, being a local alternative, to compete with small trucks.

Overall, in the literature, LMD is considered the most expensive logistics process related to business to consumer orders (Lim & Srai, 2018; Mangiaracina et al., 2019; Seghezzi et al., 2020). However, this research revealed that even with this statement, Brazilian LMD service providers interviewed do not prioritize cost over security, which makes sense considering Brazil's reality. According to data from (NTC & Logistica (2019), the rate of cargo theft in Brazil increased over the years, in 2017 there were almost 26 thousand cases, representing a value subtracted from BRL 1.6 billion in highways and urban areas, not surprisingly Brazil is ranked as (132nd/141) for security pillar on World Economic Forum report (Schwab, 2019).

Another common scholar's statement is that there is a gap between consumer desires (service level and quality) and logistics companies' concerns (reduce costs, stay competitive) (de Araújo et al., 2020; Mangiaracina et al., 2019) Our research results indicate that this fact could be changing because the cost was not the first in the rank and value-added is ranked in the last position.

5 Conclusion

Our research opened a new perspective related to last-mile e-commerce expectation, focusing on logistics providers' angle rather than the final consumer experience. The objective was to look inside logistics companies (local and multinational) to understand how those companies consider applicable to provide a better experience for e-consumers.

The analytic hierarch analysis enabled us to have a more holistic perspective from the Brazilian market and comprehend the most applicable criteria for LMD service providers. Evidencing is not only a cost-driven statement but opening new possibilities in terms of e-commerce LMD innovation and investments. Obviously, cost still plays an important role in this process.

The unprecedented AHP outcome, prioritizing security over costs shed the light on new perspectives in this field. One indication is that experts' predilection for smart lockers as the number one priority alternative, overpassing motorcycles, and small trucks, including cost criterion and considering Brazil's transportation matrix – majority road transport – made this choice not so obvious. These results could suggest a desire of LMD providers to consider innovative e-commerce solutions and may lead the Industry to draw a new chapter of Brazilian LMD.

We conclude that the current global landscape may affect some results. Security over cost criterion, for instance, may have a connotation in Health Security. We need to take into account that security not only entails cargo but people as well. Therefore, it was necessary to create safety measures to deal with logistics operations during the pandemic crisis. Security is a genuine concern from now on that we should observe for further research in LMD. This may be evidence for the choice of the smart locker as a priority alternative, for being considered a secure way to deliver and to be contactless, avoiding coronavirus contamination from a deliveryman, or vice-versa.

As the limitation of the work, the results found may be influenced by COVID-19, mostly in Brazil, when until 26th March reported by the official Data Repository (Center for Systems Science and Engineering (CSSE) at Johns Hopkins University, 2021) the country has 12.4 million of cases and 307 thousand confirmed deaths, representing almost 10% of worldwide cases, but should be not invalidated because of it.

Despite those unprecedented figures, the future is still unknown regarding the pandemic. However, online new e-consumers certainly will be a trend, being recommended continuous investments and research in this field.

Finally, we believed that the findings of this paper can contribute to LMD research in this sense to comprehend the challenges and the new consumers' behavior towards the e-commerce segment. Therefore, we cannot consider LMD only in the context of the current pandemic crisis and its effects rather than a more comprehensive view involving the feasibility of arising other crises and consumers' trends.

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Our sympathy to all victims of the COVID-19

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5 Final Considerations

This work had as main target study the last mile logistics chain. To do so, integrate it to e-commerce urban delivery and analyze the current and future scenarios to understand the most feasible innovative alternatives to overcome the challenges identified in the literature.

It was structured in the form of articles that studied different aspects last-mile logistics and e-commerce implications. Each article is perfrmed to respond to the specific goals presented - sometimes more than one.

5.1 Literature implications

In this sense, articles I and II were more focused on understanding the literature on general aspects, expanding prior research in these fields, and starting to incline into e-commerce challenges as presented briefly in Article I. The initial finding in Article I, related to lockers alternative, agrees with the closing article IV, confirming the relevance indicated in terms of cost-efficiency, risk reduction and positive perception of the final consumer, adding a layer of LMD provider in Article IV.

Article III was crucial to conduct this research, lending support for article IV and leading to an important discussion on stakeholders' expectations among the e-commerce supply chain. Even though this comprehensive literature review, it was possible to shed light on logistics parcel providers, e-Shops, and e-Consumers gap expectations. The study confirmed the assumption that when it comes to LMD e-commerce, the present literature is very oriented on customer experience perspective but lack other perspectives such as LMD providers.

The closing article IV contradicts a literature statement that logistics providers are mainly concerned and prioritizes cost criterion over others. The results provide insight into a possible change in that perspective which makes security overpasses cost criterion. On the feasible alternatives side, traditional choices, such as small truck deliveries lost place for more innovative alternatives such as smart lockers. Certainly, it is soon to build a new statement, but it's important to not suppress these results and pay attention on other criteria rather than cost.

5.2 Managerial implications

During this research, the world were surprised by an unprecedented pandemic – COVID-19. It changed (still changing) the world, imposing new challenges, and puts an uncertainty mark in many areas, besides health. It is necessary to understand

that one of the roles of a researcher is to be tuned and try to anticipate objections in their research field. Because of this belief in article IV, it was incorporated COVID-19 impacts and trends, considering that LMD and e-commerce played a key role in 2020.

In this context this research allows logistics and e-commerce retails decision-makers to have more information and understand the expectations from the whole e-commerce and last-mile supply chain, making possible to build feasible solutions meeting those expectations and most important to build a resilient and efficient LMD system.

5.3 Future research agenda

This study covered all proposed objectives, at the same time a new challenge was raised – pandemic. Future research should go deeper into COVID-19 impacts, opportunities, and challenges for LMD related to e-commerce. In 2020, the world was not prepared for the high demand and “stay home” scenario, now its time to step back and analyze what we learned from it and how we can build a resilient LMD system, interconnected with omnichannel and other e-commerce trends to meet both consumer and providers expectations.

It will be important to have a post-COVID-19 comparison, to understand the trends and permanent impacts on e-commerce sales, consumer behaviors, and LMD disruption solutions and add cost-implications applied to the alternatives available.

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