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Contribution of Best Practices to Promote Sustainable Urban Freight Transport

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Abstract

Urban logistics decision makers face serious challenges in trying to make urban freight transport (UFT) efficient and sustainable. Therefore, it is necessary to identify best practices (BPs) to promote improvements on activity levels, modal shifts to lower-carbon transport systems, lowering energy and intensity, and reducing fuel carbon intensity. This paper conducts an exhaustive literature review that seeks to identify that are directly applicable to BPs promoting sustainable UFT and that indicate the opportunities and challenges of urban logistics. The results indicate that, although BPs make sense for themselves, the most powerful effect occurs when two or more of them are used together, multiplying their strengths. Furthermore, there is an expressive participation of environmental and economic indicators (costs and service levels) to the detriment of social indicators, thus indicating a literary gap.

Key-words: Urban Freight Transport, Best Practice, Sustainable Indicators, Benefits and Barriers.

1. Introduction

Urban logistics is an extremely flexible activity which adapts to current deep changes in demographics, urban economy, new buying and distribution behaviors, new consumers and enterprises

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demands (Alice, 2015). Due to economic crisis, intense competitiveness and external environmental and social pressure, enterprises responsible for freight transport desire to become even more competitive and sustainable. Therefore, these companies aim to improve urban freight transport (UFT) efficiency by reducing costs, raising service level, and minimizing environmental and social impacts through the adoption of policies to improve their operations (Browne et al., 2012; Greene & Lewis, 2016).

In addition, despite the economic benefits generated by UFT, there is a justification for better interaction between decision makers and stakeholders (companies, government, society, etc.), as well as greater government intervention in the market, to establish the balance between cost and benefit (guided by economic, social and environmental) derived from UFT. According to Sims et al. (2014), the lack of more aggressive and sustained implementation of mitigation policies makes emissions from the transport sector rise faster than other fields of final energy use, which can reach approximately 12 gigatons of CO_2 by 2050.

A large part of these emissions come from activities related to UFT (Lundstrom, 2019); thus, it becomes necessary to develop strategic business policies based on the adoption of best practices (BP) (Macharis & Melo, 2011) which aim, for example, for improvements on activity levels, modal shifts to lower-carbon transport systems, lowering energy and intensity and reducing fuel carbon intensity (CAT, 2016).

In this regard, the aim of the study is to answer the following research questions: (1) What BPs can be adopted to promote the sustainable UFT? and (2) What are the benefits and barriers in adopting each BP in relation to the indicators to promote sustainable UFT? To achieve its objectives, this paper conducts an exhaustive literature review that seeks to identify relevant studies, directly applicable to the subject.

This paper is structured as it follows: Section 1 introduces the context of the subject, the problem and research objectives; Section 2 puts UFT into context; Section 3 presents the steps of the research methodology directed to BPs applied to UFT; in Section 4, through a literature review, BPs are identified and conceptualized and, in addition, the main benefits and barriers to the implementation of BPs applied in UFT are discussed; and Section 5 contains the final considerations.

2. Urban Freight Transport

UFT is the delivery of consumer goods in cities and suburban areas, including the reverse flow of used goods and clean waste (Behrends et al., 2008). Moreover, urban freight includes all goods

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movements generated by local businesses' economic needs. In other words, all deliveries and collections of supplies, materials, parts, consumables, mail, and leavings that enterprises require to operate (Macharis & Melo, 2011).

According to Barbosa & Vanelslander (2017) and Oliveira & D'Agosto (2017), UFT is composed of distribution, last mile and collection. Distribution is known as transport from one origin to multiple destinations. Conversely, collection is the transport from multiple origins to one destination. Last mile delivery is defined as the movement of goods from a transportation hub up to final delivery destination, wherein the delivery destination is usually a personal residence (Cherrett & Allen, 2019).

The main characteristics that define distribution are related to transport systems, logistics network infrastructure, decisions on location, consolidation models, storage, interaction between vehicles and infrastructure, externalities, and performance of freight transport policies. In the collection and last mile segments, the main characteristics are related to the problems of routing multiple deliveries or multiple collections and accessibility to urban areas (Barbosa et al., 2017).

The means of action that interfere with the functioning of UFT can be classified into four classes: (i) material infrastructures, that consist in the construction of new infrastructures to optimize the transport of goods; (ii) non-material infrastructures, that generally consist of solutions related to research, learning and training, while telematics in terms of intelligent transport systems can also be considered; (iii) equipment, consisting of the introduction of new standards for freight and transportation units; and (iv) governance, which consists of actions related to traffic rules and limits (Russo & Comi, 2016).

UFT has three general problem categories: (i) local last-mile or first-mile delivery and pickup; (ii) environmental impacts; and (iii) trade node problem, such as places with large ports or airports, inter-modal transfer points, or border crossings. In order to improve UFT management, programs based on labeling and certification, on incentives to voluntary emission reductions, local land use policies and parks and stricter national standards for efficiency and fuel emissions for heavy trucks can be adopted (Dablanc et al., 2013).

3. Methodology

In order to further explore the existing approaches to BP applied to UFT, identifying the opportunities and challenges of urban logistics, this paper follows the methodology described in Figure 1.

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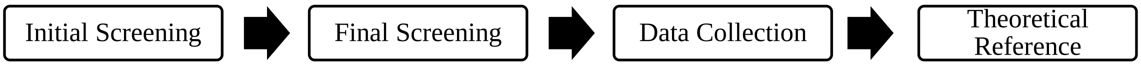
Figure 1 - Methodology Steps



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The First Step, called Initial Screening, consists of conducting direct searches in databases (Web of Science, Scopus, ScienceDirect and among others) in order to identify studies directly applicable to research, by reading the title, abstract and keywords. This screening seeks to identify and eliminate studies that do not have objectives compatible with the present study.

The Second Step, called Final Screening, consists of conducting a more in-depth review of the articles included in the Initial Screening, by reading the complete paper. This screening seeks to identify studies that, although they have objectives compatible with the present study, do not have appropriate relevance to be included. This can happen because: (i) the research does not present a well-founded bibliographic review; (ii) there is no technical innovation; (iii) the limitations are not explicitly stated; and (iv) the results and conclusions are not consistent with the pre-established objectives.

The Third Step, called Data Collection, consists of collecting data on freight transport solutions identified in the articles selected in the Final Screening, as well as evaluating these solutions, identifying opportunities and barriers proven through case studies. The Fourth Step, called Theoretical Reference, consists of exposing the results found through an exhaustive literature review, as well as discussing them.

4. Best Practice Applied to Urban Freight Transport

According to Mittal et al. (2018), BPs are applied to a large variety of organizations, which can be planned or implemented by private or public enterprises and public-private partnerships (PPPs). BPs must be appropriate to a defined theme or relevant question, based on real experiences (pilot experiment, strategies) or study analyzes, with positive effects (qualitative and quantitative) on indicators relevant to UFT (BESTUFS, 2007).

Thus, there is a set of BPs capable of making sustainable freight transport viable (Santém, 2013). Many companies tried individual solutions to improve their business models with and, by adopting BPs, these companies have the potential to develop these actions (CLECAT, 2010). However, according to the physical, political and social characteristics that distinguish cities, it is essential to make it clear that there is no BP that can fulfill the necessary mitigation function on its own; it often depends on the conditions of the structure that can hinder the streaming of the results (BREUIL & SPRUNT, 2009).

4.1. Best Practices Identified and your Concepts

The objective of this research is to identify and discuss internal and external solutions promoted by private companies and/or PPPs focused on the urban freight segment for distribution, collection and last mile, classified into four classes: (i) materials infrastructure, (ii) non - material infrastructure, (iii) equipment and (iv) governance defined by Russo & Comi (2016), as already discussed in Section 2.

Among the previous studies identified in the literature review, we can mention the Center of Excellence for the Sustainable Urban Cargo System (CoE-SUFS), Best Urban Cargo Solutions (BESTUFS), Factory of Good Practices for Cargo Transportation (BESTFACT), Smart Freight Center (SFC), McKinsey Center for Business and Environment, Brazilian Green Logistics Program (PLVB), Transportation Decarbonization Alliance (TDA) and MDS Transmodal.

From the identification, selection of the BPs presented in previous studies and classification, by the approach of Russo & Comi (2016), the BPs are shown in Table 1 which are better explained in the next subsections.

Table 1 - BPs by Classes Selected in Literature

Class	**Best Practice**	**Description**
Materials infrastructure	Implementation of urban freight consolidation centers in urban areas	Urban freight consolidation centers are defined as fixed buildings located in urban central areas that reduce the distance between the warehouse and centrally located customers (Cherret & Allen, 2019).
	Implementation distribution centers near the factory	Distribution centers (DC) are fixed buildings particularly used by a company close to one of its factories that reduce long trips to supply the physical distribution network's stocks (Oliveira & D'Agosto, 2017).
	Implementation of Micro-consolidation platforms	Micro-consolidation platforms concentrate on bundling goods near the reception point by the implementation of logistical platforms in urban central areas (Janjevic & Ndiaye, 2014).
	Use of click & Collect services	Regarding the use of click and collect services, it occurs when a buyer purchases a product online (website or mobile application) and the product arrives at the collection station (Jara et al., 2018; Cherret & Allen, 2019).
	Use of parcel lockers	Parcel lockers are structures positioned in locations where customers can pick up packages with an access code previously sent to their mobile apps (Bouton et al., 2017).
Non - materials infrastructure	Use of information systems to track and monitor the fleet	The use of information systems is necessary for real-time monitoring fleet vehicles that can be combined with the use of Global Positioning System (GPS) and Geographic Information Systems (GIS) (Vivaldini et al., 2012).

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	Use of route optimization	Route optimization is a system for real-time travel planning which provides suggestions and alerts in case of traffic events or deviations from initial plans (Baudel et al., 2016).
	Use of practice Eco-driving	Eco-driving is a training program to instruct drivers and employees in the processes of acceleration / deceleration, driving speed, choice of route and use of idling (Huang et al., 2018).
	Use of Crowd logistics service (or Crowdsourcing)	Crowd Logistic service or Crowdsourcing refers to independent individuals who voluntarily participate in the delivery of consumer goods or offer short-term storage space to deliver to third parties (Rai et al., 2017).
Equipment	Use of additives to improve the fuel energy efficiency	The use of additives to improve fuel energy efficiency can contribute to fuel economy and emission reduction, keeping the vehicle's performance at an optimal level throughout its lifetime and helping to meet regional and international quality standards (Rashedul et al., 2014).
	Adoption of vehicles preventive maintenance	Preventive vehicle maintenance consists of optimizing and scheduling frequent and preventive repairs, extending the lifetime of vehicles (Vintr & Holub, 2003).
	Improvement in vehicle occupancy	Improvement in vehicle occupancy consists of making better use of the vehicle's volumetric capacity, considering the arrangement of the boxes and the delivery sequence (Pedruzzi et al., 2016).
	Fleet renovation and modernization	Fleet renovation and modernization is the total or partial replacement of the vehicle or equipment fleet to guarantee ideal operating conditions and technological innovations.
	Use of cleaner energy sources	Use of cleaner energy sources and use of vehicles with greater energy efficiency is defined as alternative energy sources, which in any modes of transport and propulsion system, allow low or zero-emissions.
	Use of vehicles with greater energy efficiency	
	Optimization of loading and unloading operations with motorized equipment use	According to Oliveira & D'Agosto (2017), optimization of loading and unloading operations with motorized equipment use means the use of motorized devices, which can be powered by fuel or electricity, in-vehicle loading and unloading operations.
	Mode shift to use of drones	A modal shift occurs when a mode of transport has a comparative advantage over indicators such as energy use and generation of air pollutants and greenhouse gases (GHG). The use of drones refers to the use of unmanned aerial vehicles (UAVs) (Lange et al., 2017).
	Mode shift to use of Freight Cycles (bicycles / tricycles)	
	Use of different types of vehicles to carry out deliveries and collections	The use of different types of vehicles to carry out deliveries and collections consists of using smaller vehicles to deliver and collect in order to reduce delivery time and meet customer needs in areas of restricted traffic for medium and large vehicles (Oliveira & D'Agosto, 2017).
Governance	Vehicle weight and size regulations	Vehicle weight and size regulations are frequently put in place by urban authorities for environmental and security reasons to prevent vehicles above a certain weight, size (length or width) or number of axles from using either a particular road or area.
	Nighttime collection and distribution	Night-time collection and distribution are the delivery process to retailers and shops in the inner-city area during the night hours (BESTUFS, 2007).
	Fiscal / Subsidies	Fiscal / Subsidies are actions promoted by public initiative and adopted by private companies such as tax incentives / economic subsidies encourage the use of green freight alternatives (TDA, 2019).

4.2. Case Studies about the Best Practices

According to the results obtained through the literature review presented in Table 1, there is a set of 21 BPs applicable to UFT, which complicates the process of choice by decision makers, as it can lead to some doubts about the best decision and what impacts would be generated by wrong choices.

Table 2 - Description of Study of the Cases about BPs Applied in UFT

Classes		**Best Practices**	**Case**	**Reference**
Materials Infrastructure	BP1	Implementation of urban freight consolidation centers in urban areas	Construction and operation of Consolidation Centre: London and Fukuoka	SEStran (2010)
	BP2	Implementation distribution centers near the factory	Implementation of Ports within urban areas in Padua, Italy	Russo and Comi (2011)
			Freight distribution center in the city center of Paris, France / UDC to deliver products in restaurants and stores with cold storage facilities in Stockholm, Sweden / Privately operated UDC for deliveries in Monaco	Tario et al. (2011)
	BP3	Implementation of Micro-consolidation platforms	Freight operator - Walbrook Wharf in London, England	WYG (2019)
	BP4	Use of click & Collect services	Comparative study: centralized distribution with Click and Collect vs. decentralized distribution with home delivery in local food chains in Linz, Austria	Melkonyan et al. (2020)
	BP5	Use of parcel lockers	Parcel lockers in postal service in Krakow, Poland	Iwan et al. (2016)
Non - materials infrastructure	BP6	Use of information systems to track and monitor the fleet	Information Transport System: COST321 Urban Goods Transport in European Communities	Melo (2010)
	BP7	Use of route optimization	Intelligent Freight Routing Optimization in Vienna, Austria	Letnik et al. (2018)
	BP8	Use of practice Eco-driving	Waste collection trucks in Rio de Janeiro, Brazil	Goes et al (2019)
	BP9	Use of Crowd logistics service (or Crowdsourcing)	Delivery service companies in China	Li et al. (2019)
Equipment	BP10	Use of additives to improve the fuel energy efficiency	Fuel diesel with peroxide fuel additive in India	Senthil et al. (2015)
			Use of detergent additives in cities of Venezuela	Srivastava and Hancsók (2014)
	BP11	Adoption of vehicles preventive maintenance	Preventive maintenance of vehicles at Port of Valparaíso, Chile	CEPAL (2016)
	BP12	Improvement in vehicle occupancy	Double-deck / High-cube Trailers	McKinnon and Campbell (1997)

	BP13	Fleet renovation and modernization	Fleet renovation and modernization in Madrid, Spain	Lumbreras et al. (2008)
	BP14	Use of cleaner energy sources	Project cleaner energy sources New York City Cycle - Lifecycle to Electric Urban Delivery Trucks	Lee et al. (2013)
	BP15	Use of vehicles with greater energy efficiency	Use of vehicles with greater energy efficiency in California's transportation by 2050	Yang et al. (2009)
	BP16	Optimization of loading and unloading operations with motorized equipment use	Loading and unloading operations with the use of motorized equipment in Germany	Weidemann and Fischer (2018)
	BP17	Mode shift to use of drones	Delivery by drone vs. delivery by truck at an industry in Los Angeles, United States	Goodchild and Toy (2018)
		Mode shift to use of Freight Cycles (bycicles / trycicles)	Combined use of mobile-depots and cargo tricycle - Use Truck's Parking Point in Rio de Janeiro, Brazil	Marujo et al. (2018)
	BP18	Use of different types of vehicles to carry out deliveries and collections	Electric vehicles of smaller dimensions by postal service in Rio de Janeiro, Brazil	Bandeira et al. (2019)
			Use of droids to delivery	Joerss et al. (2016); Cherrett and Allen (2018); Hunt (2018)
			Autonomous Ground Vehicles (AGV) in Paris, France	Hanappe et al. (2018)
Governance	BP19	Vehicle weight and size regulations	Urban goods distribution by electric cargo cycles in São Paulo, Brazil	Ormondet al. (2018)
			Studies of options for weight reduction of different types of heavy vehicles in the EU	Hill et al. (2015)
	BP20	Nighttime collection and distribution	Night deliveries between in Belgium	Verlinde et al. (2010)
			Night delivery for fuel distribution in Rio de Janeiro, Brazil	Silva et al. (2018)
	BP21	Fiscal / Subsidies	PIEK program in the Netherlands	Holguín-Veras et al. (2018)
			Supporting electric freight vehicles in Hamburg, Germany	Best (2007); Taef et al. (2014)

Source: Authors.

4.2.1 Description

In order to minimize the occurrence of wrong choices, a new literature review process is carried out (as shown in Table 2). Its aim is to identify case studies that assist, through the presentation of benefits and barriers, in the construction of parameters and / or preparation of premises for performance evaluation of indicators to promote sustainable UFT addressed in the BPs and facilitate the primary choice process. As a result, 30 case studies were identified among the BPs according to their respective classes that will be discussed through its benefits and barriers.

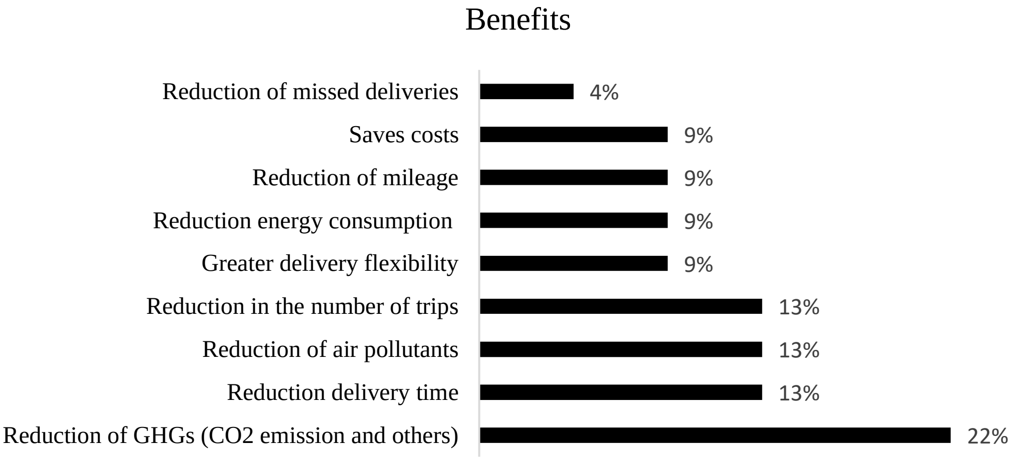
4.2.2 Benefits and Barriers

In order to balancing the pros and cons, one should consider the often-conflicting interests of the different stakeholders involved. Thus, it is important to discuss the relationship between the indicators to promote sustainable UFT and how the BPs, according to the corresponding classes.

From the evaluation of the case studies, 15 indicators were identified that contributed to the generation of benefits and 20 indicators that represent barriers to the implementation of BPs.

The benefits identified in the set of BPs association to the classes of Materials Infrastructure are shown in Figure 2.

Figure 2 - Generated Benefits by Materials Infrastructure



Source: Authors

In the case studies that foresee the construction of new infrastructures such as consolidation centers (BP1), Distribution Centers (BP2), micro consolidation platform (BP3), use of click & collect services (BP4) and the use of parcel lockers (BP5).

BP1 addresses three different situations: (i) consolidation center for construction projects in central London, reducing the number of trips by 70% and CO_2 emissions by 73%, due to the availability of materials near other projects, in addition to an improvement in service level, due to increased flexibility; (ii) external consolidation center for London's airport retailers, reducing the number of trips by 70%, with estimated weekly CO_2 emission reductions of 3,100 kg; (iii) consolidation center as a public-private partnership involving 36 cargo transporters in Fukuoka, Japan, reducing by 65% the number of vehicles, 28% the distance traveled, 70% the number of vehicle trips, with a weekly CO_2 savings of 3,100 kg, in addition to a decrease in the parking time of vehicles in the central area.

BP2 comprises six cases: (i) DC implemented in the urban area of Padua, Italy, leading to a 27% reduction in trip duration, a total reduction of external costs of 174,000 €/year and of 38.4 tons of CO_2 in 15 months; (ii) the installation of a freight distribution center in downtown Paris, France resulting in savings of 112 tons of CO_2 in 24 months; (iii) the development of a DC to deliver products in restaurants and stores with cold storage facilities in Stockholm, Sweden present estimates of a 17% reduction in energy consumption and pollutant emission and a vehicle miles traveled (VMT) decrease of 65%; (iv) the private operation of a DC using 6.5 ton vehicles in Monaco, leading to a 21% VMT and a 36% energy consumption reduction, plus a similar reduction in pollutant emissions.

BP3 addresses the case of the freight operator of Walbrook Wharf in London, UK that experienced a reduction in the number of van trips and identified potential savings in emissions, improving air quality (CO_2e, NOx, PM10 etc.).

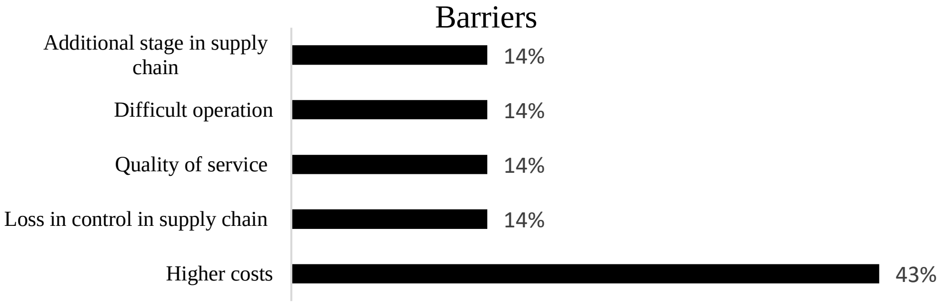
BP4 includes a comparative study between centralized distribution with Click and Collect and decentralized distribution with home delivery in local food chains in Linz, Austria, contributing to a reduction of 43 t CO_2/year, 20 kg NOx/year. In addition, it promotes social interaction, flexibility in deliveries and increased total sales.

BP5 is illustrated by the use of parcel lockers in postal service in Krakow, Poland, which resulted in an estimated reduction of 53% of km travelled per day, 95% of CO_2 emission in tons/year, with increase of 90% in parcels delivered per day.

The reduction of transport activity and consequently the reduction of the distance covered can better contribute to these results, as it can increase the efficiency between the quantity of goods transported and the distance covered (vehicle kilometer, ton kilometer – t.km).

The barriers identified in the set of BPs association to the Material Infrastructure are shown in Figure 3.

Figure 3 - Barriers Found for Material Infrastructure.



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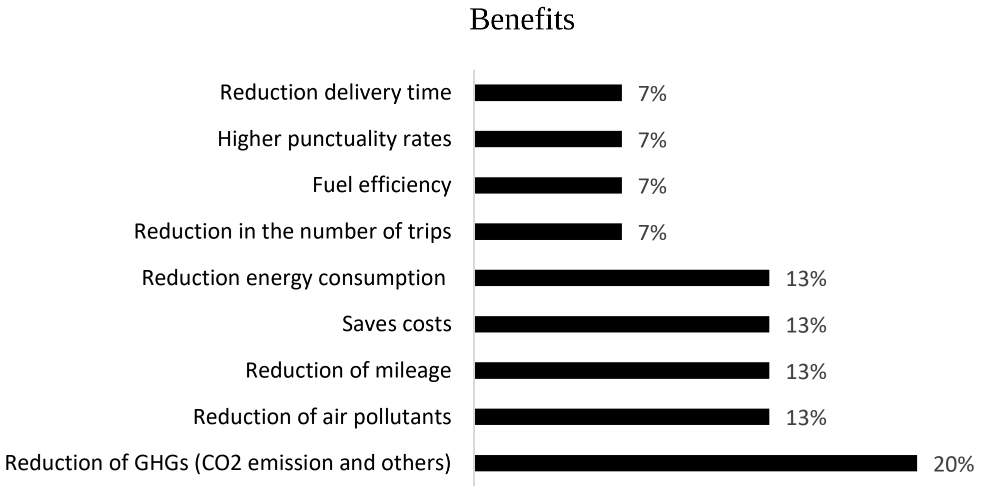
Given that in many cases infrastructure works are required and it is directly inserted in the supply chain network, as it is in direct contact with suppliers and customers, the biggest barriers encountered are high costs, mainly for the implementation and operationalization of activities, loss of control and increased complexity in the supply chain and for maintaining a reasonable level of service.

The benefits identified in the set of BPs association to the classes of Non-material Infrastructure are shown in Figure 4.

Figure 4 - Generated Benefits by Non-materials Infrastructure



Source: Authors

In case studies referring to Non-materials Infrastructure BPs, solutions comprise the use of information systems to track and monitor the fleet (BP6), the use of route optimization (BP7), the practice of eco-driving (BP8) and the use of crowd logistics service (or crowdsourcing) (BP9).

BP6 is represented by the use of Information Transport System: COST321 Urban Goods Transport in European Communities, whose results were a decrease of 10% in vehicle mileage due to better loading capacity and reductions in fuel consumption and pollutant emissions through the improvement in the efficiency of transportation.

BP7 addresses the case of the introduction of Intelligent Freight Routing Optimization in Vienna, resulting in reductions of 20% reduction in fuel consumption and emissions, 60% in time, 15% in mileage and up to 30% in delivery costs.

BP8 comprises the case of waste collection trucks in Rio de Janeiro, proving that waste compacting trucks with a capacity of 15 m^3 showed a fuel economy improvement of 0.8% (from 1.21

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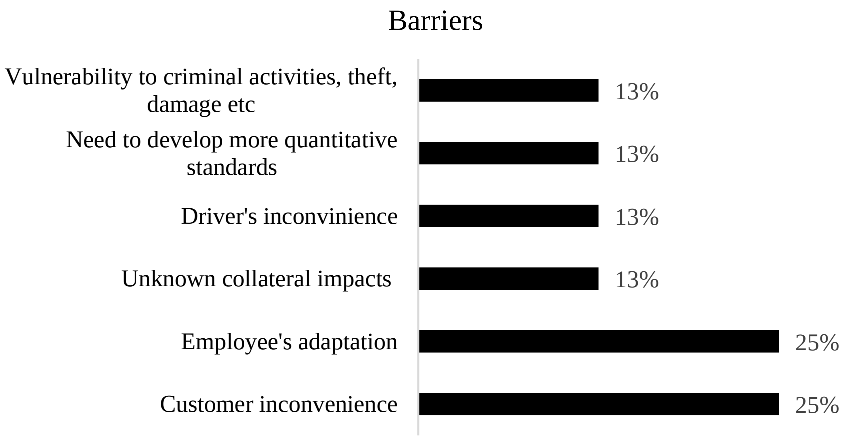
to 1.22 km/l), and tractor and semi-trailer trucks, with a capacity of 45 m^3, showed an improvement of 7.1% (1.70 to 1.83 km/l).

BP9 comprises the case of delivery service companies in Chinese cities, showing results such as reduced costs by approximately 10%, by using operator services during peak hours, a decrease in delivery time between 20% and 50% and better delivery punctuality for drivers.

As customers are more willing to schedule their times to pick up or receive their orders, the number of trips and missed deliveries is reduced, and parcel deliveries and punctuality rates are increased, causing reductions in fuel consumption, GHG, air pollutants and costs.

The barriers identified in the set of BPs association to the Non-material Infrastructure are shown in Figure 5.

Figure 5 - Barriers Found for Non-material Infrastructure

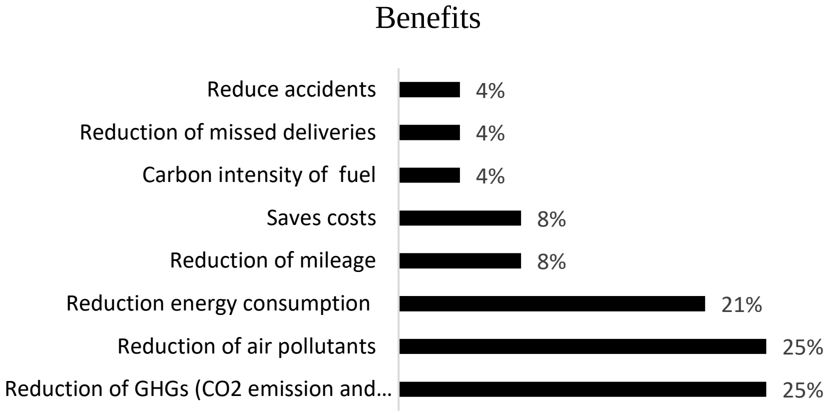


Source: Authors

For many cases, it requires technological information systems, education and training practices, and direct interaction between customer and fulfillment of the request. The greatest barriers encountered are adaptation of the employee to the system, perception of inconvenient action by the customer for participating in the operational process of the service, the inconveniences caused by the complexity of the systems for drivers and operators, the need to develop standards, unknown collateral impacts and an increase in the vulnerability and dangerous practices by the customer when purchasing orders.

The benefits identified in the set of BPs association to Equipment are shown in Figure 6.

Figure 6 - Generated Benefits by Equipment.



Source: Authors

In case studies referring to BPs focused on Equipment, the solutions are: Use of additives to improve the fuel energy efficiency (BP10); Adoption of vehicles preventive maintenance (BP11); Improvement in vehicle occupancy (BP12); Fleet renovation and modernization (BP13); Use of cleaner energy sources (BP14); Use of vehicles with greater energy efficiency (BP15); Optimization of loading and unloading operations with motorized equipment use (BP16); Mode shift (BP17) and Use of different types of vehicles to carry out deliveries and collections (BP18).

BP10 is portraited by two cases: (i) the use of fuel diesel with peroxide fuel additive at 0.15% in cities of India, leading to an approximate reduction of 28% in NOx emission; and (ii) the use of detergent additives, in Venezuelan cities, whose results showed a 6–10% reduction of CO, 2-10% of CO_2 and 13–24% of HC emissions, and an improvement in fuel economy by 2% to 10% from test trucks despite a NOx increase (2–3%).

BP11, BP12 and BP13 address one case each, which are, respectively: (i) the preventive maintenance of vehicles at Port of Valparaíso for Haulage Companies in Valparaíso, Chile, leading to 7-15% fuel savings; (ii) the improvement of vehicle occupancy by using Double-deck / High-cube Trailers of 32½ tonnes, in British cities, which showed that, for every 525 million kilometers reduced per year, 197 million liters of fuel, 510,225 tonnes of CO_2 and 1,974 tons of CO would be saved., although, in the case of air pollutants, they would have a greater margin of reduction if combined to the replacement of older and more environmentally damaging equipment with new trailers in compliance with the latest standards and (iii) the fleet renovation and modernization to improve the technologies used in vehicles in Madrid, Spain, whose reductions were 24.70% for NOx, 17.63% for PM10, 21.19% for PM2.5, 29.14% for CO, 20.23% for NMVOC, while the CO_2 emissions is very low

(0,55%), when the percentage of the old fleet is less than 0.02% for heavy vehicles with a load less than 32 tonnes, 0.005% for heavy vehicles with a load greater than 32t.

BP14 comprises the case of Project cleaner energy sources by Electric Urban Delivery Trucks, in New York, US, which concluded that, when compared to the use of diesel urban delivery trucks and from the drive cycle with frequent stops and low average speed, electric trucks emit 42% to 61% less GHG and consume 32% to 54% less energy than diesel trucks, depending on the vehicle's efficiency cases, whereas for a drive cycle with less frequent stops and medium high speed, electric trucks emit 19% to 43% less GHG and consume 5% to 34% less energy, but cost 1% more than the equivalent diesel.

BP15 comprises the case of the use of vehicles with greater energy efficiency in California’s transportation, whose prospective scenarios for alternative fuels (hydrogen and electricity) indicate a 74% reduction in the carbon intensity of transport fuels between 1990 and 2050, by use of advanced electric-drive technologies (PHEVs, BEVs and FCVs) and low-carbon hydrogen and electricity.

BP16 addresses just one case, which is the study about the practice of loading and unloading operations with the use of motorized equipment (Applied Freight Beamer Germany). The study concluded that emissions were reduced by 73% (CO_2) and by 81% (NOx) in the real electricity mix, and by 100% taking clean power as a basis compared with diesel system.

BP17 comprises two distinct situations, as follows: (i) the Delivery by drone compared to delivery truck in an industry in Los Angeles, US, in which the use of a drone helped to reduce CO_2 emissions and increased the delivery perimeter by 98%, and verified that emission results vary greatly and are highly dependent on the energy requirements of the drone, as well as the distance it must travel and the number of recipients it serves, mainly when service zones are close to the depot, having small numbers of stops, or both; and (ii) the combined use of mobile-depots and cargo tricycle – through use Truck’s Parking Point in Rio de Janeiro, Brazil, whose results showed that, in the comparison between total delivery by truck and interaction between delivery by truck and four cargo tricycles, the reductions observed per kilometer varied between 51.9% and 67.9% for CO_2, 20.8% and 38.8% for CO, 55.6% and 67.6% for NOX, 20.3% and 38.3% for NMHC and 49% and 62% for PM, whereas the probability of being less expensive than the traditional installation varied between 6.5% and 59.2%.

BP18 is exemplified by three case studies, as follows: (i) the use of electric vehicles of smaller dimensions by the postal service in Rio de Janeiro, Brazil, which concludes that trade-offs between initial journeys by bus and final journeys by light fossil fuel vehicle versus journeys using exclusively the electric tricycle result in reductions of 28% in total daily cost of the deliveries and of 100% in emissions in mean distance of the 13.31 km and 6.55 km/h; (ii) the use of droids for delivery, which points that the droids can acquire the functions of parcel lockers and reduce the number of missed deliveries in urban areas, are indicated for urban areas with high density (above 1 million inhabitants), and (iii) the use of AGV in Paris, France, as it is expected to significantly reduce by as high as 90 % the accidents because it promises to reduce the human error that contributes to congestion on city streets and fuel use up to 10 % as a result of truck platooning.

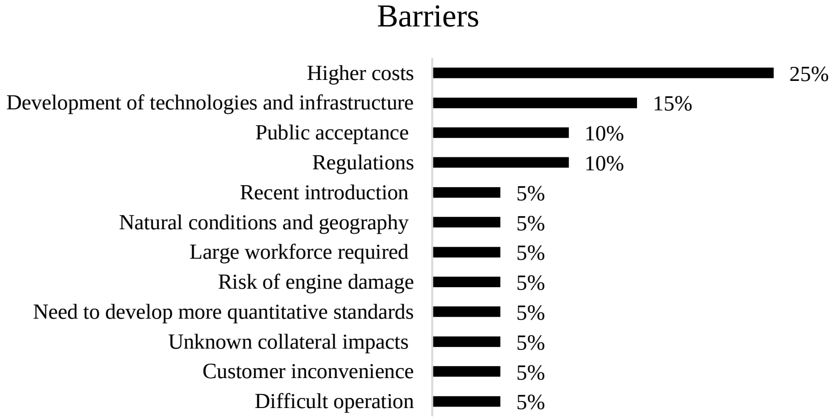
BPs related to new standards for operating freight transport generate benefits from improving intensity and use of fuel, which in turn help reduce the carbon intensity in the fuel, generating mainly a reduction in atmospheric pollutants, since preventive maintenance, renewal and acquisition of vehicles with greater energy efficiency induce the use of more updated in terms of environmental regulations as proposed by the Motor Vehicle Air Pollution Control Program (PROCONVE).

Regarding technologies such additive uses to improve energy efficiency of fuels and equipment implementation to control vehicle emissions, it is observed a greater benefit generation with reduction of atmospheric pollutants that aim to meet local and regional environmental impact problems. According to Senthil et al. (2015), fuel additives are mainly used to improve fuel economy, reduce emission like smoke, CO, HC, NOx and PM. Emission control equipment types can be represented by catalytic converters, diesel particulate filters and oxygen, NOx, and temperature sensors, whose main objective is to control emissions of atmospheric pollutants such as PM and NOx.

The reduction in activity, such as those stimulated by the optimization of the loading and unloading operation and the use of different modes of transport or changes in the mode of transport, help mainly to reduce the distance traveled and GHG emission. The use of energy from cleaner sources directly assists in reducing fuel consumption and contribute to reducing accidents and reducing costs.

The barriers identified in the set of BPs association to the Equipment are shown in Figure 7.

Figure 7 - Barriers Found for Equipment

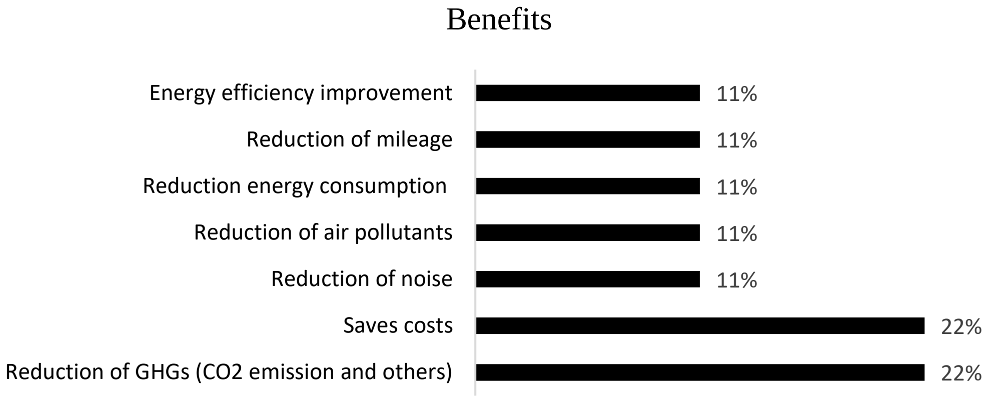


Source: Authors

Due to the great need to develop infrastructure or adopt new technologies, the main barriers observed are mainly the high cost for the implementation and operation of BPs, acceptance for the use of new equipment by the market, regulations that ensure the use of this equipment, besides the possible operational discomfort and, for the customer, risk, adequate natural and geographical conditions and large workforce requirements.

The benefits identified in the set of BPs association to Governance are shown in Figure 8.

Figure 8 - Generated Benefits by Governance



Source: Authors

In case studies of BPs involving Governance include vehicle weight and size regulations (BP19), Night-time collection and distribution (BP20) and Fiscal / Subsidies (BP21).

BPs related to traffic rules and/or limits present benefits from adopting actions such as offering tax incentives and subsidies and approaches to improve the carbon intensity by reducing vehicle weight or vehicle size and reducing activity provided by the change in delivery schedule as it occurs in nighttime delivery. The indicators that contribute benefits are cost reduction, fuel consumption, air pollutants, GHG and noise generation.

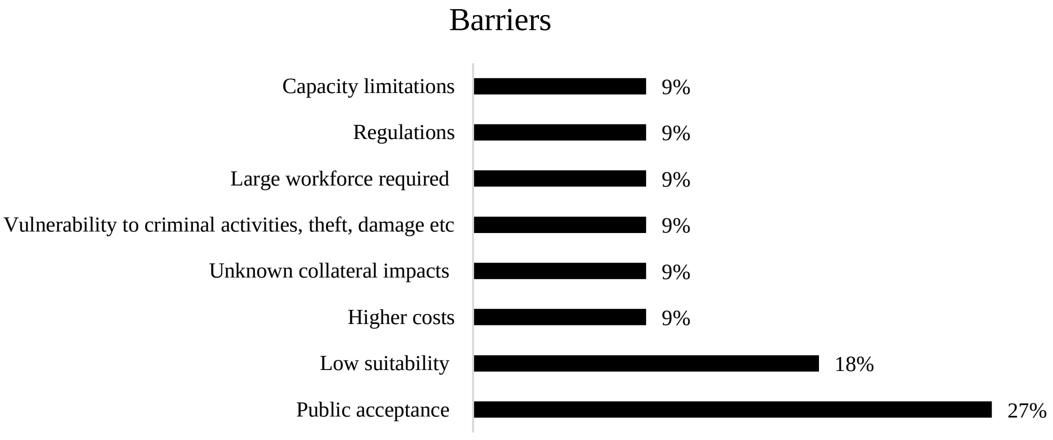
BP19 comprises two distinct cases: (i) urban goods distribution starting of TNT FEDEX company by electric cargo cycles in São Paulo, Brazil, which concludes that trade-offs between tricycles and diesel vans result in cost reductions of 31% and CO_2, and emissions reductions of 97%, in a scenario characterized by a fleet of 15 electric tricycle and diesel van, daily load of 500 kg and 5000 kg to electric tricycle and diesel van respectively, distance traveled of 84 km and 30 km to electric tricycle and diesel van respectively, and 3 and 1 number of vehicles to electric tricycle and diesel van respectively; and (ii) studies of options for weight reduction of different types of heavy vehicles in European Union, that identified that, for each 100 kg of the weight reduction of Light-duty vehicle, urban commercial use and light truck, urban commercial use is capable of generating savings of 0.39 l / 100km of diesel and 0.27 l/km of diesel, respectively, and 7.7g CO_2 / km and 5.3g CO_2 / km respectively.

BP20 features two case studies, as follows: (i) Night deliveries between 7 pm and 7 am in cities in Belgium, which is seen as a good alternative as delivery at night with a subsidy scheme and noise standards results in a truck free urban environment during the day and is not disturbing at night, being able to reduce fuel consumption in the supply chain by around 10% (14 million liters of fuel), whereas the regional operating chain could save up to 858,000 euros per year, the national operating chain could save almost 5 million euros and the emission of air pollutants could be reduced by between 42% and 44%, and (ii) Night delivery for fuel distribution in Rio de Janeiro, Brazil, using tank trucks with fleet capacity of transport below 20 m3 to more than one delivery in the same travel, experiencing results such as a 13.5 % reduction in CO_2e, a 13% reduction in CO, PM and NOx, plus a 25-40% saving in costs.

BP21 is illustrated by two situations, which are: (i) PIEK national regulation program in cities of Netherlands on delivery noise of trucks, which is an initiative based on subsidies to acquisition of available technologies to lower noise deliver, including low-noise lift platforms, noise absorbing coatings and low-noise carts, and (ii) the support for electric freight vehicles in Hamburg, Germany, which financially aids the purchase of electric freight vehicles over 3.5 tonnes, increasing the number of electric vehicles and improving the municipality's air quality mainly by reducing N_2O, while also reducing the value of companies' capital investments from subsidy programs.

The barriers identified in the set of BPs association to the Governance are shown in Figure 9.

Figure 9 - Barriers Found for Governance



Source: Authors

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Due to the great need to develop rules and stimulate the reduction of traffic and its impacts on society, the main barriers verified are the low acceptance by the government or private initiative to stimulate the development of these actions (improvement on security, determination of new rules for different types of materials, financial incentives, etc.), low adequacy to daily life, high implementation costs, increased insecurity and vulnerability in the delivery activity, need for well-defined regulations and increased demand for workforce.

5. Final Considerations

Urban logistics decision makers and stakeholders need to make UFT more sustainable to reduce the negative impacts arising from their activities such as the increase in GHG emissions. Thus, this paper aimed to search which BPs are adopted to solve UFT problems and what are the benefits and barriers in adopting each BP to promote sustainable.

With an exhaustive literature review, it is noted that the solutions make sense in and of themselves. The most powerful effect, however, happens when two or more of them are used together, multiplying their respective strengths. What matters, then, is selecting the right options. Different combinations will work for different kinds of cities and different customers.

To meet the needs of companies to promote a sustainable UFT in the processes of distribution, last mile and collection, BPs, according to their particularities, were able to contribute to the development of the sector, as they contribute to improving the performance of indicators essential for the operation of urban transport.

With the literature review carried out, there was an expressive participation of environmental and economic indicators (costs and service levels) to the detriment of social indicators, directly represented by the reduction of accidents. Thus, a literature review focused on generating a comparative basis for social indicators is a suggestion for future studies.

The benefits generated by the analysis of case studies may represent a benchmark for other enterprise' studies. However, it is necessary to evaluate the characteristics of each case. Furthermore, the main barriers detected address problems with additional costs, technical skills, adequacy of technology use, which can be solved with time and new studies.

It is also worth mentioning that the BPs, indicated in this research, alone or in combination, can benefit urban economies, the environment and society. However, for five sectors in particular - retail, logistics, public sector, automotive and energy - changes in urban commercial transport still challenge their existing revenues and operating models, which requires further studies and government participation to establish actions, rules and incentives.

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