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Urban Freight Transport measures in the São Paulo Metropolitan Region in recent decades

Medidas de Transporte Urbano de Cargas na Região Metropolitana de São Paulo nas últimas décadas

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ABSTRACT
Several cities usually have constrained areas shared by people and freight vehicles. Then, public authorities manage urban space use conflicts by implementing measures to limit the negative impacts of freight activities, and some measures reveal other (political) reasons to take place. The measures are classified by infrastructure (ring roads, on-street parking and un/loading areas, pick-up points), governance (truck traffic control, zones, time-windows, preferred routes and urban tolls) and equipment (type of vehicles and alternative fuels). This study analyzes the Urban Freight Transport (UFT) management measures in São Paulo Metropolitan Area (SPMA). We made an in-depth analysis of UFT measures in SPMA from 1960 to 2020. We searched cities' document databases and used Python routines to recognize and filter text information, then compared the emergence of measures with changes in the population, GDP, and fleet. We conclude that the off-street unloading/loading and restrictions to traffic are the most common measures implemented by the cities in SPMA over time. Most cities with high growth also increase the demand for UFT, leading to restrictions regarding large vehicles in the city center. Cities that are nearby São Paulo city and present the fastest-growing truck fleet appear not to invest in having truck restrictions; usually, these cities attract warehouses and/or carriers from where the delivery in São Paulo city. Moreover, we found that public policies have not been coordinated among cities and that most measures are not assessed before implementing them.

RESUMO
Várias cidades costumam ter áreas restritas compartilhadas por pessoas e veículos de carga. Logo, as autoridades públicas geralmente gerenciam os conflitos de uso do espaço urbano implementando medidas para limitar os impactos negativos das atividades de transporte de mercadorias, e algumas medidas revelam outras razões (políticas) para serem implementadas. As medidas são classificadas por infraestrutura (anel viário, estacionamento na rua e áreas de descarga/descarga, pontos de coleta), governança (controle de tráfego de caminhões, zoneamento, janelas de tempo, rotas preferenciais e pedágios urbanos) e equipamentos (tipo de veículos e combustíveis alternativos). Este estudo analisa as medidas de gestão do Transporte Urbano de Cargas (TUC) na Região Metropolitana de São Paulo (RMSP). Fizemos uma análise aprofundada

das medidas UFT na RMSP de 1960 a 2020. Pesquisamos bancos de dados de documentos das cidades e usamos rotinas Python para reconhecer e filtrar informações de texto, depois comparamos o surgimento de medidas com mudanças na população, PIB e frota. Concluímos que o descarregamento/carregamento fora da via e as restrições ao tráfego de veículos pesados são as medidas mais comuns implementadas pelas cidades da RMSP ao longo do tempo. A maioria das cidades com alto crescimento também apresenta aumento da demanda por UFT, levando a restrições principalmente em relação a veículos de grande porte no centro da cidade. Cidades perto da cidade de São Paulo e que apresentam uma crescente frota de caminhões parecem não investir na restrição de caminhões; geralmente essas cidades atraem armazéns e/ou transportadoras de onde fazem a entrega na cidade de São Paulo. Além disso, constatamos que as políticas públicas não têm sido coordenadas entre os municípios e que a maioria das medidas não é avaliada antes de sua implementação.

1. INTRODUCTION

In recent decades, megacities have experienced a significant increase in the challenges related to urban freight transportation (UFT) (Kin, Verlinde and Macharis, 2017). Operations from distribution centers in megacities are almost not feasible due to the growing use of land for residential and commercial purposes, increasing land prices (Guerin et al., 2021). Logistics operators have then moved outside urban areas in a process called *logistics sprawling* (see the summary provided by Dablanc and Browne, 2019), demanding many light vehicles for daily deliveries to many stores located in the cities to better deal with truck regulations. These vehicles intensify environmental problems (Oliveira et al., 2017), increase traffic accidents, cargo theft, and contribute to traffic congestion and a long load-unload queue (Vieira and Fransoo, 2015).

Public authorities usually address these problems by implementing restrictive truck measures to limit the negative impacts of freight activities (Letnik et al., 2018). The literature shows a set of measures (Russo and Comi, 2011) and some descriptive reports on UFT solutions attempted to address these problems in Europe, such as the Best Urban Freight Solutions (BESTUFS), Transferability of Urban Logistics Concepts and Practices from a Worldwide Perspective (TURBLOG_WW), Cleaner and better transport in cities (CIVITAS), Sustainable Urban Goods Logistics Achieved by Regional and local policies (SUGAR), and many others [see NOVELOG (2019)]. Public agents in Brazil have put in place a few concrete and similar measures to our knowledge. Only recently, in 2012, Brazilian Law 12587 established the Urban Mobility National Policy (UMNP), determining that cities with more than 20,000 inhabitants should develop an Urban Mobility Plan (UMP) comprising both passenger and cargo transport (Dias et al., 2018). However, the effectiveness of regulations and side effects of restricting truck traffic (for instance) is not always evaluated before they are put in place; they are not usually assessed afterwards due to limited data and resources available; and the truck measures are just copied by cities, which neglect the UFT problem and leave this issue to the private sector (Dias et al., 2018).

Based on Dias et al. (2020), Holguín-Veras et al. (2018), Holguín-Veras et al. (2015), Dias et al. (2018), Russo and Comi (2011), Kin, Verlinde and Macharis (2017) and some of the previously mentioned reports, the following UFT measures will be analyzed: ring roads or beltways, on-street parking and loading, off-street parking and loading, pick-up

points, truck traffic restrictions, time-windows, preferred routes, urban tolls, smaller vehicles, and alternative fuels.

This study aims to analyze the UFT measures in SPMA and their relation with population, Gross Domestic Product (GDP), and fleet across cities. First, we will proceed with a detailed qualitative analysis of the measures implemented in SPMA in recent decades. To achieve this objective, we conducted a detailed account of UFT measures in the São Paulo Metropolitan Area from 1960 to 2020. Then, we investigate the changes in population, GDP, and fleet in the period following the UFT system model proposed by Kin, Verlinde and Macharis (2017).

Different from some recent studies regarding the analysis of the UFT measures by the public sector in Brazilian cities, our investigation contributes to the state-of-the-art by providing a detailed documental analysis of historical data of UFT measures that the cities in SPMA have implemented. Most research applied surveys and protocol interviews with experts or public managers (Vieira et al., 2021; Dias et al., 2018; 2020). While the latest studies have discussed the UFT measure adopted by the cities, including some SPMA cities (Dias et a., 2018), the present study proposes an investigation of these measures over time and their relation to population, GDP and fleet. Indeed, Dias et al. (2018) analyzed Brazilian cities' Urban Mobility Plans using cross-section data which can be a limited analysis since the main problem is considering only one period to evaluate the changes. Through the published laws and complementary data, our longitudinal study revealed changes in city policies. Some of measures go and back over time, some measures (for example, traffic truck restriction) may cause sprawl logistics in this region (Guerin et al., 2021), and some measures are created to reduce region traffic (ring road). The 'off-street/on-street unloading/loading' and restrictions to traffic are the most common and the first measures implemented by the cities. Moreover, this research contributes to the literature by providing a timeline of measures, which is insightful for studies on the transformation of the urban environment and social-economic aspects of the investigated municipalities. The timeline of UFT measures may be helpful to reveal how these measures occurred and can be expected by the growth and development of cities.

To the best of our knowledge, this is the first study regarding the measures implemented by the municipalities in Latin American countries. Since urban freight is a component of complexity in large cities with economic and social relevance, its different aspects can interest diverse scientific fields such as engineering, economics, geography, and public health. Research work in UFT focuses on the performance of proposed solutions, discussion of their practice, and the urban policies and reactions of UFT stakeholders; however, the analyses of such measures over time are scarce. Ideally, the findings of our study may provide the foundation for authorities to better plan and implement urban policies that address UFT. Although the replicability of findings in other regions consists of a different research topic, this study also can support other urban areas (for example, cities with fast grow) in establishing policies and planning that include UFT as a fundamental aspect of sustaining the city and its economy.

2. THEORETICAL BACKGROUND AND PROPOSITIONS

Kin, Verlinde and Macharis (2017) provide a framework for evaluating UFT based on the three-layer transport model Behrends (2011) proposed. It includes a third element in the

system, the context, consisting of the physical environment regulated by authorities. Demand for goods results in freight flows that, in their turn, require logistics facilities and infrastructure, all of that happening in a physical environment, which is the urban area. Stakeholders act and interact within this scenario, and each component has certain factors influencing it. However, Kin, Verlinde and Macharis (2017) do not indicate the drivers for the implementation of UFT measures and their consequences on urban policies.

2.1. Drivers for implementation of UFT measures

UFT is managed as a local issue in most countries, in which local authorities create regulations to control its impacts and transport externalities (Ewbank, Vieira and Fransoo, 2020). These regulations (or measures) usually are related to the type of vehicle (weight and size) and accessibility to certain regions of a city (Vieira et al., 2021). However, Dias et al. (2018) state that public managers lack the background to develop Urban Master Plans (UMPs) and are unaware of urban logistics demands in cities or have neglected aspects of urban freight in UMPs. Actions addressing UFT seem to be replicated by cities without a local impact assessment (Dias et al., 2020). It also happens in Europe, where large cities as Paris, Berlin and Helsinki are benchmarks for the cities such as Lisbon, Athens, Budapest, Dublin, Warsaw and others (Kiba-Janiak, 2017). These cities present low-medium maturity levels in planning and implementing UFT measures. Summarizing, it means that the cities focus on passenger, low-cost projects, do not gather any data on urban freight transport, or the data is available in a fragmentary way or without frequency. Holguin-Veras et al. (2018) point out that public decision-makers face difficulties identifying effective measures to address UFT issues due to the lack of a framework, data, and training to support their actions. Therefore, they frequently resort to familiar approaches, such as engineering and various types of regulations. Quak (2008) states that UFT policies usually emerge from the (perceived) problems caused by traffic congestion rather than an essential activity supporting urban living, also from the noise and pollution problems caused by freight vehicles (Lagorio, Pinto and Golini, 2016). The authors suggest that there comes the point where authorities feel pressurized to regulate UFT, with limited view to truck fleet grow (type and number of vehicle) and local population (Taniguchi and Thompson, 2015). The measures may be implemented by the large cities (Dias et al., 2020), which have high GDP.

Therefore, we posit the following:

Proposition 1: Observable and measurable externalities of truck traffic in urban areas is why governance measures restrict their circulation.

Proposition 2: The urban area's observable and measurable characteristics, such as demographics, are the implicit drivers behind the emergence of governance measures restricting truck circulation.

2.2. Consequences of UFT Measures

Evaluation after implementing a measure is an ex-post evaluation. However, the input data in modeling urban freight systems are not available in many cases due to the confidentiality of freight operators and lack of collection schemes, for example. Besides that, simulation results are difficult to validate due to the same unavailability of data

(Taniguchi et al., 2001; Lindholm, 2012). The increasing access to tracking systems and technology to monitor, store, and handle large amounts of data can enable more analyses in the future.

Econometrics provides the ground and tools to assess the probability that the studied variables affect the studied outcome. He, Gouveia and Salvo (2019) analyzed a quasi-experimental scenario after the inauguration of the São Paulo beltway, comparing health, pollution, and congestion data before and after the decrease in truck traffic on a road that crosses the city. By implementing the ring road, there was a reduction in congestion, pollution, and hospitalizations resulting from cargo vehicles, which were previously increased due to the distance from central areas used by trucks before opening the ring road. However, the impacts of widely adopted UFT solutions and their transferability to other settings are not entirely understood (Quak, 2008). As an illustration, road pricing initiatives can result in drivers diverting routes, causing pollution and congestion in other areas and limiting the efficiency and effectiveness of such measures (Ruesch, 2004). He, Gouveia and Salvo (2019) indicate that a ring road may alleviate congestion; however, results are not sustained over time, in contrast to the reduction of nitrogen oxide emissions, which are lower for as long as the prohibition of truck traffic persists. McLeod et al. (2019) point out that problems caused by freight transport policies can reach beyond local planning jurisdiction limits so that a local initiative has effects across regions. Therefore, we present the third proposition:

Proposition 3: UFT actions have effects on surrounding municipalities.

3. SÃO PAULO METROPOLITAN AREA

3.1. Population

The SPMA comprises the 39 cities in Table 1 with the sub-region, population, and Human Development Index (HDI). In 2020, the state population was estimated at 44.3 million people, which corresponds to 20% of Brazil's population, living in 248,219.94 km^2, or 3% of the country's territory.

All cities have a high HDI considering the UN (2019) classification. It varies 22.6% in the region, considering the highest GDP (São Caetano do Sul) and the lowest (Francisco Morato), reflecting the inequality in SPMA. Indeed, in the 1980s, Caieiras, Francisco Morato, and Franco da Rocha´s urbanization processes were marked by low-income population settlements and land occupation (EMPLASA, 2021). São Paulo ranks fourth, tied with São Bernardo do Campo. The top three in descending order are: São Caetano, Santo André and Santana de Parnaíba.

Manufacturing facilities are located mainly in the SPMA Southeast, Guarulhos, and Osasco. Although there still is a relevant industrial activity in the city of São Paulo, its industrialization degree has decreased due to the urban expansion, and many facilities have moved to other locations in the state.

Table 1: SPMA cities

City	Sub-region	Population (2018)	HDI (2010)
Arujá	East	86,746	0.784
Barueri	Northwest	259,793	0.786
Biritiba Mirim	East	31,571	0.712
Caieiras	North	97,763	0.781
Cajamar	North	74,910	0.728
Carapicuíba	Northwest	390,010	0.749
Cotia	Southwest	238,189	0.780
Diadema	Southeast	401,159	0.757
Embu das Artes	Southwest	264,787	0.735
Embu-Guaçu	Southwest	66,993	0.749
Ferraz de Vasconcelos	East	188,035	0.738
Francisco Morato	North	170,189	0.703
Franco da Rocha	North	148,126	0.731
Guararema	East	28,692	0.731
Guarulhos	East	1,325,750	0.763
Itapecerica da Serra	Southwest	166,229	0.742
Itapevi	Northwest	229,982	0.735
Itaquaquecetuba	East	360,462	0.714
Jandira	Northwest	120,523	0.760
Juquitiba	Southwest	30,040	0.709
Mairiporã	North	95,122	0.788
Mauá	Southeast	451,947	0.766
Mogi das Cruzes	East	423,912	0.783
Osasco	Northwest	677,750	0.776
Pirapora do Bom Jesus	Northwest	18,188	0.727
Poá	East	113,719	0.771
Ribeirão Pires	Southeast	117,917	0.784
Rio Grande da Serra	Southeast	48,648	0.749
Salesópolis	East	16,590	0.732
Santa Isabel	East	54,191	0.738
Santana de Parnaíba	Northwest	132,317	0.814
Santo André	Southeast	690,551	0.815
São Bernardo do Campo	Southeast	803,771	0.805
São Caetano do Sul	Southeast	150,988	0.862
São Lourenço da Serra	Southwest	15,246	0.728
São Paulo	Not applicable	11,753,659	0.805
Suzano	East	285,257	0.765
Taboão da Serra	Southwest	275,988	0.769
Vargem Grande Paulista	Southwest	50,797	0.770
SPMA	Not applicable	20.856.507	Not applicable

Source: Based on data from SEADE (2020).

3.2. SPMA gross domestic product

In 2017, SPMA contributed to 17% of Brazil's gross domestic product (SEADE, 2020). Despite having the highest GDP in the country, the income per capita is below half of Brazil's minimum wage in 30% of SPMA households. Osasco, Barueri, Cajamar, and Itapevi, located to the West of São Paulo, improved their share of SPMA's GDP between 2002 and 2016, as shown in Table 2.

Table 2: GDP share of SPMA cities

City	2016 GDP share	2002 GDP share	2016 Ranking	2002 Ranking	Ranking Change
São Paulo	62.0%	64.5%	1	1	0
Osasco	6.7%	4.2%	2	4	2
Guarulhos	4.9%	4.3%	3	3	0
Barueri	4.3%	3.8%	4	5	1
São Bernardo do Campo	3.8%	5.2%	5	2	-3
Santo André	2.3%	2.9%	6	6	0
Mogi das Cruzes	1.3%	1.2%	7	10	3
Mauá	1.3%	1.3%	8	9	1
São Caetano do Sul	1.2%	2.2%	9	7	-2
Diadema	1.2%	1.5%	10	8	-2
Cajamar	1.2%	0.6%	11	15	4
Suzano	1.1%	0.4%	12	20	8
Embu das Artes	1.0%	0.8%	13	12	-1
Cotia	0.9%	0.4%	14	17	3
Itapevi	0.9%	1.1%	15	11	-4
Santana de Parnaíba	0.8%	0.6%	16	16	0
Taboão da Serra	0.8%	0.7%	17	14	-3
Itaquaquecetuba	0.6%	0.4%	18	19	1
Carapicuíba	0.5%	0.4%	19	18	-1
Arujá	0.4%	0.2%	20	26	6
Poá	0.4%	0.8%	21	13	-8
Itapecerica da Serra	0.3%	0.3%	22	22	0
Jandira	0.3%	0.3%	23	21	-2
Franco da Rocha	0.3%	0.2%	24	23	-1
Caieiras	0.3%	0.2%	25	27	2
Ferraz de Vasconcelos	0.2%	0.2%	26	24	-2
Ribeirão Pires	0.2%	0.2%	27	25	-2
Vargem Grande Paulista	0.2%	0.1%	28	31	3
Santa Isabel	0.1%	0.1%	29	28	-1
Francisco Morato	0.1%	0.1%	30	29	-1
Guararema	0.1%	0.1%	31	32	1
Mairiporã	0.1%	0.1%	32	30	-2
Embu-Guaçu	0.1%	0.1%	33	33	0
Biritiba-Mirim	0.1%	0.1%	34	35	1
Rio Grande da Serra	0.1%	0.0%	35	37	2
Juquitiba	0.0%	0.1%	36	34	-2
Pirapora do Bom Jesus	0.0%	0.0%	37	39	2
São Lourenço da Serra	0.0%	0.0%	38	38	0
Salesópolis	0.0%	0.1%	39	36	-3

Source: IBGE (2020).

3.3 Fleet

The SPMA population grew around 30% in 20 years, and the number of cars increased from 5.8 million in 2007 to 8.6 million in 2017, representing a 48% expansion (UN, 2019). The SPMA owns 13% of all vehicles in Brazil (SINDIPEÇAS, 2020). However, analyzing the evolution, the SPMA has reduced its participation over the years.

Considering vehicles related to logistics, e.g., trucks (over 3,500 kg) and vans (below 3,500 kg), the representativeness of the SPMA in Brazil's fleet is much smaller. In December 2017, residents of SPMA owned 9.5% of the truck fleet and 10.8% of all vans in Brazil. Concerning trucks, the city of São Paulo holds 50.42% of the entire fleet of trucks

in the SPMA. Guarulhos is the second municipality with 8.09%, followed by São Bernardo do Campo with 4.3%. Regarding vans, the municipality of São Paulo has 61.4% of the fleet, followed by Guarulhos with 5.1% and São Bernardo do Campo with 4.3%. This concentration of pickup trucks in São Paulo is possibly due to city traffic restrictions on trucks (SEADE, 2020).

4. METHODOLOGICAL APPROACH

The research draws insight from qualitative and quantitative data regarding SPMA. Qualitative data corresponds to the presence and characteristics of UFT measures from each city council. In contrast, the quantitative part corresponds to variables that characterize a given city and its freight system, according to the model proposed by Kin, Verlinde and Macharis (2017). These quantitative data consist of data from each municipality. Specifically, the population data are available in the public database managed by the State System for Statistical Data Analysis (SEADE, 2020) and GDP by IBGE (2020). Fleet data has been gathered from the national traffic authority (SINDIPEÇAS, 2020). The research steps are depicted in Figure 1.

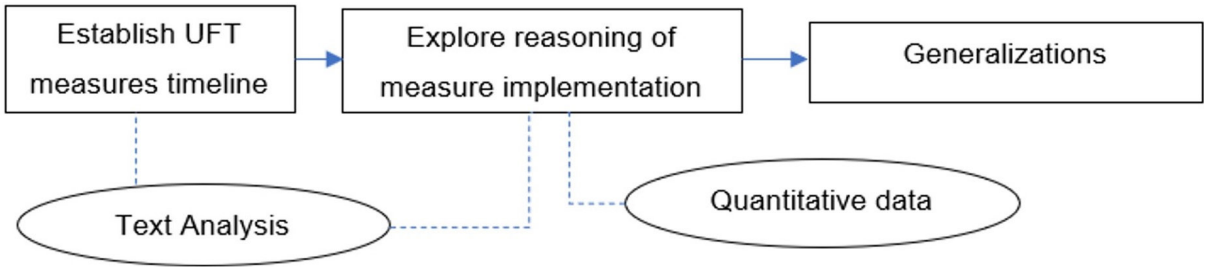

Figure 1. Research scheme.

4.1. Data collection: identifying UFT measures and documents

The following steps for data collection are described in the four sections within this methodological step.

4.1.1. Collection of documents

The literature review indicated that measures related to zoning areas and land use are commonly adopted in urban planning (Dias et al., 2018), which helps locate different types of buildings according to their use. We do not consider comprehensive plans, land-use, and zoning regulations *per se* as UFT measures, as they relate to UFT issues in an indirect, unfocused way. However, they are sources of information if they mention parking requirements for loading and unloading within the facilities.

Considering that authorities eventually take action to address issues raised by UFT and the framework of institutional ethnography, we chose the formal publications by city councils, city executive administrations, and local associations as primary information sources containing the coding units. Thus, we identified websites for each city council and executive administration and collected relevant documents from these sources employing search engines, where we used the coding units as keywords.

All the search terms and their meaning are shown in Table 3.

Table 3: Keywords indicating UFT measures

Search Steps	Meaning of Keyword in English
Primary search	Truck/trucks "Cargo vehicle/vehicles"
	"Loading and unloading"
	Urban Mobility
Secondary search	Master Plan/Comprehensive Plan
	Building Code
	Zoning
	Land-use
	Traffic
	Cargo

The column "Search Steps" in Table 3 refers to the steps used to maximize the detection of documents possibly addressing UFT. To ensure that we find all the pertinent documentation, we examined specific documents in pdf format that might contain relevant information, such as the Building Codes, as suggested by Holguín-Veras et al. (2018). Finally, the primary search yielded few results. We reran it using broader terms such as cargo or filters for transport and traffic, if available on SE's city website. For example, we visited the website of the Union of Cargo Transport Companies of São Paulo and Surroundings (SETCESP - *Sindicato das Empresas de Transportes de Carga de São Paulo e Região*) and the Traffic Engineering Committee website, which exists only in the city of São Paulo. This process allowed us to find documents for which primary search terms were undetectable or not indexed.

4.1.2. Processing of document

This step aimed to remove unrelated files and prepare the files for the information extraction. Many files involved parking spots for trucks licensed by municipalities as freight service providers, similar to taxi licensing. Although such regulations could mention curbside parking locations for the vehicles within their scope, this practice does not characterize a UFT measure because it does not address a freight issue. As the semantic unit related to such ordinances had the expression "rental" together with "truck"/"trucks", a Python routine was developed to analyze documents and remove those within this category. Processing the document set also involved using a Python OCR tool to convert image files to text.

4.1.3. Information extraction

The information extraction step previously required an interpretation of the text of each document. We used a routine written in Python to parse all the files to do this. In this case, the entire page containing the coding unit, the number, and the regulation's year was extracted. Afterward, the result was compiled into files for each city in just one text. Whole pages were extracted due to the need for context to execute the next step, which was categorization. In this last stage, we validated if the keyword text corresponded to a UFT initiative and was classified in one of the groups in the second column of Table 4.

Table 4: Measures analyzed in SPMA

Type of Measure	Measure
Infrastructure	Ring roads or beltways
Infrastructure	On-street parking and loading - OnSPL
Infrastructure	Off-street parking and loading - OffSPL
Infrastructure	Pick-up points
Governance	Truck Traffic Restrictions - TTR: VER, ZMRC, time-windows
Governance	Preferred Routes
Governance	Urban Tolls
Equipment	Smaller Vehicles / VUC
Equipment	Alternative fuels

4.1.4. Information categorization

In many cases, access restraints to specific zones and streets (ZMRCs and VERs), weight limits, and access and delivery time windows are part of the same prohibition. Therefore, we grouped these into *truck traffic restrictions* for some considerations, keeping them separated when the distinction was evident in the regulation text. In practice, the category on-street parking and loading also relates to delivery time windows; however, the study indicated that the location of the operation is the most relevant factor for authorities.

4.2. Data analysis

To establish the SPMA measures timeline, we conducted a content analysis, "a research technique for making replicable and valid inferences from texts (or other meaningful matter)" (Krippendorff, 2004). Although commonly associated with quantifying mentions of a word within texts (quantitative content analysis), in this study, we seek to apprehend meaning from textual sources, thus performing a qualitative content analysis.

The first part of the research involved the Collection of UFT measures information by dividing the data presentation into two time periods: 1960 to 1980 and 1980 to 2020. We describe the initiatives that emerged in each period and then the evolution of measures in each city. The second part explored relationships among urban indicators and the emergence of UFT measures using charts and tables. As we do not have data available for the whole timespan of measures, we focus on restrictions to the traffic of freight vehicles from 2002 to 2018 and discuss their surfacing considering demographics, GDP, and fleet data.

5. RESULTS AND DISCUSSION

5.1. General results

From 1960 to 1980, only 14 cities had rules related to UFT, predominantly off-street loading/unloading, henceforth abbreviated to L/U. Regulations state that L/U must take place within the property for specific land uses and/or types of facilities. When established in master plans, zoning, and land use laws, this requirement came with exceptions for cases where the land use did not correspond to that allowed in the area. Some cities even modified a previous regulation to include such exceptions. For example, in São Paulo city, the measure 'L/U area' was not considered if loading and unloading occurred during the night.

Table 5 shows UFT measures from 1981 to 2020, organized in four-year periods according to the city presupposed mayor mandates for all the 39 cities of SPMA. During the 1980s, more cities, including São Paulo, implemented the first restrictions on truck traffic by limiting the weight or areas and time of circulation. More municipalities also adopted On-street L/U rules while off-street requirements lost their predominance. By the end of the decade, when the SPMA had its current configuration, almost 50% of its cities had adopted some regulation affecting UFT. In 2000, this number had risen to 30. In 2020, the number of municipalities with a rule related to freight in the urban area reached 37.

Table 5: Timeline of UFT measures in SPMA

	1981-1984	1985-1988	1989-1992	1993-1996	1997-2000	2001-2004	2005-2008	2009-2012	2013-2016	2017-1920
Arujá				OffS[1]	OffS,UT		OnS,TTR	TTR		
Barueri			OffS	OffS	OffS		OffS	TTR	OffS	OffS,OnS, VER
Biritiba-mirim						TTR		TTR		OnS
Caieiras				OnS		WR		OnS		ADT
Cajamar	TTR, PR						OffS		OnS, TTR	PR, OffS, TTR, OnS
Cotia				OnS	OnS		OffS			TTR
Diadema					OnS		OnS	TTR		
Embu das Artes		OnS	OnS	OnS						OffS
F.de Vasconcelos			OnS		OnS	OnS			OffS	OnS
Francisco Morato		WR		WR						
Franco da Rocha		OnS,WR, OffS	OnS	OnS	OnS	OnS	OnS	OffS		OffS,*TTR*
Guararema								OnS,PR, TTR		
Guarulhos		WR, OnS	WR, OnS	WR, OnS		TTR	OffS			
I. da Serra					OnS	OnS	RR	OnS,TTR, OffS	OffS	
Itapevi				OnS				OnS	OnS,TTR	
Itaquaquecetuba			OffS	OffS			OnS, OffS			
Jandira										OnS
Juquitiba				OffS			TTR			OffS
Mairiporã					TTR		OnS,TTR	TTR	TTR	
Mauá					OnS			OnS		
Mogi das Cruzes		OnS, TTR			OnS		OnS, *TTR*			
Osasco						OnS		OffS, ZMRC	OffS	
P.do Bom Jesus							TTR			
Poá	OnS			OnS	WR					
Ribeirão Pires	OnS, OffS	OnS,WR	TTR	OffS,TTR	OnS		OnS		OnS	
R. G. da Serra					WR					
Salesópolis							OffS			
Santa Isabel							OnS	OnS[2]		
S. de Parnaíba			OnS, OffS	OffS			WR	TTR	OffS	OffS,WR
S. B. do Campo							OffS	OffS		OnS
S. C. do Sul	OnS		TTR,OnS		ADT	OnS	OnS			
Suzano						RR				OffS,TTR
Taboão da Serra				OffS				OnS, OffS, TTR		TTR
V. G. Paulista										OnS
São Paulo	ZMRC	UT, VER	ZMRC	VUC, ZMRC	RR		ND	VER, RR	RR	Comfrota, Urban Lockers

Note: ADT: alternate-day travel; OnS: on-street parking and loading; OffS: off-Street parking and loading; UT: urban toll; TTR: truck traffic restriction; PR: preferred route; VER: Restricted Arterial Road; WR: weight restriction; ZMRC: truck traffic restricted area; RR: ring road; VUC: Urban Cargo Vehicle; ND: night deliveries. Red: not in force. *Gray, italic:* legal ground requiring further action. Without regulations between 1981-2020: Carapicuíba, Embu-Guaçu, S. Lourenço da Serra, Santo André.

[1]Regulation is unclear.

[2]Review without changes.

Further analysis of Table 5 indicates that the most common initiative addressing UFT is the establishment of rules for on-street loading and unloading, adopted over time by 27 of the 39 municipalities. The number is slightly above that of cities with some truck circulation constraint, whether establishing it based on the vehicle weight or other rules such as time windows or restricted zones and roads. This amounted to 23 cities in 2020, with most of them implementing them in the 1980s (eight cities) and the 2000s (five) and the last four in the 2010s. The timeline of the measures also shows that the rules for loading and unloading precede the restrictions on truck traffic, except in some cases, such as the cities of Pirapora do Bom Jesus and Biritiba-Mirim.

Among the 24 cities that currently have some restrictions on truck circulation, eight cities refer to weight restrictions. More constraining circulation rules substituted the weight limits in five of them. Santa Isabel, Rio Grande da Serra, and Poá, cities where restrictions intensifying rules were not identified, created their WRs within the urban perimeter before 2000.

There were urban tolls in the cities of Arujá and São Paulo. In Arujá, the first regulation appeared in 1998 with the preamble "charge for resurfacing streets". Citizens' "formal" requests to remove remaining infrastructure in 2005 and 2006 provided evidence that tolls had operated for some time. In at least one of the locations, the toll had been replaced by a truck traffic prohibition, according to a city ordinance from 2008 that aimed at exempting truck owners living in the area. In São Paulo, toll charging was established in 1987 for loading and unloading in downtown pedestrian-only streets. This initiative remains in effect: vehicles up to seven tons can access these lanes by purchasing tickets that grant a 30-minute window for boarding and alighting. The operation must be carried out between 8 pm, and 7 am due to pedestrian safety.

The last row in Table 5 shows that São Paulo has the most significant number of initiatives addressing UFT. The early need to implement traffic plans and policies resulted in the creation of the *Companhia de Engenharia de Tráfego* - CET (Traffic Engineering Company) in 1976 to monitor congestion and participate in the development and implementation of traffic control policies. In contrast, by 2020, Pirapora do Bom Jesus city did not have any local government entity addressing transportation or traffic reporting directly to the central administration.

On-street parking and loading addressing UFT in SPMA are in many cases related to the management of curbside parking by limiting and charging its use, which became known locally as the "Blue Zone". Deliveries to premises such as small stores located in commercial areas might be impacted by such rules if parking for loading and unloading is prohibited or limited. For example, the parking charge system introduced in Cajamar in 2013 required loading and unloading outside the parking meter's operating hours. Thus, deliveries in regulated streets could only be carried out after 5 pm and before 8 am on weekdays and after 12 pm on Saturdays. In 2015, the Ferraz de Vasconcelos local council created a rule with similar effects, but focusing on loading and unloading, requiring them to be carried out from 9:30 pm. to 9:30 am and allowing cargo vehicles to park in bays during the day, where loading and unloading were prohibited, except in signposted bays. São Caetano do Sul and São Paulo created places for loading and unloading while also allowing operations outside the parking meter operating hours, which can be beneficial if the number of bays matches the demand for freight vehicles. Caieiras and Diadema are examples of cities that created rules for loading and unloading on the road outside of managing parking on the sidewalk. The formerly established time windows for

loading and unloading on central roads and Diadema prohibited these operations at peak times on some roadways. During the 2000s, new urban mobility regulations mentioned urban loading and unloading facilities within the urban perimeter as a policy, as illustrated by São Caetano do Sul city Mobility Plan in 2016.

Off-street rules have been revisited to establish more comprehensive requirements over time. New regulatory paradigms emerge with concepts such as Traffic Generators and Environmental Impact Reports. In Guarulhos, the Building Code regulation of 2005 defined different types of PGTs according to building size, establishing the need for loading/unloading areas according to land use by the traffic generator. For example, shopping centers between 1000 and 2000m^2 were considered mini generators, requiring two bays for freight operations. Land uses considered non-impacting (non-generators of traffic) could also be bound to allocate space for loading and unloading, as illustrated by the requirement of truck freight yards, with unspecified dimensions, for commerce and service facilities sized above 500 m^2. The cities Cajamar, Barueri and Franco da Rocha had similar requirements for truck parking necessary in industries, warehouses, non-retailer commercial activities and similar uses, establishing the need for one loading and unloading bay in premises with less than 400 m^2 occupied by buildings, with a minimum of one bay for any premises below 400 m^2. Barueri published this rule in 1993, while Cajamar and Franco da Rocha included it in their Building Codes in the 2000s.

5.2. Relation of Urban Attributes and UFT in SPMA

5.2.1. Population

During the 1980s, truck traffic and weight restrictions emerged in the cities Cajamar, Francisco Morato and Franco da Rocha (North sub-region of SPMA), Ribeirão Pires and São Caetano do Sul (Southeast of SPMA), and Guarulhos and Mogi das Cruzes (East sub-region of SPMA). The population of these cities from 1950 until 2010 is presented in Table 6 and their percentual change.

Table 6: Population evolution from 1950 to 2010 for cities with either TTR or WRs in the 1980s

	1950	1960	1970	1980	1991	2000	2010
Cajamar	-[1]	6,438	10,440	21,941	33,495	50,568	63,989
%growth	-	-	62%	110%	53%	51%	27%
Francisco Morato	26,262[2]	27,930[2]	11,210	28,462	82,276	133,143	154,287
Franco da Rocha			36,391	50,710	84,912	107,883	131,389
Combined %growth[2]	-	6%	70%	66%	111%	44%	19%
Ribeirão Pires	-[3]	21205	29,117	56,487	84,529	104,305	112,994
%growth	-	-	37%	94%	50%	23%	8%
São Caetano do Sul	60,200	114,421	150,171	163,030	149,436	140,241	149,185
%growth	-	90%	31%	9%	-8%	-6%	6%
Guarulhos	35000	101000	237000	532726	781895	1069609	1220653
%growth	-	189%	135%	125%	47%	37%	14%
Mogi das Cruzes	30243	100194	138749	198081	271981	329653	387260
%growth	-	231%	38%	43%	37%	21%	17%
Santana de Parnaiba	10,556	5,244	5,428	10,070	36,848	74,343	108,474
%growth	0%	-50%	4%	86%	266%	102%	46%

[1] Cajamar became an autonomous city in 1959.
[2] Franco da Rocha had Francisco Morato as a district before its emancipation in 1964.
[3] Ribeirão Pires was emancipated in 1953.

Most cities in Table 6 show high growth contextualizing São Paulo urban sprawl, increasing the demand for UFT, leading to restrictions mostly regarding large vehicles in the city center (Cajamar, Francisco Morato, Guarulhos and Mogi das Cruzes) or within the urban tissue (Franco da Rocha and later Francisco Morato). The restriction of trucks in Ribeirão Pires (over 10t) in 1986 came about as its streets were used as an alternative route from a blocked stretch of the SP-31, which cut through the city close to its central area. In the early 1990s, the municipality prohibited the circulation of trucks with net loads over 2t. Truck loading and unloading had already been restricted in some city center streets in 1973, leading to changes during the 1980s to implement OnSPL management while keeping dedicated bays for L/U.

São Caetano do Sul decreased its population and industrialization between 1980 and 1991. Therefore, the TTR in the central perimeter in 1989, published as an additional requirement to establish L/U windows, cannot be connected to an increase in demand for UFT due to population growth. As previous regulations (1977 and 1983) mentioned vacancies for L/U within the parking meter areas, the municipal administration may have sought to compensate for the loss of tax revenue resulting from a reduction in industrial activity. The increased relevance of the service sector may also have led to more significant traffic of people and goods in the city, resulting in the need to control freight vehicle traffic.

The highest population growth in this set of cities is in Santana de Parnaíba, from 1980 to 1991. The only regulation on heavy vehicles consisted of L/U time windows created in 1990 to comply with historical site preservation requirements. The city kept growing fast during the 1990s and, by 2005, started a new set of rules to restrict truck circulation.

During the 1990s, Mairiporã, Poá, and Rio Grande da Serra restricted large vehicles in the same year as the Brazilian Traffic Code, 1997, and São Caetano do Sul had an experimental license plate rotation program in 1998. The population increased by 56% in Mairiporã and around 30% in Poá and Rio Grande da Serra between 1991 and 2000 when the census took place. They all had a population growth of around 45% in the previous decade, except for São Caetano do Sul. The increased number of inhabitants is aligned with a growing UFT demand, but as the case of São Caetano do Sul shows, it is not the only factor involved in the emergence of UFT measures.

5.2.2. GDP

Kin, Verlinde and Macharis (2017) enumerates GDP as an indicator related to the demand side of the UFT model. Thus, we consider other data for 2002 and 2018 not available in the previous years. Therefore, we selected the cities with the highest GDP growth rate, as shown in Table 7.

Seventeen cities created regulations to control heavy vehicle circulation during the 2002-2020 period (and possibly more). Table 7 shows nine of them among the highest growing economies of SPMA either from 2002 to 2010 or from 2010 to 2018, with five making the top 10 list in both periods. Only two cities among the fastest-growing cities did not restrict truck traffic in the first period: Ferraz de Vasconcelos and Embu das Artes. In the second period, five cities form the group without differences in the city number, with measures in each group suggesting a lag between what causes the elevation in the indicator and the emergence of UFT initiatives. Embu das Artes absence of regulations

would point to other factors affecting the administrator's decision to constrain freight vehicles' circulation. However, the IPTC (2019) mentions some restrictions in the city, although the regulation does not indicate this.

Table 7: Top 10 cities by GDP average annual growth between 2002-2010 and 2010-2018

2002-2010		2010-2018	
City	**GDP growth/yr**	**City**	**GDP growth/yr**
Itapevi[(1)]	23%	Arujá[(1)]	16%
Pirapora do Bom Jesus[(1)]	20%	Cajamar[(1)]	15%
Ferraz de Vasconcelos	19%	Embu das Artes	15%
Arujá[(1)]	17%	Itapevi[(1)]	11%
Osasco[(1)]	17%	Vargem Grande Paulista	11%
Embu das Artes	17%	Biritiba Mirim	11%
Cajamar[(1)]	16%	Itaquaquecetuba	11%
Cotia[(1)]	15%	Caieiras[(1)]	10%
Caieiras[(1)]	15%	Santana de Parnaíba[(1)]	9,5%
Itapecerica da Serra[(1)]	15%	Jandira	9,2%

Source: SEADE (2020).
[(1)]Cities that limited circulation of heavy vehicles between 2002 and 2018.

5.2.3. Fleet

An increase in the truck fleet without improvements in the infrastructure can lead to accelerated wear and tear and motivate restrictions, considering the selected cities (Table 8).

Table 8: Top 10 cities by average growth/year of the truck fleet per 100 people

2002-2010		2010-2018	
City	**Growth/yr**	**City**	**Growth/yr**
Ribeirão Pires	20.4%	Rio Grande da Serra	10.9%
Juquitiba[(1)]	12.0%	Itaquaquecetuba	6.6%
Carapicuíba	11.2%	Embu-Guaçu	5.7%
Guararema[(1)]	11.2%	Ferraz de Vasconcelos	5.4%
Barueri[(1)]	10.1%	Guararema[(1)]	5.1%
Ferraz de Vasconcelos	9.8%	Salesópolis	4.8%
Embu-Guaçu	9.3%	Pirapora do Bom Jesus[(1)]	4.7%
Embu das Artes	8.7%	Suzano[(1)]	4.4%
Osasco[(1)]	8.6%	Biritiba-Mirim	4.4%
Santa Isabel	7.8%	Mairiporã[(1)]	4.2%

Source: SEADE (2020).
[(1)]Cities that limited circulation of heavy vehicles between 2002-2018.

5.3. Discussion of the propositions

We devised three propositions, from which we address the first two together since they complement each other:

Proposition 1: Observable and measurable externalities of truck traffic in urban areas is why governance measures restrict their circulation.

Proposition 2: The urban area's observable and measurable characteristics, such as demographics, are the implicit drivers behind the emergence of governance measures restricting truck circulation.

Historically, public authorities did not use data in SPMA cities nor discuss with stakeholders to adopt measures, except for São Paulo and other cities in recent years. Although Holguin-Veras et al. (2018) pointed out that public decision-makers have difficulties in identifying effective measures due to the lack of data, cross-referencing the collected data shows little evaluation. In addition, cross-referencing the data reveals that such decision-makers may not assess the situation before creating rules in an objective and detailed way, focusing on the consequences for the various stakeholders. Revising the norms confirms that the residents park their trucks or transport their own production, indicating that the decision-maker had minimal knowledge of the reality of the population. This also supports Quak's (2008) proposition that UFT policies generally emerge from problems rather than objective evaluation. The exception concerns significant undertakings such as the ring road, for which detailed studies are available. The ring road focused on reducing congestion, mainly in freight vehicles, but also contributed to reducing externalities (accidents, pollution) in the SPMA.

With few exceptions, most cities with high population, consequently more demand for transport services, present more measure for traffic regulations. Most cities focus on infrastructure (on-street parking and un/loading areas) and governance (truck traffic control, time-windows), and few focus on equipment or other infrastructure and governance measures like preferred routes and ring roads. These results are aligned with Kiba-Janiak (2017) and Dias et al. (2020). Interestingly, the cities with the considerably increased fleet in the last years usually have low adoption of measures. GDP appears to be slightly related to the increasing of measures.

Proposition 3: UFT actions have effects on surrounding municipalities.

SPMA cities managed UFT locally, even if some efforts existed in the Greater ABC cities to coordinate actions. In Brazil, the background for penalties for non-compliant drivers is established, and the authorization to regulate their traffic exists in the national traffic laws. We observed that the vehicles waiting for inbounding roadways to approach São Paulo are the main consequence of the restrictions adopted by the city. Taboão da Serra had to implement the same restriction to avoid affluent truck traffic, consistent with Quak (2008) and McLeod et al. (2019).

Moreover, we found that three types of regulations have been historically created to address UFT: off-street L/U, on-street, and restrictions to traffic. As the land occupation in the urban environment intensified, administrations made the first efforts to avoid that L/U would happen in the streets, requiring some types of buildings to have an area for loading and unloading. In the absence of regulation, the public space would be used in the interest of service undertakings. Thus, we consider that the lack of planning for L/U space in service facilities, also characterized by small commercial facilities, influenced the congestion observed in central areas. The dispute over road space becomes clear when we consider the need to manage loading and unloading areas and parking on the road for all vehicles, leaving aside the management of L/U areas for cargo vehicles.

Table 8 indicates that the truck fleet grew slower from 2010 to 2018 compared to the previous period. Seven cities out of the 17 presented restrictions on heavy vehicles on their roads between 2002 and 2018. Biritiba-Mirim adopted restrictive measures that

were not enacted as regulations and not published in the legislation. However, most cities with the fastest-growing truck fleet did not have prohibitions until 2020, or they seem not to be in force, which is the case of Ribeirão Pires and Rio Grande da Serra. That suggests a preference for cities without restrictions to install transportation premises. Indeed, Guerin et al. (2021) data show that many cities in Table 8 attracted warehouses and/or carriers, accounting for at least part of the truck fleet increase. For example, this is not the case, though, for Juquitiba and Ferraz de Vasconcelos. In December 2020, almost 77% of registered carriers corresponded to individual contractors, owning around 38% of the transport vehicles fleet (ANTT, 2021).

5.4. Further considerations

Therefore, the rules that organize truck traffic and impact UFT in the SPMA change significantly between cities. Only three cities adopted aligned rules: Osasco, Taboão da Serra, and São Paulo. The city of Taboão da Serra had to face the effects of restrictions imposed in the city of São Paulo. The first ban in the SPMA, in 1970, sought to avoid the damage caused by trucks that deviated from weight inspections when leaving São Paulo; Arujá implemented urban tolls operated to charge vehicles leaving the main highway to avoid interstate tolls. These are examples of the issue mentioned by McLeod et al. (2019): freight transport policies go beyond the boundaries of local planning jurisdiction.

In most cases, however, UFT measures are conditioned by the urban planning paradigm and perceiving the nuisance. This is demonstrated by the fact that most cities restrict L/U and/or circulation in central areas, as they concentrate the movement of people during the day and are more densely occupied. However, there is no data to confirm whether this initiative increases security - several mentions banning freight vehicles to reduce congestion, although passenger vehicles significantly contribute to congestion. Regarding the paradigm shift, the current urban mobility plans include the transportation of goods in their texts; however, this does not mean that cities have evaluated their current situations and created plans to effectively address the problems, as there is an example of a set formed by three cities that have precisely the same writing on their PlanMobs.

Considering Lindholm´s (2012) approach to UFT measures as “tested solutions”, only four cities would have adopted UFT measures: Santana de Parnaíba, Barueri, Arujá, and São Paulo. These cities had pilot programs before the rules were applied, although only São Paulo published ex-post evaluations presenting data as a test. Cities exemplify the relationship between measures and economic development, as we note the emergence of regulations associated with GDP growth in these cities.

6. CONCLUSIONS

We conclude that the off-street unloading/loading and restrictions to traffic are the first and the most common measures implemented by the cities in SPMA over the years. The infrastructure and governance are the most adopted measures by the cities, while the equipment measures and high-cost infrastructure measures are adopted by a few ones. Most cities with high population growth also increase the demand for UFT, leading to

restrictions regarding large vehicles in the city center. However, most cities (nearby São Paulo city) with the fastest-growing truck fleet appear not to invest in the truck restriction; usually, these cities attract warehouses and/or carriers from where the delivery is in São Paulo city.

Our investigation also shows that observable and measurable externalities of truck traffic in urban areas are not the main reason for governance measures restricting their circulation. Instead, some characteristics of the urban area are the implicit drivers that lead to restrictions when the nuisance needs to be quickly addressed. So, this study can provide insights for SPMA on what can be improved for its future development, considering its social and economic heterogeneities. We also conclude that public policies have not been coordinated among cities and that most measures are not assessed before implementation.

For public decision-makers, we recommend UFT management training. We advise more significant consideration for L/U parking near shopping centers to safely foster economic activity for small commercial facilities, allowing hired drivers to park more easily. We also recommend searching for alternative vehicles (such as cargo bikes) and more innovative solutions through automatically guided vehicles.

Most cities do not provide open access to them on the world wide web. However, they can be obtained in the context of the Information Access Law (Lei de Acesso à Informação) or consulted in the official diaries. The unavailability of city hall and administrative subdivision ordinances or '*portarias*' is a limitation of this study, meaning that some UFT measures might not have been identified even if in place. Another limitation is using datasets compiled for the SPMA; however, additional and specific information may be restricted in individual city files. As such, an investigation would require extensive data collection and could involve physical Collection, and we did not include this in the study.

We recommend that future research focus on the results of UFT measures and their sustainability, and their impacts on individual third-party drivers: are they more affected by penalties on loading and unloading? How well are they informed on restrictions? We suspect that the characteristics of the work market of truck drivers in Brazil are unique and that more needs to be done regarding the economic impacts of this scenario.

REFERENCES

ANTT (2021) Registro nacional de transportadores rodoviários de cargas. Available at: <https://portal.antt.gov.br/rntrc> (accessed 05/08/2023).

Behrends, S. (2011) *Urban Freight Transport Sustainability the Interaction of Urban Freight and Intermodal Transport*. Theses (Ph.D.). Department of Technology Management and Economics, Chalmers University of Technology, Gothenburg. Available at: <https://publications.lib.chalmers.se/records/fulltext/150735.pdf [[Q1: Q1]]> (accessed 05/08/2023).

Dablanc, L. and M. Browne (2019) Introduction to special section on logistics sprawl, *Journal of Transport Geography*, v. 88, p. 102390. DOI: 10.1016/j.jtrangeo.2019.01.010.

Dias, J.M.; G.B. Sobanski; J.E.R. Silva et al. (2018) Are Brazilian cities ready to develop an ef8icient urban freight mobility plan, *Urbe. Revista Brasileira de Gestão Urbana*, v. 10, n. 3, p. 587-99. DOI: 10.1590/2175-3369.010.003.ao07.

Dias, J.M.; J.G.V. Vieira; J.E.A. da Silva et al. (2020) Os PlanMobs têm contemplado o transporte urbano de carga, *Transportes*, v. 28, n. 3, p. 103-20. DOI: 10.14295/transportes.v28i3.1887.

EMPLASA (2021) Expansão da Área Urbana da Região Metropolitana de São Paulo. Available at <http://www.igc.sp.gov.br/produtos/arquivos/ExpansaoDaAreaUrbanizadaDaRmspAte2002.pdf> (accessed 05/08/2023).

Ewbank, H.; J.G.V. Vieira and J. Fransoo (2020) The impact of urban freight transport and mobility on transport externalities in the SPMR, *Transportation Research Procedia*, v. 46, p. 101-8. DOI: 10.1016/j.trpro.2020.03.169.

Guerin, L.; J.G.V. Vieira; R.L.M. Oliveira et al. (2021) The geography of warehouses in the São Paulo Metropolitan Region and contributing factors to this spatial distribution, *Journal of Transport Geography*, v. 91, p. 102976. DOI: 10.1016/j.jtrangeo.2021.102976.

He, J.; N. Gouveia and A. Salvo (2019) External effects of diesel trucks circulating inside the Sao Paulo megacity, *Journal of the European Economic Association*, v. 17, n. 3, p. 947-89. DOI: 10.1093/jeea/jvy015.

Holguín-Veras, J.; J. Amaya Leal; I. Sanchez-Diaz et al. (2018) State of the art and practice of urban freight management: Part I: infrastructure, vehicle-related, and traffic operations, *Transportation Research Part A, Policy and Practice*, v. 137, p. 360-82. DOI: 10.1016/j.tra.2018.10.037.

Holguín-Veras, J.; J. Amaya-Leal; J. Wojtowicz et al. (2015) *Improving Freight System Performance in Metropolitan Areas: A Planning Guide*. Washington, DC: Transportation Research Board. DOI: 10.17226/22159.

IBGE (2020) Available at: <https://www.ibge.gov.br/> (accessed 05/08/2023).

IPTC (2019) Restrições de Circulação na GRMSP: Veículos de Carga - Versão 2.0. Available at: <http://iptcsp.com.br/restricoes-de-circulacao-de-veiculos-de-carga-na-grmsp/> (accessed 05/08/2023).

Kiba-Janiak, M. (2017) Urban freight transport in city strategic planning, *Research in Transportation Business & Management*, v. 24, p. 4-16. DOI: 10.1016/j.rtbm.2017.05.003.

Kin, B.; S. Verlinde and C. Macharis (2017) Sustainable urban freight transport in megacities in emerging markets. *Sustainable Cities and Society*, v. 32, p. 31-41. DOI: 10.1016/j.scs.2017.03.011.

Krippendorff, K. (2004) *Content Analysis: An Introduction to Its Methodology* (3rd ed.). Thousand Oaks: SAGE.

Lagorio, A.; R. Pinto and R. Golini (2016) Research in urban logistics: a systematic literature review. *International Journal of Physical Distribution & Logistics Management*, v. 46, n. 10, p. 908-31. DOI: 10.1108/IJPDLM-01-2016-0008.

Letnik, T.; M. Marksel; G. Luppino et al. (2018) Review of policies and measures for sustainable and energy efficient urban transport, *Energy*, v. 163, p. 245-57. DOI: 10.1016/j.energy.2018.08.096.

Lindholm, M. (2012) How local authority decision makers address freight transport in the urban area. *Procedia: Social and Behavioral Sciences*, v. 39, p. 134-45. DOI: 10.1016/j.sbspro.2012.03.096.

Mcleod, S.; J.H.M. Schapper; C. Curtis et al. (2019) Conceptualizing freight generation for transport and land use planning: a review and synthesis of the literature. *Transport Policy*, v. 74, p. 24-34. DOI: 10.1016/j.tranpol.2018.11.007.

NOVELOG (2019) Initiatives in sustainable city logistics. New cooperative business models and guidance for sustainable city logistics. Available at: <https://civitas.eu/projects/novelog> (accessed 05/08/2023).

Oliveira, C.; M.B.R. Albergaria; G.G. Vasconcelos et al. (2017) Sustainable vehicles-based alternatives in last mile distribution of urban freight transport: a systematic literature review. *Sustainability*, v. 9, n. 8, p. 1324. DOI: 10.3390/su9081324.

Quak, H. (2008) *Sustainability of Urban Freight Transport Retail Distribution and Local Regulations in Cities*. (Dissertation). Erasmus Research Institute of Management (ERIM), Erasmus University Rotterdam, Rotterdam. Available at: <https://repub.eur.nl/pub/11990/EPS2008124LIS9058921543Quak.pdf [[Q2: Q2]]> (accessed 08/05/2023).

Ruesch, M. (2004) Road pricing and urban freight transport: practices and developments from the BESTUFS project. In Brebbia, C.A. and L.C. Wadhwa (eds.) *Urban Transport X* (vol. 75). Southampton: WIT Press, p. 895-904.

Russo, F. and A. Comi (2011) Measures for sustainable freight transportation at urban scale: expected goals and tested results in Europe, *Journal of Urban Planning and Development*, v. 137, n. 2, p. 142-52. DOI: 10.1061/(ASCE)UP.1943-5444.0000052.

SEADE (2020) *Perfil dos Municípios Paulistas.* São Paulo: Portal de Estatísticas do Estado de São Paulo, Fundação Sistema Estadual de Análise de Dados. Available at: <http://www.perfil.seade.gov.br/#> (accessed 05/08/2023).

SINDIPEÇAS (2020) *Relatórios Estatísticos: Frota de Veículos*. São Paulo: SINDIPEÇAS. Available at: <https://www.sindipecas.org.br/sindinews/Economia/2020/RelatorioFrotaCirculante_Abril_2020.pdf> (accessed 05/08/2023).

Taniguchi, E. and R.G. Thompson (2015) Introduction. In E. Taniguchi e R.G. Thompson (eds.) *City Logistics Mapping The Future* (p. 1-12) Boca Raton: CRC Press.

Taniguchi, E.; R.G. Thompson; T. Yamada et al. (2001) Introduction. In E. Taniguchi (ed.) *City Logistics*. Amsterdam: Pergamon, p. 1–15. DOI: 10.1108/9780585473840-001.

UN (2019) *World Urbanization Prospects: The 2018 Revision*. New York: United Nation.

Vieira, J. and J. Fransoo (2015) How logistics performance of freight operators is affected by urban freight distribution issues, *Transport Policy*, v. 44, p. 37-47. DOI: 10.1016/j.tranpol.2015.06.007.

Vieira, Y.E.M.; F.D.R. Francisco; R.A.D.M. Bandeira et al. (2021) Iniciativas do poder público para o transporte urbano de carga: perspectivas de impacto no cenário brasileiro. *Urbe. Revista Brasileira de Gestão Urbana*, v. 13, p. 13. DOI: 10.1590/2175-3369.012.e20200034.