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Analysis of problems and solutions for urban freight transport in Brazilian cities

Analiza problemów miejskiego transportu towarowego i rozwiązań stosowanych w brazylijskich miastach

Abstract

This paper analyzes problems and solutions of urban freight transport in six cities of different sizes and economic profile in the State of Minas Gerais, Brazil. The data were collected in commercial establishments and analyzed through descriptive statistics and using the method of successive intervals. The results obtained reflect the retailers' point of view and indicate that the problems and solutions are different in each city considered in this paper. The availability of unloading zones is the main problem in Betim, Belo Horizonte, Contagem and Itabira. The off-peak delivery is viewed as a solution in Divinópolis, Betim and Itabira. Therefore, with no possibility to determine a single remedy as a broad national solution to urban freight transport, it is instead necessary to investigate the realities of each city so that the policymakers could implement local solutions that reduce the externalities of urban freight transport.

Key words:

urban freight transport; retailers; problems and solutions

Streszczenie

W artykule przeanalizowano problemy miejskiego transportu towarowego i związane z tym rozwiązania stosowane w sześciu brazylijskich miastach różnej wielkości i o różnym profilu ekonomicznym, zlokalizowanych w stanie Minas Gerais. Dane do badań zbierano w placówkach handlowych i analizowano za pomocą statystyk opisowych oraz metodą kolejnych interwałów. Uzyskane wyniki odzwierciedlają punkt widzenia detaliści i wskazują, że problemy poszczególnych miast nie są jednakowe, podobnie jak potencjalne rozwiązania. Dostępność stref rozładunku jest głównym problemem w miastach Betim, Belo Horizonte, Contagem i Itabira. Natomiast dostawy poza godzinami szczytu są postrzegane jako rozwiązanie w Divinópolis, Betim i Itabira. Nie ma możliwości określenia jednego środka zaradczego jako szerokiego krajowego rozwiązania dla miejskiego transportu towarowego. Zamiast tego konieczne jest zbadanie realiów każdego miasta, aby decydenci mogli wdrożyć lokalne rozwiązania, które złagodzą efekty zewnętrzne miejskiego transportu towarowego.

Słowa kluczowe:

miejski transport towarowy, detaliści, problemy i rozwiązania

JEL: R41, R58

Introduction and background

The urban freight, being an essential condition for the economic exchanges between spatially dispersed places, plays pivotal role in performance of a region, in sustaining the population's lifestyle and in maintaining the competitiveness of industrial and commercial activities. It is vital for modern society to have the products available in the right place and at the right time (Dablanc, 2007; Dell'Ollio *et al.*, 2017; Kin *et al.*, 2017; Rodseth, 2017).

Currently in Brazil 86% of the population lives in urban areas and this percentage is expected to reach 91.1% by 2030. The growth of the urban population increases the demand for goods, and, consequently, the freight movements in the city (Comi and Nuzzolo, 2016). In this context, an efficient urban transport system is fundamental (Kijewska, 2016; Kijewska *et al.*, 2016). Also, the externalities of this activity need to be known and monitored in order to ensure both the efficiency in the operation of the business and in the population's quality of life. Despite this, urban freight transport planning is not widely discussed in the cities (Cui *et al.*, 2015).

In Brazil, the Federal Law 12,587/2012 establishes the obligation to create urban mobility plans in cities with more than 20,000 inhabitants, considering the characteristics of transport modes and the infrastructure to move both people and cargo. Despite this requirement, the data to understand the urban freight transport system is still scarce in Brazilian cities. Similarly, Brazilian municipalities have struggled in incorporating the cargo into urban mobility plans due to poor knowledge in the area among policymakers (Dias *et al.*, 2018).

According to Kin *et al.* (2017), local authorities are responsible for implementing measures to regulate freight transportation in urban areas. These measures are often considered as failures because they do not achieve the principal objective and, sometimes, produce adverse effects. One of the main reasons for this is that prior to implementation, the interests of the different actors involved in and impacted by urban logistics are not sufficiently taken into account in the decision-making process (Stathopoulos *et al.*, 2012; Bjerkan *et al.*, 2014; Witkowski & Kiba-Janiak, 2014; Milan *et al.*, 2015; Dell'Ollio *et al.*, 2017; Holguín-Veras *et al.*, 2017a, b).

Instead, to learn about the issue of urban freight transport in order to implement sustainable solutions is essential to minimize its negative externalities without harming the economy and the quality of life in our cities. Therefore, to identify who are the actors involved in city logistics and to understand their preferences and perceptions is indispensable to create and implement effective public policies capable of ensuring sound operation of this sector (Holguín-Veras *et al.*, 2017a, b). Stathopoulos *et al.*

(2012) stated that the failure to consider particular problems of the stakeholders involved in city logistics compromises the successful introduction of innovative urban transport policies.

The main stakeholders involved in urban logistics are the retailers, shippers, transporters, population and government (Taniguchi *et al.*, 2001; Tamagawa *et al.*, 2010; Anand *et al.*, 2012; Stathopoulos *et al.*, 2012; Milan *et al.*, 2015). Among these, the retailers play an important role since their behavior directly affects the results of urban freight transport. The participation of retailers in the discussion of city logistics solutions is fundamental to avoid failure of these initiatives. Also, they are more resistant to any innovation related to city logistics than other players in the goods delivery chain (Van Duin *et al.*, 2010; Taniguchi *et al.*, 2016; Oliveira & Oliveira, 2016).

In this context, our research questions are as follows: "Are the urban freight transport problems and solutions similar for different cities?" and "Could we generalize the solutions for urban freight transport to the Brazilian reality?" To answer these questions, the problems and solutions for urban freight transport were analyzed in six Brazilian cities: Betim, Belo Horizonte, Contagem, Divinópolis, Itabira and Nova Lima. Each of these cities have different demographic and economic characteristics that can impact in various ways the perception of problems and solutions related to urban freight transport (UFT). We intended to identify patterns (if existing) for the problems and solutions associated with UFT in the analyzed cities from the retailer's point of view. This study is complementary to Furquim *et al.* (2018) and Oliveira *et al.* (2018a).

Research Approach

The data was collected through presential interview in commercial establishments located in the city center of each of the above-mentioned cities. We used the questionnaire proposed by Furquim *et al.* (2018) and adapted by Oliveira *et al.* (2018a). The problems and solutions evaluated are:

- Problems:
 - availability of unloading zones (unloading);
 - movement of goods from the parking area to the commercial establishment (movement);
 - transit of vehicles in the delivery operation (transit);
 - flexibility in the delivery time (flexibility).
- Solutions
 - off-peak delivery (off-peak);
 - monetary incentive to off-peak delivery (incentive);

- regulation of unloading zones (regulation);
- restriction to freight vehicles (restriction).

Further details on the questionnaire can be obtained in Oliveira *et al.* (2018a).

The commercial establishments in the central area of these cities were visited and their respective owners or responsible employees were invited to participate in the research.

We analyzed the data using measures of central tendency like median, mode, and quartiles. These measures reveal the importance of the problem/solution as evaluated from the point of view of the interviewed.

Also, the correlation between the problems and solutions were analyzed through the Spearman correlation. Finally, using the method of successive intervals, the problems and solutions were ranked in terms of importance, based on the opinions collected. The method of successive intervals identifies the importance of each problem and solution analyzed, being a simple application method to prioritize problems and solutions. Providelo and Sanches (2011) provide further details of the technique. Oliveira *et al.* (2018a) also used this method to order problems and solutions of UFT.

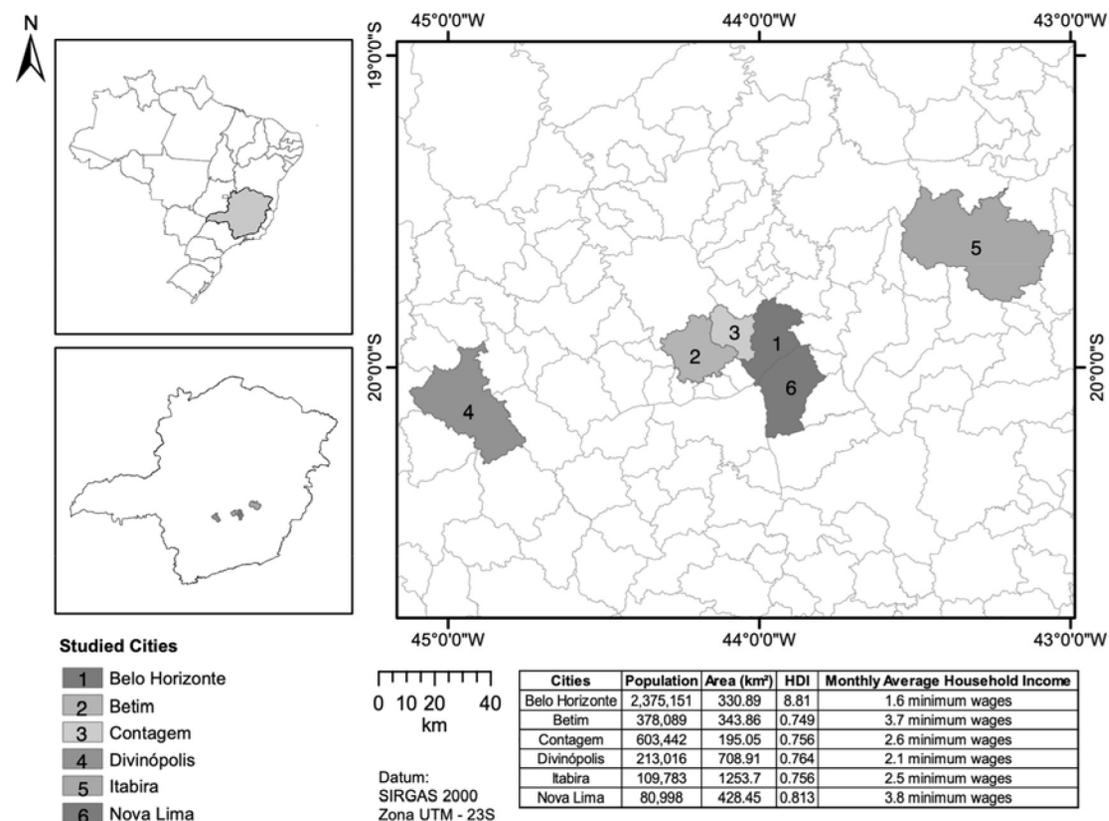
Area of study

Figure 1 illustrates the location of the cities considered in our survey. Belo Horizonte is the capital of the State of Minas Gerais. Betim, Contagem, Nova Lima are comprised in the Metropolitan Region of Belo Horizonte. Itabira is located to the East and Divinópolis to the West of Belo Horizonte. Table 1 also shows some information about these municipalities.

The Brazilian Ministry of Cities created a classification for cities according to the population to suggest roadmaps in order to elaborate adequate urban mobility plans (Brazil, 2015). The classes of the Ministry of Cities are: (i) 20 to 60 thousand inhabitants; (ii) 60 to 100 thousand; (iii) 100 to 250 thousand; (iv) 250 to 500 thousand and, (v) municipalities with a population of more than 500 thousand inhabitants. Obligated to develop urban mobility plans are municipalities with more than 20,000 inhabitants, and others required so by law (as located in metropolitan areas and touristic areas).

In this study, two cities (Belo Horizonte and Contagem) have a 100% urban population exceeding 500 thousand. All cities in the study are required to

Figure 1
Location of cities in Brazil and Minas Gerais State



Source: own study.

Table 1
Socioeconomic information

City	Population	Ministry of Cities Classification (in thousands)	Urban population	HDI	Based economy
Betim	378,089	250–500	99%	0.749	Industry
Belo Horizonte	2,375,151	> 500	100%	0.810	Service
Contagem	603,442	> 500	100%	0.756	Industry
Divinópolis	213,016	100–250	97%	0.764	Industry
Itabira	109,783	100–250	93%	0.756	Industry
Nova Lima	80,998	60–100	98%	0.813	Industry and Service

Source: Brazil, 2008; Brazil, 2015; SEBRAE, 2017.

develop urban mobility plans, including solutions to urban freight transport. Except for Belo Horizonte, the cities' economy is based on industry. The HDI (Human Development Index) is considered elevated in these cities compared with others municipalities in Minas Gerais State (Table 1).

Where the cities have different socioeconomic characteristics, will the problems and solutions for urban freight transport occur similar? The answer to this question will be presented in the next section.

Findings

In this study, 1,050 businesses were interviewed (Table 2). All interviews were held in the central area, except in Belo Horizonte, where the interviews were held in different regions of the city. The different range of the sample (62 to 622) is due to the different size of the central area of each municipality. We tried to interview the maximum number of respondents in each city, except in Belo Horizonte, which we defined a minimum sample of the 384 establishments.

Figure 2 shows the products marketed by the commercial establishments. Predominance of food, beverage and clothing can be observed. In Belo

Horizonte, Contagem and Divinópolis, the number of drugstores is significant indeed (10%, 13% and 14%, respectively).

The descriptive statistics of the problems and solutions related to UFT are presented in Table 3. Regarding the problems, the availability of L/U areas is considered a significant problem in Divinópolis and Nova Lima, since the median value is 8, which indicates that at least 50% of respondents assigned values above 7 for this variable. In Nova Lima (median = 8) the movement of goods is considered a problem. In Divinópolis (median = 7), Betim and Nova Lima (median = 7), the traffic during the delivery operation is considered a problem. Finally, flexibility in the reception hours was not considered to have major impact on the receipt of products by at least 50% of the retailers in Betim (median = 5), Divinópolis (median = 5), and Contagem (median = 3), Nova Lima (median = 2) and Itabira (median = 0).

In relation to the solutions to UFT, off-peak delivery is reckoned a positive solution for urban freight transport in Betim (median = 10). If this solution was incentivized by financial subsidy, the acceptability by retailers would increase, except for Belo Horizonte. Regarding the regulation of unloading zones, retailers from Belo Horizonte and Betim evaluated it positively (median = 9). Also, 50% of retailers attributed an intermediate opinion in Divinópolis and Itabira (medians = 6). However, there is no consensus between the interviewed regarding the 1st quartile = 3. Finally, the restriction on freight vehicles is considered an effective solution for the retailers of Betim (median = 7) and Nova Lima (median = 9).

The correlation of the problems and solution produces interesting highlights:

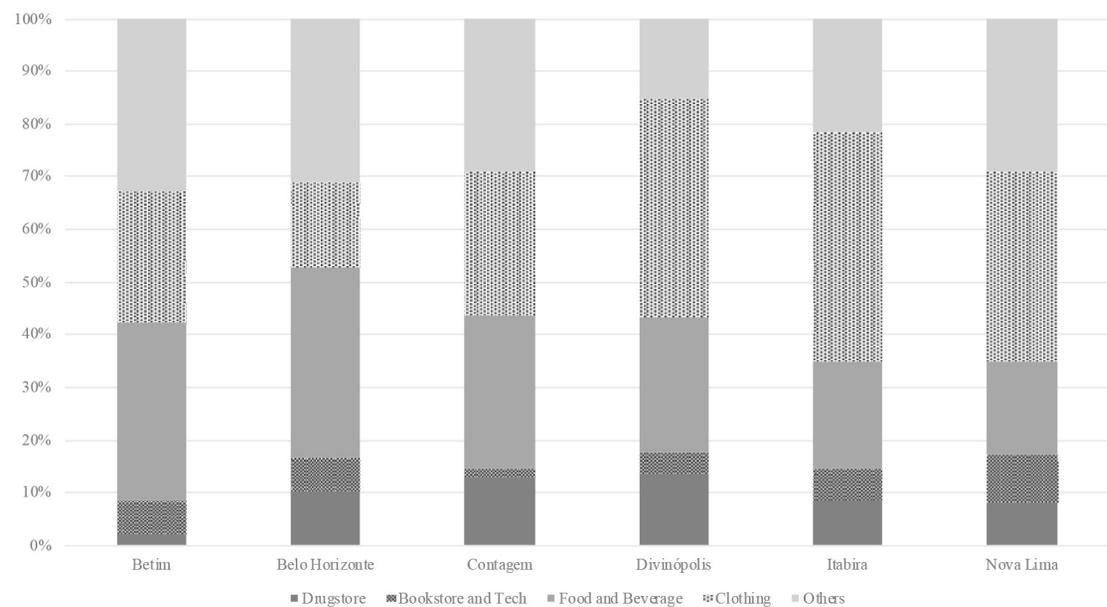
- availability of areas has correlation with the movement of goods in Betim (0.91), Divinópolis (0.54), Itabira (0.64), and Nova Lima (0.80);
- availability of areas has correlation with transit vehicle in the delivery operation in Betim (0.86) and Belo Horizonte (0.52);

Table 2
Sample

City	Sample
Betim	91
Belo Horizonte	622
Contagem	62
Divinópolis	118
Itabira	69
Nova Lima	88

Source: own study.

Figure 2
Products marketed by the commercial establishments



Source: own study.

- movement of goods has correlation with transit vehicle in the delivery operation in Betim (0.92), Contagem (0.54), and Divinópolis (0.55);
- transit vehicle in the delivery operation has a moderate correlation with flexibility in the delivery time in Itabira (0.68).

Considering the results, the financial subsidy to off-peak delivery has correlation with off-peak delivery in Betim (0.64), Belo Horizonte (0.75), and Nova Lima (0.60). This result indicates that retailers hardly accept measures developed in terms of city logistics. Problems persist but solutions applied cannot change the current dynamic of the business activity.

Table 4 presents the results of the analysis of the Method of Successive Intervals (MSI). For the retailers of Betim, Belo Horizonte, Contagem and Itabira, the main problem in urban freight transport is the availability of areas (scale = 1.00). The movement of goods is seen as serious problem (scale = 1.00) in Divinópolis, but is considered irrelevant by the retailers of Itabira (scale = 0.00). In Nova Lima, vehicular transit in the delivery operation was considered a serious problem (scale = 1.00).

The retailers' perception of the solutions to UFT indicated that off-peak delivery is a positive solution in Betim (scale = 0.86), Divinópolis and Itabira (scales = 1.00). Also, the retailers of Betim and Itabira (scales = 1.00) consider this an interesting solution if supported by a financial incentive to off-peak delivery. The regulation of unloading zones is perceived as positive in Belo Horizonte, Itabira and Nova Lima (scale = 1.00). Finally, the restriction to

the freight vehicles is an efficient solution in Betim (scale = 0.71), Belo Horizonte, (scale = 0.94) and Contagem (scales = 1.00).

Discussion

The discussion focuses on the research approach, problems and solutions. Regarding the research approach, the data were easy to collect, and the method can be replicated to other cities. Similar to the results obtained by Oliveira *et al.* (2018a), the problems and solutions analyzed include those that can be implemented in the Brazilian context. Also, they provide a perspective on where the planning of the UFT in Brazilian cities should start from.

Regarding the problems, the availability of unloading zones is reckoned a problem in three of the six cities studied. When analyzing the correlation of the retailers' perception, availability of these places presents correlation with the traffic of vehicles in four of the six cities and correlation with the movement of goods — in three cities.

Regarding solutions to UFT, off-peak delivery is considered a promising solution for retailers in Divinópolis and, with financial incentive, finds positive acceptance from the retailers in Betim and Itabira. The regulation of the unloading zones is considered the best solution by the retailers of Belo Horizonte and Nova Lima. The restriction of freight vehicles is considered a solution to UFT only in Contagem.

Table 3

Descriptive statistics of the problems and solutions related to UFT

Problems	Statistics	Betim	Belo Horizonte	Contagem	Divinópolis	Itabira	Nova Lima
Unloading zones	Mode	0	10	0	10	0	8
	1 st quartile	0.5	3	1	5	0	7
	Median	7	8	5.5	8	3	8
	3 rd quartile	9	10	9	10	5	9
Movement of goods	Mode	0	10	5	0	0	8
	1 st quartile	0	0	0	0	0	6
	Median	6	4	5	5	0	8
	3 rd quartile	8.5	7.5	8	9	5	9
Transit of vehicles in delivery operation	Mode	8	0	5	10	0	8
	1 st quartile	5	4	2	5	0	6
	Median	7	7	5	8	0	7
	3 rd quartile	8	9	8	10	5	8
Flexibility in the delivery time	Mode	5	0	0	0	0	2
	1 st quartile	2.5	0	0	0	0	1
	Median	5	4	3	5	0	2
	3 rd quartile	7.5	7	5	7.75	4	2
Solutions	Statistics	Betim	Belo Horizonte	Contagem	Divinópolis	Itabira	Nova Lima
Off-peak delivery	Mode	10	0	0	0	0	2
	1 st quartile	9	0	0	0	0	1
	Median	10	0	1	0	0	2
	3 rd quartile	10	5	5.75	0	0	3
Incentive to off-peak delivery	Mode	10	0	0	0	10	8
	1 st quartile	5	0	0	0	0	3
	Median	9	2	0.25	9	9	7
	3 rd quartile	10	6	7	10	10	8
Regulation of unloading zones	Mode	10	10	0	0	10	2
	1 st quartile	6.5	7	2	3	3	2
	Median	9	9	4	6	6	3
	3 rd quartile	10	10	6.75	10	10	4
Restriction to urban freight vehicles	Mode	10	0	10	10	0	10
	1 st quartile	5	0	2	0	0	7.25
	Median	7	5	6	0	0	9
	3 rd quartile	9	7	9	5	5	10

Source: own study.

Therefore, off-peak delivery could be an alternative especially to retailers with extended working hours. However, the needs of the industry should be examined in order to identify those whose change of delivery times will not impact the profitability of their businesses. Monetary incentives, which may be in the form of reduced tax burden, can be offered for entrepreneurs participating in the program, who consider reducing the number of freight vehicles in the peak time of the road traffic system.

Also, the regulation of unloading zones can be a solution to minimize the externalities related to

UFT. In this context, Prata *et al.* (2018) propose a model to optimize the unloading areas based on the demand of the retailers. Also, areas designated for unloading operations should be compatible with the size of cargo vehicles (Prata *et al.*, 2018). Therefore, municipalities should implement simple and efficient solutions focused on solving the problem and improving urban mobility.

Finally, the restriction to freight vehicles movements in urban areas, despite being a measure suggested by Brazil (2015), cannot be considered a solution since it brings no benefits or reduction of

Table 4
MSI results for problems and solutions

Problems and Solutions	Betim	Belo Horizonte	Contagem	Divinópolis	Itabira	Nova Lima
Problems						
Unloading	1.00	1.00	1.00	0.44	1.00	0.15
Movement	0.65	0.12	0.28	1.00	0.00	0.00
Transit	0.55	0.67	0.57	0.37	0.31	1.00
Flexibility	0.00	0.00	0.00	0.00	0.08	0.16
Solution						
Off-peak	0.86	0.00	0.49	1.00	0.97	0.36
Incentive	1.00	0.90	0.35	0.54	1.00	0.00
Regulation	0.00	1.00	0.00	0.00	0.00	1.00
Restriction	0.71	0.94	1.00	0.08	0.04	0.60

Source: own study.

externalities for urban freight transport. The restriction of freight vehicle causes changes in the profile of the fleet. When combined with other measures, such as low emission zones, it can contribute to the improvement of air quality (Oliveira *et al.*, 2018a). However, this is not yet a concern of the Brazilian rulers, because, in general, the restriction is implemented to improve fluidity for private vehicles and/or road safety. In this sense, the restriction to freight vehicle, in the Brazilian context, is not a sustainable solution to UFT and need to be implemented with caution in order to avoid creation of new problems (for example, increased number of small freight vehicles).

The results presented in this paper are complementary to Oliveira *et al.* (2018a) and show

that a sustainable urban freight transport is still a long and challenging way in Brazil. Divergent viewpoints among stakeholders in cities show that no solution can be considered as a broad national public policy. In this sense, what is necessary is more convergence in terms of solutions that are easy and efficient to implement in order to reduce the externalities of UFT. One solution is efficient when it brings benefits to all stakeholders, and, consequently, brings sustainability to urban freight transport.

We suggest to analyze the urban freight mobility plans of these cities (Betim, Belo Horizonte, Contagem, Divinópolis, Itabira and Nova Lima) to relate the guidelines of these plans with the problems/solutions identified in this paper.

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