Scientific Article DOI: 10.1590/2175-3369.012.e20190140

Retailers and carriers' viewpoint on Sorocaba's city logistics: a spatial analysis

Perspectiva dos varejistas e transportadores sobre a logística urbana da cidade de Sorocaba: uma análise espacial

Thales Stevan Guedes Furquim[a], Renata Lúcia Magalhães de Oliveira[b], José Geraldo Vidal Vieira[a]

[a] Universidade Federal de São Carlos (UFSCar), Centro de Ciências em Gestão e Tecnologia (CCGT), Departamento de Engenharia de Produção (DEP-So), Sorocaba, SP, Brasil
[b] Centro Federal de Educação Tecnológica de Minas Gerais, Departamento de Ciências Socias Aplicadas, Belo Horizonte, MG, Brasil

How to cite: Furquim, T. S. G., Oliveira, R. L. M., & Vieira, J. G. V. (2020). Retailers and carriers' viewpoint on Sorocaba's city logistics: a spatial analysis. *urbe. Revista Brasileira de Gestão Urbana*, 12, e20190140. https://doi.org/10.1590/2175-3369.012.e20190140

Abstract

The spatial differentiation of the main constraints and challenges on urban freight transportation can support more assertive public policies and measures, subsidizing city logistics solutions. This paper presents the use of spatial analysis to characterize retailers and carriers' perceptions on the most important constraints and challenges faced during the urban freight delivery in the central area of Sorocaba/SP. To identify possible clustered patterns concerning problems and solutions from the stakeholders' viewpoint, the data were analyzed through two spatial techniques: Average Nearest Neighbors and Getis Gi Ord* Hot Spots analysis. These two methodological approaches provide a spatial concentration analysis. As a result, we determined the spatial patterns of stakeholders' perception for the two groups of variables assessed: (i) the Northwestern portion of Sorocaba's central area is not prepared to receive the demands of vehicles, and the stakeholders present restrictions related to off-peak deliveries; (ii) the Northeastern region has the greatest negative perception regarding the assessed attributes, and shows little evidence that the loading and unloading space is not appropriate.

Keywords: Spatial analysis. Urban freight. Local constraints. Logistical challenges.

Resumo

A diferenciação espacial das principais restrições e desafios referentes ao transporte urbano de carga podem apoiar políticas públicas e medidas mais assertivas, subsidiando as soluções logísticas da cidade. O objetivo deste artigo é apresentar o uso da análise espacial para obter percepções de varejistas e transportadoras sobre as principais restrições e desafios enfrentados durante a entrega de cargas na área urbana central de Sorocaba/SP. Para identificar possíveis padrões agrupados em relação aos problemas e soluções do ponto de vista das partes interessadas, os dados foram analisados por meio de duas técnicas espaciais: Média de vizinhos mais próximos e Getis Gi Ord Hot Spots. Essas duas*

TSGF is bachelor of Production Engineering, e-mail: thalesgfurquim@gmail.com
RLMO is an assistant professor, Graduate Program in Geotechnics and Transportation, e-mail: renataoliveira@cefetmg.br
JGVV is an associate professor, Graduate Program in Production Engineering (PPGEP-So), e-mail: jose-vidal@ufscar.br

abordagens metodológicas fornecem uma análise de concentração espacial. Como resultado, podemos determinar padrões espaciais para os dois grupos de variáveis avaliados: (i) a porção Noroeste da área central de Sorocaba não está preparada para receber as demandas de veículos e as partes interessadas apresentam restrições relacionadas a entregas fora de pico; (ii) a região Nordeste tem a maior percepção negativa em relação aos atributos avaliados e pouca evidência de que o espaço para carga e descarga não seja adequado.

Palavras-chave: *Análise espacial. Frete urbano. Restrições locais. Desafios logísticos.*

Introduction

As urbanization increases, the levels of logistic activities are also enhanced to meet the demand for consumption, mainly in the central areas of the cities. Hence, the intensity of urban movement of goods also increases, generating some externalities such as poor air quality, noise and greenhouse gas emissions (Sekovski et al., 2012; Iwan et al., 2018). Some recent studies state that urban freight distribution contributes to the development of bottlenecks and environmental problems in cities (Betanzo-Quezada et al., 2015). In a complementary way, Carvalho et al. (2019) states that the impact generated by freight movement reduces the attractiveness of urban areas, impairs the quality of life, mobility, and accessibility in these localities. Additionally, Prata et al. (2012) also list some problems, as a result of the urban goods distribution (UGD), namely: (i) increased traffic; (ii) vehicle traffic in areas with inadequate road geometry and structure; (iii) impairment of pedestrian safety; (iv) noise and environmental pollution, through the emission of pollutants from the burning of fossil fuels; and (v) inefficiencies for all actors involved in deliveries.

To mitigate these problems, load distribution systems must evolve to comprehend the interdependence between urban freight distribution and city economy (Betanzo-Quezada et al., 2015). Therefore, it is necessary to implement urban logistics solutions that allow the optimization of delivery activities in urban areas (Taniguchi et al., 2001) concerning last mile delivery – the most expensive part in the distribution system (Ranieri et al., 2018; Cárdenas et al., 2017). For instance, in last mile deliveries, there is a high potential to use pick up points (Ferrucci & Bock, 2014), parcel lockers (Deutsch & Golany, 2018) and crowdshipping (Castillo et al., 2018) to deliver e-commerce purchases. Also, within the context of the activities related to the UGD, it is essential to highlight the spatial context where urban deliveries occur. Significant local restrictions, such as the existence of traffic windows for certain types of vehicles, restrictions on infrastructure, loading and unloading restrictions for certain types of vehicles (capacity of parking spaces) and restriction on unloading for certain types of vehicles based on the time at which the unloading is still happening (Iwan et al., 2018; Taniguchi et al., 1999).

Macário (2007) argue that, because of the lack of a holistic view of the city, the lack of knowledge of the appropriate tools to solve urban logistics problems, and the challenging acceptability of the main actors, local authorities often deny the mandatory attention to problems related to freight distribution in urban areas. Therefore, the collaboration and active participation of local authorities, carriers, and retailers in discussions focusing on improving the UGD are crucial (for instance, see the european projects: C-Liege, 2013; Grass, 2016; Novelog, 2018).

Moreover, characterizing the perception of stakeholders regarding the constraint and challenges related to the urban distribution of goods becomes critical to subsidize knowledge for the public authorities and adopt more effective actions in different cities. Different authors have developed investigations that have the perception of UDG decision makers as the main methodological and phenomenologial focus (Lindholm & Browne, 2013; Marcucci & Gatta, 2017; Serafini et al., 2018; Allen et al., 2018; Bjørgen et al., 2019). Nevertheless, not many studies discuss this approach considering the location of activities as an important attribute for opinion-forming. In Brazil, Furquim et al. (2018) carried out a study in a medium-sized city (Sorocaba-SP/Brazil) to identify the primary constraints and logistical challenges of the region, from the point of view of retailers and carriers operating in the central area of the municipality. Despite that, there is still a shortfall concerning the identification of local concentrations of problems and solutions acceptability in the central district of Sorocaba, disregarding the spatial heteogeneity of the Central Business District of Sorocaba.

Therefore, in this paper, we propose the identification of locational patterns regarding the perception of retailers and carriers about the main constraints and logistical challenges in the central area of Sorocaba through the use of spatial analysis techniques. The segmentation of the territory can be used as a subsidy for proposing more effective public policies and measures, aimed at solving the constraints and mitigating the challenges in different areas of the central region of the city of Sorocaba. Also, the methodological structure proposed for this analysis is an additional contribution of this paper, since it can support guidelines that enable (i) the spatial differentiation of phenomena related to human choice, and (ii) to relate the location of activities with other attributes of the investigated subjects. Thus, better targeted solutions for the freight movement in urban areas can be developed and implemented, in different scale, taking into account the need to adapt the methodological approach to local specificities.

Urban goods distribution

Local restrictions on the movement of freight vehicles

The freight distribution is essential for the survival of society, but it is also a significant problem about the sustainability of transport activities (Behrends et al., 2008). There are several factors that lead to loss of efficiency in the freight movement in cities, such as: congestion; obstacles caused by excessive use of streets such as defective pavement and lack of traffic signalling (e.g. demarcation of places); spaces that are not suitable for loading and unloading (Oliveira, 2014); and also all the factors presented in the introduction of this paper. For instance, the analysis of Iwan et al. (2018) has shown that the existance of load and unloading bays contributes to the reduction of negative environmental effects of urban freight transport. To mitigate these problems, several medium and large cities around the world have implemented and are implementing a variety of restrictions concerning the movement of freight vehicles in urban areas (Russo & Comi, 2010).

In Mexico City, for example, studies of the local urban freight distribution were carried out to implement new policies to control the emission of pollutants (Lozano, 2006). Due to the high socio-environmental impact of the vehicles used, the tendency is to increasingly create barriers with a focus on sustainability that affect the activities of the carriers (Colicchia et al., 2013). Studies in Sweden show that there is an absence of knowledge about the impacts of the externalities generated by the movement of freight vehicles in urban areas (Lindholm, 2010).

Despite numerous standards and recommendations on better integration between urban freight planning, mobility, land use planning, and urban traffic management (European Commission, 2005), little has been done to ensure that the impacts generated from UGD externalities are mitigated efficiently (Lindholm, 2010). It is a fact that the more significant the number of vehicles, the higher the quantity and intensity of urban problems due to the UGD (Bontempo et al., 2014). These problems refer to (i) the loss of operational efficiency; and (ii) the externalities previously mentioned (Barczak & Duarte, 2012).

Logistics challenges faced by urban freight carriers and retailers

Small, medium and large-size retailers base their profits on the movement of goods, large retailers also boost their profits based on offering finance (Saltorato et al., 2014). Logistics management focused on the urban goods distribution encompasses public and private issues. To solve the challenges related to this activity, it is necessary to align the main actors (shippers, population, public authorities, carriers, and logistics operators) regarding the economic, social, and environmental aims (Dablanc, 2009). This approach will ensure the implementation of mobility plans for cities that meet the demands of the parties involved in the logistics challenges in densely populated areas.

Over the last few years, logistics efficiency improvements have been made to boost competitiveness among companies of different sizes through efficient approaches to urban freight distribution. As consumption patterns in urban areas changes, it is necessary to adapt urban logistics to meet the demand derived from this consumption, directly impacting the urban environment, through competition with public and private transportation (Flora et al., 2019). Researchers suggest that smaller and specialized retailers may be responsible for a considerable volume of small-sized vehicle movement (Cherrett et al., 2012). Therefore, urban logistics solutions can help ease the problems of freight transportation (C-Liege, 2013).

As an alternative to deliveries during periods of high concentration of traffic, overnight deliveries have lowered operating costs for carriers due to increased delivery efficiency. On the other hand, overnight deliveries can generate noise for residents (Holguín-Veras, 2008), increase cargo theft, and enhance receiving costs since there will be a necessity to pay overtime journeys for both retailers and carriers. Despite the rise in labor costs, overnight deliveries increase productivity gains (Allen et al., 2000).

A possible alternative to serving the demand is to increase the frequency of delivery and use smaller vehicles with the objective of improving flexibility (Cidell, 2010). According to Cherrett et al. (2012), small retailers tend to receive merchandise without scheduling their deliveries. Furquim et al. (2018) state that many establishments do not schedule their deliveries of goods because the orders are made according to the variation in the stock level of the products. Scheduling deliveries are essential to avoid a retail breach, guaranteeing that consumers always find what they are seeking.

Rodrigue et al. (2017) present different strategies for UGD that, in light of the urban logistics concept, can increase the efficiency of operations and mitigate their externalities. Some of these strategies are: (i) rationalization of deliveries, with operations at different times, and collaborative operations; (ii) structured logistics facilities in order to promote higher transport efficiency, which can include equipment to enable the last mile efficiency, such as pick-up points and structuring logistics zones in the peripheral areas of cities; and (iii) modal adaptation, through which it is possible to make deliveries with differentiated types of vehicles' motorization or even non-motorized vehicles, reducing emissions and noise in cities.

Materials and methods

The study area is the central business district (CBD) of Sorocaba, counting on an area of about 1.7 km^2. In this area, there are two categorized regions regarding the circulation of heavy vehicles: (i) total restraint area, allowing only the transit of urban freight vehicles (UFV); and (ii) extended restraint area, with hourly window access restrictions for larger freight vehicles. It should be noted that in this central region there is a significant concentration of demand for freight flows due to the high commercial density (176 establishments per km^2).

A statistically valid sample was determined to develop the survey with the retailers, as presented in Furquim et al. (2018). From a total of 299 retailers, classified by economic activity and located in the CBD of Sorocaba, the research was conducted on 165 establishments. The sample of the carriers was established by convenience focusing on covering the most important areas evenly, totaling 62 carriers distributed among the most representative segments observed on the retailers' survey. The surveys were conducted on site. The spatial distributions of retailers and carriers are shown in Figure 1.

Initial data collection and analysis were also performed by Furquim et al. (2018). For the data collection, two surveys were structured, one for the application with the carriers and the other for the retailers. On the initial analyses, descriptive statistics tools were used to estimate measures of central tendency and variability of attributes related to restrictions assigned by retailers and carriers. The attributes related to the logistics challenges were analyzed by Furquim et al. (2018) through factor analysis, both for retailers and for carriers. Furquim et al. (2018) identified three factors for each group of actors. For retailers: (i) infrastructure and sound externalities; (ii) goods receipt outside of business hours; and (iii) the moment of unloading. For carriers: (i) deliveries made outside of business hours; (ii) political-environmental issues; and (iii) physical space for deliveries (Furquim et al., 2018).

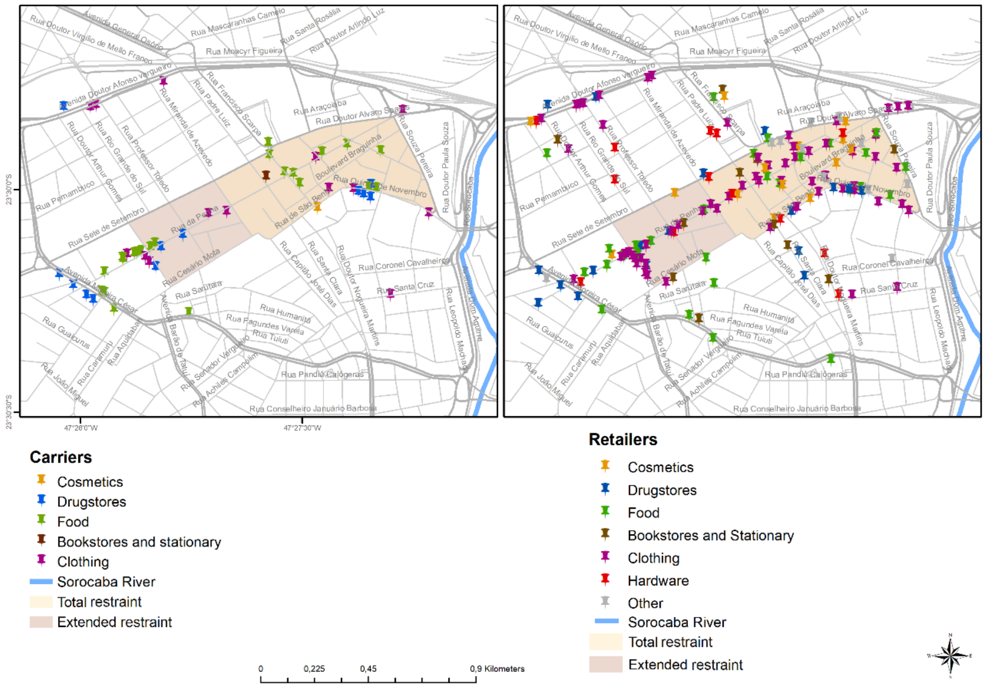

Figure 1 - Location of retailers and carriers surveyed in Sorocaba. Source: Own elaboration.

The descriptive analyses and the factors identified allowed the spatial analysis. According to Longley et al. (2013), spatial analysis can be described as a technique that pursues the identification of existing patterns in spatial data and establishment of relationships between different geographic attributes. Thus, the most important attributes and factors concerning logistics problems and solutions through stakeholders' perceptions were spatialized, relating the location of each establishment and the location of deliveries for carriers, with the respective information for each attribute and each factor. The QGIS 2.14.15 and ArcGIS 10.3.1 software were used for spatialization and analysis of the results.

Moreover, with spatially located data, an analysis of the spatial pattern of retailers' viewpoint by economic segment was performed. For this purpose, we considered the technique Average Nearest Neighbours that is used to measure the Euclidean distance between each point and its nearest neighbor and then calculate the average of all the nearest distances. If the mean distance is smaller than a mean distance for a hypothetical random distribution, the points distribution is considered to be clustered. According to Mitchell (2005), if the mean of the shortest distances is higher than the hypothetical random distribution, the points are considered to be scattered.

The spatial concentrations resulting in clusters of retailers or carriers with the same perception regarding attributes and factors were then analyzed. For this methodological step, the Getis Ord Gi* was implemented through ArcGIS 10.3.1 software. This technique, which allows the measurement of local spatial autocorrelation, supports the identification of clusters of high and low values about their neighborhood for the variable under analysis (each factor or attribute). Through its application, statistics G_i^* is calculated, and the results are analysed considering the z-scores and p-values of this statistics, resulting in measures of statistical significance and indicating if the null hypothesis should be rejected, point by point. The null hypothesis is that the data are not concentrated in space (Mitchell, 2005; Almeida, 2012; Longley et al., 2013).

The primary analysis is to indicate if a clustering of high or low values is more intense than expected in a random distribution using the same values. To determine these measures of statistical significance, each attribute or factor was analyzed individually aiming at the determination of spatial relationships. Bandwidths of 275 meters for retailers and 370 meters for carriers were considered. This bandwidth was determined considering that all features have at least one neighbor. In the presentation of results, a parameter representing the statistical significance determined using p-value, and Z-score was considered for confidence intervals of 99, 95 and 90%. Further details on the techniques considered can be seized in Mitchell (2005) and Longley et al. (2013).

The spatial patterns and agglomerations related to logistics problems and solutions (attributes and factors) were analyzed to structure a subdivision of the study area into regions that are more sensitive to specific attributes and factors, both from retailers' and carriers' perspectives, subsidizing local public policy to mitigate problems with acceptable and effective city logistics solutions.

Results

As presented, the spatial analysis was structured to determine the subareas with homogeneity regarding the attributes and factors that reflect the actors' opinions (retailers and carriers) about constraints and logistics challenges within the study area (Furquim et al., 2018).

Table 1 presents the parameters resulting from the analysis of the spatial structure (Average Nearest Neighbors) of retailers, by economic segment. The first interpretation of this structure, considering only the retailers' sites, is that the clustered distribution of the clothing sector impacts the distribution of the other points in a significant way since this type of business represents 40% of the sample. Another observation is the randomness of the location of pharmacies and foodstuffs, which might indicate that the spatial coverage may have been determined regarding socioeconomic and demographic factors to serve consumers, and not only using symmetry to locate the establishments. Moreover, the agglomeration of commercial and service activities in space can result in a greater efficiency concerning the urban goods distribution since it reduces the delivery distances. On the other hand, it might indicate a site impacted by UGD externalities, such as congestion, which contributes to the reduction of logistics efficiency and quality of life.

Table 1 - Spatial structure analysis of retail establishments by segment

Retailers segment	*z-score*	*p-value*	Spatial structure analysis
Cosmetics	4.06	0.000048	Scattered
Computing	3.29	0.001007	Scattered
Bookstores and stationary	3.45	0.000552	Scattered
Others	3.21	0.001331	Scattered
Pharmacies	-0.03	0.974014	Random
Foodstuffs	1.47	0.141036	Random
Clothing	-3.31	0.000949	Cluster
All	-7.63	0.000000	Cluster

z-score refers to how far from the mean a data point is. If a Z-score is 0, it indicates that the data point's score is identical to the mean score. p-value is used in hypothesis testing to help you support or reject the null hypothesis. In the Table 1, p-value 0.000048 is 0.0048%. This means there is a 0.0048% chance the results could be random (i.e. happened by chance). On the other hand, a large p-value of 0.974014 means the results have a 97% probability of being completely random and not due to anything in the experiment. The smaller the p-value, the more important ("significant") the results. Source: Own elaboration.

To identify some patterns of spatial homogeneity regarding the perception of retailers and carriers on the constraints and logistics challenges (not only the location of the phenomenon), hot spots were generated and represented considering the Getis Ord Gi* tool and respective statistical significance. This analysis was done in an aggregated way according to the segment of retailers and carriers since the number of stratified observations for each sector would be insufficient for the analysis. For the interpretation of the spatial distributions concerning the attributes and factors through stakeholders' viewpoints, the evaluation parameters for characterizing clustered patterns are described in Table 2 which is based on the study of Furquim et al. (2018).

Table 2 - Parameters for the cluster analysis

Actor	Type of attribute	Variables/Factors	Hot Spot (Close to 10)	Cold Spot (Close to 1)
Retailers	Local constraints (variables)	Place to receive goods	The locations available for goods reception are adequate	The locations available for goods reception are not adequate
		Difficulty in moving goods	There is no difficulty in moving goods	There is difficulty in moving goods
		Intense traffic	There is no heavy traffic	There is heavy traffic
	Logistical challenges (factors)	Infrastructure and sound externalities	The infrastructure is good	The infrastructure is poor
		Inbound delivery outside business hours	Agree with the nightly inbound delivery	Do not agree with the nightly inbound delivery
		Unloading moment	The space for receiving goods is adequate; security does not affect the receipt of goods	The space for receiving goods is not adequate; security affects the receipt of goods
Carriers	Local constraints (variables)	Safety	Restrictions on delivery time do not affect safety	-
		Proper place for loading and unloading	The locations available for loading/unloading are adequate	The locations available for loading/unloading are not adequate
		Vehicle size	-	Local restrictions on vehicle size affect performance.
	Logistical challenges (factors)	Deliveries are done outside of business hours	Agree on overnight delivery	Do not agree on overnight delivery
		Environmental policy	Agree to bear costs to reduce the externalities generated by urban freight transportation	Do not agree to bear costs to reduce the externalities generated by urban freight transportation
		Physical space for deliveries	The locations available for delivery are sufficient	The locations available for delivery are not sufficient

Source: Own elaboration.

First of all, the clustering pattern of retailers' perception regarding local restrictions and logistics challenges was assessed. Considering the local restrictions (Figure 2), it is noticed that there is a spatial concentration of opinions in the Northeastern region (in purple), where the interviewed establishments consider that the place dedicated to receiving goods is not adequate. This inadequacy is corroborated by the existence of difficulties in carrying out the movement of goods in the same area. However, there is no evident spatial pattern that characterizes the retailers' perception of traffic as a constraint. The central (highlighted in pale pink) and the Northwestern (highlighted in light blue) areas show a concentration of retailers who do not perceive difficulties in moving goods. Consistently, in the same central area, merchants believe there is an adequate place for receiving goods.

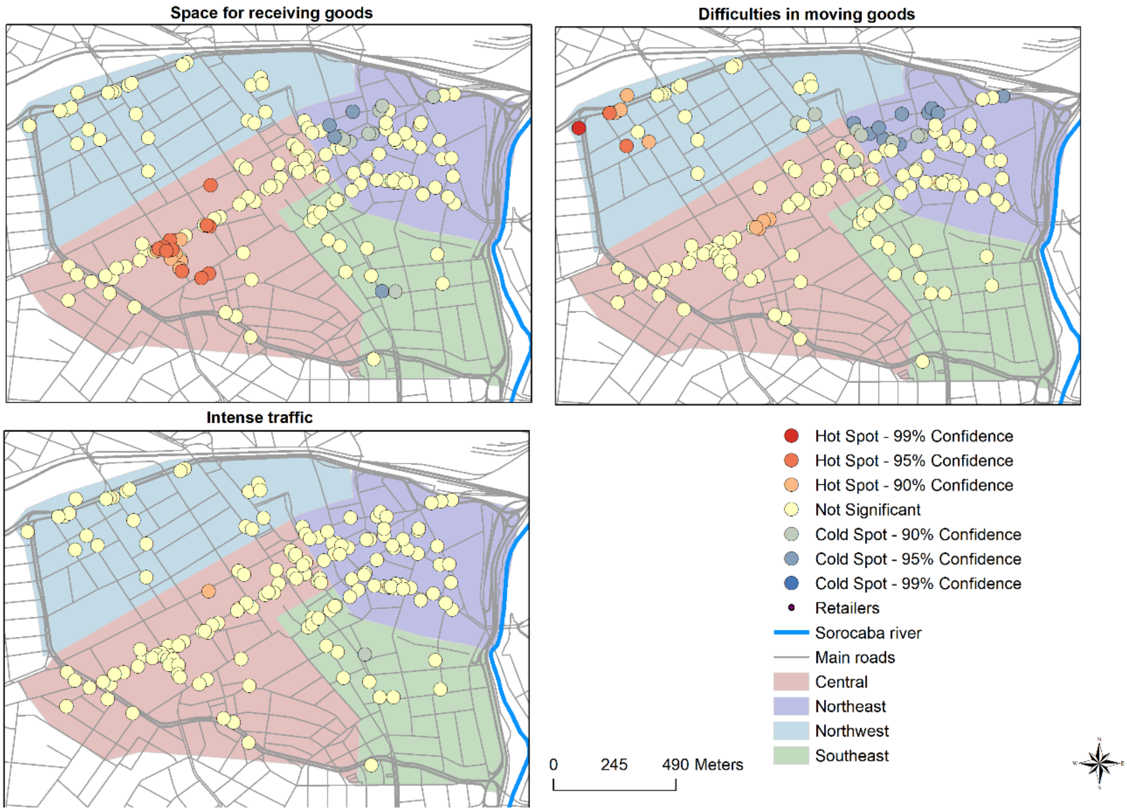

Figure 2 - Cluster analysis from retailers' perspective on local constraints. Source: Own elaboration.

Regarding the logistics challenges, the analyses indicated that the challenges concerning the delivery moment are consistent with the perception that loading and unloading areas are not adequate as restrictions (Figure 3). The spatial concentration in the northwest of the CDB is in agreement with the actors' perception about constraints to the movement of loads in this area, reaffirming that there are no negative impacts on both variables. It should also be noted that there is an area in the southeast of the CBD where retailers also believe that the unloading conditions are not a challenge for receiving goods. In the Northeastern portion, the merchants consider that receiving outside of business hours is a suitable solution and that externalities from infrastructure conditions and sound challenge corroborate the perception regarding the problems faced by the retailers on the unloading activity. On the other hand, the center presents a small agglomeration of retailers that do not regard these two challenges as limitations to their business operations.

The local constraints analysis related to the loading and unloading locations from the perspective of the carriers (Figure 4) corroborates the view of the retailers in the central portion of the study area. However, considering the Northwestern area, there is a divergence of opinions: the carriers state that the place for loading and unloading is not adequate, while retailers state otherwise, sustaining that there are no difficulties in moving goods in this area.

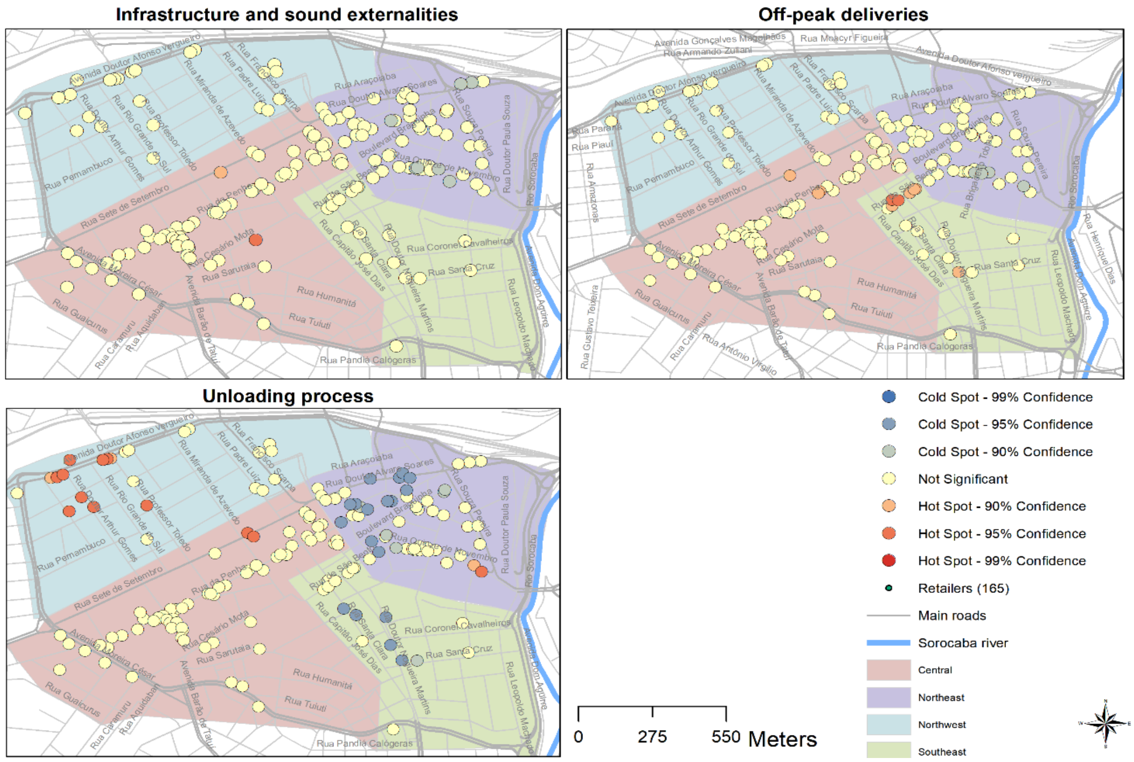

Figure 3 - Cluster analysis from retailers' perspective on logistical challenges. Source: Own elaboration.

Additionally, carriers believe that vehicle size affects the performance level of their operations. In the same region where the carriers state that they do not have a suitable place to load and unload (northwest), there are constraints regarding the size of the vehicle that negatively impact their activities, a fact that is not realized by the retailers.

Figure 5 shows the perceptions of carriers regarding the logistical challenges. Any tendency of agglomeration or spatial dispersion of those attributes cannot be noticed. There is a small concentration of carriers from the northwest that considers deliveries made outside of business hours a challenge. Also, some carriers agree that the central portion of the study area presents challenges regarding the physical space for deliveries, divergent from the perception of retailers.

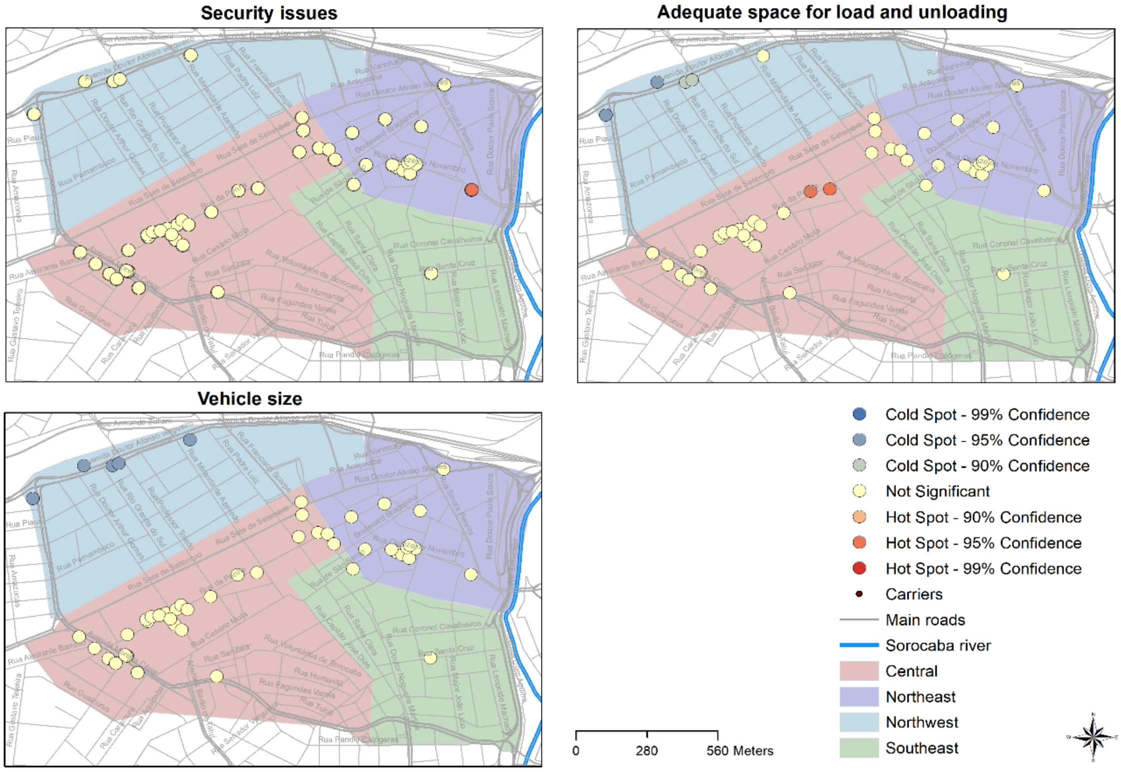

Figure 4 - Cluster analysis from carriers' perspective on local constraints. Source: Own elaboration.

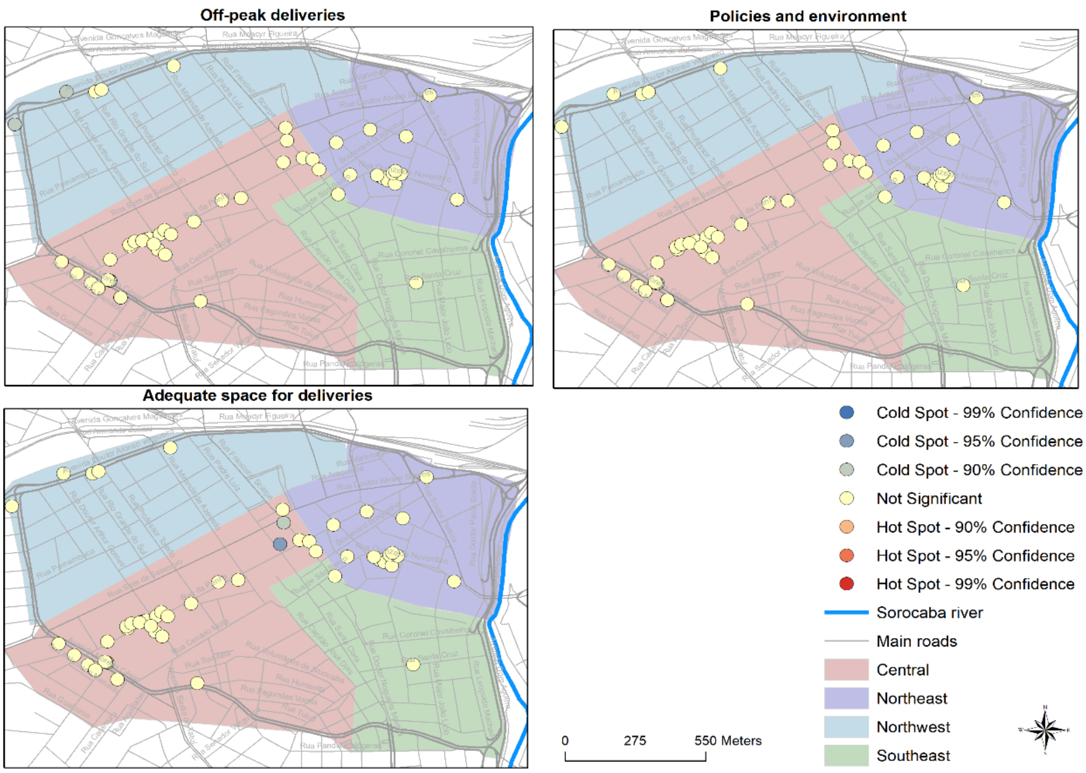

Figure 5 - Cluster analysis from carriers' perspective on logistical challenges. Source: Own elaboration.

Discussion of results and propositions

The Northwestern portion of the study area is characterized as the place with the best adequacy of space available for the accommodation of the vehicles during loading and unloading, according to retailers. However, considering all the attributes assessed by the carriers, both constraints, and challenges, this area presents problems regarding loading and unloading. For the actors responsible for the transportation, this area is not adequate to receive the vehicle demand and presented restrictions for off-peak operations. Similarly, although with convergence between the opinions of retailers and carriers, the Northeastern area is the only area with a spatial concentration of negative perceptions regarding the evaluated attributes.

The central portion of Sorocaba's CDB is characterized by the presence of retailers who do not identify significant constraints or challenges that could compromise logistics operations. This corroborated the perception of carriers; the majority believe that this area is suitable for loading and unloading operations. In contrast, some carriers evaluate the physical space for deliveries as a logistics challenge. There is a minor spatial concentration in the southeast regarding retailer and carriers' opinions. Besides, only the retailers believed that loading and unloading conditions are not adequate in this area, but they do not perceive off-peak deliveries as a challenge.

Therefore, it is possible to conclude, under the spatial syntheses carried out in this section, that the northeastern and northwestern portions of the study area are the ones that demand more attention. In these areas, there are no positive evaluations from the viewpoint of retailers considering the receiving of goods at off-peak hours, which indicates that there may be security-related issues in these areas. Therefore, safety enhancement measures should be adopted. The Northeastern portion is the area with the highest negative perception regarding the attributes investigated. It is interesting to assess, operationally, the existing bottlenecks about the accommodation structure of vehicles for loading and unloading operations. There may be a scarcity of parking space, due to the usage of parking spaces by vehicles that are not delivering goods, and to an underprivileged location of parking space in relation to the establishments that demand the most intense flow of goods.

Final considerations

In this paper, the location of the main constraints and challenges faced by retailers and carriers to receive and distribute urban goods in Sorocaba was analyzed. The methodological approach considered different spatial analysis tools, allowing the proposition of local solutions for different regions of the study area.

The spatial analysis made it possible to identify groups of actors that, significantly, perceive the same restrictions or challenges locally. The results indicated that there are specific areas that suffer from the lack of adequate space (site and dimensioning) for loading and unloading goods, which negatively impact the performance of the actors involved. This analysis is important so that the proposals and implementation of public policies are even more effective since it characterizes the problems and feasible solutions locally. In this regard, municipal management should prioritize a diagnosis (infrastructure and operation) in the Northeastern portion of the central area of Sorocaba, aiming at the promotion of adequate and acceptable improvements in the urban goods distribution in the CDB.

The work will contribute to a better analysis of the impacts related to urban logistics in the central area of Sorocaba, offering notes that can be studied in more detail in future works. However, analysis of local challenges from the perspective of carriers was limited due to the struggle in collecting information from these players.

As forthcoming work for the same studyarea, further investigation with sample increase by type of commercial establishment should be performed, because it will be possible to relate the spatial structure to the perception of retailers by type of economic activity. Also, operational aspects of the delivery process can be investigated, in order to allow the assessment of economy of scale in collaborative deliveries in areas of the CBD.

Furthermore, the methodological approach proposed for the local analysis developed in this paper can be reproduced for other studyarea scales and for other locations. Local assessment can subsidize the proposition of different solutions according to the respective sites from the agents' viewpoint.

Acknowledgements

The authors would like to thank the retailers and carriers researched for their willingness and for collaborating with the survey for the development of this study. This work was supported by the National Council for Scientific and Technological Development (CNPq), process 309516/2016-1 and FAPESP (2015/12041-9).

References

Almeida, E. (2012). *Econometria espacial aplicada*. Campinas: Alínea.

Allen, J., Anderson, S., Browne, M., & Jones, P. (2000). *A framework for considering policies to encourage sustainable urban freight traffic and goods/service flows: summary report*. Westminster: University of Westminster. Research project: Sustainable Cities Programme.

Allen, J., Piecyk, M., Piotrowska, M., McLeod, F., Cherrett, T., Ghali, K., Nguyen, T., Bektas, T., Bates, O., Friday, A., Wise, S., & Austwick, M. (2018). Understanding the impact of e-commerce on last-mile light goods vehicle activity in urban areas: the case of London. *Transportation Research Part D, Transport and Environment*, 61, 325-338. http://dx.doi.org/10.1016/j.trd.2017.07.020.

Barczak, R., & Duarte, F. (2012). Impactos ambientais da mobilidade urbana: cinco categorias de medidas mitigadoras. *urbe. Revista Brasileira de Gestão Urbana*, 4(1), 13-32. http://dx.doi.org/10.1590/S2175-33692012000100002.

Behrends, S., Lindholm, M., & Woxenius, J. (2008). The impact of urban freight transport: a definition of sustainability from an actor's perspective. *Transportation Planning and Technology*, 31(6), 693-713. http://dx.doi.org/10.1080/03081060802493247.

Betanzo-Quezada, E., Romero-Navarrete, J., & Obregón-Biosca, S. (2015). Researches on urban freight transport in the Mexican city of Queretaro: from central to peri-urban areas. *Journal of Urban and Environmental Engineering*, 9(1), 12-21. http://dx.doi.org/10.4090/juee.2015.v9n1.012021.

Bjørgen, A., Seter, H., Kristensen, T., & Pitera, K. (2019). The potential for coordinated logistics planning at the local level: a Norwegian in-depth study of public and private stakeholders. *Journal of Transport Geography*, 76, 34-41. http://dx.doi.org/10.1016/j.jtrangeo.2019.02.010.

Bontempo, A. P., Cunha, C. B., Botter, D. A., & Yoshizaki, H. (2014). Evaluating restrictions on the circulation of freight vehicles in brazilian cities. *Procedia: Social and Behavioral Sciences*, 125, 275-283. http://dx.doi.org/10.1016/j.sbspro.2014.01.1473.

Cárdenas, I., Beckers, J., & Vanelslander, T. (2017). E-commerce last-mile in Belgium: developing an external cost delivery index'. *Research in Transportation Business & Management*, 24, 123-129. http://dx.doi.org/10.1016/j.rtbm.2017.07.006.

Carvalho, N. L. A., Ribeiro, P. C. C., Oliveira, L. K., Silva, J. E. A. R., & Vieira, J. G. V. (2019). Criteria to implement UDCs in historical cities: a Brazilian case study. *European Transport*, 72(1), 1-29.

Castillo, V. E., Bell, J. E., Rose, W. J., & Rodrigues, A. M. (2018). Crowdsourcing last mile delivery: strategic implications and future research directions. *Journal of Business Logistics*, 39(1), 7-25.

Cidell, J. (2010). Concentration and decentralization: the new geography of freight distribution in US metropolitan areas. *Journal of Transport Geography*, 18(3), 363-371. http://dx.doi.org/10.1016/j.jtrangeo.2009.06.017.

C-Liege. (2013). *Clean last mile transport and logistics management for smart and efficient local governments in Europe*. Retrieved in 2019, September 10, from http://www.c-liege.eu/home.html

Colicchia, C., Marchet, G., Melacini, M., & Perotti, S. (2013). Building environmental sustainability: empirical evidence from Logistics Service Providers. *Journal of Cleaner Production*, 59, 197-209. http://dx.doi.org/10.1016/j.jclepro.2013.06.057.

Cherrett, T., Allen, J., McLeod, F., Maynard, S., Hickford, A., & Browne, M. (2012). Understanding urban freight activity: key issues for freight planning. *Journal of Transport Geography*, 24, 22-32. http://dx.doi.org/10.1016/j.jtrangeo.2012.05.008.

Dablanc, L. (2009). *Urban freight: freight transport: a key for the new urban economy*. Washington: The Transport Research Support Program.

Deutsch, Y., & Golany, B. (2018). A parcel locker network as a solution to the logistics last mile problem. *International Journal of Production Research*, 56(1-2), 251-261. http://dx.doi.org/10.1080/00207543.2017.1395490.

European Commission. (2005). *Thematic strategy on the urban environment*. Brussels.

Ferrucci, F., & Bock, S. (2014). Real-time control of express pickup and delivery processes in a dynamic environment. *Transportation Research Part B: Methodological*, 63, 1-14. http://dx.doi.org/10.1016/j.trb.2014.02.001.

Flora, M., Ewbank, H., & Vieira, J. G. V. (2019). Framework for urban freight transport analysis in medium-sized cities. *urbe. Revista Brasileira de Gestão Urbana*, 11, e20180203. http://dx.doi.org/10.1590/2175-3369.011.e20180203.

Furquim, T. S. G., Vieira, J. G. V., & Oliveira, R. M. (2018). Restrições de carga urbana e desafios logísticos: percepção de varejistas e motoristas em Sorocaba. *Transportes*, 26(1), 142-156. http://dx.doi.org/10.14295/transportes.v26i1.1354.

Grass. (2016). *Green and sustainable freight transport systems in cities*. Retrieved in 2019, September 10, from http://www.grassproject.eu

Holguín-Veras, J. (2008). Necessary conditions for off-hour deliveries and the effectiveness of urban freight road pricing and alternative financial policies in competitive markets. *Transp. Research A*, 42(2), 392-413. http://dx.doi.org/10.1016/j.tra.2007.10.008.

Iwan, S., Kijewska, K., Johansen, B. G., Eidhammer, O., Małecki, K., Konicki, W., & Thompson, R. G. (2018). Analysis of the environmental impacts of unloading bays based on cellular automata simulation. *Transportation Research Part D, Transport and Environment*, 61, 104-117. http://dx.doi.org/10.1016/j.trd.2017.03.020.

Lindholm, M. A. (2010). Sustainable perspective on urban freight transport: factors affecting local authorities in the planning procedures. *Procedia: Social and Behavioral Sciences*, 2(3), 6205-6216. http://dx.doi.org/10.1016/j.sbspro.2010.04.031.

Lindholm, M. A., & Browne, M. (2013). Local authority cooperation with urban freight stakeholders: a comparison of partnership approaches. *European Journal of Transport and Infrastructure Research*, 13(1), 20-38.

Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2013). *Sistemas e ciência da informação geográfica* (Vol. 3). Porto Alegre: Bookman.

Lozano, A. (2006). *Estudio integral metropolitano de transporte de carga y medio ambiente para el Valle de México*. México: Universidad Nacional Autonoma de México, Comision Ambiental Metropolitana. Final report.

Macário, R. (2007). *Logurb: optimização de sistemas logísticos de distribuição de mercadorias em meio urbano: state of the art da logística urbana*. Lisboa: Fundação de Ciência e Tecnologia.

Marcucci, E., & Gatta, V. (2017). Investigating the potential for off-hour deliveries in the city of Rome: Retailers' perceptions and stated reactions. *Transportation Research Part A, Policy and Practice*, 102, 142-156. http://dx.doi.org/10.1016/j.tra.2017.02.001.

Mitchell, A. (2005). *The ESRI guide to GIS analysis* (Vol. 2). Redlands: ESRI Press.

Novelog. (2018). *New cooperative business models and guidance for sustainable city logistics*. Retrieved in 2019, September 10, from http://www.novelog.eu

Oliveira, L. K. (2014). Diagnóstico das vagas de carga e descarga para a distribuição urbana de mercadorias: um estudo de caso em Belo Horizonte. *Journal of Transport Literature*, 8(1), 178-209. http://dx.doi.org/10.1590/S2238-10312014000100009.

Prata, B. A., Oliveira, L. K., Dutra, N. G. S., & Pereira, W. A., No. (2012). *Logística urbana: fundamentos e aplicações*. Curitiba: CRV. http://dx.doi.org/10.24824/978858042326.6.

Ranieri, L., Digiesi, S., Silvestri, B., & Roccotelli, M. (2018). A review of last mile logistics innovations in an externalities cost reduction vision. *Sustainability*, 10(3), 782. http://dx.doi.org/10.3390/su10030782.

Rodrigue, J. P., Comtois, C., & Slack, B. (2017). *The geography of transport systems* (4th ed.). London: Routledge.

Russo, F., & Comi, A. (2010). A classification of city logistics measures and connected impacts. *Procedia: Social and Behavioral Sciences*, 2(3), 6355-6365. http://dx.doi.org/10.1016/j.sbspro.2010.04.044.

Saltorato, P., Domingues, L. C., Donadone, J. C., & Guimarães, M. R. N. (2014). From stores to banks: the financialization of the retail trade in Brazil. *Latin American Perspectives*, 41(5), 110-128. http://dx.doi.org/10.1177/0094582X14544278.

Sekovski, I., Newton, A., & Dennison, W. C. (2012). Megacities in the coastal zone: using a driver-pressure-stateimpact-response framework to address complex environmental problems. *Estuarine, Coastal and Shelf Science*, 96(1), 48-59. http://dx.doi.org/10.1016/j.ecss.2011.07.011.

Serafini, S., Nigro, M., Gatta, V., & Marcucci, E. (2018). Sustainable crowdshipping using public transport: a case study evaluation in Rome. *Transportation Research Procedia*, 30, 101-110. http://dx.doi.org/10.1016/j.trpro.2018.09.012.

Taniguchi, E., Thompson, R. G., Yamada, T., & Van Duin, R. (2001). *City logistics: network modelling and intelligent transport systems*. Amsterdam: Elsevier Science. http://dx.doi.org/10.1108/9780585473840.

Taniguchi, E., Thompson, R. G., & Yamada, T. (1999). Modelling city logistics. In E. Taniguchi, & R. G. Thompson (Eds.), *City logistics I*. Kyoto: Institute for Systems Science Research.

Editor: Fábio Duarte

Received: June 05, 2019
Approved: Nov. 08, 2019