Freight villages and urban goods distribution: perspectives of freight transport operators, experts, and policymakers from multi-criteria decision analysis

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Abstract: A freight village is an option to reduce the externalities of urban freight transport and improve the efficiency of this activity. In this sense, its location is a factor in the accomplishment of the benefits promoted by city logistics solutions. This paper evaluates the use of freight villages for urban goods distribution. We used a multi-criteria decision analysis to identify the viewpoints of stakeholders involved in this solution (carriers, experts and policymakers). We applied this method to a case study in the city of Palmas, Brazil. The results indicate that there are different perspectives on the relevance of the criteria analysed, reinforcing the need for dialogue and participation of various stakeholders in the planning of urban freight transport, to encourage logistical solutions consistent with the requirements of urban freight transport.

Keywords: urban freight transport; urban distribution centre; freight village; freight cluster; multi-criteria decision analysis; analytic hierarchy process; stakeholders.

Reference to this paper should be made as follows: de Senna, B.A., Bracarense, L.D.S.F.P., de Oliveira, L.K. and de Oliveira, R.L.M. (2021) 'Freight villages and urban goods distribution: perspectives of freight transport operators, experts, and policymakers from multi-criteria decision analysis', *World Review of Intermodal Transportation Research*, Vol. 10, No. 1, pp.30–45.

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This paper is a revised and expanded version of a paper entitled 'Stakeholders' viewpoint on the integration of urban distribution centers and freight villages in Palmas, Brazil' presented at the '3rd VREF Conference on Urban Freight', Gothenburg, 17–19 October 2018.

1 Introduction

Land use and associated activity within cities influence urban freight transport. However, land use planning in urban areas often neglects freight and logistics considerations. As a consequence, one can observe the logistics sprawl phenomenon, which is the trend of logistics terminals moving from the inner city to peripheral metropolitan areas (Dablanc and Ross, 2012; Dablanc, 2014). Logistics sprawl can increase the distance travelled by freight vehicles and can also be related to urban sprawl.

Taniguchi and Thompson (2003) proposed the concept of city logistics with a focus on measures to reduce the social and environmental cost related to urban freight transport and optimise the operational efficiency to minimise urban freight impacts. The Urban Distribution Centre (UDC) is one of the city logistics solutions proposed to reduce the inefficient utilisation of freight vehicles in urban areas (Ehmke, 2012; Oliveira and Correia, 2014). The rationale for a UDC is 'to divide the freight transport into two parts: the part inside the city and the part outside the city' (Quak, 2011, p.48).

In this sense, a freight village could work as an urban distribution centre. Also called as a freight cluster or logistics terminal (Holguín-Veras et al., 2018), the implementation of a Freight Village (FV) provides improvements in transport services and brings competition at a local and regional level (Cambra-Fierro and Ruiz-Benitez, 2009). A FV

has the objective of seeking maximum efficiency and improving logistics transportation services, by grouping industry, warehousing, and logistics companies together (Rodrigue, 2012). Another advantage is the use of a multimodal system that allows the integration of transportation modes and reduces costs and delivery time, preserving space for freight activities in metropolitan areas (Holguín-Veras et al., 2018). FVs 'increase a firm's flexibility and responsiveness and assist in gaining market share from the competitors' (Almotairi, 2012, p.23).

In this context, this paper analyses the use of freight villages for urban freight transport considering the perspectives of freight transport operators, experts, and policymakers. We examine if the freight village has characteristics, which improve the effectiveness of urban freight transport. For this assessment, we analyse the points of view of different stakeholders using multi-criteria decision analysis.

This analysis has importance due the increase in freight villages in Latin-American cities. Rodrigue (2012) indicated benefits from freight villages as a logistics project as opportunities for Latin American and Caribbean cities. Also, in Brazil, there are many projects proposed in Belo Horizonte, Goiânia, Porto Alegre, São Paulo, Recife, and Palmas. We have also observed one opportunity to use the freight village also for urban deliveries.

In addition, we also considered it essential to investigate in depth the preferences of stakeholders (Stathopoulos et al., 2011), including opinions gleaned from transport surveys, strategies, and regional master planning. The results presented in this paper contribute to this understanding. In this sense, this paper contributes to an approach which supports future studies regarding the use of freight villages for urban distribution in the Brazilian and Latin-American contexts.

2 Similarities between a freight village and urban distribution centre, and stakeholders involvement

Freight village, logistics platform, or logistics cluster are different designations with the same purpose. A freight village is a place where different agents of the supply chain can be integrated into the same physical space, assisting logistics flows and acting as a strategic interfaces between networks of regional and global dimensions, with the aim of improving supply chain efficiency (Cambra-Fierro and Ruiz-Benitez, 2009). According to Europlatforms (2016), logistic platforms (or logistics centres) are areas with activities related to transport, logistics, and goods distribution carried out by several operators. Similarly, Afandizadeh and Moayedfar (2008) considered the freight village to be an area in which different managers conduct activities related to urban, regional, and international freight transportation, logistics, and distribution.

Similar main characteristics between FV and an UDC are described in Table 1, including the activity description, logistics facilities, type of goods handled, control system, and multimodality characteristics. Considering these similarities, the FV could be described as a general facility and the UDC provides specific services. Therefore, the UDC can be viewed as a part of the FV, resembling of the facility at Cityporto Padova, in Italy.

Table 1 Comparison of freight village and urban distribution centre characteristics.

Characteristics	*Freight village*	*Urban distribution centre*
Description	Transport and logistics activities carried out by different operators.	Receive goods from various suppliers, store and supply the local market.
Logistics facilities	Area for general services, transport, and logistics operators.	Area for receiving, cross-docking, warehousing, picking, and shipping.
Type of goods	All goods	General goods.
Control system	Control of entry and exit of visitors, staff and freight vehicles. The control of each commodity is the responsibility of the logistics service provider.	Strict control over the goods, identifying the type of goods, validity, temperature control (if necessary), and delivery time.
Intermodal	In general, there are.	In general, there are not. However, there can be.

In the Cityporto case, the main success factor is the location of the UDC within the FV. This case has a good reputation among operators because it is located near their logistics platforms and sufficiently far from shops in the inner city (Leonardi et al., 2014). Kayikci (2010) indicated that 'the location of the logistics centres is a key element in enhancing the efficiency of urban freight transport systems and initialising relative supply chain activities sufficiently' (p.6298). Thus, FV and UDC locations 'should be selected carefully; otherwise, it may cause irreversible consequences in city planning and also it may create bottlenecks that lead to rapid increase in cost in providing transport solutions' (Kayikci, 2010, p.6298).

When considering the involvement of the stakeholders regarding the implementation of an urban distribution centre or freight village, freight behavioural analysis and data collection are difficult, partly due to there being many decision-makers (Stathopoulos et al., 2011).

Also, 'Since the decisions that generate flows of goods in the urban area originate from the private sector (retailers, wholesalers, and freight companies), policymakers have the task of facilitating/restraining these flows or regulating the wider transport system' (Stathopoulos et al., 2011 p.79).

This statement explains the lack of involvement of the private sector in the definition of public policies for freight transportation. First, there is a lack of clarity from local authorities about who these stakeholders are. Second, how might these actors act in the definition of public policies? Finally, how might these stakeholders work together to make public policies and effective measures for the sector? These challenges, which are well recognised in Europe and the US, challenge local authorities in Brazilian cities.

The main stakeholders involved in a UDC are retailers, freight companies, and local authorities. Retailers are the receivers of goods and the main component of retailer behaviour is the type of good moved (Stathopoulos et al., 2011). The most relevant aspect for freight companies is minimising transportation costs. The local authority is an important stakeholder in urban freight transport because they are responsible for regulations regarding the local road network and have the opportunity to create possibilities for or barriers to freight transport in an urban area (Lindholm, 2014).

Unfortunately, despite the importance of UDCs as a city logistics solution, few papers address stakeholders' behaviour in this context. Considering the city logistics measures analysed in this paper, transport operators have a negative view of UDCs; they

introduce a break in the chain of distribution because of a loss of control and legal responsibility for the goods transported (Stathopoulos et al., 2011). Oliveira and Oliveira (2012) identified a perception of UDCs from carriers, retailers, and local authorities. For the local authority, it is recognised that the implementation of a UDC is important but could be very expensive or even unfeasible when one considers the need for space in dense urban areas, indicating the need for incentives to implement this measure. Retailers declared the level of efficiency of the UDC as a low-level attribute, but the use of UDCs is advantageous for the carriers.

Lebeau et al. (2015) presented a bottom-up approach using Multi-Criteria Analysis (MCA) to consider the interests of stakeholders involved in the implementation of a UDC, while evaluating different implementation scenarios. The scenario that performed best for citizens, authorities, and receivers resulted in the worst performance for shippers and logistics service providers.

Also, Oliveira et al. (2012) used the stated preference technique to determine the main characteristics of a UDC, which would get most support from retailers and carriers. The results indicate that investment in new technologies, improvements in the load factor, and reductions in parking problems are considered important consequences of the implementation of an UDC. These results are similar to Stathapoulos et al. (2012), who stated that a UDC is an important freight solution if combined with a reserved lane for goods. Also, one in three carriers would consider using a UDC in the presence of a stricter time-window scenario (Stathapoulos et al., 2012). It is important to highlight that UDC maintenance costs are not a big issue for carriers (Stathapoulos et al., 2011, 2012).

The literature focuses on the urban distribution stakeholder's viewpoint concerning UDCs, but investigations about the use of freight villages for urban distribution are not very widespread. In the next section, we present the research approach to develop the analysis proposed in this paper.

3 Multi-criteria analysis for city logistics

According to Oliveira and Correia (2014), the evaluation of a UDC is complicated due to multiple objectives: number of routes, distance travelled, number of vehicles, travel time, the number of deliveries, load factor, frequency of delivery, parking time, fuel consumption, pollutant emissions, and operating costs. In general, the location of a UDC directly influences the results of these evaluation criteria, because it has implications for traffic, the environment, and trade relations among the agents (Browne et al., 2005). For the objectives proposed in this paper, we need to use a method that can allow the assessment of multiple and conflicting goals.

In this sense, Ambrosino et al. (2012) suggest Multi-Criteria Analysis (MCA) as one of the evaluation methods to determine the degree of feasibility of city logistics measures. Taniguchi et al. (2012) indicate MCA as a technique for enhancing the practical application of city logistics. MCA can be used to combine some performance measures produced from simulation models to aid the identification of optimal city logistics measures and can be used to evaluate the location planning of freight terminals (Taniguchi et al., 2016). Also, MCA aims to facilitate decision-making in the selection of optimal sites, land suitability analysis, and resource assessments, and the Analytical Hierarchy Process (AHP) is a flexible technique, used in previous studies for the location of facilities (Fraile et al., 2016). The evaluation of an FV location is a Multi-Criteria

Decision-Making (MCDM) problem including quantitative and qualitative criteria (Ozceylan et al., 2016, p.38). Also, the location of the UDC reduces the volume of freight vehicles (Fraile et al., 2016, p.479).

'MCA consists of a group of approaches, which allow accounting explicitly for multiple criteria, to support individuals or groups to rank, select and compare different alternatives' (Cinelli et al., 2014, p.140). Also, 'every decision is made within a decision environment, which is defined as the collection of information, alternatives, values, and preferences available at the time when the decision must be made' (Mateo, 2012, p.7). There are four main reasons to use MCA (Mateo, 2012):

- it allows the investigation and integration of the interests and objectives of multiple actors because the input of quantitative and qualitative information from every actor is taken into account as criteria and weight factors;
- it deals with the complexity of the multi-actor setting by providing output information that can be easily communicated to actors;
- it is a well-known and commonly applied method of alternatives assessment that also includes different versions of the method developed and researched for specific problems and/or contexts; and
- it is a method which allows objectivity and the inclusion of different perceptions and interests of actors without consuming much effort of cost.

Many scholars have used MCA to evaluate city logistics measures. Fusco et al. (2004) used AHP to compare and select possible drop-points for deliveries from e-commerce. Karpso et al. (2005) used a multi-criteria approach to evaluate the development of an FV in Northern Greece and to identify a set of decision criteria – including environmental quality; contributions to local, regional, and national economies; attractiveness for private sector financing; land-use changes; as well as compatibility with other plans – to evaluate the effect of an FV.

Verlinde et al. (2010) investigated public support for night delivery in Belgian cities using MCA, and the results indicate that this tool is appropriate for measuring public support due to its ability to incorporate the views of different stakeholders and their criteria. Kayikci (2010) explored the applicability of a conceptual model based on a combination of the fuzzy-AHP and artificial neural networks methods in the process of selecting the location of an intermodal logistics centre. According to this author, the model helps practitioners to decide with regard to the considered criteria and contribution to relative city logistics issues.

Bu et al. (2012) proposed a choice method for selecting optimal city distribution locations in an urbanised area. AHP was the method used to obtain the subjective weight vector of all attributes to obtain to a decision about the importance degree of each indicator for the location of city distribution transshipment.

González-Feliu and Salanova (2013) considered a multi-criteria decision method to estimate the risk in collaborative transportation systems. Macharis et al. (2013) described a stakeholder-based approach, using a multi-actor MCA devoted to urban and inter-urban freight transport. González-Feliu et al. (2013) used MCA to analyse the viability of urban logistics pooling to help urban goods movement decision-makers in their strategic choices. From the results, collaboration is not evident and this can lead to cost reduction in some conditions.

Leonardi et al. (2014) used MCA considering the criteria: innovation and feasibility; the magnitude of impacts, information accessibility, and transferability to selected urban freight solutions. Morfoulaki et al. (2016) presented policy measures regarding the enhancement of urban logistics procedures in small to medium-sized cities, evaluated using a MCA method. The results from the experts' viewpoint indicate that Sustainable Urban Logistics Plans need to consider, mainly, user awareness and information about sustainable urban freight transport, information maps, and spatial and temporal restrictions. Kiba-Janiak (2016) identified the key success factors for city logistics and their importance from the perspective of various groups of stakeholders, using the Delphi method among experts from different places around the world.

Fraile et al. (2016) defined a decision model to determine the optimal location of various facilities in an urban area based on the use of a Geographic Information System (GIS). This approach can be used by sectors responsible for transport infrastructure and logistics. The criteria used were: accessibility, population density, public transportation stops, shopping areas, industrial parks, land for construction development, and the existence of cycle lanes. Other issues considered were the availability of public parking for private vehicles, underground cycle parking, and UDCs. For the UDC case, the most important factors were proximity to residential areas, population density, and accessibility to cars. A similar approach was used by Ozceylan et al. (2016) to evaluate potential locations for FVs using a GIS-based MCA method. Pamucar et al. (2016) considered the integration of the multi-criteria method, which involved the weighted linear combination and the modified Dijkstra algorithm within a GIS to optimise green routes for the city logistics centre.

This section presents the literature about MCA with regard to city logistics. Despite the diverse applications of MCA, the research approach proposed in this article has not yet been analysed. Thus, we believe this paper contributes to the literature by introducing an instrument that allows analysis of the use of freight villages for urban freight transport in countries where a freight village is a national policy for freight transport, like Brazil.

4 Research approach

One of the most widely applied MCA methods is the Analytic Hierarchy Process (AHP). The AHP is a performance-aggregation-based approach to evaluate tangible and intangible criteria in relative terms using an absolute scale (Saaty, 1987). The basic inputs to the AHP are answers from the decision-makers to a series of questions in a general form: e.g., 'How important is Criterion A compared with Criterion B?' AHP incorporates a useful technique for checking the consistency of the decision-makers' assessments, thus reducing the bias in the decision-making process.

The AHP method is implemented through the definition of criteria and sub-criteria, the assignment of weights to the criteria and the computation of the vector of criteria weights, and construction of the evaluation matrix.

In this paper, we define criteria concerning the operation and infrastructure to evaluate the use of a freight village for urban goods distribution by identifying the compatibility and requirements of UDCs and FVs. These criteria allow us to ask: 'Despite the increase in distance, does the use of FVs bring positive advantages to the supply chain?' Table 2 presents the criteria and sub-criteria proposed in this paper. We identified these from the literature review and classified them into locational and operational aspects.

Table 2 Criteria and sub-criteria to evaluate the use of freight village for urban goods distribution

Aspect	*Criteria*	*Sub-criteria*
Locational	*Cost* related to the operational cost of the distribution system: In this study, we analyse the cost related to the location of the UDC. In general, the location of a UDC impacts the performance of urban freight transport. If the facility is established closer to urban areas, the impact is positive because this reduces the operational cost. Nevertheless, this area can be expensive because central areas are more valuable than peripheral areas.	*Distance* influences the operational cost (fuel, maintenance, and labour costs). Considering that FVs are, in general, located in peripheral areas, the UDC would be located far from the main urban delivery areas, with direct impacts on cost and, consequently, inducing a logistics sprawl.
		There is *Area Availability* outside of central aareas in urban centres due to real estate speculation and lack of urban freight discussion in urban planning. The relationship between availability, possible later expansion and area value influences the location decisions regarding the UDCs.
Locational and operational	Positive and negative *impacts* with the use of an FV for urban goods distribution	*Pollutant emissions* due to an increase in distance travelled.
		If the UDC is closer to the central area, it increases the number of freight vehicles with a *visual impact* on residents.
		Noise generated by freight vehicles during loading/unloading operations, if the UDC is located in an urban area.
		If the UDC is located in a peripheral area, it is important to consider truck routes to central areas to avoid *Degradation of the Pavements* in urban area.
		An UDC generates employment opportunities, with positive *Social Impacts*.
	Delivery time is fundamental for service level assessment and can be influenced by distance, specialised workforce, and equipment.	*Distance*: if the UDC is closer to the central areas, non-motorised vehicles can be used to make deliveries, avoiding and reducing congestion
		Specialised workforce can reduce delivery times
		The use of adequate *equipment* can reduce delivery times
	Intermodal transport improves the supply chain management and reduces costs. We could consider transport by road, rail, air, sea, and waterways.	No sub-criteria
Operational	*Service quality* related to carrying out delivery without damage. A specialised lab or/and equipment are important.	*Specialised labour* avoids damage and improves service quality
		Equipment improves the service quality and productivity

Although the impact on traffic is an important externality of urban freight transport, it was not included in this research, because of the city network characteristics. It is a planned city for 1 million inhabitants, that counts a population under 300,000 inhabitants, so the traffic congestion is punctual and the perception of this impact in the city is very particular, not been comparable to most of other cities in Brazil and other countries.

The AHP method has three steps: (i) computing the vector of criteria weights; (ii) computing the matrix of options scores, and (iii) ranking the alternatives.

To compute the vector of criteria weights and construct the evaluation matrix, we used the Saaty method (Saaty, 1980). The relative importance between two criteria is measured according to a numerical scale from 1 to 9 (Saaty, 1987):

- 1: *j* and *k* are equally important
- 3: *j* is slightly more important than *k*
- 5: *j* is more important than *k*
- 7: *j* is strongly more important than *k*
- 9: *j* is absolutely more important than *k*
- 2, 4, 6, 8: Intermediate values between the two adjacent judgments

Considering the results, we computed a matrix of option scores, ranked the options and checked the consistency of the pairwise comparison. Details of the calculation procedure can be found in Saaty (1980, 1987). We used the AHP method to carry out a case study in Palmas, Brazil. We considered the point of view of experts, carriers, and policymakers. The actors were chosen because of their knowledge of the city of Palmas and their professional experience. In the expert group, we interviewed logistics experts and academics who had already been to the city. In the carrier group, we interviewed managers of distribution centres and logistics operators in Palmas. In the policymaker group, we interviewed those responsible for the municipal and state departments of transportation.

The results of the case study are presented in the next section.

5 Case study

Palmas is the capital of Tocantins State and was founded in 1989. Palmas is a planned city and occupies an area of 2219 km^2. The landscape consists of wide avenues, environmental preservation, and good public spaces. During the first decade of this century, Palmas was the capital with the highest population growth in Brazil. Currently, it has 272,729 inhabitants and the services sector is the main economic activity of the city.

In Palmas, urban goods distribution occurs through warehouses or distribution centres located in peripheral areas. Palmas has a well-defined zoning policy, determined by Law 386/1993, regarding the following areas: administrative area, retail and services area, leisure and culture area, residential area, and green area. The area for retail and services is subdivided into: centre, urban, vicinal, regional, and local. The area for warehouses and carriers is included in the regional retail and services area and is composed of blocks in the margins of the TO-050 highway. However, blocks 112 South and 912 South are the most used by carriers and shops for the location of storage or distribution centres.

The government of Tocantins is interested in implementing an FV at Palmas Airport to optimise freight transport to the Tocantins and neighbouring states, enhancing import and export trades, and supporting the regional economic development of Tocantins. The airport site has 23,739,952 m², one of the largest in Brazil. The freight terminal has an area of 4000 m². Palmas Airport is located 25 km from the central region of the capital city. We present the location of Palmas Airport, the warehouse area, and main commercial areas in Figure 1.

Figure 1 Palmas Airport and route to main commercial areas

5.1 Multi-criteria analysis results

We interviewed four policymakers, seven carriers and four experts in Palmas, and all interviews were in person. The importance each stakeholder gives to each criterion and sub-criteria is presented in Table 3. The results allow us to compare the degree of importance of each criterion for the location of the UDC from the stakeholders' viewpoints.

Table 3 Criteria and sub-criteria weightings by stakeholders

Criteria	*General weighting*	*Sub-criteria*	*Weighting*		
			Policymakers	*Carriers*	*Experts*
Cost	Policymakers: 0.136 Carriers: 0.350 Experts: 0.460	Distance	0.844	0.617	0.500
		Area available	0.156	0.383	0.500
Impacts	Policymakers: 0.347 Carriers: 0.066 Experts: 0.222	Pollutant emission	0.414	0.301	0.304
		Degradation of the pavement	0.121	0.126	0.092
		Visual impact	0.076	0.084	0.057
		Noise	0.110	0.086	0.189
		Social impact	0.280	0.404	0.359
Delivery time	Policymakers: 0.153 Carriers: 0.247 Experts: 0.113	Distance	0.470	0.148	0.583
		Specialised labour	0.380	0.560	0.318
		Equipment	0.150	0.292	0.099
Intermodal transport			0.152	0.079	0.039
Service quality	Policymakers: 0.213 Carriers: 0.259 Experts: 0.166	Specialised labour	0.663	0.826	0.667
		Equipment	0.338	0.174	0.333

The questions posed did not generate clear results from the policymaker group. There was no prevalence of either locational or operational aspects as relevant issues for the location of the UDC. This group classified the general impact criterion as the most important and cost as the least important (general weighting = 0.347). These results could have been achieved because carriers and retailers have made an investment and are responsible for operating costs. Another interesting result is that the pollutant emission sub-criterion is considered relevant by the policymakers. This result can be explained by the fact that any environmental impact in the city is under the responsibility of the government and, in particular, pollutant emissions is the most difficult to fix. Measures to reduce the levels of pollutant emissions are still in developing in Brazilian cities and the high propensity of private vehicle use brings the need to restrict the circulation of other types of vehicles (in this case, freight vehicles) to maintain an urban environment acceptable to citizens.

The carriers considered the cost of using the freight village for urban freight transport to be the most important criterion (general weighting = 0.35); this directly impacts the carriers' profits. Also, quality of service and delivery time are important issues to be considered, which reflect directly on the reputation of the company. These results indicate that carriers consider scenarios, which reduce operating costs and improve the quality of service. Thus, in the case of Palmas, considering the location of warehouses, the use of the freight village for urban goods distribution in Palmas is not considered positive. The sub-criterion of specialised labour, which impacts on the criteria of delivery time and service quality, was highlighted by carriers, surpassing the importance given to distance. These results indicate a propensity for carriers to prioritise operational aspects for urban freight transport in line with the objectives of this stakeholder.

The cost was also the criterion regarded as most important for experts (general weighting = 0.46), followed by the impact. An interesting fact is that intermodality was not considered important by all the stakeholders: this fact is explained by the predominance of road transportation in Brazil, which has little prospect of change, despite the fact that Palmas is located in a strategic region for the installation of an intermodal facility.

5.2 Scenarios analysis

We analysed two scenarios: the current scenario (S0), where the warehouse is closer to commercial areas and one considering one urban distribution centre inside the freight village for urban deliveries to Palmas (S1). The comparative results of the scenarios are presented in Table 4. The divergence of results is a reflection of the weightings given to the criteria and sub-criteria. However, these weightings are directly related to the interests of each stakeholder.

Table 4 Comparative results

Criteria	*Sub-criteria*	*Policymakers*		*Carriers*		*Experts*	
		S0	*S1*	*S0*	*S1*	*S0*	*S1*
Cost	Distance	0.23	0.06	0.43	0.11	0.46	0.12
	Area available	0.02	0.03	0.13	0.20	0.23	0.35
Impacts	Pollutant emission	0.29	0.07	0.04	0.01	0.13	0.03
	Degradation pavement	0.06	0.04	0.01	0.01	0.03	0.02
	Visual impact	0.04	0.05	0.01	0.01	0.02	0.03
	Noise	0.05	0.08	0.01	0.01	0.06	0.08
	Social impact	0.10	0.19	0.03	0.05	0.08	0.16
Delivery time	Distance	0.14	0.04	0.07	0.02	0.13	0.03
	Specialised labour	0.06	0.12	0.14	0.28	0.04	0.07
	Equipment	0.02	0.05	0.07	0.14	0.01	0.02
Intermodal transport		0.15	0.08	0.15	0.04	0.08	0.02
Service quality	Specialised labour	0.14	0.28	0.21	0.43	0.11	0.22
	Equipment	0.07	0.14	0.04	0.09	0.06	0.11
General weighting		1.30	1.30	1.24	1.44	1.37	1.28

In general, the carriers consider the scenario where the urban distribution centre is located in the freight village to be positive (general weighting = 0.44) and specialised labour (related to service quality) is the sub-criteria most important for this (weighting = 0.43). The experts consider that the current scenario is the most interesting scenario (weighting = 1.37) due to the proximity of the warehouse to the city centre (weighting = 0.46) and the specialised labour necessary to ensure quality service (weighting = 0.11). For the policymakers, both scenarios are interesting (weighting = 1.30 in both case).

The results of the evaluation by experts deserve special attention because the ranking criteria for that group's decision-making are a balance between the interests of the other two groups. In the case of Palmas, looking at the current scenario of the city, we observed that the warehouse area is located next to major road accesses, situated at the limits of the urban area, facilitating the transit of larger vehicles. Furthermore, the

average distances from commercial areas to the warehouse area are relatively small (6.6 km) compared with the distance to the freight village location (16.2 km). These locational characteristics contribute to the minimisation of urban logistics problems. Also, the location of the airport is far from commercial areas, compared with the existing scenario. Thus, we conclude that locational aspects are more important than operational issues.

6 Conclusions

In this paper, we proposed an MCA to evaluate the integration of an urban distribution centre into a freight village. We carried out a case study in Palmas, Brazil. The variables selected for the model considered the most relevant aspects to assess the integration of these logistics facilities. Although the integration has been evaluated as theoretically compatible, this may not be feasible due to several attributes, depending on the interests of the stakeholders involved in the decision-making process.

Government, carriers, and experts considered the relevance of each criterion for the location of an urban distribution centre, bearing in mind different aspects. These differences are consistent with the individual interests identified in the literature review. According to the differences in judgment, a solution that could be the most viable to carriers regarding cost, for example, may be considered impractical for the government due to the respective impacts.

The results reinforce the needs for dialogue and participation of the various stakeholders in the decision-making processes regarding logistics solutions, so that they can adequately generate improvements in urban freight transport. The results also confirm the literature on the importance of locating logistics centres to improve urban freight transport systems efficiency (Kayikci, 2010; Leonardi et al., 2014).

The results presented in this paper have some limitations. A first issue is increasing the sample of respondents to be possible use other MCA technique. Also, the sub-criteria were selected considering the characteristics of Palmas. However, other characteristics may be incorporated in future studies, which consider the particularities of the case study analysed.

In this way, we suggest further investigation into the prevalence of locational and operational aspects in the choice process. In addition, we suggest including the impact on traffic as a sub-criteria in a new survey for future application. This sub-criterion was not compatible with Palmas and was therefore not included in this study. Finally, we suggest using an alternative MCA technique to evaluate the results.

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