

*Proposal of survey technique to get origin-destination data of freight transport: a case study in Central Market of Belo Horizonte (Brazil)*

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# **PROPOSAL OF SURVEY TECHNIQUE TO OBTAIN ORIGIN-DESTINATION DATA ON FREIGHT TRANSPORT: A CASE STUDY IN THE CENTRAL MARKET OF BELO HORIZONTE (BRAZIL)**

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## **ABSTRACT**

Obtaining data for planning freight transportation in urban areas is currently one of the major challenges of urban planners. The lack of information for correct planning causes the implementation of urban logistics solutions that are not always efficient. This work proposes and validates a method to obtain data on the origin-destination of goods in urban areas, by surveying retailers. The method was applied to the Central Market in Belo Horizonte, a place that represents the logistics of a town. This study consisted of a questionnaire given to retailers of the Central Market with questions regarding the distribution process and information concerning the origin of the load and delivery frequency. The results indicated that retailers know the process of urban distribution, understand the issues of the activities and even infer solutions. Furthermore, retailers know the origin of the goods received, since often they place the orders themselves. This way, we can conclude that the results were satisfactory and significant, and indicate that this form of data collection can be used to compose a trustworthy database for city logistics, especially for small and medium size towns.

*Keywords: urban freight transport data; city logistics; O-D freight transport survey.*

## **INTRODUCTION**

The economic and population growth in urban areas has led to the growth of demand for goods and services (Cherrett *et al.*, 2012). Approximately 80% of European citizens live in an urban area, and urban populations are forecast to increase in both more and less developed regions across the world over the coming decades (European Commission, 2007; United Nations, 2006, cited in Cherrett *et al.*, 2012). In Latin America, 79.4% of the people live in urban areas (United Nations, 2012). In Brazil, the numbers are even more impressive: 84.4% of the population lives in urban areas (IBGE, 2010) and the forecast is that by 2020, 90% of the Brazilian population will live in urban areas (United Nations, 2012). This means there will be rising demand for urban transport services.

According to Dablanc (2007), freight transport represents 25% of the total traffic of a city. Moreover, the globalization of the economy coupled with the opening of international markets has increased distances between the source of raw materials, the producer of goods and their final consumers (Dutra, 2004). This new configuration has increased the number of trips required along the logistics chain and, consequently, requires a greater number of trucks on urban roads.

In addition, urban freight distribution typically occurs in areas that are characterized by a concentration of commercial establishments and often residential buildings, so while it is essential for the local economy, it causes problems such as congestion, pollution, noise and vibrations, reducing the well-being of people and the accessibility and attractiveness of urban areas (Oliveira *et al.*, 2012). Finding solutions to conciliate this economic need with the problems is a daunting task for urban planners and policymakers. This task is even more difficult due to the lack of information to estimate the impacts of policy changes and to understand and plan freight movements to, from and within regions. Therefore, freight movement data is an indispensable input to transportation planning. Data collection on freight transportation, however, is particularly costly and time consuming. In this sense, methods are necessary for collecting consistent information for planning of urban freight distribution.

In the transportation sector, the consistency of surveys is rare (Friedrich *et al.*, 2003) despite the need. With respect to freight flows, it becomes more complex due to the large number of agents and products involved. The study conducted by Friedrich *et al.* (2003) presents methods and models of demand and networks for analyzing transport flows. The authors argue that the integration of planning tools offers advantages which go far beyond the pure technical implementation. "Collecting and maintaining consistent planning data cause significant, recurring effort, which can be reduced, if e.g. a single common network is used for both passenger and freight transport planning." (Friedrich *et al.*, 2003). However, this still is a challenge for the passenger and freight transport planning.

For Rongviriyapanich and Suppiyatrakul (2011), various survey methods can be employed to collect freight transportation data and each survey technique has its own advantages and drawbacks. For example, commodity flow surveying is an approach to collecting data from

shippers, while roadside interviews can be used to gather data from truck drivers (Rongviriyapanich and Suppiyatrakul, 2011). Their study offers rich and detailed data on origin-destination and mode share, which cannot be easily obtained by other techniques.

Rongviriyapanich and Suppiyatrakul (2011) used a commodity flow survey to collect freight movement data in Thailand. The survey covered establishments in various industries including agriculture, mining, manufacturing, wholesale and retail trade. In order to avoid double counting, only outbound shipments were sampled from all target industries except agriculture. The reason is that it would be very costly to conduct surveys at farms. Thus, agricultural products, such as rice and sugarcane, were sampled from inbound shipments from establishments in the agro-industrial sector. The population was stratified by geography, industry and size of establishment. Establishments in each stratum were sampled based on a three-stage sample design (i.e., establishments, reporting weeks and shipments). Shipment data collected in the survey included: (1) total number of shipments in the specified week; (2) value and weight of shipments; (3) type of product; (4) origin-destination and (5) mode of transport.

Another classic technique is roadside surveying, which collects data from truck drivers. This requires less cooperation from interviewees due to the availability of weight measurements at the survey locations. Nonetheless, road side survey suffers from incomplete coverage of survey locations and double counting, which can be somehow corrected (Kuwahara and Sullivan, 1987 cited in Rongviriyapanich and Suppiyatrakul, 2011).

According to Holguín-Veras and Jaller (2012), designing a comprehensive data collection framework requires the use of a systematic approach. The authors present a summary of data collection methods and a data collect framework. Each alternative has advantages and disadvantages, and for the authors the best approach is the combination of alternatives that best fits the needs and constraints of the participating agents.

For Holguín-Veras and Jaller (2012), research involving retailers can provide excellent data about the goods received. But, receivers are unaware of the transportation load aspects. According to the authors, the data from these surveys are useful for freight trip demand generation models. The data collection method focusing on shippers captures data about the characteristics of the cargo and can be complemented with shipment tracking, but information is also necessary from carriers on freight pick-up locations and travel patterns.

In this context, this paper presents a survey technique to collect freight transport data from retailers or receivers and the results of its application in Belo Horizonte (Brazil), to validate this data collection method. We first present the methodological procedures of the survey technique, followed by the results and analysis of the application of the method.

## **METHODOLOGICAL PROCEDURES**

The basic steps and procedures we used were: creation of a questionnaire, application of the survey in the field, and data tabulation and analysis. The questionnaire was the main tool for

data collection used in this work, consisted of questions to capture the information on the most recent day goods were received in the establishment. The data collected in the survey included: (1) type of product; (2) total number of deliveries on the specified day; (3) weight of shipments; (4) origin-destination of goods and (5) urban freight transport problems.

As the goal of the study was to assess the effectiveness of data collection from retailers, we decided to apply the questionnaire in the Central Market of Belo Horizonte, which since its creation in 1929 has sold a wide range of products. With an area of 14,000 m<sup>2</sup>, the market houses 372 commercial establishments that sell food, clothing, handicrafts, flowers, kitchen utensils, beverages and animals, along with a food court offering typical food of Minas Gerais.

Before the applying the questionnaire, we visited the retailers to explain the study and invite them to participate. The questionnaire was applied in August 2011. All the 372 establishments were visited. Of these, the owners or managers of 237 agreed to participate, a 64% response rate, with a sampling error of 4%.

## **RESULTS AND ANALYSES**

After gathering the data, we tabulated it to obtain the types of products, period and frequency of delivery, product origin, main routes used and delivery problems, which are detailed in this section.

### **Types of products**

Since it is a local market, the main products are foods, handicrafts, natural products and herbal medicines, household goods, fruits and vegetables, accounting for 54.1% of the total products (Figure 1). Figure 2 shows the diversity of other types of establishments in the market, responsible for 13.9% of the products sold in the market. The types of goods found in the application of the research were categorized so that products with similar characteristics could be allocated in the same category. Some food products received an individual rating because they are items with great representation.

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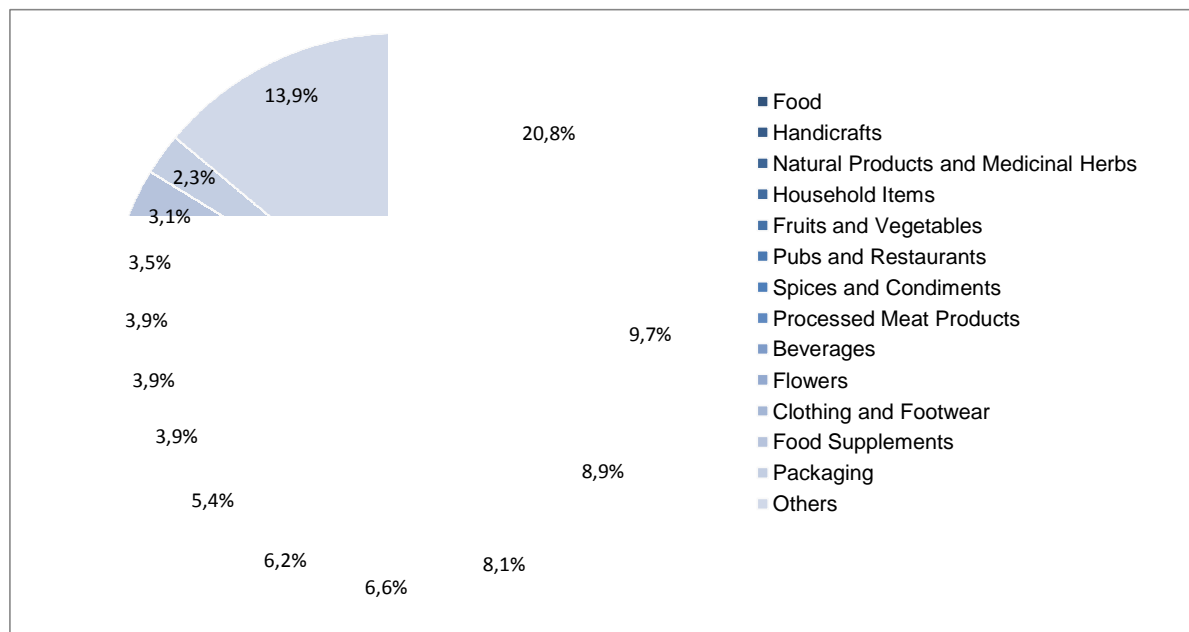


Figure 1: Percentage of the types of products sold at the Central Market.

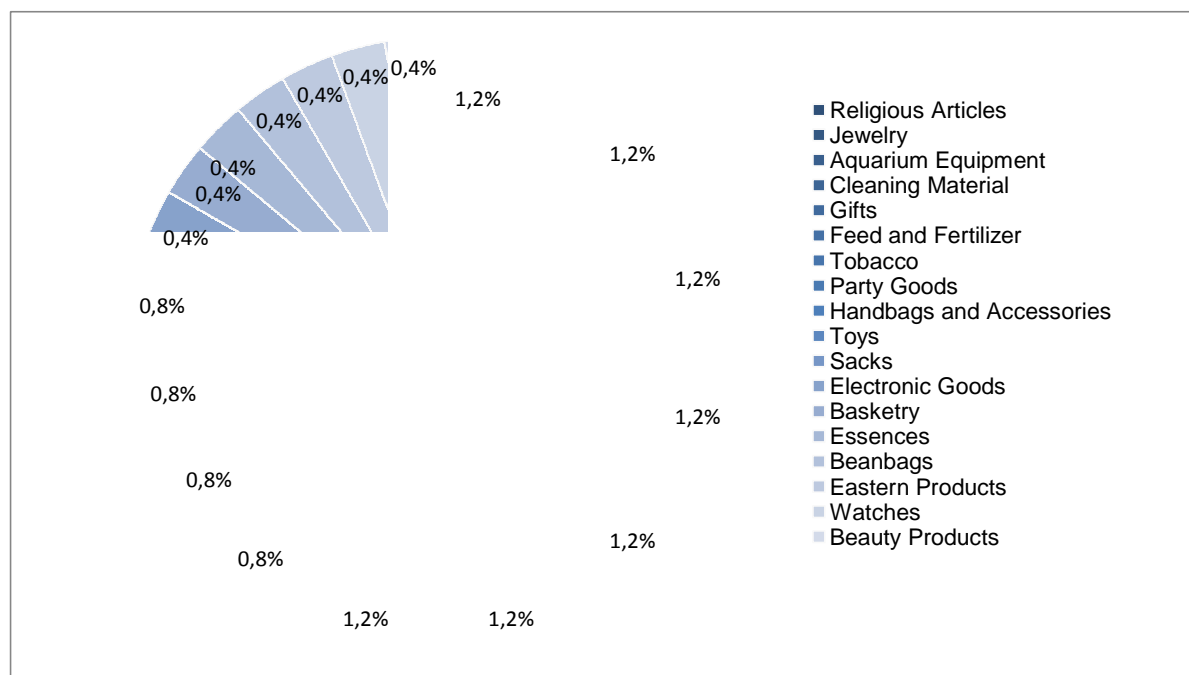


Figure 2: Percentage of the others types of products sold at the Central Market.

### Period and frequency of delivery of goods

The diversity of products sold in the market affects the delivery process. The majority of establishments receive their products in the morning, as shown in Figure 3. This is due to the fact that the market sells many fresh products. The peak delivery interval is between 10:00 and 11:00, with 15.7% of the deliveries in this period, as shown in Figure 4. The figure also shows the large concentration of deliveries of goods in the morning between 08:00 and 12:00. In the afternoon, the frequency of delivery is lower, and its peak occurs from 13:00 to

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14:00, but the pace of deliveries is relatively steady between 13:00 and 18:00. Other relevant information is that between 05:00 and 06:00, there is a significant and momentary peak caused by delivery of processed meat products, which occurs mostly at this time.

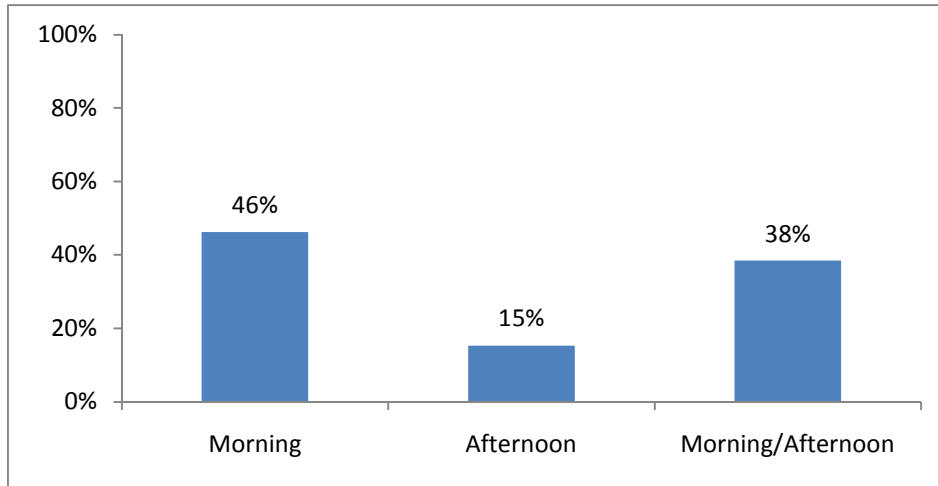


Figure 3: Concentration of deliveries by general time intervals.

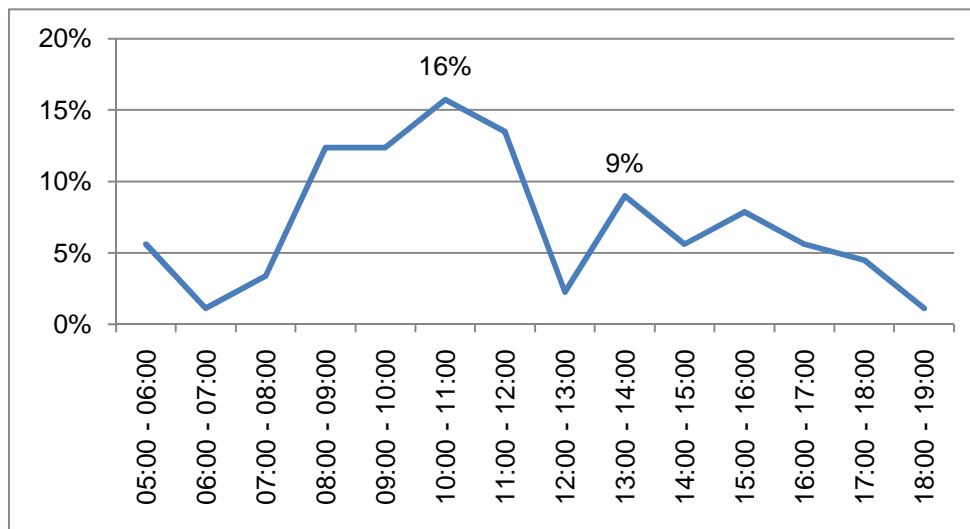


Figure 4: Concentration of deliveries by hourly time intervals.

At the Central Market of Belo Horizonte, most establishments receive goods daily, as can be seen in Figure 5. Furthermore, 87.0% of establishments receive products at least once a week, which shows the turnover of products and the intense flow this requires. Establishments that sell food, handicrafts and refrigerated foods, as well as bars and restaurants, are the most representative in the volume of daily deliveries, as shown in Table 1.

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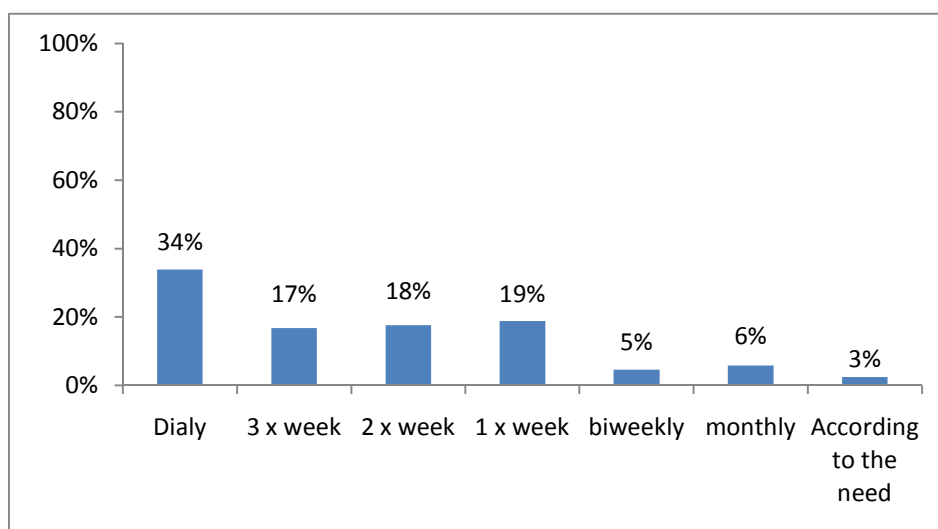


Figure 5 - Frequency of occurrence of deliveries in the Central Market.

Table 1 - Frequency of deliveries by type of product.

Product Type	Daily	3 x week	2 x week	week	Bimonthly
Foods	62.3%	27.5%	5.8%	4.3%	0.0%
Handicrafts	77.8%	0.0%	0.0%	22.2%	0.0%
Natural Products and Medicinal Herbs	12.5%	0.0%	25.0%	31.3%	31.3%
Household Items	38.5%	23.1%	30.8%	7.7%	0.0%
Fruits and Vegetables	20.0%	60.0%	20.0%	0.0%	0.0%
Bars and Restaurants	87.5%	0.0%	12.5%	0.0%	0.0%
Spices and Condiments	0.0%	60.0%	40.0%	0.0%	0.0%
Processed Meat Products	66.7%	11.1%	3.7%	18.5%	0.0%
Beverages	16.7%	11.1%	5.6%	44.4%	22.2%
Flowers	0.0%	0.0%	33.3%	66.7%	0.0%
Clothing and Footwear	29.4%	17.6%	41.2%	11.8%	0.0%
Food Supplements	10.7%	35.7%	28.6%	17.9%	7.1%
Packaging	0.0%	0.0%	25.0%	25.0%	50.0%
Others	23.1%	7.7%	19.2%	26.9%	23.1%

Furthermore, the survey revealed the amount of goods delivered to the market, with the leader being processed meats, with a volume per shipment (600 boxes / delivery) even though also accounting for 66.7% of daily deliveries.

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Table 2 - Average quantity of products delivered to the establishments of the Central Market.

<b>Product Type</b>	<b>Quantity</b>	<b>Unit</b>
Foods	72.0	Box
Handicrafts	6.0	Box
Natural Products and Medicinal Herbs	9.0	Box
Household Items	14.0	Box
Fruits and Vegetables	15.0	Box
Bars and Restaurants	15.0	Box
Spices and Condiments	13.0	Box
Processed Meat Products	600.0	Box
Beverages	3.0	Box
Flowers	77.0	Box
Clothing and Footwear	4.5	Box
Food Supplements	7.5	Box
Packaging	60.0	Box

### **Origin/destination of goods delivered to the Central Market**

Information about the origin/destination of goods in urban areas is fundamental for the definition of public policies. Among the different ways to get these data, this study tests the hypothesis that retailers are an important source of information, since the destination is already known. The following information validates the method presented in this study.

The first classification was in relation to the place of origin of goods. The results presented in Figure 6 indicate that most of the goods originated from the state of Minas Gerais itself, followed by products from the neighboring state of São Paulo, with 24.6%. The two states together account for 87.5% of all products that come to the market for subsequent sale. Santa Catarina (SC) and Rio Grande do Sul (RS), in southern Brazil, also stand out, each with 2.4%. The remaining 7.7% of the goods came from 10 other states.

Among the cities in Minas Gerais, Belo Horizonte and Contagem, located in the Belo Horizonte metropolitan area, represent 41.7% of the delivery origins from the state. Furthermore, 44.9% of the goods come from 49 different municipalities that provide products to the market. This highlights that beyond the importance of regional public policies, the logistics development in Minas Gerais is crucial to the state's economy.



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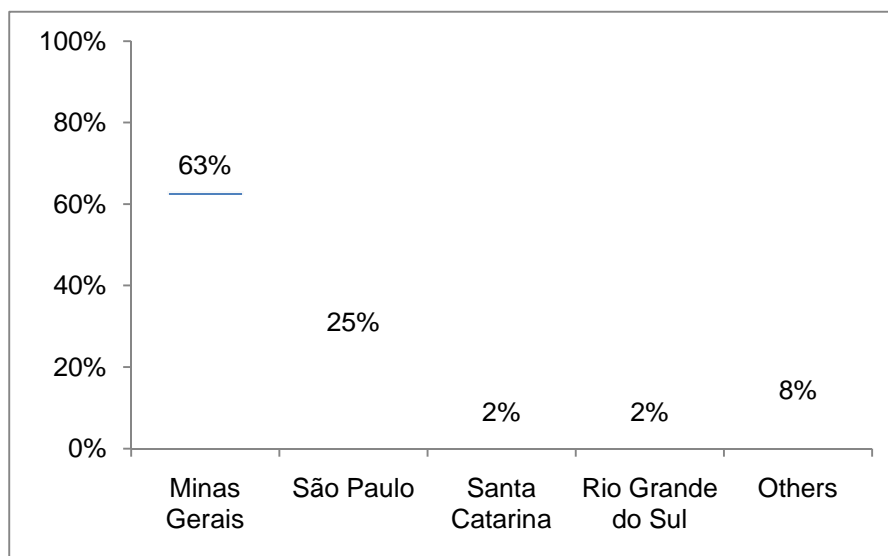


Figure 6 – Deliveries by state of origin.

Among deliveries from the BH metropolitan area, the CEASA-MG, the main food warehouse in the region, located in Contagem, is the main origin of the goods to the Central Market, representing 66.7% of the deliveries and 15.4% of total deliveries of the state. The beverage maker AMBEV is also another important shipper, with 71.4% of deliveries with origin in Santa Luzia city and 3.2% of the total from Minas Gerais.

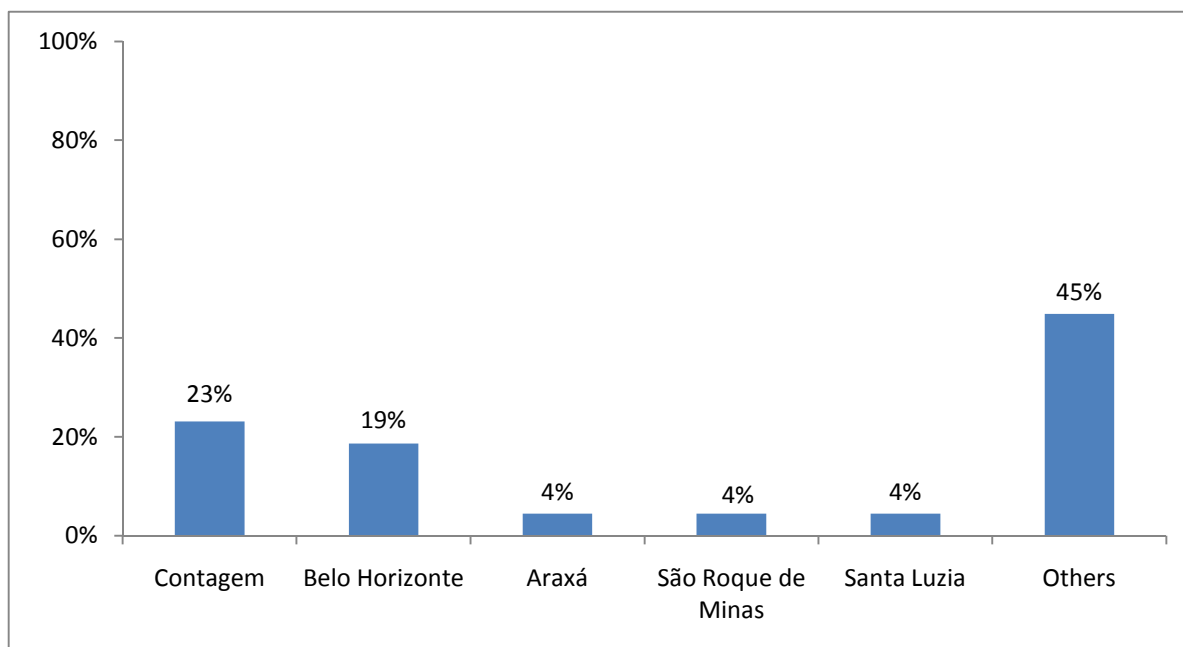


Figure 7: Cities of Minas Gerais originating goods to the market and percentage in the state.

The vehicles park on the surroundings of the Central Market, as shown in Figure 8. On Goitacazes and Curitiba streets, there are regulated places for the loading/unloading

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operations and these are heavily used. In addition, 6% of carriers who deliver low volumes utilize the market's private parking lot, which is paid.



Figure 8: Unloading places in the Central Market

Additionally, to assess the knowledge of retailers about issues related to product delivery, we asked them about issues related to the operation itself. Regarding the average unloading time, 50.9% said that it occurs in less than 20 minutes, as shown in Figure 9. This finding is consistent with the results of a study conducted by Oliveira et al. (2011).

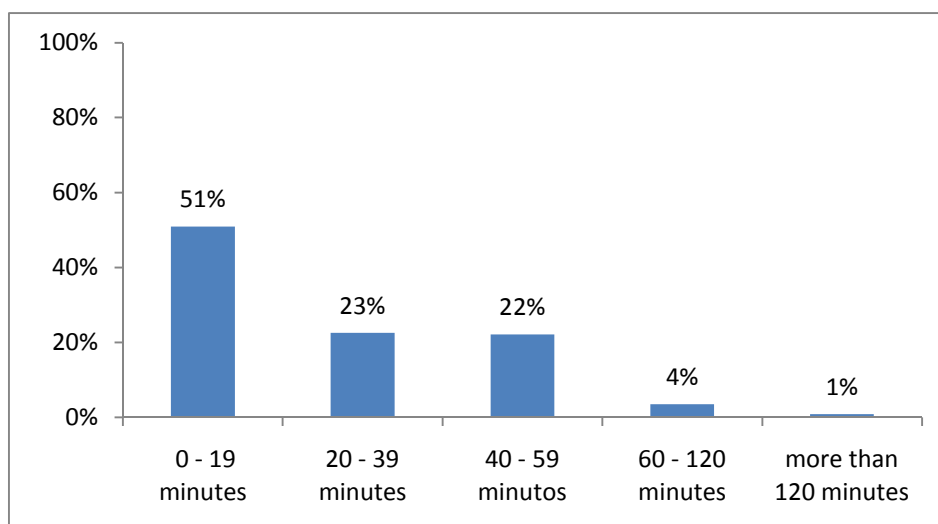


Figure 9: Average unloading time

Furthermore, 91.4% of respondents stated that the main problem for the delivery of goods at Central Market is parking. According to Oliveira *et al.* (2011), in Belo Horizonte, on average 58% of regulated spaces for loading/unloading of goods are occupied by private vehicles,

and the streets surrounding the Central Market present occupancy greater than 62%. This implies that vehicles traveling on streets close to the market seeking a place to park either illegally double-park to unload or use the market's customer parking area for unloading, even though it was designed for passenger vehicles and offers no adequate infrastructure for unloading operations.

## **POLICY IMPLICATIONS AND CONCLUSIONS**

The results obtained using this technique indicate that this method can be considered simple and effective for collecting primary urban distribution data. To minimize the weaknesses of the method, namely that receivers are unaware of the transport load aspects, as indicated by Holguín-Veras and Jalles (2012), we suggest that interviews always be conducted with the owners or managers of the establishment, as done in this study.

Thus, this method can be used as an important tool to obtain data for the development of urban freight mobility planning. The results of surveys conducted among retailers to determine origin-destination of products is valid for obtaining information about the origin of goods. The technique has the advantage of being easy to perform and providing details on the last element in the supply chain. The disadvantage of this technique is the impossibility of identifying the vehicle and routes used. This problem can be resolved by applying a similar survey to carriers. Despite these factors, we conclude that the survey technique can be used when one needs data for urban logistics planning.

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