

RELEVANT ATTRIBUTES IN OVERNIGHT GOODS DELIVERY: RESEARCHERS', TRANSPORTERS' AND RETAILERS' PREFERENCE IN URBAN DISTRIBUTION

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ABSTRACT

This paper introduces an exploratory research to identify the attributes required to accomplish the overnight goods delivery in urban areas from the point of view of researchers, transporters and retailers. The identification of preferences is important to assess the impacts of the policies provided for the overnight delivery that are being deployed in most urban centers. The urban goods distribution represents $\frac{1}{4}$ of the total traffic in the city and a reality that every society must learn to live with this problem, because without it there would be no economic activity. Policies such as just-in-time, delivery points and overnight distribution being practiced by different sectors of industry and commerce as a strategy to ensure growth and competitive advantage of their products. An urban logistics policy is one way to reduce the impacts of urban distribution, which seeks to reduce the diseconomies of the logistic process within a city. However developing policies for urban logistics requires breaking paradigms and behavior change among those involved in urban distribution, seeking innovative solutions that improve the supply chain. This paper brings to the discussion of urban distribution, assessing the behavior of those involved in overnight distribution process. The analysis was performed using a stated preference technique, that working issues such as delivery time, extra costs and improving service level. Results showed the divergent views among researchers, transporters and retailers about the strategies that should be implemented to reduce the impacts of growing demand for urban goods distribution. Furthermore, the results guide future works done by researchers and urban planners.

INTRODUCTION

The urban goods delivery occurs in urban areas that are characterized by the concentration of residences and commercial activities, and it has importance in the transport system to represent an important component in developing the economy. However, the consequences of this distribution, such as congestion, pollution, noise and vibration, reduce the welfare, accessibility and attractiveness of urban areas (Oliveira, 2007).

The urban goods distribution involves many stakeholders, with different activities, interests and responsibilities, which make the benefits even more difficult (Ogden, 1992). The importance of urban freight can be seen as an aggravating factor necessary to the local and urban economies, which require a large amount of daily trips for supplies. In Brazil, the urban freight transport accounts for 10% of vehicle-km and nearly 20% of the road occupation compared with private cars. However, in terms of harmful emissions, the urban freight transport contributes 60% in the emission of pollutants in urban areas. This situation can be explained both by the average consumption of fossil fuel by heavy vehicles, as the delivery speed in these areas and also, poor organization of deliveries (Pinto, 2002).

The overnight goods distribution is an alternative to reduce the flow of heavy vehicles in urban centers, but the studies about this theme is reduced. The impacts of stakeholders involved in overnight goods delivery need to be considered for the success these initiatives. In this context, this article presents the attributes that are relevant to the overnight goods distribution, with the study of case for Belo Horizonte (MG). Searches were conducted using the stated choice technique; the results show contradictory ideas of this policy. This paper presents the concepts, stated choice technique used to conduct the research, the results, and the conclusions.

THE OVERNIGHT GOODS DELIVERY

With the rapid and intense growth of metropolis, the freight transport reaches a larger area to meet the needs and expectations of customers. Thus, the goods distribution in urban areas is becoming increasingly complex and expensive, because they always expect a higher efficiency with lower costs.

The time required to accomplish the good distribution can be divided into stages as the loading time of the vehicle, travel time from the distribution center or factory to the customer, parking time, unloading time and, finally, the return travel time (from customers to distribution center or factory).

The overnight delivery is the delivery to retailers and shops in the urban area during the night hours when the city is usually quiet and inactive. In Brazil, the typical time is between 20.00 h and 7.00h.

The overnight delivery addresses the following aspects (Forkert and Eichhorn, 2004):

- The delivery during night time with specially equipped low noise vehicles;

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- Allowance for larger trucks to enter the city centre which are restricted during the day time.

The benefits with the implementation overnight delivery are (Forkert and Eichhorn, 2004):

- Reduces delays for the logistics services providers by using the free road capacities at night;
- Faster travel time for all vehicles;
- Reduces emissions and energy consumption (less congestion during night time, direct access to the shops);
- Increases logistics efficiencies in terms of the deployment of heavy goods vehicles and manpower;
- Consolidation and clustering of shipments;
- Positive contribution to road safety.

For the transport operator the main benefits derive from the use of bigger vehicles and from a reduction of travel time during night time. The benefits for society are the reduction of travel time for all vehicles during the daytime and a reduction of the number of delivery vehicles operating in the city centre. The retailers can benefit from a better organisation of the receiving the goods and less disturbance for the customers. Furthermore, the reduction of travel time leads to less pollution and energy consumption.

In Barcelona (Spain) in about 20 locations in the city and across the metropolitan area, goods are delivered overnight and the solution has been extended within a short period of time to about 140 supermarket outlets all over Spain. The night delivery was concentrated between 23.00h and 24.00h in the night and between 5.00h and 6.00h in the morning. It was utilized 40t trucks to do the delivery in the night. The noise equipment used was adapted, both for truck as well as the loading and unloading. As a result the trial was successful in terms of noise. About seven trucks could be replaced during day time allowing two large trucks to enter the city during the night time (Forkert and Eichhorn, 2004).

For the successful implementation of night delivery is necessarily the cooperation of the public side and the private sector. The key stakeholders are (Forkert and Eichhorn, 2004):

- The city administration is a main stakeholder being responsible for the necessary framework in the city as basis for a night delivery scheme. The city administration is responsible for the necessary access restrictions to the area concerned and noise levels;
- The transport operator are responsible for negotiations with the own system suppliers for an adaptation of the equipment used and with the receivers in order to guarantee the receiving of the goods during night time;
- The retailers need to find arrangements with regard to the receiving of the goods during night time. Either dedicated staff has to be on site if an attended delivery is planned or a technical solution has to be found if an unattended delivery shall take place.

Before the implementation, the following key aspects should be considered (Forkert and Eichhorn, 2004):

- The acceptance of night delivery can differ from country to country;
- Technical solutions for low noise equipment are available;

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- Public financial supports can encourage buyers and users to make use of the low noise equipment;
- The existing noise limits have to be respected;
- Local access regulations have to be considered and adopted;
- Urban space for deliveries has to be available;
- Organisation of the receiving of the goods during night times or in the morning at the receiver's side is needed.

Forkert and Eichhorn (2004) quote as success factors:

- Quality label indicating that quiet equipment is used;
- Openness of city authorities concerning alternatives delivery schemes;
- Research to develop low noise equipment and improve organization;
- The shops are able to receive the goods during night time;
- Infrastructure around the ramps, quiet loading and unloading locations, quiet pavement;
- Training of drivers and ramp personnel;
- Contracts between retailer/receivers and shippers ensuring that goods are transported with quiet equipment;
- Co-operation between shippers and transporters ensuring that the transporters use quiet equipment.

In Brazil, there are few cities that have adopted the night distribution. Sao Paulo City took the overnight goods delivery, where changes the routine of the city, despite increases in costs resulting from labor charges, led to an increase in productivity of up to 50% per vehicle, offsetting costs and allowing a reduction of transport costs. However, this measure was not well received by the customer, having to provide staff for receiving the goods. In São Paulo, the heavy truck can only run from 9.00p.m. to 5.00a.m. in Zone Maximum Restriction of Movement, from Monday to Friday. On Saturdays, are forbidden to run from 10 to 14 hours. However, there are Urban Vehicle Truck (VUC) that is a little truck, with capacity 2,5t and also this vehicle need to respect the local rotation of vehicles, based on the last number of the license plates. According to the last digits of the vehicle's plate, there is a restriction to travel in this region from 7.00a.m. to 10.00a.m. and from 5p.m. to 9.00p.m. (CET-SP, 2010). This restriction is also valid for passenger cars.

In Rio de Janeiro City, in specific residential areas, larger trucks are allowed to travel, load and unload only during a particular time of day. In these areas, trucks up to 2t capacity are allowed anytime (Carvalho *et al.*, 2000).

METHODOLOGICAL PROCEDURES

The manifestation of individuals' preferences for a particular product or service reflects its performance concerning a set of options available. Some events allow to clearly identify the components of the user's action for a given product or servicing (Almeida, 1999).

For some types of analysis, such as changes in the service provided, implementation of a service and identification of unknown scenarios, these techniques become ineffective

because it is not clearly detected the relative importance of variables, making it impossible to obtain results to guide future predictions or new situations (Martin et al., 2005).

In this case, the stated choice preference technique becomes appropriate, because it is more flexible (Kroes and Sheldon, 1988), since it permits the analysis does not necessarily exist and to identify the relevant characteristics for users of the service studied. It can be used in marketing studies, for example, to analyze the impact of introducing a new product in the system.

With the stated choice preference technique, it is possible to identify the relative importance of each characteristic in relation to others. This allows further configuration of the service closer to the desires of users. As disadvantage, these techniques offer the fact that users do not necessarily do what they said.

The stated choice preference technique involves the preferences of individuals and their behavior is estimated using the choice models, and it is possible to analyze nonexistent situations real, and identify characteristics of the system under study those are relevant for the user. Also, it is possible to explore combinations of attributes and their variability. Thus, it allows to know the relative importance of each attribute selected. Thus, it is possible to set up situations for the service examination close of the users' interests.

Still, for this work development, these techniques are more appropriate, since it is possible to analyze the behavior of users before a different picture of reality. Thus, it is determined the service characteristics that are actually relevant for the user, but not yet implemented or are not available.

Stated Choice Preferences

The most common definition in the literature for the term stated choice preference techniques is attributed to Kroes and Sheldon (1988), who defined these as a family of techniques, that use individual responses regarding the preference of respondents, in a number of options, to estimate the utility function.

The stated choice preference technique is based on interviews and presents to the respondent a set of options, which are scenarios or hypothetical alternatives, constructed by the researcher. The respondent, through a range of options, choose your preference. The data collected are processed by statistical models that adjust the parameters to define a utility function.

Stated Choice Preferences Characteristics

The stated choice preference technique can be seen as an interaction between a research method and behavioral theory (Novaes *et al.*, 1996). The paradigms used to human behavior model are not focused with the behavioral theory alone, but with methods that can be used to test aspects of this theory.

One of the main objectives of stated choice preference experiments is to build a set of hypothetical options but realistic, known alternatives (Ortuzar, 1994; Ortúzar e Willumsem, 1990).

The main features of the stated choice preference technique are (Almeida, 1999):

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- The respondent is subject to a series of choices; the set of alternatives is constructed in such way that considers the main factors that influencing the choice on the problem under study;
- The set of options presented to the respondent consists of hypothetical alternatives, which are not part of the current set of alternatives, but they approach the maximum possible reality;
- Each alternative is represented by a set of attributes that identify the product or the service;
- The attributes levels in each alternative are specified by researcher and interviewee in the form of options. The number of levels considerate should be as large as possible that the researcher can distinguish even when individuals are willing to exchange one for another option; however, a lot of levels can make the experimental design very complex and difficult the process choice;
- The individuals can report their preferences in three ways: by putting them in order of preference (ranking), submitting a rating scale (rating) or choosing the preferred option by a set of available alternatives (choice).

Utility Function

The basic principle of discrete choice models states that the probability of an individual to make a right choice is function of their socioeconomic characteristics and the attractiveness in question compared to others (Ben-Akiva e Lerman, 1985).

To represent the attractiveness of an alternative compared to others, you can use the concept of utility. The utility represents the benefit that an individual perceives when consuming resources on different goods or services.

The concept of utility followed an order of evolution to reach the place in the models of choice. Initially, it was expressed in generalized cost functions that transform the attributes into a single monetary variable that expresses the cost perceived by the consumer. Next, the concept of utility has to be used in behavioral models of aggregate levels, when base on observations. Finally, has become the preference model, which fit the stated choice preference methods.

Within the behavioral models, the process of decision about choosing an alternative is influenced by rational and subjective factors. The rational factors are explained by individuals' socioeconomic characteristics. The subjective factors are those that are not expressed directly from economic concepts, for example, comfort in public transportation.

The utility is given by the value assigned by a person to the product. It is assumed that individuals choose a combination of products that maximize their utility. The configuration commonly used is:

$$U_i = a_0 + a_1X_1 + \dots + a_nX_n$$

where:

U_i is the option utility i ;

X_1, \dots, X_n are the product attributes;

a_1, \dots, a_n are the model coefficients;

a_0 is the model constant.

The model coefficients represent the relative values of attributes for the overall utility of the product and the constant a_0 can be interpreted as a slope for (in favor) or against the product.

Each variable X represents an attribute or characteristic related to the alternative in question and their relative importance can be perceived by its coefficient. The coefficients can also be used to determine monetary values and specify utility functions in models of prediction. The utility defined is based on some basic premises, namely:

- Consistency: under identical conditions the probability to choose some alternative should not be altered.
- Transitivity: if compared two alternatives i and j , through their utilities, and then compare alternatives j and k following alternative must be true “if the alternative i is better than the alternative j and the alternative j is better than the alternative k , then the alternative i is better than the alternative k ”.

There are two ways to use the utility in a choice process. At first, when the utility of alternative i (U_i) is greater than the utility of alternative j (U_j), it chooses the alternative i . For the second form, it calculates the alternatives of choice probabilities i and j from U_i and U_j which concludes that the user would choose i with probability P_i and the alternative j with probability P_j .

The second way avoids sudden interpretations, when, for example, $U_i > U_j$, and implicitly considers the uncertainties associated with behavioural patterns.

Modelling the structure of the users decision (or buyers) is usually made based on the LOGIT model (Sena, 1994a, 1994b), whose functional form for the multinomial case, is,

$$P_i = \frac{e^{U_i}}{\sum_{j=1}^n e^{U_j}},$$

where P_i is the probability of alternative i be chosen.

ANALITICAL MODEL

In this work, to apply the stated choice technique, was considered the following attributes: operational cost, operational time, investment and period of the day. These attributes are justified based on market criteria, can be defined as:

- Operational cost: cost that focuses on variables such as fuel, payment of salaries, vehicle maintenance, etc. For those involved in the goods distribution, the increase in operating cost directly impacts in company profit. It wants to minimize this cost to increase profitability;
- Operational time: total cycle time to complete the delivery of the goods, including loading time, travel time, time to park the vehicle, discharge time and return trip time. Transporters and retailers want minimum operational time to get the maximum service level;
- Investment: necessary to acquire suitable equipment for overnight delivery to minimize the impacts caused by the operation, as equipment for loading and unloading and vehicles emitting less noise;

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- Period of the day: period that the operation of goods delivery is carried out (daytime or night time).

These attributes were defined as the characteristics and expected changes in the system after the implementation of overnight goods delivery. For each attribute considered in the study were defined two levels of choice. The first level corresponds to the current situation and the second level considers the consequences of changing the operation for the night time. The description of the attributes and their levels, respectively, is shown in Table 1.

Table 1 – Attributes and respective levels used in this research

Attribute	Level
Operational Cost	0: The operating cost keeps the same 1: Reduction in operational costs
Operational Time	0: The operational time keeps the same 1: Reduction in operational time
Investment	0: No investment 1: Investment with equipment and/or vehicle
Period of the day	0: Daytime 1: Night Time

In elaboration of this experiment, it was necessary to determine the form of presentation of the alternatives to the interviewees. A widely used method, because it is easy to prepare and the cost is not high, is to present the alternatives in the form of choice cards, containing the attributes and levels. The making of these cards requires attention, because the information must be clear, accurate and easily understood by respondents.

In execution of the interview, the interviewee should be well informed what the procedure with the cards set will be present. There are three ways to obtain information about the interviewee's preference:

- choice, when the respondent chooses the best alternative;
- rating, when the respondent gives grade to alternatives;
- ranking, when the respondent order the alternatives according your preference.

The acquisition of preferences for order, ranking, is widely used (Almeida, 1999). Camargo *apud* Martins *et al.* (2005) concluded that ordering the alternatives is less tiring for the interviewee in the conditions presented. In this work, it was opted to use ranking, in which the interviewee order the alternatives according to their preferences.

The number of alternatives presented varies depending on the situation worked out, being, generally, between four and nine cards. The quantity of cards presented for the respondents increase the difficulty in ordering the preferences; but the number can be changed according the target population.

The results obtained analyzing the number of attributes and level indicated an experiment following factorial arrangements, been used for the Test 1.1 by Souza (1999), and presented in the Table 2.

Table 2 – List of cards used in the application of questionnaires

Cards	Alternatives
1	0000 1110 1101 0011
2	1100 0010 0001 1111
3	1000 0110 0101 1011
4	0100 1010 1001 0111

To calculate the coefficients values presented previously was used the program LMPC (Multinomial Logit with Conditional Probability) by Souza (1999).

In addition to these results, the software also provides conditions to test the null hypothesis of all parameters while, using the equation $-2[F(0)-F(B)]$, where $F(0)$ represents the value of the likelihood function for all null coefficients and $F(B)$ represents the value of the function (Martins *et al.*, 2005).

This research was applied *in loco* for the transporters and retailers from the inner-city of Belo Horizonte (MG) and for researchers in city logistic in Brazil. The value obtained for test the null hypothesis indicated the rejection of the null hypothesis of all parameters simultaneously. For the rho test, the value found was between 0,2 and 0,5, considered an excellent value for Ortúzar and Willumsen (1994) and Senna (1994).

RESEARCHERS' PREFERENCES

Among the researches in the field of urban logistics were interviewed teachers and specialists. The results are in Table 3.

Table 3 – Researches' Results by LMPC Program

Attribute	Coefficient	Standard Deviation	T Test	IC (t=2,5%)
Operational Cost	0,7237	0,2893	2,5014	[0,145;1,302]
Operational Time	0,5793	0,2871	2,0176	[0,005;1,154]
Investment	0,0365	0,2656	0,1373	[-0,495;0,568]
Period of the Day	0,3358	0,2741	1,2252	[-0,212;0,884]

As shown in Figure 1, the percentages indicate the relevance of attributes by the researches, where the operational cost is more important and, thereafter, the operational time. It is observed that the period of the day is not significant, although this attribute is the issue under study.

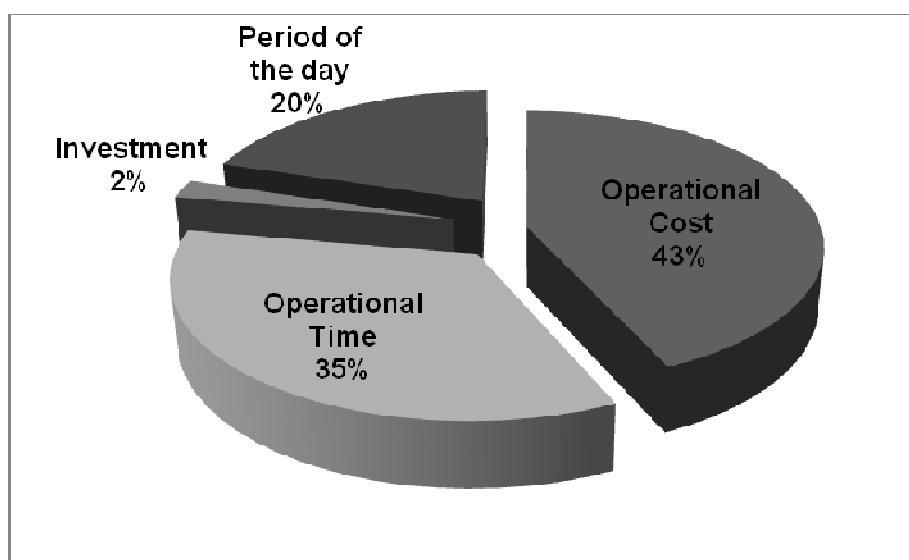


Figure 1: Percentage of the attributes declared by researchers in city logistics

TRANSPORTERS' PREFERENCES

With the socioeconomic information, it was possible to characterize the respondents, an important factor and should be analyzed in conjunction with the survey results of stated choice preference. Among the transporters, respondents transporting various types of loads, which were grouped into three categories: beverages (10%), food (15%), and other goods (75%) (Figure 2).

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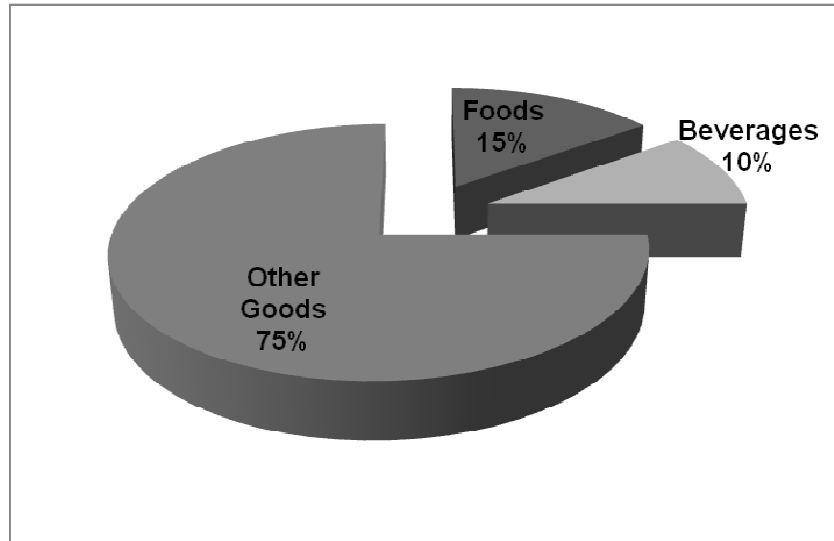


Figure 2 – Percentage of goods delivered by carrier

The preference results of the transporters are in Table 4.

Table 4 – Transporters' Results by LMPC Program

Attribute	Coefficient	Standard Deviation	T Test	IC (t=2,5%)
Operational Cost	0,4452	0,1813	2,4558	[0,083;0,808]
Operational Time	0,1698	0,1793	0,9472	[-0,189;0,528]
Investment	-0,3956	0,1858	-2,1292	[-0,767;-0,024]
Period of the day	-0,3382	0,1739	-1,9452	[-0,686;0,010]

As shown in Figure 3, the operational cost and investments are the most significant, but the period of the day which the delivery occurs is also relevant by the carrier.

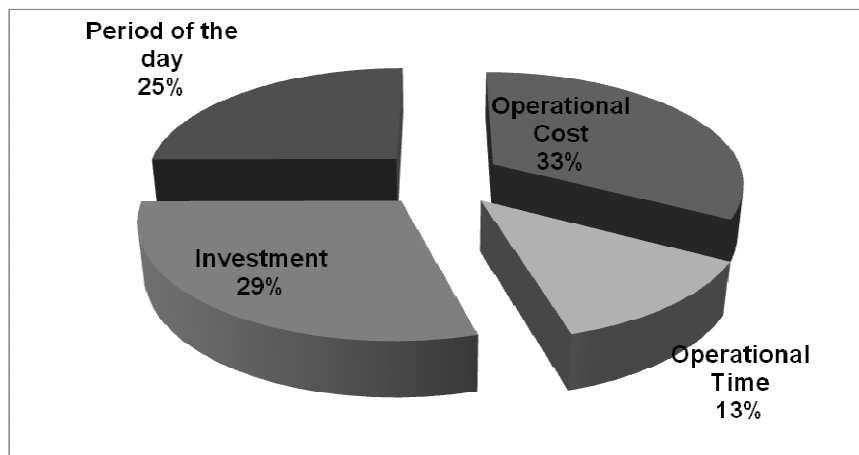


Figure 3 – Percentages of attributes preference by carriers.

RETAILERS' PREFERENCES

Respondents of the retail sector were, in most, food businesses, as shown in Figure 4.

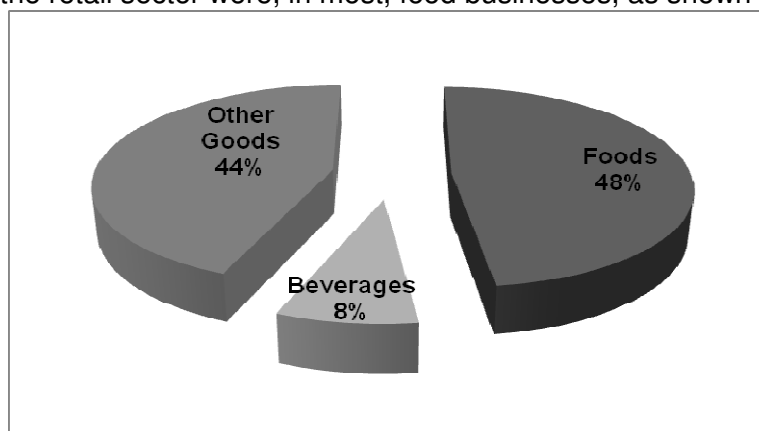


Figure 4 – Kind of goods received by retailers.

During the interview, the retailers indicated as important factors for delivery, the frequency, quality and flexibility in delivery times during business hours. It is also evident that, for retailers, reducing operational cost of delivery is not significant; it perceives that with a high cost it is necessary to invest in someone to receive the products.

In the retailers view, overnight delivery is not an interesting solution because it is necessary to invest in staff and security for the receipt of goods and would not have many benefits themselves with this policy. The preference results by retailers are in Table 5.

Table 5 – Retailers' Results by LMPC Program

Attribute	Coefficient	Standard Deviation	T Test	IC (t=2,5%)
Operational Cost	1,1371	0,2428	4,6839	[0,652;1,623]
Operational Time	0,0183	0,2113	0,0864	[-0,404;0,441]
Investment	-3,1191	0,3603	-8,6563	[-3,840;-2,398]
Period of the day	-1,0921	0,2434	-4,4873	[-1,579;-0,605]

As shown in Figure 5, the attribute considered more important in the search by retailers is the investment, and after, the period of the day and the operational cost. This reflects the dissatisfaction of the retailer to receive the product at night and see as an operating cost, investment in manpower for the project viable.

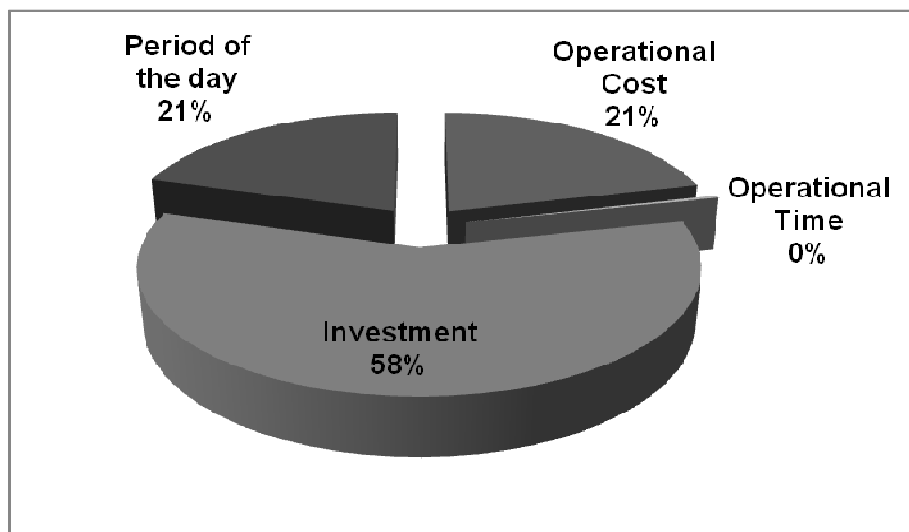


Figure 5 – Percentages of attributes preference by retailers.

CONCLUSIONS

Generally, the society is resistant to adopt new ideas. Apply the stated choice preference technique in this context it is important to identify the attributes that are factors of success for a new idea.

The overnight goods delivery is an innovative solution to reduce the number of load vehicles in inner-cities. Belo Horizonte is one of the cities that is being implemented this solution for the central region, seeking to reduce the high levels of congestion.

Survey data indicate that the overnight delivery of goods is important, but has major negative impacts. The transporter cites the lack of security as a major factor, because of the high levels of marginality in central region. For the retailer, to dedicate an employee to receive the goods at night has a significant economic impact, which is one of the factors that cannot make the project feasible. It is necessary to get partnerships between transporters and retailers seeking a joint solution to this problem. Actually, in Belo Horizonte, although there is a law to forbid large vehicles in inner-city, it is observed too often, this vehicles operating in these regions because of the lack of supervision to curb such practices.

Despite the search results, it knows the importance of overnight goods delivery, which makes clear the need for public-private partnerships for the deployment of solutions, provision of subsidies, investment in public safety for the success of such initiatives. Still, this work indicates that the way to the solutions deployment such as overnight delivery requires more than legislation implemented by the government, but the development of projects covering the current problems in the goods distribution with solutions that incorporate the disadvantages mentioned to gain competitive advantage.

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