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Evaluation of the City Logistics Performance Through Structural Equations Model

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ABSTRACT The objective of this work is to propose a model for evaluating the performance of city logistics by questioning the relationship between the stakeholders involved, key performance factors in terms of efficiency and responsiveness, and urban parameters. The study is of the quantitative exploratory-descriptive type, using auto-administered cross-sectional survey procedure, in which the questionnaire question instrument is available online. The agents classified as shippers were questioned and the data obtained were analyzed using Structural Equation Modeling (SEM) based on Partial Least Squares (PLS) through Smartpls ®software. Five hypotheses were tested, in which the involved stakeholders factor in the SEM model was not statistically significant in relation to the performance of city logistics, pointing to the need for attention to this in terms of the strategic alignment from a new definition of the agents covered in the distribution of goods in the urban area. In addition, 56.4% of the variance in the city logistic performance variable was explained by the model.

INDEX TERMS City logistics performance, stakeholders, key performance factors, urban parameters, structural equation modeling (SEM).

I. INTRODUCTION

The delivery of goods is vitally important for residents and companies in urban areas, considering that there are few activities that occur without the movement of goods. However, despite this relevance, the transport of cargo within the urban perimeter consists of one of the main disturbing of life in the cities [1], [2].

Congestion, precarious parking practices, environmental disturbances (gas and noise emissions), accident risk, increased logistics costs and consequently, product prices, correspond to negative externalities associated to freight operations, impacting both the lives of people residing or working in cities, such as the productivity of companies in urban areas and their supply chains [2], [3].

This situation tends to increase, since the number of cargo vehicles moving in urban areas is multiplying and it is expected to continue to grow at an accelerated pace. This is due to the current practices of production and distribution based on zero stock and timely deliveries, growth of e-commerce and mainly, the trend of global urbanization, with migration of people from the fields and small towns [2], [4], [5].

In order to reduce the impact of freight vehicle movements in terms of negative externalities, city logistics projects have been developed in order to coordinate the activities resulting from freight operations within the city [2]. According to [6], the performance of city logistics is considered an important factor for the sustainable growth of cities.

A logistic performance assessment system should provide information to assist stakeholders in decision-making [7]. Its process requires agents to perform four steps: design, facilitate, encourage and intensify performance. In the case of designing performance, there are three types of related components: models, measures and methods for measurement. A performance model, object proposed in this study, consists of a chosen structure that binds the overall performance with different decision elements in fulfilling the objectives [8].

The proposed approach is aimed at a performance model that intends to provide a structure to analyze city logistics

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from three attributes: stakeholders involved, key performance factors in terms of efficiency and responsiveness and urban parameters. This model with their respective measurement and structural sub-models is the scientific contribution of this research.

The main objective is to test a set of hypotheses focusing on the factors mentioned and to provide relevant information to decision-makers concerning important issues for shippers.

This study focused on the perceptions/opinions of the shippers (manufacturers, wholesalers and retailers), acquiring perceived information on issues related to the components of city logistics based on survey. It can be argued that these perceptions do not adequately reflect the evaluation of the performance of city logistics. However, the shippers have a close relationship with all the weighted stakeholders, therefore, directly suffering the particularities of each, as well as the logistical operations covered and their consequences.

The remainder of this article is structured as follows. The following section contains a review of the literature covering issues related to city logistics and its attributes. After, it follows a description of the applied research method, addressing an introduction of the partial least squares structural equation modeling (PLS-SEM) technique, research structure, study hypotheses, data collection instrument and sample size. The results obtained are analyzed and discussed in the penultimate section. Finally, in the conclusions, the main findings are presented and the implications of the model are highlighted.

II. LITERATURE REVIEW

The movement of goods in the urban environment is considered a topic of concern and needs further deepening so that interventions are optimized.

According to [9] logistics is defined as the process of planning, implementation and control of the efficient and effective flow of goods, services and related information from the point of origin to the point of consumption for the purpose of meeting the requirements of customers. This flow when interacting with the urban landscape, it began to suffer with negative externalities. During the years 90, some European countries, namely: Germany, Holland, Belgium, Switzerland and Denmark, initiated projects referring to alternative models, known as city logistics [10].

[11], [12] defined city logistics as the process of total optimization of logistics activities by private companies in urban areas, with the support of advanced information systems, considering the traffic environment and its congestion, safety and energy consumption in the context of a market economy.

For [13], the basic objectives of city logistics address three points of view: economic, social and environmental. For this purpose, improvements in cargo traffic are planned for efficiency, acceptance and sustainability requirements, respectively.

According to [14], city logistics consists of the term used to assign specific concepts and practices involved in the distribution of goods in urban areas with their specific problems, such as: congestion, places not suitable for parking, among other.

According to [15], through city logistics, it is possible to reduce congestion and increase mobility through the control of cargo vehicles operating in urban centers, as well as to reduce levels of air and sound pollution improving the quality of life of inhabitants.

Thus, it can be said that city logistics is the process of planning, organizing, coordinating, controlling and optimizing efficiently the transport and consolidation of goods, as well as services, information and revenue in the urban area, observing the plurality of the cities and agents involved, and also the rationality and relevant strategies of the latter.

From this definition, three constructs related to city logistics are highlighted: stakeholders involved, key performance factors and urban characteristics, to be detailed below.

The movement of goods in the urban area involves a large number of actors, each with different roles, problems and objectives [10]–[12]. City logistics models need to recognize these factors, predicting a set of performance and impact measures for each group involved.

According to [12], [16]–[18], there are 05 agents involved in the distribution of goods in the urban area: (a) shippers, (b) receivers, (c) logistics service providers, (d) residents, and (e) public administration.

Shippers send goods, usually through logistic service providers, seeking to maximize service level in terms of lower services costs and delivery/collection time, greater reliability and flexibility, and better information. In just in time (JIT) transport systems, the reliability of goods delivery in terms of damage to goods or without any delay has become indispensable. Manufacturers, wholesalers and retailers are classified as shippers.

The receivers receive the products within the urban perimeter, which may be the final consumers or commercial establishments. Your concerns are related to the receipt of your goods in the shortest possible delivery time and in a correct manner.

Logistics service providers may be responsible for the distribution and aim to minimize the costs of delivering and collecting goods to receivers in order to maximize profits. To do so, they need to provide high levels of service at a lower cost, facing the inefficiency of the system related to the difficulty of operating the vehicles in urban areas due to traffic congestion. In this category, it is possible to include both carriers and logistic operators, whose difference is associated to the activity developed, in which the latter do not only carry out transport, but also other activities of the logistics chain as storage, for example.

Residents correspond to people who live, work and buy in cities. They would like to minimize traffic congestion, noise, air pollution and traffic accidents near the commercial and residential areas.

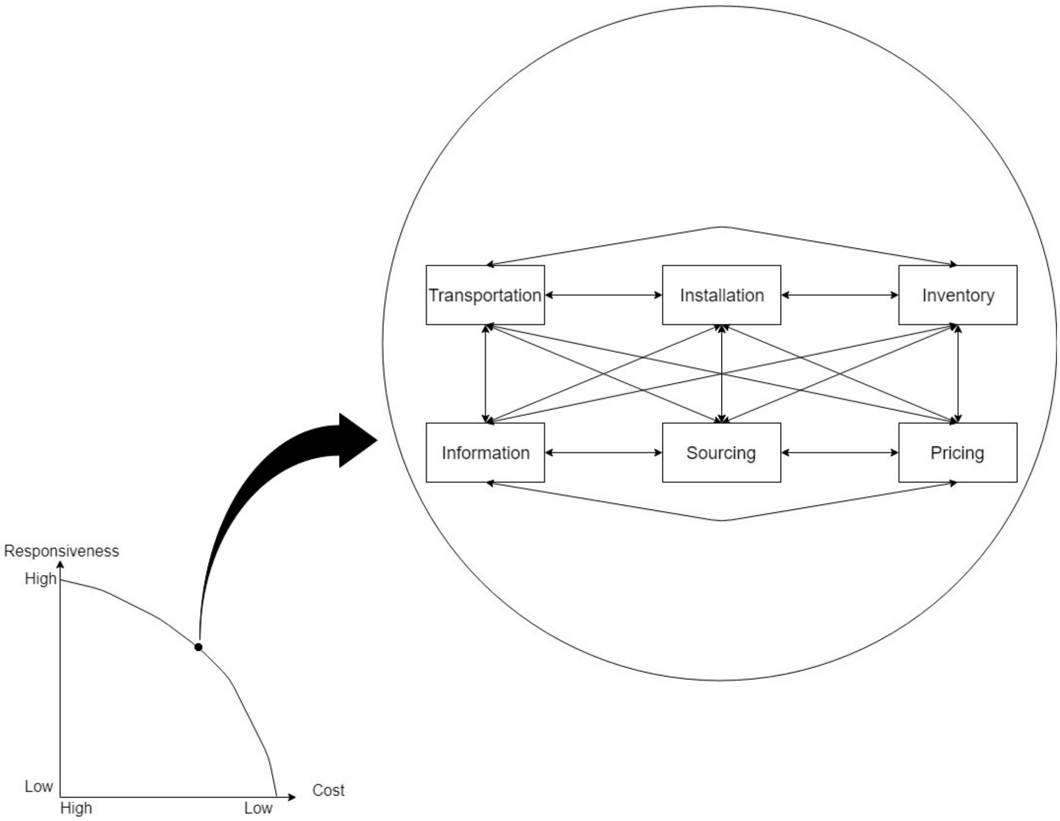

FIGURE 1. Structuring the logistic and inter-functional key factors in the efficient cost-responsivity frontier Source: Adapted from [25].

Public administration can be considered the municipal, state or national government. It tries to improve the city's economic development, congestion levels and the environment, increase job opportunities and reduce road accidents. It must be neutral in resolving any conflict between stakeholders involved in the urban distribution of goods, so they have a vital role in coordinating and promoting city logistics initiatives.

Some authors treat the receptors and residents as a single agent [12]. However, this document will be tested as heterogeneous actors. In addition, for this study, non-governmental organizations – non-profit entities active in the areas of health, education, social assistance, economic, environmental, among others, who perform solidarity actions for public can be in the local, state, national and international spheres [19] – were also considered as an agent involved in the performance of city logistics activities to be examined. This is because non-governmental organizations are intervening in a complementary way to public administration, contributing to the establishment and maintenance of the ecological state of law [20]. Urbanists, traffic and transportation engineers and universities were considered as part of the public administration.

With regard to improving the performance of city logistics in terms of efficiency and responsiveness, most studies examine only the transport and installation factors as determinants for achieving the desired level. For example, it stands out [21]–[24] that they recommend the development of consolidation strategies, in which it is possible to reduce delivery costs by means of distance or time gains and the adoption of subsidies for both urban consolidation centers and for alternative collection and delivery systems.

According to [25], both logistic key factors (transportation, installation and inventory) and inter-functional (sourcing, pricing and information) determine the performance of any supply chain. Thus, it is understood that due to the urban chain being contained in the global, city logistics includes both factors interacting with each other to determine its performance and thus considered in this evaluation (FIGURE 1).

In this way, transportation involves moving inventory from one point to another in the supply chain. Installation is the actual physical location where the product is stored, assembled, or manufactured. Inventory covers all raw materials, work in process and finished products that are flowing within the global supply chain, and for this document is considered only the latter. Sourcing is the choice of who will perform a certain activity, such as production, storage, transportation or information management. Pricing determines how much a company will charge for goods and services it makes available. And lastly, information consists of data and analysis regarding facilities, transportation, inventory, costs, prices and customers throughout the supply chain.

The urban cargo transport system influences urban configuration [26], [27]. Thus, it is fundamental to understand the relation of load with constraints of urban planning, namely: demographic density, installment, use and occupation of the land, urban road system and legislation.

Accordance to [28], the demographic density consists of the number of inhabitants per surface unit. Reference [27], [29], [30] point out that the high urban density means a greater need for movement of goods for this area, i.e. increased movement of cargo vehicles, therefore reaching the road capacity.

In order to avoid that certain spaces do not exist unnecessary lotions and aiming the territorial ordering, it must establish policies of planning, control and supervision of the installment, use and occupation of urban land. To this end, a basic infrastructure is involved, consisting of urban stormwater drainage equipment, public lighting, sanitary sewage, drinking water supply, public and home electrical energy and circulation [31]. In the Brazilian scenario, local administration is responsible for promoting the appropriate territorial planning [32].

Among the basic infrastructure is the set of intra circulation pathways, called the urban road system. This is complex with a view to the provision of various urban functions (displacement of motor vehicles, non-motorized, pedestrian and sociability), contributing to universal access to cities, fostering and achieving the conditions that cooperate urban mobility, as a consequence, of the performance of city logistics. Logistics activities depend on efficient road operation, including fluidity, capacity, security, economics and externalities [27], [33].

Finally, as previously mentioned, the transport of goods in the urban perimeter intensified congestion and other externalities. This pushes legislators to impose restrictions to meet the aspirations of the population. In this way, there are many institutes of law that deals with the legislation applied to the distribution of urban cargo, namely: tax, consumer, administrative, constitutional, environmental, work, civil and criminal [17].

[26], [34] point out some important measures regarding the urban road system as: access conditions (entry criteria in urban areas based on the environmental performance of trucks and monetary incentives for delivery of goods outside the peak hours). In addition, according to [34]–[36], regarding land use and demographic density, namely: planning and regulation of the provision of spaces, as well as demographic characteristics and purchasing behavior, respectively, correspond to measures that contribute to the performance of city logistics.

III. METHOD

Based on the one presented in the previous section, a preliminary model was defined in order to design the questionnaire and collect data in companies to be presented in the next section. After the survey, the proposed model was evaluated by means of an exploratory approach using the analysis of structural equations of minimal partial squares (PLS), with the purpose of obtaining the most appropriate model in terms of reliability and validity. The model statistic was calculated, the results discussed, and the recommendations suggested.

A. STRUCTURAL EQUATION MODELING

According to [37], [38], Structural Equation Modeling (SEM) allows both the definition of latent variables indirectly measured from variables observed as the accounting for the measurement error of the latter.

The latent variables can be classified as their function in two types: exogenous and endogenous. The first, identically called independent or predictive, constitute those that are not influenced or do not suffer the effect of other variables in the model. And the latter, similarly, called of dependents, represent those that suffer influence from other variables present in the model.

The SEM can be organized according to the relational structure between the variables in two submodels: measurement and structural. The measurement theory specifies how the latent variables are measured, making use of confirmatory factorial analysis. The structural theory presents how the latent variables relate to each other, and the localization and sequence of these are based on the theory and/or experience of the researcher, using regression analysis and path to verify both the predictive capacities of the model and the relationships between the latent variables [37], [39].

Two are the equations that represent the measurement model [39]:

$$x = \lambda_x \xi + \delta \tag{1}$$

$$y = \lambda_y \eta + \varepsilon \tag{2}$$

In which x and y are the variables observed; λ_x it is the matrix of coefficients that associates the observed variables and the exogenous latent variables; ξ it is the vector of the exogenous latent variables; δ it is the vector of measurement errors in exogenous variables; λ_y it is the matrix of coefficients that associates the observed variables and the endogenous latent variables; η it is the vector of the endogenous latent variables; ε it is the vector of measurement errors in the endogenous variables.

The structural model can be expressed by (Krajangsri & Pongpeng, 2017):

$$\eta = \beta\eta + \Gamma\xi + \zeta \tag{3}$$

In which η it is a vector of the endogenous latent variables; ξ it is the vector of exogenous variables; ζ it is the vector of latent errors in the equations; β it is the matrix of coefficients that binds the endogenous variables; Γ it is the matrix of coefficients relating the exogenous variables to the endogenous.

There are two types of SEM: based on covariance (CB-SEM) and partial least squares (PLS-SEM). CB-SEM is used to confirm or reject theories and PLS-SEM to develop theories, through maximization of the variance of endogenous constructions [37]. The latter has gained acceptance in many business disciplines, such as operations management, due to three main reasons: data distribution (non-normal data), small sample size and use of formative indicators [41]–[45] and it was the used in this document.

TABLE 1. Summary of evaluation measures for reflective indicators.

Purpose	Indicator/Procedure	References
Convergent validity	Average extracted variance (AVE)	[41]
Internal consistency	Cronbach's alpha Composite reliability	
Discriminant validity	Cross loads Fornell and Larcker criteria	[51] [50]

When using the PLS-SEM, it is necessary to follow a process in several stages involving the specification of the internal and external models, evaluation of the external model and evaluation of the internal model [45].

Once the measurement and structural models have been specified, the next step is to run the PLS-SEM algorithm. initially, it evaluates the reliability and validity of measurement model measurements based on the results and at this time, it is considered that the relationships of the structural model are accurately represented. It is important to emphasize that depending on the measurement approach, reflective or formative, the evaluation measures are different. The summary table presented below (TABLE 1) shows only the measures of reflective treatment because it is used in the model proposed here.

The AVE corresponds to the portion of the existing data in the variables that is explained by each of the respective latent variables to their sets of variables. This means saying how much on average the variables correlate positively with their latent variables [46]. According to Fornell and Larcker's criteria [47], The values of the AVEs must be greater than 0.5. Source: Adapted from [49], [12]

According to [37], values of both Cronbach's alpha, Rho_A and reliability composed of 0.60 to 0.70 are considered adequate in exploratory research, between 0.7 and 0.9 are considered satisfactory in more advanced stages of the research and above 0.9 are not desirable, because indicate that the latent variables are measuring the same phenomenon. In addition, Cronbach's alpha is sensitive to the number of items and generally tends to underestimate the reliability of internal consistency. Already Rho_A returns an average value between Cronbach's alpha and composite reliability. Thus, due to the limitations of Cronbach's alpha it is technically more appropriate to use composite reliability [37].

Discriminant validity is understood as an indicator that measures the independence of a latent variable in relation to another [37], [46], it can be evaluated by observing cross-loads [48] or by the Fornell and Larcker criteria [47]. In the case of cross-loads, the discriminant validity is adequate when the higher factorial loads of the observed variables are in their respective latent variables. For the Fornell and Larcker criterion, when a construct shares more variation with its associated indicators than with any other construct [37].

Next, the evaluation of hypothetical relationships within the structural model is evaluated (TABLE 2).

For the evaluation of collinearity, each set of predictive constructs must be examined separately for each subpart of the model. For this, tolerance values below 0.20 (variance inflation factor -VIF above 5) in the predictive constructs is classified as a critical level of collinearity [37].

For the hypothetical relationships between the constructs represented by the path coefficients, the values usually fall between the limits -1 and $+1$. To verify that these are significant evaluates their standard error that is obtained by means of *boostrapping*, a technique in which many samples are taken from the original sample with substitution and that calculates the empirical t values and the p values for all coefficients.

The Pearson's determination coefficients are then evaluated (R^2). According to [37], [46], the R^2 evaluates the amount of variance of the endogenous variables that is explained by all the exogenous variables linked, representing a measure of the predictive power within the sample.

According to [49], regarding the area of social and behavioral sciences, it suggests the small effect classification for $R^2 = 2\%$, mean effect for $R^2 = 13\%$ and great effect for $R^2 = 26\%$. This convention will be adopted in this document.

Following the evaluation, the size of the effect or indicator of Cohen (f^2) aims to evaluate the contribution of an exogenous construct to a R^2 value in the endogenous latent variable. The guidelines are that values of 0.02, 0.15 and 0.35, respectively, represent small, medium and large effects of the exogenous latent variable [37], [49].

Subsequently, it analyzes the value of Stone-Geisser (Q^2), in which it evaluates how much the model approaches what was expected of it, that is, the predictive relevance of the path model for a particular dependent construct for values greater than zero [37], [46]. For this purpose, it uses the "Blindfolding" technique of reuse of samples that systematically omits data points and provides a prognosis of their original values [48]..

According to [37], the value of Q^2 can be calculated by means of two approaches: cross-validation of construct redundancy and cross-validation of the communality of the construct. The first is based on the estimates of the path model of the structural model and the measurement model. While, the second uses only the estimated scores for the target endogenous construct.

B. RESEARCH FRAMEWORK

This study tries to develop a predictive model for evaluating the performance of city logistics and validating the model in Brazilian companies classified as shippers. The main variables involving the constructs were detected, according to Table 3 below. The Figure 2 shows the paths between the attributes and the performance of city logistics.

C. STUDY HYPOTHESES

Five hypotheses were developed from the model. These hypotheses given below and presented in Figure 2 relate the

TABLE 2. Summary of the structural model evaluation measures.

Purpose	Indicator/Procedure	References
Collinearity	Collinearity	[49]
Evaluate the portion of the variance of the endogenous variables that is explained by the structural model	Pearson's coefficient of determination (R^2)	[52]
Evaluation of how much each construct is useful for adjusting the model	Cohen effect size or indicator (f^2)	
Evaluating the accuracy of the adjusted model	Predictive validity or Stone-Geisser indicator or cross-validity redundancy (Q^2)	[41]
Evaluation of causal relations	Path coefficient	

TABLE 3. Attributes framework for assessing city logistics.

Constructs	Indicator variables and brief description
City logistics performance (CLP)	CLP1: Integration: collaboration between the agents involved
	CLP2: Efficiency: meet prioritizing costs
	CLP3: Responsiveness: responsiveness to the customer
	CLP4: Sustainability: balance between the three pillars: environmental, economic and social
Stakeholders involved (SI)	SI1: Shippers: agents responsible for sending goods
	SI2: Receivers: agents responsible for receiving goods
	SI3: Public administration: agent responsible for the planning and development of public policies and may be of municipal, state or national character
	SI4: Logistic service providers: agents responsible for adding value to the product or service related to logistics activity
	SI5: Residents: agents who live, work and shop in the city
	SI6: Non-governmental organizations: non-profit agents and perform various types of solidarity actions for specific audiences, and can act in the areas of health, education, social assistance, economic, environmental, among others, under local, state, national and even international [23]
Logistic and inter-functional key factors (LIKF)	LIKF1: Transportation: stock movement from one point to another
	LIKF2: Installation: locations where stock is stored, assembled or manufactured
	LIKF3: Inventory: finished products within a supply chain
	LIKF4: Pricing: how much a company will charge for goods and services it makes available
	LIKF5: Sourcing: choice (internal/outsourcing) of who will perform a certain supply chain activity
	LIKF6: Information: consists of data and analysis regarding stock, transportation, costs, prices and customers
Urban parameters (UP)	UP1: Demographic density: measures the distribution of the population residing in a given territory
	UP2: Installment, use and occupation: related to territorial planning
	UP3: Urban road system: intra circulation routes
	UP4: Legislation: body of laws that regularizes the movement of people and goods in the urban area

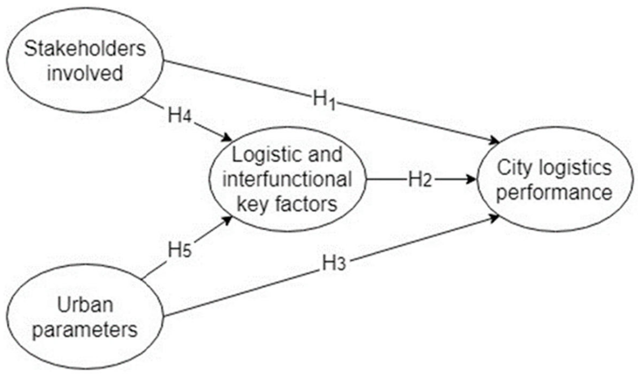

FIGURE 2. Preliminary research model.

identified constructs of city logistics in the literature review with their performance (TABLE 4).

D. ELABORATION OF THE DATA COLLECTION INSTRUMENT

For data collection, it was adopted the use of the cross-self-administered online survey, in which the interrogation technique was used questionnaire with the five-point Likert attitude scale.

The survey was developed in defined phases, as [60], in: (a) specification of the objectives; (b) operationalization of concepts and variables; (c) elaboration of the data collection instrument; (d) pre-test of the instrument; (e) sample selection; (f) data collection and verification; (g) analysis and interpretation of the data; (h) presentation of the results.

The questionnaire is divided into a letter of presentation, cadastral data and questions that measure the constructs of the model. The different questions are presented in appendix A and the collected data can be verified in https://drive.google.com/drive/folders/1OFxanZkKA32O68D3fytSw25DYiz91giy?usp = sharing.

E. SAMPLE SIZE

As mentioned in the previous section, with the purpose of collecting data to test the proposed hypotheses, the survey technique was used.

The selection of the target audience was based on the list of the thousand largest Brazilian companies elaborated by "Valor Econômico" Magazine in the year 2018 [61] in which 10 were randomly selected from each sector of activity, namely: food and beverages; retail trade; pharmaceutical and cosmetics; textile, leather and garment; e, electronics. The randomness in the selection of companies was used in order to avoid biases. For the application of the questionnaire, the eligibility criterion of the respondents was to be a logistics professional with experience of at least 2 years and be active in the market in the area. The contact was made via a professional relationship site with sending e-mail to the chosen person explaining the research and asking for the collaboration. It was sent 600 e-mails, with a return of 99 respondents, corresponding to a return rate of 16,5 %.

TABLE 4. Hypotheses developed.

Hypotheses	Description	Reference
H_1	The stakeholders involved (SI) are positively related to the city logistics performance (CLP)	[8], [17]–[19], [53]–[56]
H_2	The logistic and inter-functional key factors (LIKF) are positively related to the city logistics performance (CLP)	[17], [25], [51], [53]-[54]
H_3	The urban parameters (UP) are positively related to the city logistics performance (CLP)	[18], [30], [31], [33], [34], [37], [40], [57]–[60]
H_4	The stakeholders involved (SI) are positively related to the logistic and inter-functional key factors (LIKF)	[8], [17]–[19], [53], [55]
H_5	The urban parameters (UP) are positively related to the logistic and inter-functional key factors (LIKF)	[18], [30], [31], [33], [34], [37], [38], [57], [58], [61]

TABLE 5. Setting quality values for the sem model.

Latent variables	Observable variables	Loads	Cronbach's alpha	Rho_A	Composite reliability	AVE
City logistics performance (CLP)	CLP1	0,577	0,728	0,745	0,834	0,563
	CLP2	0,684				
	CLP3	0,849				
	CLP4	0,855				
Stakeholders involved (SI)	SI1	0,550	0,701	0,697	0,793	**0,392**
	SI2	0,669				
	SI3	0,669				
	SI4	0,529				
	SI5	0,677				
	SI6	0,646				
Logistic and inter-functional key factors (LIKF)	LIKF1	0,757	0,833	0,842	0,879	0,550
	LIKF2	0,861				
	LIKF3	0,664				
	LIKF4	0,813				
	LIKF5	0,669				
	LIKF6	0,662				
Urban parameters (UP)	UP1	0,554	0,730	0,770	0,833	0,564
	UP2	0,897				
	UP3	0,842				
	UP4	0,660				

It is worth noting that a minimum value of 77 observations was necessary to reach a statistical power of 80% to identify values of R^2 of at least 0.1 with a probability of error of 5%, which was higher in this research [37], [62].

IV. ANALYSIS, RESULTS AND DISCUSSION

The model presented in Figure 2 was proposed after an exploratory analysis. Subsequently, the model was tested in order to validate the significance and the quality of the prediction. To this end, it used the modeling of structural equations of partial least square type (PLS-SEM).

Firstly, the data used to test the model were discussed observing the characteristics of the sample, such as validity and reliability. The following are the model's specification process and the results of both the measurement model and the structural. Finally, the discussion about the results of the PLS model was given.

SmartPLS Software® [63] was used to evaluate the model for all statistics. For the weighting scheme of the PLS algorithm, the maximum iteration and the stop criterion were configured for the path at 300 and 10-7, respectively. For bootstrapping, the following configurations were selected, namely: number of subsamples of 5x103 in order to ensure the stability of the results; no signal alteration, in which the results are presented as they are, characterizing a conservatively estimation; complete bootstrapping, with generation of all available results; Bootstrap corrected and accelerated as a confidence interval method because it is the most stable and it does not need excessive computational resource; two-tailed test; and, significance level of 0.1 for being a study of exploratory nature. For the blindfolding, the standard omission distance was adopted 7.

A. MEASUREMENT MODEL TEST

The first aspect to be observed in relation to the measurement models are convergent validities, obtained by the observations of the AVE. Fornell and Larcker criteria were used [47], according to which the values of the AVEs must be greater than 0.5, thus admitting that the model converges to a satisfactory result.

The analysis of Table 5 shows that only the latent variable stakeholders involved did not present the value of the AVE > 0.5. Under these conditions, [46] recommend the elimination of the variables observed with factor loads (correlations) of lower value in order to increase the value of the AVE. This elimination occurs because the AVE is the average of the high factorial loads squared.

The following tests were performed to adjust the AVE from the subtraction of variables: (a) of lower factorial load (SI1, SI3 and SI4); (b) included to assess the interaction in

TABLE 6. Values of the quality of adjustment of the sem model after elimination of the variables observed with values of the lower factorial loads.

Latent variables	Observable variables	Loads	Cronbach's alpha	Rho_A	Composite reliability	AVE
City logistics performance (CLP)	CLP1	0,570	0,728	0,748	0,834	0,564
	CLP2	0,687				
	CLP3	0,851				
	CLP4	0,857				
Stakeholders involved (SI)	SI1	0,778	0,767	0,768	0,851	0,588
	SI2	0,751				
	SI3	0,802				
	SI4	0,726				
Logistic and inter-functional key factors (LIKF)	LIKF1	0,740	0,833	0,843	0,879	0,550
	LIKF2	0,862				
	LIKF3	0,649				
	LIKF4	0,807				
	LIKF5	0,678				
	LIKF6	0,689				
Urban parameters (UP)	UP1	0,517	0,730	0,769	0,833	0,564
	UP2	0,907				
	UP3	0,847				
	UP4	0,681				

TABLE 7. Cross-load values of the variables observed in the latent variables.

	Stakeholders involved	Logistic and inter-functional key factors	Urban parameters	City logistics performance
CLP1	0,155	0,349	0,510	0,568
CLP2	0,410	0,500	0,444	0,689
CLP3	0,332	0,468	0,639	0,851
CLP4	0,304	0,430	0,529	0,857
SI1	0,773	0,212	0,247	0,242
SI2	0,782	0,394	0,266	0,295
SI3	0,816	0,345	0,188	0,293
SI4	0,692	0,324	0,317	0,381
LIKF1	0,244	0,743	0,415	0,352
LIKF2	0,311	0,859	0,520	0,531
LIKF3	0,299	0,662	0,476	0,415
LIKF4	0,362	0,818	0,522	0,442
LIKF5	0,291	0,672	0,358	0,379
LIKF6	0,400	0,672	0,325	0,460
UP1	0,385	0,490	0,556	0,418
UP2	0,303	0,462	0,896	0,645
UP3	0,187	0,534	0,841	0,626
UP4	0,115	0,234	0,659	0,386

city logistics (SI5 and SI6). It was decided to remove the added variables, following the proposed by [12].

Table 6 shows the new values of the adjustment quality, indicating that the measurement model has sufficient reliability and convergent validity.

After guaranteeing the convergent validity, it should be observed the values of internal consistency (Cronbach's alpha), Rho_A and the composite reliability, with the purpose of evaluating whether the sample is free of biases and whether the answers are reliable.

It is observed that the values of the composite reliability are adequate (TABLE 6), therefore, the reliability of the model is valid. Then, the evaluation of the discriminant validity of the SEM was made by observing the cross loads and the criterion of Fornell and Larcker [47].

Observing Table 7, it appears that the factorial loads of the variables observed in the original latent variables are higher than in others. Thus, by this criterion, it can be inferred that the model has discriminant validity.

When the criterion of Fornell and Lucker is employed (TABLE 8), it is also observed that the model has discriminant validity, since the square roots of the AVEs are higher than the correlations between the constructs. If the criteria were not met, the removal of new observed variables would be necessary.

With the guarantee of discriminant validity, the adjustments of the measurement models were completed and part for the analysis of the structural model.

B. STRUCTURAL MODEL TESTING

The first analysis of this second moment corresponds to verifying whether the structural model presents collinearity problems. Observing the set of constructs SI, LIKF and UP as predictors of CLP and SI and UP as of LIKF, all the values of the collinearity statistic (VIF) in relation to the internal values are below 5, corresponding to 1.242; 1.707; 1.569 and 1.128; 1.128, respectively. Thus, the collinearity between the constructs is not a critical issue in the structural model.

After that, we analyzed the path coefficients, which represent the hypothetical relationships between the constructs [37]. All path coefficients are positive, and magnitudes are greater than 0.134. The highest 0.550 value is for UP (TABLE 9), indicating that this construct is the main conductor in the CPL, followed by LIKF (0.201). The SI

TABLE 8. Values of correlations between latent variables and square roots of the values of the aves in the main diagonal.

Latent variables	Stakeholders involved	Logistic and inter-functional involved	City logistics performance	Urban parameters
Stakeholders involved	0,767			
Logistic and inter-functional key factors	0,405	0,751		
City logistics performance	0,430	0,586	0,742	
Urban parameters	0,337	0,714	0,596	0,751

TABLE 9. Structural model results.

	Hypotheses			Path coefficient	Standard Deviation	T test	p value*	f² (Effect size)	q² (Effect size
H_1	Stakeholders involved	→	City logistics performance	0,134	0,108	1,243	0,214	0,033	0,0112
H_2	Logistic and inter-functional key factors	→	City logistics performance	0,201	0,103	1,948	0,051	0,054	0,0168
H_3	Urban parameters	→	City logistics performance	0,550	0,083	6,635	0,000	0,442	0,1360
H_4	Stakeholders involved	→	Logistic and inter-functional key factors	0,259	0,093	2,783	0,005	0,102	0,0338
H_5	Urban parameters	→	Logistic and inter-functional key factors	0,508	0,089	5,696	0,000	0,391	0,1402

*p<0,1

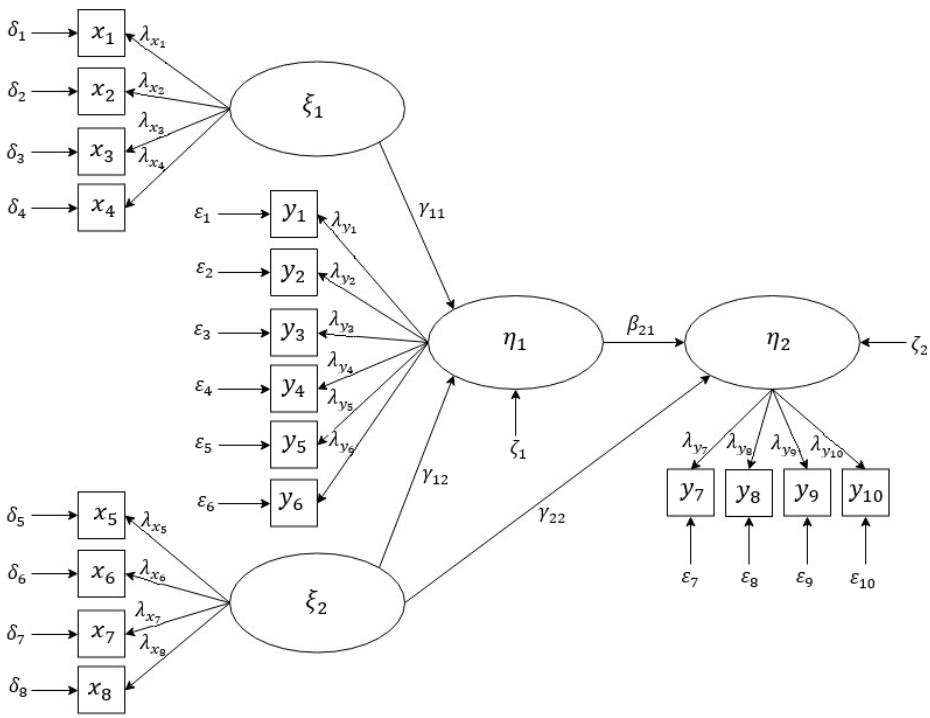

FIGURE 3. Resultant Valuation Model.

construct has little weight in the CLP (0.134), but it is relevant in the LIKF (0.259).

Next, it evaluates the significance of the relationships and the critical T values by means of the method "bootstrapping" which settings were cited above.

It was observed that the relationship SI → CLP is not significant (TABLE 9), therefore, H1 is not supported. Considering that a two-tailed test with significance level equal to 10% was used, the critical T value should be greater than 1.65 [37]. It was found that SI has a lower T-value

(1.243), reinforcing the non-significance of the construct in the prediction of CLP.

Thus, the value of R^2 of the variable CLP is 0,564 and the LIKF is 0.414. Soon, variables can be classified as substantial. It can be inferred that 56.4% of the variance in the CLP variable was explained by the model.

With respect to the size of the effect (f^2), the LIKF construct has a small effect on the CLP, while UP has a large effect. In relation to the LIKF, SI has small impact and UP, large (TABLE 9).

Cross-validation of the construct redundancy was approached with a view to the inclusion of the structural model. The value of Q^2 was 0.287 and 0.201 for CLP and LIKF, respectively, demonstrating that the model has accuracy.

Finally, the size of the q^2 effect was measured manually. This approach is similar to the size of the f^2 effect to evaluate the values of R^2, in which it measures the relative impact of predictive relevance [37]. Thus, the size of the q^2 effect of the LIKF variables in the CLP variable is classified as small and UP, medium; and the variable SI in LIKF, small and UP, medium (TABLE 6).

Therefore, it is possible to infer that the proposed model provides important information for decision makers, considering that from the variables indicated the predictive power of the model is satisfactory, and the resulting model is presented in Figure 3.

where:

ξ_1 Stakeholders involved
ξ_2 Urban parameters
η_1 Logistic and inter-functional key factors
η_2 City logistics performance
x_1 Shippers
x_2 Receivers
x_3 Public administration
x_4 Logistics service providers
x_5 Demographic density
x_6 Installments, use and occupation of the soil
x_7 Urban road system
x_8 Legislation
y_1 Transportation
y_2 Installation
y_3 Inventory
y_4 Pricing
y_5 Sourcing
y_6 Information
y_7 Integration
y_8 Efficiency
y_9 Responsiveness
y_{10} Sustainability

Finally, the structural model can be expressed by:

$$\eta_1 = 0,265\xi_1 + 0,507\xi_2 + \zeta_1 \quad (4)$$
$$\eta_2 = {}^{0,570\xi_2 + \zeta_2}/_{0,755} \quad (5)$$

C. DISCUSSION

This document analyzed the determinants from the point of view of the shippers in relation to the performance of city logistics in Brazilian companies considered as manufacturers, wholesalers or retailers from the proposition of a model with two latent variables exogenous and two endogenous.

The results showed that in the level of constructs, urban parameters are the most important factor to achieve a good performance of city logistics, followed by key logistic and inter-functional factors.

Although the stakeholders involved construct has been referred to as a non-significant predictor for the performance of city logistics, this study suggests that its magnitude is related to the lack of strategic alignment of skills in perform different tasks in the distribution of goods in the urban area.

Corroborating [14], [24], [26], [34], [56], [57], [64]–[66], in order to avoid failures in logistical initiatives and observing the plurality, rationality and relevant strategies of the stakeholders involved, the search for combined solutions is an important condition for the good performance of city logistics.

At the level of indicators, all indicators of the exogenous constructs contribute to the realization of the indicators of the endogenous construct in order to be positively correlated. It is important to emphasize that the elimination of the variables observed "residents" and "non-governmental organizations" was necessary in order to increase the value of the AVE [46], following the proposed by [12] agents involved in city logistics. A justification for the non-inclusion of these actors is related to the need to safeguard public administration in environmental and social issues (quality in urban life) and it should be concerned with the elaboration of public policies and laws, as well as exercise the supervision, that is, the effective control. In this way, there would be overlap of interests in case of maintenance of these variables observed in the model.

V. CONCLUSION

This article focuses on exploring the elements that relate to the performance of city logistics using structural equation modeling. In the context of cities that support sustainability and dynamic interaction, the performance of city logistics plays a critical role. Existing research on this theme focuses on concepts being undertaken pilot studies, but very few models and formal methods are devoted to their evaluation. This work aims to contribute to the filling of this gap.

Based on the systematic review of the literature, a preliminary evaluation model was suggested, and companies classified as shippers had their logistics professionals questioned about the impact of the various attributes on the activities of distribution of goods in the urban perimeter. To this end, the research grouped the data and through an exploratory approach was analyzed the model proposed using structural equations of partial least square type (PLS-SEM).

Section A – Submission Letter

Section B – Cadastral data
Sector

Position

City/State of the company in which you work

Main product line of the company in which you work
1. Food and beverage
2. Pharmaceutical and cosmetics
3.Textile, Leather and garment
4.Electronics
5. Retail trade

Classification of the company in which you work
1. Manufacturer 2. Wholesaler
3. Retailer

How many years have you worked in the company?
1. Up to 5 years 2. From 6 to 10 years
3. From 11 to 15 years 4. From 16 to 20 years
5. From 21 to 25 years 6. Over 25 years

Number of employees that the company owns
1. From 1 to 19 employees
2. From 100 to 499 employees
3. From 20 to 99 employees
4. 500 or more employees

How many years have you worked in the logistics area?
1. Up to 5 years 2. From 6 to 10 years
3. From 11 to 15 years 4. From 16 to 20 years
5. From 21 to 25 years 6. Over 25 years

Section C – Measurement items of the constructs
Question – Please tick how strong the relationship between you and stakeholders has been pointed out in the last 2 years:

Item	Reference	Very weak	Weak	Neutral	Strong	Very strong
		1	2	3	4	5
Other shippers	SI1					
Receivers	SI2					
Public administration	SI3					
Logistic service Providers	SI4					
Residents	SI5					
Non-governmental organizations	SI6					

Question – Please leave your opinion as to the level of influence of the following items in the distribution of goods in the urban area:

Item	Reference	Minimum	Moderate	Average	Significant	Strong
		1	2	3	4	5
Planning a set of vehicle requests	LIKF1					
Route planning/optimization						
Queues for loading/unloading						
Balancing travel with and without load						
Flexibility of delivery time (overnight delivery)						
Vehicle type						
Good type						
Scheduled time or prompt reception on the part of the customer						
Location of deposit	LIKF2					
Organization of physical space						
Single central base for dispatch of good by municipality or region						
Consolidation of loads (costs, customer timeout and service level)						
Costs involved in inventory maintenance	LIKF3					
Inventory turnover						
Multiple customer segments	LIKF4					
Freight price	LIKF5					
Ability to improve process efficiency						

Item	Reference	Minimum	Moderate	Average	Significant	Strong
		1	2	3	4	5
Network optimization experience						
Flexibility to adapt Market changes						
Appropriate vehicles as secured under contract						
Information sharing (destination data, sales forecast, stock, vehicle requirements/availability, specific events)	LIKF6					
Information systems sharing						
Use of software						

Question – Please leave your opinion in terms of the level of influence of the items below in the distribution of goods in the urban area:

Item	Reference	Minimum	Moderate	Average	Significant	Strong
		1	2	3	4	5
Population concentration in certain regions and other non	UP1					
Territorial ordering (planning, control and supervision of installment, land use and occupation)	UP2					
Functional hierarchization of the pathways	UP3					
Frequency of intersections (crossings)						
Narrow access roads						
Ease of access and route of the roads						
Controls (speed, heavy vehicles, transport routes, circulation, parking, pedestrian flow)						
Regulatory mechanisms (environmental, consumer, tax, constitutional and other issues)	UP4					
Circulation restrictions (volume and weight of loads, vehicle size, speed limit)						
Law of the driver (Law nº 13.103, March 02, 2015)						
Specific regulatory and supervisory bodies						

Question – Please leave your opinion in terms of the level of contribution of each item below for the performance of the distribution of goods in the urban area:

Item	Reference	Minimum	Moderate	Average	Significant	Strong
		1	2	3	4	5
Integration with other shippers	CLP1					
Integration with receiver						
Integration with public administration						
Integration with logistic service providers						
Integration with residents						
Integration with non-governmental organizations						
Differentiating costs	CLP2					
On-time deliveries	CLP3					
Deliveries without error						
Quality of services rendered						
Customer servisse flexibility						
Environmental sustainability	CLP4					
Social sustainability						
Economic sustainability						

This technique incorporates both formative and reflective constructs, in addition to working with nominal data with less stringent distributional assumptions.

The statistics of the proposed model were calculated and used as support to demonstrate the statistical power of the model. The Pearson's coefficient (R2) that evaluates the variance portion of the city logistics performance is 56.4%, characterizing a substantial predictive power.

The results also identified that the variable urban parameters is the main influencer of the performance of urban logistics, followed by key factors of logistic and inter-functional performance. In addition, the hypothesis H1, the stakeholders involved are positively related to the performance of city logistics, but it was not statistically significant. It is understood that the lack of heterogeneity of the interested parties involved in city logistics operations has contributed to this result.

There are some limitations to this research: (1) the sample is intentional and non-probabilistic and extracted from Brazilian companies considered as shippers; (2) includes distribution of consumer goods in urban areas, not covering services such as: movement of people, water, energy, sewage, among others; (3) focuses on the type of logistic movements, which refers to the replenishment process, allowing stores, deposits and final consumers to be kept not being approached the movements of the final consumers traveling from their zone of residence/consumption for others in order to make their purchases; (4) the model presents only one diagnosis without practical interventions.

In the future, this proposed modeling could be implemented in a decision support system and, in this way, could be a useful tool to evaluate the impacts of measures and policies of movement of goods in the urban area. In addition, this research will continue to identify and verify the relationships of other attributes with the performance of city logistics.

APPENDIX

QUESTIONNAIRE ITEMS

See Questionnaire Items as shown at the pages 11 and 12.

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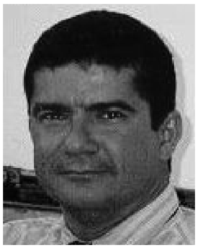

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