

THE ROLE OF CARGO TRANSSHIPMENT IN THE RELATIONSHIP BETWEEN ROUTING AND ADDED VALUE

Submission: 24/08/2017

Accept: 27/09/2018

Edilson Ramos Dias¹

Roberto Giro Moori²

Roberto Ramos de Morais³

Valdir Antonio Vitorino Filho⁴

ABSTRACT

The aim of this article was to verify the impact of cargo transshipment on the relationship between routing and value addition of companies specialized in the road transport of long steels for civil construction. Cargo transshipment is a process of loading and unloading, fractional of products, that consumes time, causes disruption to the industrial activities, commercial and mainly, generates costs inadequately. Considering this context, a research of an exploratory nature of the quantitative type was carried out, in which a sample of 74 transport companies, linked to the steel and independent mills, were used. The collected data, treated by modeling in structural equations using the Partial Least Squares – Path Modeling (PLS-PM), revealed that the transshipment, partially, mediates the relationship between routing and value addition. From this result, it was evidenced that transport managers still need to evolve in the processes of cargo transshipments, through managerial training and elaboration of solutions, involving loading and unloading of products, which are vital for the addition of logistic value to the construction industry.

Keywords: Routing; Loading; Unloading; Transshipment; Adding of logistic Value.

1 Master Science of Business Administration from Mackenzie Presbyterian University (São Paulo, Brazil), Master of Business Administration from ESPM (São Paulo, Brazil), Bachelor of Accounting and Business Administration from Tiberiça College (São Paulo, Brazil). Invited professor for Logistics disciplines at the Mackenzie Presbyterian University and UNISA University, São Paulo, Brazil. E-mail: er_dias@hotmail.com
ORCID: <https://orcid.org/0000-0002-5478-0183>

2 Doctor and Master Science of Production Engineering from USP (University of São Paulo), Bachelor of Mechanical Engineering from UNESP (State University). Full professor at the Postgraduate Program in Business Management Course at the Mackenzie Presbyterian University in São Paulo, Brazil. E-mail: roberto.g.moori@gmail.com. ORCID: <https://orcid.org/0000-0001-5690-746X>

3 Master of Production Engineering from Politécnica School of USP and bachelor of Mechanical Engineering from FEI. Professor at the business management graduate program of Mackenzie Presbyterian University and at logistics technological course of FATEC. São Paulo, Brazil. E-mail: rrmorais@uol.com.br. ORCID: <https://orcid.org/0000-0001-6467-5320>

4 Doctorate in Business Administration from Methodist University of Piracicaba (São Paulo, Brazil), Master in Business Administration from Methodist University of Piracicaba (São Paulo, Brazil), Graduated in Business Administration from Faculty Cenequista de Capivari. Basic, technical and technological teacher at the Federal Institute of São Paulo. São Paulo, Brazil. E-mail: valdir.vitorino@gmail.com
ORCID: <https://orcid.org/0000-0002-2610-2553>

RESUMO

O objetivo deste artigo foi o de verificar o impacto do transbordo de cargas na relação entre roteirização e adição de valor, em empresas rodoviárias de transportes de aços longos para a construção civil. O transbordo de cargas é um processo de carregamento e descarregamento, fracionado de produtos, que consome tempo, causa transtorno às atividades industriais, comerciais e, principalmente, gera custos inadequadamente. Diante desse contexto, realizou-se uma pesquisa de natureza exploratória do tipo quantitativo, em que se utilizou uma amostra de 74 empresas transportadoras, vinculadas às usinas siderúrgicas e independentes. Os dados coletados, tratados pela modelagem em equações estruturais a técnica da Partial Least Squares – Path Modeling (PLS-PM), revelaram que o transbordo medeia, parcialmente, a relação entre roteirização e adição de valor. Diante do resultado obtido, evidenciou-se que os gestores de transportes ainda precisam evoluir nos processos de transbordos de cargas, por meio de capacitação gerencial e elaboração de soluções, que envolvam os carregamentos e descarregamentos de cargas, que são vitais para a adição de valor logístico para o ramo da construção civil.

Palavras-chave: Roteirização; Carregamento; Descarregamento; Transbordo; Adição de valor logístico.

1 INTRODUCTION

Every day, issues related to Brazilian logistics are discussed and commented on print, audiovisual, and sound media. For instance: “we’ve lost a day just to make the transshipment between one road network and another, and highways transport is neither a better option” (ZAPAROLLI, 2014); “agents found that a truck and a semi-trailer, both from the state of Minas Gerais, were transporting steel bars, corresponding to one third of the load, in addition to bales of clothing [layettes and others] and candy boxes” (G1, 2014).

These examples suggest that the Brazilian logistics, in order to meet those which are the best in the world, has enormous challenges, which does not focus only on lack of infrastructure, but on management. According to Ballou (2006), even if cargos have the same origin and destination points and a single modal, it does not mean that the necessary course will be completed exactly in the same time. Conditions of time, traffic congestion, number of scales, and difference in the time required for the freight consolidating may cause delays. Variability of the trip time is a measure of the uncertainty on the performance of the shipper.

Another aspect that reflects on the shipping time is the interface between the vehicle and the destination place, since in the loading and unloading operations, at the terminals, is where most frequently breaking and damaging of transported products occur. In addition, some products require specific locations and equipment to be loaded and unloaded. For example, in long steel unloading process in the city of São Paulo, SP, such must be carried out in the construction sites. If the material is manually created, we must first remove the beams, since the weight of the steel does not allow the movement of many bars at the same time (GIRIBOLA, 2013). To add value, depending on the product, Alvarenga and Novaes (2002) argue that in addition to providing proper equipment, both in transport as in the loading and unloading processes, there must be an efficient routing process, especially when there are deliver of products, split into small amounts and intended for multiple clients.

Considering routing is an important tool for efficiency in transport, and times for loading, unloading, and cargo transshipments have great significance in the use of the vehicle, we aim to answer the following question: “Does cargo transshipment mediate the relationship between routing and logistic added value?” Our objective was to verify the impact of loading, unloading, and cargo transshipments on added value, in highway companies of long steel transports for construction.

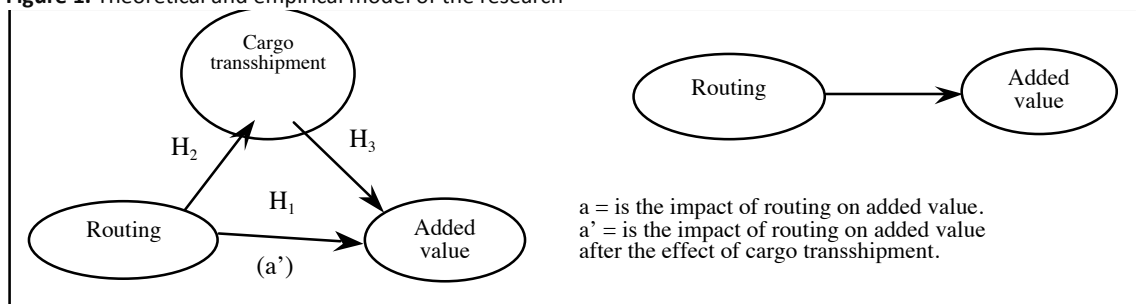
By “transshipment operation,” we mean a direct transfer process of merchandise from a modal to another; by “loading and unloading operations,” the immobilization process of the modal, due to the time strictly necessary for loading or unloading of goods. Both logistic operations were generally named as transshipments, in order to make its understanding easier, since they have similar process cycles.

Our study is organized in five parts, in addition to this introduction. In the second part we present a literature review; in the third, the used methodology; in the fourth part, the analyses of data and results. Finally, in the fifth part we present the conclusions and suggestions for further research.

2 LITERATURE REVIEW AND HYPOTHESES

In order to implement the problem and the goal of our research, we developed the theoretical and empirical model shown in Figure 1.

Figure 1. Theoretical and empirical model of the research



Source: Adapted from Baron and Kenny (1986) and Iacobucci, Saldanha and Deng (2007).

As we can observe in Figure 1, added value (dependent variable) can be predicted in two ways. The first establishes a direct relationship with routing (independent variable). The second presupposes that cargo transshipment (mediator variable), through routing, affects the added value. In this case, cargo transshipment mediates the relationship between routing and added value.

Statistically, a mediator variable is that which, when part of the phenomenon under study, decreases the magnitude of the relationship between an independent variable and a dependent variable (BARON; KENNY, 1986). In Figure 1 such are represented by the letters (a') and (a). To verify the magnitude between (a') and (a), and typify the mediation as “partial,” “total,” or “no mediation,” we used the *Variance Accounted For* test (VAF) (HAIR et al., 2014).

The theoretical support and the hypotheses to statistically test the theoretical and empirical model are detailed next.

2 DIRECT EFFECT

2.1.1 Influence of routing in added value

Routing or vehicle routing problem, studied for the first time by Dantzig and Ramser (1959), was defined from the generalization of the traveling salesman problem, which was concerned with making the shortest route to visit each client, once in each round. Clarke and Wright (1964) deepened the study on vehicle routing problem, proposing algorithms of the savings method in order to minimize the amount and total distance travelled by all vehicles involved

in the route, whose logic, according to Ballou (2006), consisted in starting with a fictional vehicle serving each stop and coming back to the warehouse, considered the most expensive scenario.

Another algorithm aimed at solving the routing problem is the scanning method, which consists in defining the route from the dispatching point, creating ratios of performance for each route. Ballou (2006) considers the scanning method less accurate than the “savings” method, though its application is easier. For Drexl (2012), the use of a routing process, besides the importance for companies to reduce costs, also have a macroeconomic impact on the efficient use of highway infrastructure and reduction of emission of gases harmful to the environment, making the whole process to commit to sustainability, reducing its harmful effects to society.

Vehicle routing problem was and remains being much studied. Authors, such as Cunha (2000), Garg and Prakash (1985), Popovic and Habjan (2012), and Yu, Yang and Xie (2011), developed algorithms for solving routing problems with added value by using GPS (Global Positioning System), which provides information about the location of vehicles for customers. Routing can also be deemed as an integral part of logistics, defined as

part of the supply chain management, which efficiently plans, implements, and controls the direct and reverse flow, and storage of products, as well as related services and information, from the point of origin to the point of consumption, in order to meet consumers’ needs (CSCMP, 2015, s.p., free translation).

As for Ballou (2006), the supply chain management comprises activities related to logistics, purchasing, marketing, and production management. In this sense, the management of business logistics is commonly called “supply chain management.” In addition, terms such as “value network,” “value chain,” and “lean logistics” are also used to describe similar scope and goals. According to Porter (1985), logistics is an important element of a value chain, a primary activity, being subdivided into internal and external logistics. Based on the way companies perform logistical activities, they can be differentiate by adding value to their clients (CHRISTOPHER, 2013), as: place and value (BALLOU, 2006). In addition to both values, Novaes (2007) completed with added quality and information. Thus:

H₁: Routing impacts on added value.

2.2 Indirect effect

2.2.1 Routing influence in cargo transshipment

In cargo transshipment processes, routing must be completely synchronized with it in order to avoid unnecessary routes and transshipments that add time and cost to the whole process. Planning and scheduling of vehicle routes for deliveries of goods can bring benefits concerning the use level of the vehicle and the fleet (DIAS, 2012). Hence, the use of software for routing, using delivery windows as a parameter, has been gaining space in companies. Conceição et al. (2004) described that routing based on human experience, even if aware of the local traffic and geography, still produced routes with greater distances in 10% than those generated by the routing software.

The environment of competition and innovation has led companies to adopt an efficient logistics information system to reduce operation and transportation costs, with a more rational use of vehicles. In recent years, logistics technologies, such as trucks, equipment, devices for cargo transshipments, and accessories, have considerably advanced (HOLTZ, 2016).

To find the relationship between routing and transshipment, Rabbani, Baghersad and Jafari (2013) presented the inventory routing problem (IRP), aiming to minimize inventory and transportation costs by setting delivery quantities for each client as well as routes that should be used. Other authors, such as Drexl (2012), compared commercial software, focusing on the automatic routing, its adherence, and use. On the other hand, Reiter and Gutjahr (2012) created an algorithm with a double objective: minimizing the costs of routing and adjusting the driver's workload.

On the interface between routing and transshipment, Chopra and Meindl (2011) and Pires (2011) evaluated methods for product flow, among them the *Transit Point* and the *Cross-docking*. These processes aimed at receiving loads in consolidated vehicles and transferring them to smaller vehicles, and demanding logistics managers for transshipments to be more efficient in order to avoid delays in deliveries in the final destinations.

An important factor among transshipment and routing processes are inventory levels, since conveyance of products comply with the policy of each company's inventory. According to Chopra and Meindl (2011) and Wanke (2008), inventory levels throughout the supply chain are defined by the product turnover, service time, desired service level, and unit purchase costs. These levels make routing and transshipment processes to have greater or lesser importance within the company, according to the weight of each item that compose the inventory calculation. Thus:

H₂: Routing impacts on cargo transshipment.

2.2.2 Influence of cargo transshipment in added value

In *The Transshipment Problem*, Orden (1956) defined transshipment, from the point of view of costs added to product conveyance, as an additional problem to that of routing. Garg and Prakash (1985) created an algorithm for solving the transshipment problem, in which they used methods of operational research and considered each loading and unloading point as a "node" in the solution of the problem. The aim was reducing the time between the origin and the destination, thus optimizing the process of transshipment during cargo conveyance.

According to Miao et al. (2012), transshipment problems were related to the amount of goods in the transportation and routes to be followed to transshipment centers. Moreover, they considered that, concerning the transshipment problem, the aim was to find minimum cost solutions that should satisfy all demands in all destinations. However, in the definitions of intermodal transport, Bowersox, Closs, Cooper, and Bowersox (2014) combine two or more modal types to take advantage of the economies inherent in each modal and, therefore, provide an integrated service. For Chopra and Meindl (2011), to do so, more than one mode of transportation for conveyance of goods to their destination should be used. Hence, whereas the transshipment process is part of the cargo transfer between modes, for loading and unloading of goods, the cargo transfer process occurs directly from the supplier to the final receiver.

Literature on the transshipment problem refers primarily to the question of inventory time and cost optimization, but there is a gap in the issue of equipment and infrastructure required for loading, unloading, storage, and conveyance of products.

Coyle, Bardi and Langley (2003) stated that companies that traded several types of products needed to use special or customized equipment for cargo conveyance, storage, and unloading. Studies by Sternberg et al. (2012) applied the methodology for reducing losses in the processes of loading and unloading of vehicles, and showed losses due to unnecessary conveyances.

Da Silva et al. (2012) reported that the operational efficiency of equipment, such as forklift trucks, traveling cranes, and cranes used for material conveyance in an enterprise, was something that could aid reducing costs and thereby increasing the profits by added value. In addition,

Hitt, Ireland and Hoskisson (2008) stated that the uniqueness of the resources of a company was the basis for the strategy of above-average returns. Furthermore, they mentioned that resources for equipment could be considered as inputs of the production process of a company.

Christopher (2013) pointed out that companies should work together with shipping companies to resolve potential problems on fitness of vehicles. These integrations between companies were addressed by Chopra and Meindl (2011), who described the scope of the supply chain covering all stages involved, directly or indirectly, in the processes to meet customers' requests. In addition to manufacturers and suppliers, means of transport, warehouses, retailers, and the very customers were part of the supply chain. Thus:

H₃: Cargo transshipment impacts on added value.

2.3 Transshipment mediation in the relationship between routing and added value

In transshipment processes, cargo conveyance must be efficient and quick to add value to the client. However, barriers in the operations of loading, unloading, and transshipment, rather than adding value, can cause damages. The lack of qualified personnel, appropriate structure, and equipment of the very shipper modal, or at the place of final destination of the product, can have as consequences: waste of time in activities, damages to or losses of the transported cargo, (delay on delivery and the parked vehicle might be charged, for instance, if a deadline is established in the contract or in the road waybill), and the parked vehicle might be charged.

It is important that transshipment operations are well managed. With them we will get the main logistics controls, directed to productivity such as time spent in queues for loading or unloading, cargo time, and route time. In addition to the issue of routing, another factor that influences in the cost is transshipment. According to Ballou (2006), systems of storage and handling of products absorb up to 20% of the costs of physical distribution of the enterprise.

Therefore, logistics managers must know in depth the strengths and weaknesses in the operations of loading, unloading, and transshipment, and make decisions so that the impact of routing on performance is achieved by the mediation of cargo transshipment, indicating that routing and transshipment are, in fact, synchronized, thus adding value to the logistics management. Thus:

H₄: Cargo transshipment mediates the relationship between routing and logistic added value.

3 METHODOLOGY

3.1 Method, data collection instrument, and survey participants

This descriptive and quantitative research preceded an exploratory study, conducted with a sample of three managers of transportation companies, in order to know in greater depth the phenomenon of the research: the role of cargo transshipment in the relationship between routing and performance. To this end, in-depth interviews were carried out, according to a pre-determined script, recorded on audio and transcribed, in such a way no information was lost.

Based on the results of the exploratory study, the data collection instrument was created, which consisted in four blocks. The first block referred to data on the respondents and characteristics of the companies. The second, third, and fourth blocks referred to the constructs "routing," "cargo transshipment," and "added value," with nine, eight, and six measures respectively. For the last three blocks, respondents were requested to point out the degree of agreement on a scale ranging from totally disagree (TD = 1) to totally agree (TA = 6) regarding the measures allocated in their respective constructs.

With the first version of the questionnaire, such was referred to a sample of four re-

spondents to pretest. These respondents were part of the sample of three transport companies used in the exploratory stage, in which, then, a company had two respondents. With the pretests of the first version of the questionnaire we aimed the final adjustment to evaluate the amount of measures, sequences, formats, clarity, and definition of the research protocol. After defining the final questionnaire, we selected a sample of respondents for data collection, which consisted in two subsamples. In the first subsample, by the authors' networking, 51 questionnaires were responded. In the second subsample, by indications of respondents of the networking, 23 questionnaires were responded. In both, respondents should be from the logistics field, involved in processes of routing and cargo transshipment.

To do so, respondents received an email explaining the purpose of the research with the link to the answers on the website *Google Docs*. Since the electronic data collection tool only recorded information after completing the questionnaire, of the total of 74 obtained questionnaires, none were discarded, that is, there were no incomplete questionnaires, since the Google Docs was configured in such a way incomplete questionnaires were not recorded.

3.2 Data treatments, study delimitation, and method limitation

Initially, the collected data were submitted to descriptive statistics, to examine lost data, atypical observations, or extreme responses. Then, such were submitted to multivariate statistical analysis, exploratory and confirmatory factor analysis techniques, for debug, validate measurements and scales, and identify the underlying structure (or construct) as for data matrix. Hence, for measures to be part of the construct, we investigated if both constructs and related measures met the minimum acceptable values for the following statistics: a) factor loading of the measures; b) monodimensionality of the constructs, measured by Cronbach's α ; c) composite reliability of constructs; d) content validity; e) convergent validity; and f) discriminant validity, as reported next.

After defining the validation of measures and scales, we assessed the statistical significance of the relationship between the model constructs. To do so, we used the structural equations modeling, the PLS-PM (Partial Least Squares Path-Modeling), to obtain evidence that the collected data were adjusted to the structural equation modeling. Considering that all constructs were reflexive, Goodness of Fit was used to assess the general fit, given by the geometric mean between means of the AVEs – Average variance extracted (adjusted measuring model) and the R^2 s (adjusted structural model) (TENENHAUS et al., 2005), as shown below.

$$[\text{GoF} = \sqrt[3]{\text{AVE} \times \overline{R^2}}] \rightarrow \text{Equation (1)}$$

For the evaluation of this index, Wetzels, Odekerken-Schroder and Van Oppen (2009) suggest the value of 0.36 adjusted for Social and Behavioral Sciences. However, Henseler and Sarstedt (2012) suggest not using the GoF as general adjustment index of the model for understanding that the index does not have the power to distinguish between valid and invalid models; that is, PLS does not optimize a global function, in such a way there is no index of validity of the model, such as the Chi-square, in models using the Lisrel software. In addition, we used two other indicators of quality adjustment: Stone-Geisser's or the relevant or predictive validity (Q^2) and Cohen's or effect size (f^2), as suggested by Hair Jr., Ringle and Sarstedt (2014).

To test the evidence of cargo transshipment mediation between routing and added value, we used the Variance Accounted For test (VAF):

$$VAF = \left[\frac{\beta_{12} \times \beta_{23}}{(\beta_{12} \times \beta_{23}) + \beta_{13}} \right] \rightarrow \text{Equation (2)}$$

where β_{12} , β_{23} , and β_{13} are the structural factors that resulted from the relationship between constructs [Routing and Cargo Transshipment], [Cargo Transshipment and Added Value], and [Routing and Added Value], respectively. For values $VAF > 80\%$, it means total mediation; $VAF < 20\%$, no mediation; and $20\% \leq VAF \leq 80\%$, partial mediation.

However, we must consider some limitations in the employed method and delimitations in the research. Limitations of the method were due to a sample chosen by accessibility and with a number of respondents below the recommended. It is also considered the fact that some respondents might not have clearly understood the questions, thus responding them incorrectly and influencing the final result. On the other hand, delimitations of our cross-sectional research (MALHOTRA, 2001) refer to the logistics managers of companies that produce or trade long steels in Brazil, which have direct influence in the processes of routing and transshipment, with no restriction to the State or region in which they operate. Respondents were contacted on social networks of the author's research, directly or indirectly. Differences between them are due to the company that is linked to the mills having the same corporate group, therefore, a single supplier generally operating in the same way.

4 DATA ANALYSIS AND RESULTS

Data were collected in the period from September 2014 and March 2015, with 74 questionnaires appropriated to be analyzed, showing the following characteristics:

- a. Regarding respondents, we present the demographic profile in Table 1.

Table 1 – Demographic profile of respondents

PROFESSION	%	ACADEMIC EDUCATION	%
Executive officers	13.5	Administration	56.7
Managers	32.4	Engineering	24.3
Coordinators and Supervisors	44.6	Logistics	10.8
Analysts and Technicians	9.5	Economy / Information technology	8.2
TIME IN THE PROFESSION	%	TIME IN THE ENTERPRISE	%
Less than two years	9.5	Less than 2 years	1.4
Between 2 and 5 years	37.8	Between 2 and 5 years	23.0
More than 5 years	52.7	More than 5 years	75.6

Source: Research data

Therefore, based on the profile of respondents, we can perceive that all of them were aware of the processes of routing and transshipment, especially considering the time in the profession, time in the enterprise, and academic education.

- b. Regarding the companies, we present the demographic profile in Table 2.

Table 2 – Demographic profile of enterprises

AREAS OF THE ENTERPRISES	%	SIZE – REVENUE	%
Companies linked to steel mills	63.5	Up to R\$ 2.4 million (BRL)	9.5
Autonomous companies	36.5	Between R\$ 2.4 million and R\$16 million	20.3
SITE – HEAD OFFICE (State)	%	Between R\$ 16 million and R\$90 million	16.2

São Paulo	70.1	Between R\$ 90 million and R\$300 million	13.5
Rio de Janeiro	13.5	Above R\$ 300 million	40.5
Bahia	5.4	SIZE – NUMBER OF EMPLOYEES	%
Pernambuco	4.1	Up to 99 employees	39.2
Rio Grande do Sul	2.7	Between 100 and 499 employees	31.1
Minas Gerais	1.4	Over 500 employees	29.7
Mato Grosso do Sul	1.4	TIME OF RELATIONSHIP WITH SUPPLIERS	%
Paraná	1.4	Up to 2 years	9.5
		Between 2 and 5 years	17.6
		Over 5 years	64.8
		Occasional relationship	8.1

Source: Research data

Therefore, based on the profile of the companies, we can observe that most were concentrated in the Southeast, with more than 100 employees, revenues accounting for over R\$90 million, long lasting relationships with customers, in addition to being linked to steel mills.

4.1 Descriptive analysis of collected data

After identifying atypical observations in the sample with 74 respondents, made by factor analysis, we can debug that 23 original measures resulted in an underlying structure composed of 16 parameters with factor loadings equal to or greater than 0.7, 5 related to routing, 5 related to cargo transshipment, and 6 related to added value.

The weighted average of routing was 4.94, with standard deviation equal to 0.42. For cargo transshipment, the arithmetic mean and standard deviation were 4.75 and 0.40, respectively. The “added value” construct, in its turn, featured a mean of 4.53 and standard deviation of 0.24. All measures were placed in the agreement side of the scale. We present the results in Table 3.

Table 3 – Results of the descriptive and multivariate statistics

ASSERTIONS	Average	Standard deviation	Min.	Max.	Correlation		
					1	2	3
1. Routing	4.94	0.42	3.62	5.43	<i>0.64</i>		
2. Transshipment	4.75	0.40	3.72	5.53	0.52	<i>0.62</i>	
3. Added value	4.53	0.24	4.04	4.89	0.63	0.52	<i>0.73</i>
	Original measures			→	9	8	6
	Number of measures after debugging			→	5	5	6
	Monodimensionality (Cronbach's α)			→	0.63	0.60	0.82
	Average variance extracted			→	0.41	0.39	0.54
	Composite reliability			→	0.77	0.76	0.87

Notes: significant ($\alpha \leq 0.01$).

On the diagonal of the correlation matrix, values in italics represent the square root of the Average Variance Extracted.

Source: Research data.

We observed independent variables by the measures: R_1 (uses groups of cargos during the process); R_2 (uses scheduling of deliveries for decision-making); R_3 (considers reduction of costs for routing decisions); R_4 (uses the SAP (Systeme Anwendungen und Produkte in der Datenverarbeitung) or other systems to implement the process); and R_5 (applies the “savings” or “scanning” methods to implement the process). Only the variable R_5 was below 4.0, that is, between the scale Little Disagree and Little Agree. These results indicate agreement regarding logistics

in the routing process related to authors such as Dantzig and Ramser (1959), Clarke and Wright (1964), Ballou (2006), Novaes (2007), and Popovic and Habjan (2012).

For mediating variables given by the measures: T_1 (considers opening hours of customers to schedule deliveries); T_2 (storage of products during the transfer process); T_3 (uses systems for locating products in storage sheds); T_4 (inspection of products in the cargo process, in storage sheds); and T_5 (consider customers' equipment for loading and unloading setting). Only the variable T_3 was below 4.0, that is, between the Little Disagree and Little Agree scale. Authors, such as Ballou (2006), Da Silva et al. (2012), and Christopher (2013), corroborate the mediation of transshipment in the relationship between routing and added value.

Other measures, including dependent variables (added value), converged for the agreement side of the scale as shown in Table A1 of Appendix 1.

4.2 Validation of measures and scales of constructs

Results of the factor analysis indicate that the minimum amount of three measures for each construct was in accordance with what is recommended by Hair Jr., Anderson, Tatham and Black (2005). As for reliability of measures, given by Cronbach's α and the Composite Reliability (CC), obtained values, higher than 0.6, were above the minimum limits recommended for exploratory studies.

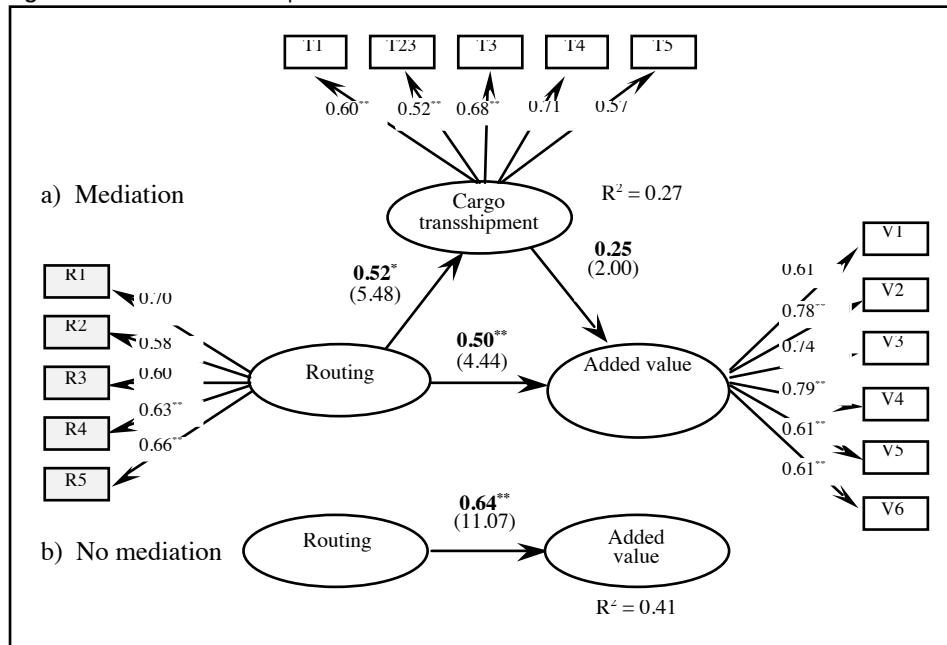
For content validity, with the exploratory study that preceded the descriptive research, each measure of construct was subjected to the evaluation of the respondents. In this stage, results were considered relevant and representative for the purpose of the project. For convergent validity, evaluated by the factor loadings and Average Variance Extracted (AVE), both statistics featured values above the recommended minimum limit of 0.5. Concerning discriminant validity, we observed that the AVE square root of each latent construct was greater than the result of its correlation with any other latent construct, thus meeting the criterion proposed by Fornell and Larcker (1981).

After validation of the measures, scales, and constructs, we created a measurement model to assess its statistical significance using the structural equation modeling, the PLS-PM. Then, we sought to typify the mediation, if it was total, partial, or non-existent. In this case, we used the Variance Accounted For test (VAF) (HAIR et al., 2014).

4.3 Evaluation of the structural model

SmartPLS 2.0 Software was used to evaluate the statistical significance of the measurement model. We present the results in Figure 2.

Figure 2. Theoretical and empirical model



Note: Model estimated by the SmartPLS software, version 2.0 M3 (Ringle et al., 2005), and significance estimated by Bootstrap, $n = 74$ and 5,000 repetitions.

Source: Research data.

In terms of global adjustment measure of the measurement model, we obtained $GoF = \sqrt{0.45 \times 0.36} = 0.40$ by applying Equation (1). Hence, results exceeded the base value of 0.36 (FORNELL; LARCKER, 1981), demonstrating that the model has good performance compared with the specified base value.

Still determining the quality adjustment variables, as suggested by Hair et al. (2014), in Table 4 we present the results for relevance indicators: Stone-Geisser, or predictive validity, (Q^2) and Cohen, or effect size, (f^2).

Table 4 – Values of the indicators for predictive validity (Q^2) and effect size (f^2)

CONSTRUCT	*CV RED (Q^2)	**CV COM (f^2)
Routing	0.10	0.10
Cargo transshipment	0.06	0.06
Added value	0.22	0.35
Reference values	$Q^2 > 0$	$f^2 = 0.02$ – minimal effect $f^2 = 0.15$ – mean effect $f^2 = 0.35$ – major effect

Notas: *CV RED = Cross-Validated Redundancy; **CV COM = Cross-Validated Communnality

Source: Research data.

According to Table 4, the indicator (Q^2) presents positive values, showing that the model reflects the reality, that is, it is useful for the prediction of the model. As for the effect size indicator (f^2), constructs presented values ranging from mean and major, indicating that data had mean effect in the adjustment of the model.

Regarding the tests of hypotheses, we present the results in Table 5.

Table 5 – Structural factors and hypothesis test

STRUCTURAL RELATIONSHIP	STRUCTURAL FACTORS	STANDARD ERROR	t value	HYPOTHESES	DECISION
Routing → Added value (β_{13})	0.50	0.11	4.44	H_1^*	Supports
Routing → Cargo transshipment (β_{12})	0.52	0.10	5.48	H_2^*	Supports
Cargo transshipment → Added value (β_{23})	0.25	0.13	2.00	H_3^{**}	Supports

Note: (*) 0.01: significance level ($t > 2.58$); (**) < 0.05 : significance level ($t > 1.96$)

Source: Research data.

According to Table 5, we observed that:

- In Hypothesis H_1 , represented by the course between routing and added value, the structural factor was 0.50, t-value equal to 4.44, indicating support to the hypothesis H_1 , $\alpha \leq 0.01$ significance level;
- In Hypothesis H_2 , represented by the course between routing and cargo transshipment, the structural factor was 0.52, t-value equal to 5.48, indicating support to the hypothesis H_2 , $\alpha \leq 0.01$ significance level;
- In Hypothesis H_3 , represented by the course between cargo transshipment and added value, the structural factor was 0.25, t-value equal to 2.00, indicating support to the hypothesis H_3 , $\alpha \leq 0.05$ significance level;
- Therefore, with these results (H_1 , H_2 , and H_3), supported according to significance levels of $\alpha \leq 0.01$, $\alpha \leq 0.01$, and $\alpha \leq 0.05$ respectively, we can infer that there was mediation of cargo transshipment in the relationship between routing and added value, thus supporting hypothesis H_4 (BARON; KENNY, 1986; IACOBUCCI et al., 2007). Nevertheless, we needed to classify whether the mediation was total or partial (HAIR et al., 2014).

In this sense, we then verified the magnitude of cargo transshipment mediation concerning the relationship between routing and added value. To do so, we used the Variance Accounted For test (VAF). Thus, by applying Equation (2), we have:

$$VAF = \left[\frac{\beta_{12} \times \beta_{23}}{(\beta_{12} \times \beta_{23}) + \beta_{13}} \right] = \left[\frac{0.52 \times 0.25}{(0.52 \times 0.25) + 0.50} \right] = 0.21 \rightarrow \text{Equation (2)}$$

Therefore, by the obtained value of 0.21, we demonstrated that cargo transshipment mediation, regarding the relationship between routing and added value, was partial (HAIR et al., 2014).

Finally, we verified the effects of routing on added value. The direct effect was equal to 0.50. The indirect effect was equal to 0.13 [$0.52 \times 0.25 = 0.13$]. Hence, the total effect was equal to 0.63 [$0.50 + 0.52 \times 0.25 = 0.63$]. We present in Table 6 the direct, indirect, and total effects.

Table 6 – Direct, indirect, and total effects of the measurement model constructs

	Added value		
	Direct effect	Indirect effect	Total effect
Routing	0.50	0.13	0.63
Cargo transshipment	0.25		0.25

Source: Research data.

The ratio of cargo transshipment in the environmental added value variance, directly and indirectly explained by routing, was of 20.6% $([0.52*0.25] / [(0.52*0.25) + 0.50] = 0.206)$.

5 CONCLUSIONS AND SUGGESTIONS FOR FURTHER STUDIES

To state that cargo transshipment mediates, in part, the relationship between routing and added value, influences the academic perspectives and managerial practices discussed next:

a) Academic perspectives: Cargo transshipment is an operational process inherent in the distribution of goods, whose split loading and unloading of goods take time, cause inconvenience to the industrial, commercial, and personal activities and, especially, increases costs inappropriately.

In this regard, developing solutions that involve cargo transshipments – such as routing and scheduling of vehicles – becomes increasingly important, to the extent some restrictions are imposed, such available time for traffic of vehicles, multiple trucks with different weight and volume capacity, maximum time of staying behind the wheel in each route, different maximum speed according to different zones, traffic barriers (lakes, deflections, mountains etc.), and intervals for drivers to rest.

Among several approaches previously suggested to tackle problems of this complexity, methods for routing of vehicles – such as scanning and savings – should be part of the daily activities of cargo transportation (Ballou, 2006). The discussion of other solution processes, classified as constructive algorithms, two-way algorithm, incomplete-optimization algorithms, and improvement methods, must also be part of routing tools.

Technological evolution and the improvement of artificial intelligence have allowed the use of digital tools for locating products in storage sheds, use of SAP systems with greater intensity and traceability of cargos, in such a way to add the maximum value to transshipment business.

At the same time, in addition to decision-making aimed at competition, managers must detail in greater depth the logistics operations, in such a way to make it competent when deciding on the adoption of the most appropriate technology to add value to the product or service, and to develop scientific methods that result in practical applications to approach the academy and the company. Hence, several opportunities for contribution and studies on the same issue are available.

b) Perspective of managerial practices: Throughout our study we tried to show the role of cargo transshipment in the relationship between routing and added value. Thus, cargo transshipment – in particular for products such as long steel used in construction, in addition to the adequacy of transport (GIRIBOLA, 2013), requires mechanical equipment for loading and unloading of products, handling for several sizes, shapes, volumes, and weights of goods such as forklifts, truck-tractor, conveyors, monorails, crawler tractor, and winches.

The correct handling, proper packaging, and other equipment for conveyance of products aid the short offset into warehouses or distribution centers. Moreover, there is a need for a specialized staff to optimize the work and reduce costs for companies, which are not always available in the delivery sites.

However, not every unloading process is held in the proper location. It is also carried out on public roads, construction sites, and in places intended for the loading and unloading shared by private vehicles. In these cases, the unloading process becomes critical, since equipment required to do so are improvised. Hence, equipment and activities for loading and unloading processes have also been the target of innovation, mainly by reducing time and greater demands of delivery windows (ARAÚJO, 2014).

Developing projects for efficient cargo loading and unloading processes, in order to minimize the time the driver remains at transshipment sites, waits inside the factories, public roads, or parking lots can significantly change the operational logistics routine.

Therefore, logistics managers are faced with great opportunities to improve the activities inherent in such processes, ranging from preparation, conveyance, and management directed at reducing the time on cargo transshipments sites and meeting the needs of the competitive market, which is added value resulting from the delivery efficiency and reduced costs.

Finally, for further studies, we suggest: a) develop a computational model for comparison of different simulations to assess the effect of changes on control variables such as equipment options for unloading products; b) broaden the sample and compare the results from the point of view of other states or business areas; and c) create scenarios for mediation of cargo transshipment, for instance, by the use of the scanning and savings methods.

REFERENCES

- ALVARENGA, A. C.; NOVAES, A. G. N. **Logística aplicada: suprimento e distribuição física**. São Paulo: Edgard Blucher, 3ª edição, 2002.
- ARAUJO, J. G. Desafios e oportunidades do transporte rodoviário. **Harvard Business Review (Brasil)**. Available from: <<http://bit.ly/2nPqDsA>>. Access on: Nov./2014, 2014.
- BALLOU, R. H. **Gerenciamento da cadeia de suprimentos: logística empresarial**. 5ª edição. Porto Alegre: Bookman, 2006.
- BARON, R. M.; KENNY, D. A. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. **Journal of personality and social psychology**, v. 51, n. 6, p. 1173, 1986.
- BOWERSOX, D. J.; CLOSS, D. J.; COOPER, M. B.; BOWERSOX, J. C. **Gestão logística de cadeias de suprimentos**. Porto Alegre: Bookman, 2014.
- CHOPRA, S.; MEINDL, P. **Gestão da cadeia de suprimentos: estratégia, planejamento e operações**. São Paulo: Pearson Prentice Hall, 2011.
- CHRISTOPHER, M. **Logística e gerenciamento da cadeia de suprimentos**. 4a ed. São Paulo: Cengage Learning, 2013.
- CLARKE, G.; WRIGHT, J. W. Scheduling of vehicles from a central depot to a number of delivery points. **Operations research**, v. 12, p. 568-581, 1964.
- CONCEIÇÃO, S. V.; CONCEIÇÃO NETO, A. S.; NASCIMENTO, E. S.; ALMEIDA, H. M.; FIALHO, L. B.; PEDROSA, L. H. C.; SILVA, M. V. **Impactos da utilização de roteirização de veículos em um centro de distribuição: um estudo de caso**. Florianópolis: XXIV Encontro Nacional de Engenharia de Produção (ENEGEP), 03 a 05 de nov de 2004.
- COYLE, J. J.; BARDI; E. J.; LANGLEY, C. J. **The management of business logistics. a supply chain perspective**. 7th ed. Ohio: South-Western Thomson Learning, 2003.
- CSCMP – COUNCIL OF SUPPLY CHAIN MANAGEMENT PROFESSIONALS. **Annual conference**. Available from:<<https://cscmp.org>>. Access on: Nov./2015. 2015.

- CUNHA, C. B. Aspectos práticos da aplicação de modelos de roteirização de veículos a problemas reais. **Transportes**, v. 8, n. 2, p. 51-74, 2000.
- DA SILVA, L. F.; LEAL JUNIOR, I. C.; GARCIA, P. A. A.; TEODORO, P. **Avaliação da localização de base de atendimento para equipamentos de movimentação de uma empresa siderúrgica**. In Simpósio de Excelência em Gestão e Tecnologia. Rio de Janeiro: SEGeT, 2012.
- DANTZIG, G. B.; RAMSER, J. H. The truck dispatching problem. **Management Science**, v. 6, p. 80-91, 1959.
- DIAS, M. A. **Logística, transporte e infraestrutura**. São Paulo: Atlas, 2012.
- DREXL, M. Rich vehicle routing in theory and practice. **Logistics Research**, v. 5, n. 1-2, p. 47-63, 2012.
- FORNELL, C.; LARCKER, D. F. Evaluating structural equation models with unobservable variables and measurement error. **Journal of marketing research**, v. 18, n. 1, p. 39-50, 1981.
- GARG, R.; PRAKASH, S. Time minimizing transshipment problem. **Indian Journal of pure and Applied Mathematics**, v. 16, n. 5, p. 449-460, 1985.
- GIRIBOLA, M. **Como estocar e movimentar aço em obra**. Available from: <<http://bit.ly/2tIjBDA>>. Access on: Oct./2016. 2013.
- G1. **Caminhão com quase 9 mil quilos de excesso de peso é detido no TO**. Available from: <<https://glo.bo/2tGGdce>>. Access on: Oct./2016, 2014.
- HAIR JR., J. F.; ANDERSON, R. E.; TATHAM, R. L.; BLACK, W. C. **Análise multivariada de dados**. 5a ed. Porto Alegre: Bookman, 2005.
- HAIR JR., J. F.; HULT, T. M.; RINGLE, C. M.; SARSTEDT, M. **A primer on partial least squares structural equation modeling (PLS-SEM)**. London: Sage, 2014.
- HENSELER, J.; SARSTEDT, M. Goodness-of-Fit Indices for partial least squares path modeling. **Computational Statistics**, v. 28, p. 565-580, 2012.
- HITT, M. A.; IRELAND, D. R.; HOSKISSON, R. E. **Administração estratégica: competitividade e globalização**. 2ª edição. São Paulo: Thomson Learning, 2008.
- HOLTZ, F. **Cultura da produtividade avança na construção civil, mas velocidade deixa a desejar**. Available from: <<http://bit.ly/2tlm4Jb>>. Access on: Oct./2016, 2016.
- IACOBUCCI, D.; SALDANHA, N.; DENG, X. A meditation on mediation: evidence that structural equations models perform better than regressions. USA: **Journal of Consumer Psychology**, v. 17, n. 2, pp. 140-154, 2007.
- MALHOTRA, N. K. **Pesquisa de marketing: uma orientação aplicada**. 3a ed. Porto Alegre: Bookman, 2001.
- MIAO, Z.; YANG, F.; FU, K.; XU, D. X. Transshipment service through crossdocks with both soft and hard time windows. **An Operation Research**, v. 192, p. 21-47, 2012.
- NOVAES, A. G. **Logística e gerenciamento da cadeia de distribuição**. 3a ed. Rio de Janeiro:

Elsevier, 2007.

- ORDEN, A. The transshipment problem. **Management Science**, v. 2, n. 3, p. 276-285, 1956.
- PIRES, S. R. I. **Gestão da cadeia de suprimentos (Supply Chain Management):** conceitos, estratégias, práticas e casos. 2a ed. São Paulo: Atlas, 2011.
- POPOVIC, A.; HABJAN, A. Exploring the effects of information quality change in road transport operations. **Industrial Management & Data Systems**, v. 112, n. 9, 1307-1325, 2012.
- PORTER, M. E. **Competitive advantage: creating and sustaining competitive performance. Competitive advantage: creating and sustaining competitive performance.** Rio de Janeiro: Campus, 1985.
- RABBANI, M.; BAGHERSAD, M.; JAFARI, R. A new hybrid GA-PSO method for solving multi-period inventory routing problem with considering financial decisions. **Journal of Industrial Engineering and Management**, v. 6, p. 4, p. 909-929, 2013.
- REITER, P.; GUTJAHR, W. J. Exact hybrid algorithms for solving a bi-objective vehicle routing problem. **Central European Journal of Operations Research**, v. 20, n. 1, p. 19-43, 2012.
- STERNBERG, H.; STEFANSSON, G.; WESTERNBERG, E.; BOIJE-GENNÄS, R.; ALLENSTRÖM, E.; NAUSKA, M. L. Applying a lean approach to identify waste in motor carrier operations. **International Journal of Productivity and Performance Management**, v. 62, n. 1, p. 47-65, 2012.
- TENENHAUS, M.; VINZI, V. E.; CHATELIN, Y.; LAURO, C. PLS-Path Modeling. **Computational Statistics & Data Analysis**, v. 48, n. 1, p. 159-205, 2005.
- WANKE, P. **Gestão de estoques na cadeia de suprimento: decisões e modelos quantitativos.** 2a ed. São Paulo: Atlas, 2008.
- WETZELS, M.; ODEKERKEN-SCHRODER, G.; VAN OPPEN, C. Using PLS path modeling for assessing hierarchical construct models: guidelines and empirical illustration. **MIS Quarterly**, v. 33, n. 1, p. 177-195, 2009.
- YU, B.; YANG, Z. Z.; XIE, J. X. A parallel improved ant colony optimization for multi-depot vehicle routing problem. **Journal of the Operational Research Society**, v. 62, n. 1, p. 183-188, 2011.
- ZAPAROLLI, D. **Custo elevado do transporte impede novos negócios.** Available from: <http://www.setsul.org.br/informa_conteudo.php?id=475>. Access on: Aug./2018. 2014.

APPENDIX 1: All assertions were measured by the scale of agreement/disagreement with six degrees of importance ranging from totally disagree (TD = 1) to totally agree (TA = 6). Arithmetic mean, standard deviation, and factor loading are also presented.

Table A1: Measures and scales of the measurement modeling

		CONSTRUCT / ASSERTIONS	Average	S. D.	Vfac	Factor
ROUTE	R ₁	uses groupings of cargos during the process	5.43	0.81	0.15	0.71
	R ₂	uses the scheduling of deliveries for decision-making	5.28	0.77	0.15	0.58
	R ₃	considers cost reduction for routing decisions	5.15	0.89	0.17	0.60
	R ₄	uses SAP system or other systems to implement the process	5.20	1.47	0.28	0.63
	R ₅	applies the “savings” or “scanning” methods to implement the process	3.62	1.67	0.46	0.66
TRANSSHIPMENT	T ₁	considers opening hours of customers to schedule deliveries	5.53	0.71	0.13	0.60
	T ₂	stores products during the transshipment process	4.89	1.19	0.24	0.52
	T ₃	uses systems for locating products in storage sheds	3.72	1.83	0.49	0.68
	T ₄	inspects products in the processes of loading, unloading, and storage	4.91	1.30	0.26	0.71
	T ₅	consider customers’ equipment for loading and unloading	4.68	1.37	0.29	0.57
ADDED VALUE	V ₁	searched for a location closer to the customers	4.12	1.47	0.36	0.61
	V ₂	improved unloading and loading time in its units	4.84	0.94	0.19	0.78
	V ₃	reduced the order cycle from its collection to delivery	4.78	0.96	0.20	0.74
	V ₄	improved the level of service to attend its customers	4.89	0.87	0.18	0.79
	V ₅	provided information to customers on the status of their requests	4.04	1.27	0.31	0.61
	V ₆	reduced operation costs of delivery to customers	4.51	0.98	0.22	0.84

Note: Average = Weighted Average; S.D. = Standard Deviation; Vfac = Variation factor; Factor = Factor loading

Source: Prepared by the authors.

Contribution of authors

Contribution	[Author 1]	[Author 2]	[Author 3]	[Author 4]
1. Definition of research problem	√	√	√	√
2. Development of hypotheses or research questions (empirical studies)	√	√	√	
3. Development of theoretical propositions (theoretical work)	√	√		
4. Theoretical foundation / Literature review	√	√		
5. Definition of methodological procedures	√	√	√	
6. Data collection	√			√
7. Statistical analysis	√	√		√
8. Analysis and interpretation of data	√	√	√	√
9. Critical revision of the manuscript	√	√		√
10. Manuscript writing	√	√		
11. Other (please specify) – <i>contact companies</i>	√		√	√