What matters in intermodal service operations from the shipper's point of view?

Ricardo S. Martins (martins@cepead.face.ufmg.br)
Professor, School of Business Administration/Federal University of Minas Gerais (UFMG). Researcher at the Interdisciplinary Center for Logistics Research (NIPE-LOG/UFMG). 6627, Antônio Carlos Av. – Zip Code 31270-901 - Belo Horizonte - Brazil

Débora S. Lobo
Professor, State University of Western Paraná (Unioeste). Researcher at the Research Group for Transport, Logistics and Systems Modeling (Translog) P.O. Box 520 Zip Code 85.900-970 Toledo–PR – Brazil - dslobo@uol.com.br

Alexandre Florindo Alves
Professor at the Graduate Program of Economics of the State University of Maringá. 5790, Colombo Av., BI C34 Room 227. Jardim Universitário – Zip Code 87.020-900 - Maringá, PR – Brazil - afalves@uem.br

Renato Luiz Sproesser
Professor at the Graduate Program of Administration at the Federal University of Mato Grosso do Sul. 1555, Filinto Muller Av. Cidade Universitária, Unidade 10. Zip Code 79070-900 – Campo Grande – MS – Brazil - drls@nin.ufms.br

Abstract
This study investigated the service desired by shippers in operating intermodal terminals. Applying the technique of stated preference, shippers indicated the ranked constructs as follows: reliability, time period, customer relations, cost, and flexibility. The results indicate that constructs associated with the quality of service are receiving higher valuation than freight.

Keywords: Transportation demand, Service level, Stated Preference

Introduction
The performance of the production and export of the Brazilian agribusinesses imply growth in the demand for transport and logistics as a whole. This sectoral production has grown in the interior of the country, moving away from the ports, which are the points of access to foreign markets.
Brazilian agribusinesses have expanded their occupation of the north and mid-west regions and huge areas of the north-east. The sources and suppliers of some raw materials and implements used in this production are also more distant, requiring more transportation services.

However, this increase in demand is strongly concentrated in road operations, causing congestion on the roads and traffic jams in the access areas to ports, with a subsequent increase in freight rates and in storage costs in the port area, and delays and even loss of shipments. In this respect, the operation of the intermodal terminals has a peculiar role in minimizing these effects.

Therefore, the study aims to answer the following question: Which constructs are desired by shippers in the services of intermodal terminals for bulk agricultural products to truly make this alternative a priority? In this article, transportation is analyzed in relation to management services, focusing on how shippers form their expectations of the services. In the traditional approach, the management of transport is discussed more as a process (Ng, Ferrin and Pearson, 1997; Neuschel and Russell, 1998) and its flow is measured by its operating performance and costs (Meixell and Norbis, 2008; Mason et al. 2003; McCann 2001).

This study is structured as follows: firstly, the introduction is presented, followed by description of the theoretical framework that deals with logistics as a business strategy. The next section presents the nature of the research and the methodological procedures used to achieve the proposed objectives, with details provided about the strategies and actions used in researching the application of the stated preference. Presented next are the study’s results, detailing the characteristics of the intermodal terminals in the region under study, the results regarding the constructs, as well as the discussion of these results. Finally, the conclusions of the work are drawn.

**Using the logistics to compete**

Logistics, viewed as a set of elementary activities that create value within and between companies, acts as a key success factor in the superior performance of production systems. Traditionally, such activities are identified as inventory, transportation, facilities, and information. These activities contribute greatly to the improvement of operations (Chopra and Meindl 2007) and to the competitiveness of businesses.

For shippers, transport services are, in general, the pillar of the distribution compound as they directly impact on customer satisfaction. In a situation requiring a certain organization of competitive products, logistics (delivery) can negatively impact on the overall evaluation (of products and services together) provided by the client. For example, this may involve the loss of fidelity or the decision to not repurchase, due to delivery performance in terms of its cost, the level of damage, deadlines, and the general consistency of services (Ballou 2004).

According to Wanke and Zinn (2004), value creation, that is, the creation of a product or service or the features that make its consumption desirable, can happen in a few moments. The role of logistics is to deliver value to those interested in possession of the product. To do this, the values of place and time have to be added. The value of place consists of making the product
available at the most appropriate place in order to affect the desire for its possession, whether this is in a retail store or wholesaler or even in the house or premises of the customer. The value of time implies that the transferal of the ownership of the property should be performed at the desired time.

In the case of bulk agricultural products, the form of agribusiness addressed in this article, among the key logistics activities previously highlighted, value is mainly created by transport. Bowersox, Closs, and Cooper (2002) suggest that the management of transport should be performed by evaluating transport services based on parameters that demonstrate performance, such as the following:

- **Speed**: time spent in transit
- **Availability**: ability to attend to any origin and destination
- **Reliability**: potential variation in the total time of service provision
- **Capacity**: condition of handling any load and any amount
- **Frequency**: ability to act at any time

The efficient flow of production at low cost becomes strategic for organizations and a great challenge for logistics. An efficient transport system will reflect choices between modes, with each one having its own characteristics that can and should be exploited in the development of transport strategies. The arrangements of classic transport modes and their respective characteristics, according to Ballou (2004), are:

- **Waterway**: high capacity at low costs, with low agility and flexibility
- **Road**: agility and flexibility, but high variable costs
- **Rail**: average capacity, average agility, low flexibility, and average costs
- **Air**: speed, low bearing capacity, high costs, and high flexibility
- **Pipeline**: low flexibility, low agility, and low costs.

However, restrictions of natural endowments or on a grand scale often lead to transport systems being structured in hubs. Thus, a shipping structure in the rail system is deployed at a particular vantage point, for example, covering a distance of 500 km for the catchment of charges to consolidate the railway operation. This is what is called intermodal operation, that implies a shipper using more than one mode of transport of goods between the origin and destination.

As in the case above, the road serves as the main integrator between modes because it has excellent capillarity. However, the transfer of charges between modes requires a physical structure that enables the transfer operation to occur quickly at a low cost, without loss or damage of cargo.

**Methodological definitions**

This is an empirical, exploratory research that sought to characterize the needs and expectations of shippers with regard to the services provided by intermodal terminals for bulk agricultural operations. This study was conducted according to criteria proposed by Collis and Hussey (2009): as to its objectives, it is an exploratory study; as to the process, this study is quantitative; and, as to logic, it ranks as inductive research. The type of procedure methodology is the survey, with non-probability sampling by accessibility.
Sample

The sampling procedure used was non-probabilistic, by accessibility and typicality. The sample involved 40 interviews with customers of intermodal terminals distributed across the states of southern Brazil: Paraná, Santa Catarina, and Rio Grande do Sul. The unit of research analysis referred to the shipping company users or potential users of intermodal terminals for bulk agricultural products. The observation units were the managers involved in the operational management process of the units. According to estimates from IBGE (2011), southern Brazil leads the national grain production, with the share of total Brazilian production being 20.2% for Paraná, 17.3% for Rio Grande do Sul, and 4.1% for Santa Catarina.

Research strategies, data collection, and type of information

Data collection occurred through the application of stated preference cards. The research strategy adopted was on-site visits. The purpose of the interview is to obtain information on a given subject, with this then used to perform diagnostics, and to collect data.

The interviews covered questions addressing the constructs and attributes of transportation. The ranking of the shippers’ preferences was obtained through the survey by using the Stated Preference technique, which will receive more attention in the next section.

Stated Preference technique

The statistical analysis for understanding the shippers’ preferences can be conducted by means of multivariate statistical techniques. These included the joint analyses of revealed preference and stated preference, with the latter selected for its suitability for the purposes of the study. This technique appears more suitable than other techniques because it essentially deals with hypothetical situations or situations in which the preferences or choices cannot be directly observed. According to Almeida and Gonçalves (2001), this set of options may be hypothetical, but it should be feasible if realized, allowing respondents to imagine them with ease.

Interviews

The research strategy adopted was to conduct interviews on site. According to Craighead and Meredith (2008), studies using respondents’ perceptions about reality have increased relative participation in research in operations management in a movement that has targeted researchers who "come out of their offices" to gain a more direct observation of the phenomenon to be studied. Consequently, these findings will have greater relevance for managers and for the elucidation of the problem being addressed.

For the elaboration of the research instrument, practical guidance from the Brazilian reality were sought which concerned the dimensions relevant to the assessment of transport in Schluter and Sena (1999), and Valente, Passaglia, and Novaes (2008). In addition to theoretical review, the research instrument also used the experience of previous studies that had similar purposes, such as Brazilian Departament of Transportation/Land Transport Agency (ANTT, 2005), and World Bank (BIRD/ANTT, 2006).
The constructs and respective levels are shown in Table 1.

Table 1–Selected constructs, respective levels, and numeric codes

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Levels</th>
<th>Code Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time Period</strong></td>
<td><em>Short:</em> delivery made quickly</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><em>Long:</em> deliveries made within a period 2 times slower than the service offered by a carrier or truck driver</td>
<td>0</td>
</tr>
<tr>
<td><strong>Customer relations</strong></td>
<td><strong>Accessible information:</strong> the operator provides facilities for communication and contact for negotiation and the company (shipper) has information about the status of the cargo in transit</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Hindered information:</strong> the operator does not offer facilities for communication and contact for negotiation and the company (shipper) does not have information about the status of the cargo in transit at the needed time</td>
<td>0</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td><em>Satisfactory:</em> reasonably lower (up to 20% lower) than the service offered by a carrier or truck driver</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><em>Unsatisfactory:</em> equal or very close (AT LEAST 10% higher) to a service offered by a carrier or truck driver</td>
<td>0</td>
</tr>
<tr>
<td><strong>Reliability</strong></td>
<td><em>High:</em> the service is reliable, leaving the shipper without concern about the punctuality and integrity of the load</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><em>Low:</em> the service is unreliable, leaving the shipper concerned about the punctuality and integrity of the load</td>
<td>0</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td><strong>Capillary Service:</strong> meets multiple points, reaching different destination points (customers and ports)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Rigid service:</strong> few routes, few destination points would be attended by the service</td>
<td>0</td>
</tr>
</tbody>
</table>
Data analysis

Statistical responses were used for the analysis of the responses by the algorithm developed by Souza (1999).

Results: Analysis

In implementing the experiment, it was decided not to present all possible combinations of levels and constructs to respondents, that is, to use the fractional factorial. The obtained results are derived from the ranking by respondents in six groups of five cards, with eight cards using the technique of partially-balanced incomplete groups suggested by Souza (1999). Often, a single repetition of a factorial experiment goes beyond the capabilities of researchers, or provides more precision than needed for the estimation of the main effects (Cochran and Cox 1978).

The use of fractional repeat experiments was proposed by Finney (1945). Since then, these experiments have been used in many applications, especially in industrial development. Their main attraction is that they allow the inclusion of five or more factors in an experiment of practical size, so that the researcher can quickly determine the effects of the factors in the outcome.

The results of the statistical model are presented in Table 2. The t-test considers the significance of the parameters \( \beta \), indicating that the results will be significant if they are above the value given in Table t-student. The LMPC software (Souza, 1999) used considers the t-test with a significance level of 95% for these parameters.

The reliability construct has a higher correlation coefficient, indicating a very strong correlation, which means that the population sampled places a lot of importance upon this attribute, and that the attribute of flexibility has less importance statistically because its correlation coefficient is very weak. According to Shikimura (2006), a very strong association exists at values of 0.90 and 1.00 and a very weak correlation at values between 0.00 and 0.19.

Regarding the t-test, Marques (2003) emphasizes that values above 2 are usually indicated as suitable for this type of experiment: as seen from the results, the attribute of reliability is statistically the most significant for respondents at 3.9806. This result also shows that there are significant differences for respondents in choosing between levels 0 and 1 of this attribute. The attribute of flexibility, with the lowest result in the t-test, has the lowest relevance for respondents. In addition, this possibly indicates that there is no significant difference making respondents choose between levels 0 and 1 of this attribute, which is statistically proven by the low score of 0.0798.

The next test was that of the likelihood ratio \( LR = -2(L(0) - L(\beta^*)) \) which aims to simultaneously test the null hypotheses of all parameters. According to Ben-Akiva and Lerman (1985), if the LR value is greater than the \( \chi^2_{(a, n)} \) value, the null hypotheses of all parameters are simultaneously rejected. In this study, the results of 43.4515 for the LR test indicate that the null hypotheses should be rejected, so the parameters are useful and therefore relevant.
In this sequence, it is possible to see the test results of the $\rho_2$ statistic (pseudo-coefficient of determination – $Rho$): the statistic $\rho_2$ has limited theoretical value from 0 to 1, but its value between 0.2 and 0.4 indicates an adjustment that is considered excellent for the multinomial logit model. In the case of the results found in this study, the $Rho$ has a good performance at 0.1709.

**Table 2– Statistical results relative to the constructs**

<table>
<thead>
<tr>
<th>Construct</th>
<th>Coefficient</th>
<th>Error</th>
<th>T-test</th>
<th>IC (t=2.5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Period</td>
<td>0.8614</td>
<td>0.279</td>
<td>3.008</td>
<td>[0.304 ; 1.419]</td>
</tr>
<tr>
<td>Customer relations</td>
<td>0.5384</td>
<td>0.252</td>
<td>2.1366</td>
<td>[0.034 ; 1.042]</td>
</tr>
<tr>
<td>Cost</td>
<td>0.3299</td>
<td>0.2209</td>
<td>1.4939</td>
<td>[-0.112 ; 0.772]</td>
</tr>
<tr>
<td>Reliability</td>
<td>0.9935</td>
<td>0.2496</td>
<td>3.9806</td>
<td>[0.494 ; 1.493]</td>
</tr>
<tr>
<td>Flexibility</td>
<td>0.0184</td>
<td>0.2304</td>
<td>0.0798</td>
<td>[-0.442 ; 0.479]</td>
</tr>
</tbody>
</table>

Number of respondents = 40  
Number of cases = 120  
$F(\text{Betas}_0) = -127.1222$  
$F(\text{Betas}_1) = -105.3964$  
$LR ( -2 [F(0)-F(B)]) = 43.4515$  
$Rho = 0.1709$  
$Rho (\text{Ajt}) = 0.1316$

Source: Study results

Another test available in Souza’s (1999) LMPC software is the test for comparing alternatives in order to know which combination of attributes and cards was most often chosen and to individually test the significance of each alternative (card shown). This test showed that all the alternatives are significant.

**Implications of the results and Conclusions**

According to Meixel and Norbis (2008), the criteria most often applied in hiring transport services, worldwide, are: above all, trust in the service, time in transit (time), and logistics costs, followed by the indices of breakdowns, vehicle availability/service flexibility, service, and shipping and service quality. For Brazilian industrial shippers, Martins et al. (2011) identified the constructs of safety and reliability as the most important services provided by carriers, followed by time period, cost, customer relations, and attending to the special requirements of customers. In the present study, the presented constructs were ranked in terms of priority in the following order: reliability, time period, customer relations, cost, and flexibility.

The results reflect the shippers’ concerns regarding the expectations of their own logistics operations, the enforcement of contracts and logistics costs as well as the quality and allocation of transport systems. Initially, shippers expressed interest in operations occurring within expected time periods, with reliability and competitive costs. Moreover, as indicated by Wanke (2012), lower tolerance of low levels of reduced service and aversion to the risk of loads being stolen also reflect the tonnage transported annually.

Thus, the coefficients in formatting the manifested services as desired by shippers provide a dimension for the quality level expected from the operation of intermodal terminals. This
alternative may even become more expensive, but this should be offset by increased reliability, allowing a reduction of storage costs in port areas as well as of shipment losses caused by delays in operations and transit during export.

On the other hand, this rationality in decision-making can also be discussed from the angle of the allocation of transport systems. In this sense, transportation costs are considered qualitatively additional to freight charges associated with the modes, which are evaluated vis-à-vis the costs relating to service quality characteristics, which include speed and total delivery time, reliability, and other indicators of logistics.

Concerning the qualitative aspect, transportation systems have to provide services within the expectations of shippers. In addition to being a competitive differential in favor of the carrier that is aware of these demands, the improvement of quality in transport can reduce the cost of the final product, for example, as a result of lower transaction costs and reduced losses.

Scherer and Martins (2003) and Martins, Lobo, and Pereira (2005) identified this trend of declining relative importance in shippers’ concern regarding cost when researching the constructs desired when hiring logistics operators. These results indicated a significant change in the market with regard to the priority attributes for freight contracting. In the bulk agricultural segment, the freight market historically prioritized price as the most relevant construct, which made transporting a commodity.

However, valuing the guarantees that only the big operators can give involves prioritizing longer-term contracts and relationships, indicating to the market that the big shippers are negotiating primarily with transportation companies with their own fleets. An immediate impact of this trend may be the reduction in the participation of freight agencies. These are established based on the disorganization and fragmentation of the service provider segment, in which the autonomous participant (“truck driver”) is predominant, as are those carriers that have a reduced fleet and are often restricted to a single vehicle.

On the other hand, this process of qualifying service and professionalism is necessary for the road transport of loads to remain competitive in light of the recent expansion, although often understated and not so widespread, of other modes of transport. In this new scenario, it seems clear that the autonomous participant is undergoing a drastic decrease in importance in the market and is increasingly dependent on the subcontracting of transportation companies.

The results reflect shippers’ concerns regarding the fulfillment of contracts and logistics costs as well as the quality and allocation of transport systems. Initially, shippers expressed interest in operations occurring within expected time periods, with reliability, and at competitive costs. On the one hand, shippers have little margin for error; therefore, they seek to minimize costs with reduced storage in port areas and reduced losses of shipments caused by delays in operations and transit during export. On the other hand, the use of only one mode of transport, normally by road, is safer in terms of the time period required and the total time of the operation.
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References


