Strategy and Distribution Logistics: The customers’ allocation in the multiple facilities using as reference the transportation costs.

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Abstract

Distribution Logistics is an important competitive advantage when the company serves customers demands with lower cost. The present study aims to analyze the problem of customers’ allocation due the insertion of new nitrogen fertilizers units in the logistic networking desing, minimizing transportation costs and hence, in the product's distribution process.

Keywords: Strategy, Distribution Logistics, Transportation Cost.

Introduction
In view of the search for superior performance in a competitive environment, the alignment between the strategic, operational, and functional levels of a company is important in building a sustainable competitive advantage in the long-term (Resende and Mendonça 2007).

The translation of a company’s business strategy to other levels within the company should be aligned so that there is no practical disconnect between the strategic and operational levels, as the decisions made at both these levels must support the company's competitive strategy.

One of the major decisions of a company at the strategic level is Logistics Network Planning that determines the number of facilities, size, and location of factories and warehouses. The transformation of this into a tactical level reflects a decision to define the allocation of customers among facilities (Kouvelis et al. 1996).

Therefore, when a new facility is introduced in the logistics network, which has a fixed place, it is necessary to revise the assignment of customers to facilities in order to minimize the transportation costs (Jayaraman and Pirkul 2001, Jayaraman and Ross 2003, Melo et al. 2009, Syarif et al. 2002).

Thus, the starting point for this paper is a case study aiming to examine the relocation of strategic customers to manufacturing facilities, to minimize total transportation costs from the deployment of new nitrogenous fertilizer units (UFNs) from XPTO company.

By applying the Classical Transportation Problem, the intention is to answer the following question: Which customers, considered strategic by the company, should be served by which facilities to minimize transportation costs?

In this sense, the study seeks to contribute more information on the use of the Classical Transportation Problem, thereby helping the management decision-making process of the company.

The study was limited to nitrogen urea fertilizer, as this product represents 70 percent of the revenues of fertilizer area from XPTO and for the four customers considered strategic by XPTO, representing a demand of 55.8 percent of the urea produced.

According to the AMA (2012), urea has a higher consumption than other nitrogen fertilizers, mainly due to a higher percentage of nutrient nitrogen and the lowest freight cost in relation to the amount of nitrogen transported. Ammonia is generally not used directly as a fertilizer due to logistics costs and the risks involved in its use. In addition, ammonium sulfate has a higher price for nitrogen.

To perform the study proposed above, the paper is organized as follows: after this introduction the section is dedicated to review of literature about strategic alignment, distribution logistics, facility location/demand allocation, the role of transport and the fertilizer sector in Brazil. In the next sections presents the methodological procedure adopted and the study development. The paper ends with some conclusions and possible directions for future research.
Review of Literature

The strategic alignment seeks to adjust the organization to its environment, and the decisions made within of each sub-strategy must be consistent with each other and converge with the overall business strategy (Borella and Padula 2010).

The translation of business strategy from one company level to other levels within the business should be aligned so that there is no practical disconnect between the strategic and operational levels.

According to Mintzberg, Ahlstrand, and Lampel (2010), the logic of strategic alignment means not separating thought from action, senior management from middle management, and people who draw up the plans from those who put them into practice.

According to Chopra and Meindl (2010), the key to achieving strategic alignment is a company's ability to find the balance between responsiveness and efficiency in meeting demand.

To support a company's competitive strategy, operational strategies, which in the case of industrial companies address supply, manufacturing, and distribution, should match the business strategies (Wheelwright 1984).

Therefore, in a competitive environment the search for superior performance can give a higher importance to distribution logistics differentiation, which can offer the creation of sustainable competitive advantages over the long-term (Resende and Mendonça 2007).

According to Pagh and Cooper (1998), the strategy of distribution logistics is designed to determine how the company will meet the needs of the market and customers with its products and services.

According to Bowersox, Closs, and Cooper (2007), the movement of logistics distribution is downstream, linking producers to end-users. These authors identify four participants in this stream: manufacturers, wholesalers, retailers, and consumers. Distribution may be direct from the manufacturer to the consumer, or indirect through intermediaries like wholesalers and retailers.

In order to become more competitive and efficient, companies make decisions at a strategic level, such as determining the number, size, and location of factories and warehouses, relocation of plants and distribution centers, including new facilities in the logistics network, influencing logistics distribution, and bringing about changes in their activities.

Besides defining where facilities are located, a study related to facility location can make a number of contributions to product, production, and distribution strategies as well as customer service policies.

Minimizing the cost of the distance between the facilities and customers is the main problem in positioning facilities (Jayaraman and Ross 2003).

Spatial distribution of customers, distance, time, costs of transport between customers and facilities, which facilities should be opened, which customers should be served from which facility in order to minimize total costs, are all issues involving facility location (Melo et al. 2009).
According to Ballou (2006), the decision to localize fixed facilities influences the development of the supply chain. This decision involves the number, location, and proportion of facilities to be used.

Capacity and cost of customer service are directly impacted by the number, size, and geographic location of the facilities (Bowersox 2007).

According to Chopra and Meindl (2010), decisions about facilities are also called design decisions in the supply chain network. For decisionmaking it is necessary to answer questions such as: what is the role of the facilities, their allocation capacity, their markets, and supplies?

However, the strategic factors of a company should be kept in mind since they have an impact on network design decisions within the supply chain. Technological, macroeconomic, and competitive factors, customer response time, and local presence, as well as the cost of logistics and facilities all need to be taken into consideration when designing network facilities (Chopra and Meindl 2010).

According to the above-mentioned authors, network design decisions are made in four phases, starting with the definition of a supply chain strategy, followed by the definition of the regional facility configuration, the choice of appropriate locations, and finally the selection of the locations.

Additionally, there is the optimization of network facilities by allocating different market demand to manufacturing facilities with the objective of minimizing the total cost of installation, inventory and transportation.

Ballou (2006) states that one of the key activities that influence distribution logistics is transport. Transport is one of the most important areas in the field of logistics network planning, given the impact that such a decision has on profitability, since it represents about 60% of the logistics costs and, therefore, can make the product less competitive in the market.

Gurgel (2000) considers transport to be an essential link between the transportation company and the customer by moving the product between the production unit and the client.

According to Chopra and Meindl (2010), transport plays a crucial role in the logistics of distribution as the products are rarely produced and consumed in the same location.

According to Ballou (2006), if a competitive strategy targets a customer who demands a very high level of responsiveness, the company can then use speed of transport as a key competitive advantage. If the company's competitive strategy targets customers who have price as their main buying decision criterion, the company can then use cost of transport to lower the cost of the product.

**Fertilizer Sector in Brazil**

Throughout the expansion of Brazilian agriculture, fertilizer consumption was sustained by increasing importation. The dependency on imported agricultural products causes Brazil to become vulnerable to changes in the fertilizer market, since domestic production of basic raw
materials for fertilizers (nitrogen, phosphorus, and potassium) have not kept up with the growth in demand (Gonçalves et al. 2008).

Data from the National Association for the Promotion of Fertilizers - ANDA in 2012 indicate that approximately 67 percent of fertilizers consumed in Brazil were imported (ANDA 2013).

However, recently the Ministry of Agriculture has proposed a decrease in the dependence of Brazilian agriculture on foreign raw materials, promoting greater domestic production by the end of 2019. The national fertilizer plan involves stimulating the search for new phosphorus and potassium deposits, and the exploitation of those already known and evaluated, as well as seeking a fair tax system so that investments in the production of phosphorus, nitrogen, and potassium will be recouped (MAPA 2012).

The goal to be achieved, according to the Ministry of Agriculture involves reducing the proportion of imports in the total consumption of phosphorus from 49% to 12%, and of nitrogen from 78% to 33% by 2016. Regarding potassium, due to the lack of viable deposits, the proportion of imports in the total consumption must continue above 80% (MAPA 2012).

With respect to nitrogen fertilizers, by 2017, only the company XPTO should invest in projects to transform natural gas into ammonia and urea, with the deployment of the so-called UFNs (Agrobrasconsult 2012).

Research Methodology

The method adopted is classified as scientific research of an applied nature, following a quantitative approach with exploratory objectives. Are used bibliography research for understanding concepts, documentary research for data collection and case study to contextualize the application and simulation of the problem as a technical procedure (Bertrand and Fransoo 2002).

The Classical Transportation Problem is the most representative of Linear Programming Problems, and of great practical application. It aims to determine the quantities of products to be transported from a set of suppliers to a set of consumers, so that the transportation total cost is minimized. The problem considers two links in the supply chain and excludes intermediate facilities such as distribution centers (Belfiore and Fávero 2012).

The classical transportation problem was solved by means of a hypothesis using MS Excel © Solver spreadsheet detailed in the equations tool:

Objective function:

$$\min \ z = \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij}x_{ij} \quad (1)$$

Subject to:
\sum_{j=1}^{n} x_{ij} \leq C_{ij}, \quad i = 1,2, \ldots, m \tag{2}

\sum_{i=1}^{m} x_{ij} \geq d_j, \quad j = 1,2, \ldots, n \tag{3}

x_{ij} \geq 0, \quad i = 1,2, \ldots, m, \quad j = 1,2, \ldots, n \tag{4}

Where:

\( m \) = origins

\( n \) = destinations

\( C_{ij} \) = unit transportation cost from supplier \( i \) to consumer \( j \)

\( X_{ij} \) = quantity transported from supplier \( i \) to consumer \( j \)

\( C_{fi} \) = supply capacity of supplier \( i \) \( (i = 1,\ldots, m) \)

\( d_j \) = demand of the destination \( j \) \( (j = 1,\ldots, n) \)

Equation 1 is the objective function of the model that seeks to minimize the transportation cost based on the distances between the facilities and strategic customers. In terms of restrictions, it is worth mentioning that Equation 2 has a capacity constraint causing limited supply and Equation 3 has the restriction of coverage of demand, in which all strategic customers must have the total of their demands satisfied. Equation 4 makes the matrix solution \( i, j \) an array of integers. The trucking costs were obtained from the Yearbook 2012 - Freight Information System (SIFRECA), which is the main reference source for the agricultural freight market in the country.

**Development**

**Presentation of the Case Study Company**

The company XPTO is the largest producer of nitrogenous fertilizers in Brazil. The company owns two factories in the northeast: the UFN-SE, with a production capacity of 657,000 tons per year of urea and 456,000 tons per year of ammonia; and UFN-BA with 474,000 tons per year of urea and 474,000 tons per year of ammonia. Additionally, XPTO has strengthened its fertilizer area with the recent acquisition of another facility in July 2013, UFN-PR in the south, with a production capacity of 700,000 tons of urea.

Although the structure and operation of the company is in ongoing, the technique regarding the allocation of demand to manufacturing facilities can be applied to review their distribution logistics and align their pre-existing company structure to the new realities of the business.
In addition, the company is currently investing in new UFN’s to grow its market share. In the center-west, Três Lagoas (MS), a plant is being built and will begin operations in September 2014, with a production capacity of 1,223 million tons per year of urea and 70,000 tons per year of ammonia. In the northeast, municipality of Laranjeiras (SE), an ammonium sulfate plant, with a production capacity of 303.00 tons per year, will open later this year. Two other units in the southeast, one in Uberaba (MG), which will produce 519,000 tons per year of ammonia, and another in Linhares (ES), with urea (755,000 tons per year) and ammonia (456,000 tons per year) production, are expected to start in September 2015 and June 2017, respectively.

For XPTO, the projects of nitrogen-based fertilizers operate in parallel with the generation of electricity. According to technical studies, there are long periods when natural gas, reserved for the generation of electricity, is available. The production of fertilizers is modulated according to the availability of natural gas.

By July 2013, the strategic clients were assigned to facilities located in the northeast of Brazil, state of Bahia and Sergipe. Client A has 21 destinations, with average annual demand of 13,901.21 tons of urea per destination. Client B has 13 destinations, with an average annual demand of 9,364.55 tons of urea per destination. Client C has 5 destinations, with an average annual demand of 9,192.55 tons of urea per destination. Client D has 5 destinations, with an average annual demand of 7,204.97 tons of urea per destination.

<table>
<thead>
<tr>
<th>Factory</th>
<th>Location</th>
<th>Operational Situation of the Factory</th>
<th>Urea</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>City/UF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UFN – SE</td>
<td>Laranjeiras/SE</td>
<td>In operation</td>
<td>657</td>
</tr>
<tr>
<td>UFN – BA</td>
<td>Camaçari/BA</td>
<td>In operation</td>
<td>474</td>
</tr>
<tr>
<td>UFN – PR</td>
<td>Araucária/PR</td>
<td>In operation starting from July/2013</td>
<td>700</td>
</tr>
<tr>
<td>UFN – III</td>
<td>Três Lagoas/MS</td>
<td>In operation starting from September/2014</td>
<td>1,223</td>
</tr>
<tr>
<td>UFN – IV</td>
<td>Linhares/ES</td>
<td>In operation starting from June/2017</td>
<td>755</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>3,809.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2,874.00</td>
</tr>
</tbody>
</table>

Simulation
New simulation scenarios are proposed as new UFN become part of the network logistic. The descriptions of the simulation scenarios are shown in Table 2. It is important to point out that the fictional demand Dummy was considered in all scenarios to balance the classical transportation problem, i.e., to equalize supply and demand once the supply capacity is greater than strategic customers’ demand. Regarding demand were considered 32 place of demand due there are common places among strategic customers.
Table 2 - Definitions of scenarios for simulations

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Characteristics</th>
<th>Transportation costs (R$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1</td>
<td>Allocation of customers to facilities UFN - SE and UFN - BA.</td>
<td></td>
</tr>
<tr>
<td>Scenario 2</td>
<td>Allocation of customers to facilities UFN - PR, considering the existence of the factories located in Scenario 1.</td>
<td></td>
</tr>
<tr>
<td>Scenario 3</td>
<td>Allocation of customers to facilities UFN III, considering the existence of the factories located in Scenarios 1 e 2.</td>
<td></td>
</tr>
<tr>
<td>Scenario 4</td>
<td>Allocation of customers to facilities da UFN IV, considering the existence of the factories located in Scenarios 1, 2 e 3.</td>
<td></td>
</tr>
</tbody>
</table>

The objective function of all scenarios was to minimize the transportation cost. The numerical results of the scenarios generated by the Solver are shown in Table 2. From an analysis of Table 2, it can be noted that the transportation cost for strategic customers decreases as the number of factories increases, as this means that customers are closer to the factories.

Table 2 - Solutions generated by the Solver for the simulated scenarios.

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Characteristics</th>
<th>Total of Factories</th>
<th>Transportation costs (R$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 0 2</td>
<td></td>
<td>92.798.672,78</td>
</tr>
<tr>
<td>2</td>
<td>2 1 3</td>
<td></td>
<td>42.937.264,30</td>
</tr>
<tr>
<td>3</td>
<td>3 1 4</td>
<td></td>
<td>31.041.808,71</td>
</tr>
<tr>
<td>4</td>
<td>4 1 5</td>
<td></td>
<td>27.418.076,59</td>
</tr>
</tbody>
</table>

General Analysis of Results

It should be noted that only the variable cost of transport has been considered in this study, other variables hasn't been considered.

The Solver solution presented for scenario 1 mentions a optimized transportation cost of R$ 92,798,672.78 from factories located in the northeast of the country (in the states of SE and BA) to the strategic customers. The supply for 32 points of demand, considering the acquisition of a plant in the south of the country, reduces transportation cost for strategic clients around 53.7 %, according to scenario 2. In scenario 3 the construction of a factory in the center-west of the country, reduces 27.70% compared with scenario 2. The reduction of transport costs for strategic customers in scenario 4 wasn’t so significant compared to the previous scenarios.

Conclusions

Achieved the proposed through applying the Classical Transportation Problem, in function of insertion of new UFN's in the logistic network, the strategic customers have been reallocated,
optimizing the transportation cost between points of supply and demand of these. The acquisition of UFN – PR provided the largest reduction in the transportation cost for strategic customers.

The study also reached the aim regarding the application of the Classical Problem of Transportation in support to decision-making process. Confirming the theory that revisions in distribution logistics are important when new plants are inserted into the network.

Limitations and directions for further research

Regarding the limitations, although the 4 customers are responsible for demand at 60 % of urea, the non-consideration of other customers feature a limitation of this study generating the following recommendations for future research: consider the whole portfolio of customers and also other means of transport as alternatives to distribution logistics.

Bibliography


