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Adapting transport modes to supply chains classified by the uncertainty supply chain model: A case study at Manaus Industrial Pole

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Abstract: This paper discusses transport modes supporting Uncertainty Supply Chain Model (USCM) in the case of Manaus Industrial Pole (PIM), an industrial cluster in the Brazilian Amazon that hosts six hundred factories with diverse logistics and supply chain managerial strategies. USCM (Lee, 2002; Fisher, 1997) develops a dot matrix classification of the supply chains considering several attributes (e.g., agility, cost, security, responsiveness) and argues that emergent economies industrial clusters, in the effort to keep attractiveness for technological frontier firms, need to adapt supply chain strategies according to USCM attributes. The paper takes a further step, discussing which transport modes are suitable to each supply chain classified at the USCM in PIM´s case. The research´s methods covered the use of PIM´s statistical official database (secondary data), interviews with the main logistical services providers of PIM and phone survey with a sample of firms (primary data). Findings confirm the theoretical argument that different supply chains will demand different transport modes running at the same time in the same industrial cluster (Oliveira, 2009). In the case of PIM, this implies investments on port and airport infrastructure and a strategic focus on air transport mode, due to (1) short life cycle of products, (2) distance from suppliers, (3) quick response to demand and (4) the fact that even PIM´s standard products use, in average, forty per cent of air transport at inbound logistics.

Key words: Uncertainty Supply Chain Model, Manaus Industrial Pole, Transport.

1. Introduction

One of the most important aspects linked to the competitiveness of emergent economies and industrial clusters refer to supply chain management and its correlated logistics strategies (Oliveira, 2009). To determine the conditions under which supply chains located in these less developed geographic contexts can operate in higher competitive level standards demands broad and detailed theoretical and empirical exam of the needs, limits and possibilities of each supply chain, as well of the public policies involved in their supporting.

Among the many supply chains theoretical perspectives (Halldorsson *et al.*, 2007) and classifying models available in the literature (e.g., Marques *et al.*, 2008), the Uncertainty Supply Chain Model (USCM) focuses as its core theoretical contribution the developing of a dot matrix classification of several supply chains, considering uncertainty as an essential parameter (Oliveira, 2009; Lee, 2002; Fisher, 1997). This uncertainty matrix is useful to categorize the supplying (raw materials/components) and demand (consumer market processes), considering the singularities of each manufactured product, as also

to indicate the suitable logistics strategies for the diverse domestic and global supply chains.

Transport modes is one of the strategic aspects to be considered in enhancing supply chain performances, but it is, at the same time, a variable strongly dependent to the characteristics of the final goods produced by the diverse existent supply chains and their respective markets.

This paper explores this theoretical linkage between the USCM and transport strategies in the context of a concrete case: the Manaus Industrial Pole (PIM). Operating as an industrial cluster in the very heart of the Brazilian Amazon (in the city of Manaus) since 1967, PIM hosts about six hundred companies manufacturing durable goods classified mainly in the sectors of consumer electronics, motorcycles, information technology hardware, chemicals, watches, among others.

2. The Uncertainty Supply Chain Model and Transport Strategy

This USCM has as core framework an Uncertainty Matrix used to categorize the supplying (raw materials and components) and demand (consumer market) processes, considering intrinsic characteristics of each manufactured product. In general terms, the USCM classification shows that there are some goods characterized by demand and supply stability, longer cycle of life and low added technological value, that will demand a more simplified logistics strategy, and that there are other goods, characterized by demand and supply instability, very short life cycle and high added technological value, will require special logistics strategies management.

Figure 1 reproduces the Uncertainty Matrix (Lee, 2002). USCM classifies products in two main categories: functional - characterized by low technological added value and stable demand (consumer market) and supply (raw material/components) processes - and innovative- characterized by cutting edge technology, unstable demand (consumer market) and supply (raw material/components)processes. For each one of these product categories, a different SCM strategy was theorized.

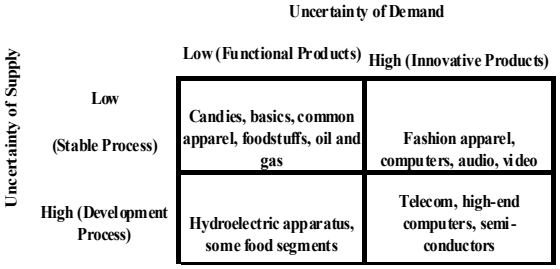

Figure 1. The uncertainty matrix (*Source: Aligning Supply Chain Strategies with Product Uncertainties: Lee, 2002*).

This being so, the products considered to present low uncertainty of supply and low uncertainty of demand are those that aggregate low technological value in their production, in other words, the life cycles of these products are usually longer and their manufacturing depends in a low degree on technological evolution. Whereas those with low uncertainty of supply and high uncertainty of demand are the audio and video, telecommunications and computer products that follow the tendencies of a market characterized by the consumption of novelties that aggregate new technologies, in the expectation of keeping up with technological evolution. These products already usually present a short life cycle and require agility in the management of their supply chains, since the tendencies in technological evolution can be very fast.

Those products with high degrees of uncertainty in supply and low degrees of uncertainty in demand (e.g., hydroelectric power generating equipment, cables and connections and mining equipment) and some food segments that transform specific raw materials. The sources for the supply of raw materials to manufacture these products are limited and this leads to uncertainty of supply, since demand is stable and the need for production remains constant from a source with scarce supply.

Goods with a high degree of uncertainty in demand and a high degree of uncertainty in supply are represented by telecommunications products, high-end computers and semi-conductors. These products have sources of even scarcer supply and that are sometimes monopolized by a handful of companies. From the point of view of demand, telecom products (e.g., mobile telephony) have short life cycle, high competitiveness and a high degree of uncertainty regarding the consumer desire to buy. Agility in the management of this supply chain is vital to the survival of the product´s manufacturing. Industrial clusters that wishes to include companies classified in the lower quadrants of the Uncertainty Model, needs to consider agility as one of its pillars of development (Oliveira, 2009).

The strategies for the uncertainty models are classified according to four types: (1) Efficient Supply Chains, (2) Supply Chains with risk coverage, (3) Sensitive Supply Chains and (4) Agile Supply Chains.

Figure 2 presents a summary of these supply chain classifications:

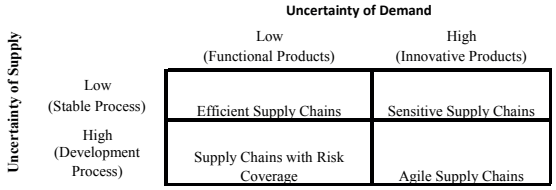

Figure 2. Supply Chain Strategies (*Source: Aligning Supply Chain Strategies with product uncertainties: Lee, 2002*).

According to Grieger (2003), the most critical variables to analyze in the USCM are: a) Fast Product Life Cycle; b) Just in Time Production; c) Cost leadership; and d) Global Competition. Based on the behavior of these variables, it is possible to research and predict which logistics strategies will be more suitable to supply chains located on one of the four quadrants of the uncertainty matrix, as, for example, the choice of the transport modes involved either to import raw materials/components or to export final goods (Oliveira, 2009). This theoretical aspect adjusts the rationality of transport decisions in the way they are currently exposed in the SCM and business logistics literature (e.g., Bowersox *et al.*, 2002), which does not explicitly and formally integrates these uncertainty variable as a SC classification parameter to be considered in firms´ logistic decision-making and strategy.

3. Methodology

The methodology used in the empirical investigation conducted in the case of the Manaus Industrial Pole (PIM) covered three main strategies: (1) The use of PIM´s official statistical database (SUFRAMA, 2015a) and PIM´s Companies´ Official Profile (SUFRAMA, 2015), as also the current customs legislation of Brazil, as documental sources of secondary data (number and name of the enterprises by sector, main manufactured goods, sector revenues, imports and exports, customs processes etc.); (2) interviews conducted with the main logistical services providers (LSP´s) of PIM as a source of primary data directed to the classification of PIM´s supply chains in the USCM quadrants and the actual usage of transport modes by each SC; and (3) phone survey with a sample of firms (also primary data) to confirm the data collected in the previous steps.

The first effort was to outline the universe of PIM´s companies in such a way as to identify how this model may fit the reality of an industrial pole (geographical delimitation), and of the current customs legislation in this country, or in their respective particularities.

From the PIM´s sector revenues, we identified the most twenty important products of PIM. Based on this products list and crossing with supply chain strategies respectively, all supply chains of these products have been identified, so was their respective companies.

Then, the LSP´s interviews and subsequently phone survey with the companies involved to confirm their most used transport modes. This survey was done by telephone and using some personal contacts with clearance people. All the information about transport modes were filled up without previous checking just to guarantee we were capturing the real transport mode in use, even knowing some products were standard.

The transport modes appointed by the theoretical model were confirmed, with increased use of air transport even in the standard product supply chains.

With regard to the purposes, this survey was explanatory and applied, because it aimed not only to clear up the factors involved, but also to contribute to the making of decisions and propose concrete solutions to concrete and immediate problems.

The universe for study refers to the group directly involved in the formulation of the problem, the companies in the Manaus Industrial Pole (PIM).

This analysis, adapted and chose the Uncertainty Model in its most extreme aspect uncertainty of supply and uncertainty of demand, using an industrial unit that has its supply chain perfectly adapted to this reality as its research universe.

The results obtained here, therefore, are restricted to the industrial units with extreme uncertainty regarding their supply chains, following the guidance of Brazilian customs legislation, and improving the processes already identified as being promising by

the case study for the Brazilian customs authorities: The Manaus Industrial Pole (PIM).

4. Results (Case Study: Manaus Industrial Pole- PIM)

The most important products of PIM represents eighty percent of the total billed by this agglomerations model within one year. A sample of these products took us twenty-seven companies whose products make up the list of the most lucrative of the PIM.

This research set out to identify the classification of these companies between global and multinational, and from the uncertainty model and its respective supply chains derived from them. Then, to identify the modes of transportation actually used for incoming inputs, independent of type of supply chains. The first result was on the PIM´s composition: seventy percent of the companies operating on it are subsidiaries of global companies. This means that logistics strategies are defined in their respective foreign dies, leaving minimal autonomy for decision and adaptation of local logistics strategies.

It helps to explains why, passed almost fifty years of PIM´s existence, until now there isn´t a single SC strategy formally formulated and implemented by policy-makers (e.g., SUFRAMA, Amazonas State Government etc.). When it checks the types of supply chains, the result was 11 Agile Supply Chains, 05 Sensitive Supply Chains, and 11 Efficient Supply Chains. This means that a total of twenty seven companies surveyed, sixteen need the air mode to remain competitive because their supply chains have a level of uncertainty still present. This represents fifty nine per cent of dependent companies of air transportation and therefore potential users of the infrastructure improvements at airports for PIM.

This high usage rate of air mode confirms the hypothesis that to remain competitive logistics of PIM, it is necessary to accept that being away from the supply base and also to final customers makes the airline the able way enable the uncertainty of supply and demand. Thus, if the expectation is to attract companies whose products are technological innovation, Brazil needs to be special attention to the logistical support of the air mode. Table 1 presents the types of companies, their supply chains and transport modes considered for inbound.

Table 1. Supply Chains Identified at PIM (*Source: Authors, 2015*).

Company Type	Products	Supply Chain	Transport Mode for Inbound	Transport Mode for Final Product
Global	Mobile Phones	Agile	Air	Air
Global	Razor & Toothbrush	Efficient	Sea	Road
Global	Pens, lighters	Efficient	Sea	Road & Air
Global	Computers & TVs	Agile	Sea Air	Air
Global	Computers & TVs	Agile	Sea Air	Air
Global	Computers & TVs	Agile	Sea Air	Air
Global	Medical Equipment	Efficient	Sea Air	Air
Multinational	Microwave Oven	Efficient	Sea	Road
Multinational	Cameras	Agile	Sea Air	NA
Multinational	Board Assembly	Agile	Sea Air	NA
Global	TV	Agile	Sea	Road & Sea
Global	ATMs	Efficient	Sea	Road & Air
Global	Mobile Phones	Agile	Air	Air
Global	Acessories for Cameras	Sensitive	Air	NA
Global	Batteries	Agile	Sea Air	NA
Global	TVs & Microwave	Efficient/Sensitive	Sea Air	Road & Sea
Global	Electric Shaver	Efficient	Sea	Road & Sea
Global	Battery Charger for Mobile Phone	Agile	Sea Air	NA
Global	TVs & Mobile Phone	Sensitive/Agile	Sea Air	Road & Air
Multinational	Electronic Components	Efficient	Sea	NA
Global	TV & Audio	Sensitive	Sea Air	Road & Air
Multinational	CD e DVD	Sensitive	Sea	Road
Multinational	Toner	Sensitive	Air	Air
Global	Air Conditioner	Efficient	Sea	Road & Sea
Multinational	Air Conditioner	Efficient	Sea	Road & Sea
Global	Air Conditioner & Microwave	Efficient	Sea	Road & Sea
Multinational	Motorcycle	Efficient	Sea	Road & Sea

5. Conclusion

Brazil is an emergent country which works with regional, multinational and global companies. Manaus Industrial Pole is very important to keep around a hundred thousand employments in a city with less than two million people and which is responsible for economic activity for the north region in Brazil.

Do not find regional or local companies listed on the most important products from PIM seems to be a worrying matter to PIM´s policy-makers. It means that domestic capital is not present in the manufacturing of high-tech products.

In the other hands, Brazil has to be able to attract and keep these international companies on different agglomeration models.

If Brazilian government as a representative of emergent economy, wants to keep industries´ competitiveness based in Brazil, a high investment on airports and air transport infrastructure has to be done. The risk, if it is not done in a short time, is to keep in Brazil only companies without innovative products and delay the consumption of innovative products by Brazilian society, since it will be imported, not manufactured in the country.

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