INDEPENDENT JOURNAL OF MANAGEMENT & PRODUCTION (IJM&P)
http://www.ijmp.jor.br v. 5, n. 2, February – May 2014.
ISSN: 2236-269X
DOI: 10.14807/ijmp.v5i2.167

SUBJECT: UNCERTAINTY SUPPLY CHAIN MODEL AND TRANSPORT IN ITS DEPLOYMENTS

Fabiana Lucena Oliveira
Universidade do Estado do Amazonas, Brazil
E-mail: flucenaoliveira@gmail.com

Submission: 14/11/2013
Accept: 28/11/2013

ABSTRACT

This article discusses the Model Uncertainty of Supply Chain, and proposes a matrix with their transportation modes best suited to their chains. From the detailed analysis of the matrix of uncertainty, it is suggested transportation modes best suited to the management of these chains, so that transport is the most appropriate optimization of the gains previously proposed by the original model, particularly when supply chains are distant from suppliers of raw materials and / or supplies.Here we analyze in detail Agile Supply Chains, which is a result of Uncertainty Supply Chain Model, with special attention to Manaus Industrial Center. This research was done at Manaus Industrial Pole, which is a model of industrial agglomerations, based in Manaus, State of Amazonas (Brazil), which contemplates different supply chains and strategies sharing same infrastructure of transport, handling and storage and clearance process and uses inbound for suppliers of raw material. The state of art contemplates supply chain management, uncertainty supply chain model, agile supply chains, Manaus Industrial Center (MIC) and Brazilian legislation, as a business case, and presents concepts and features, of each one. The main goal is to present and discuss how transport is able to support Uncertainty Supply Chain Model, in order to complete management model. The results obtained confirms the hypothesis of integrated logistics processes are able to guarantee attractively for industrial agglomerations, and open discussions when the suppliers are far from the manufacturer center, in a logistics management.

http://www.ijmp.jor.br v. 5, n. 2, February – May 2014.
ISSN: 2236-269X
DOI: 10.14807/ijmp.v5i2.167

Keywords: Uncertainty Supply chain Model, Agile supply chain; Manaus industrial pole; logistics, transport.

1 INTRODUCTION

Business Logistics, as a set of techniques and activities-means (or support) for the productive operations of companies, represents an area of technical-professional research and intervention with increasing relevance to the systemic competitiveness of countries, regions, economic blocks, sectors or individual companies. This growing relevance of Business Logistics has been especially significant over the course of the last thirty years.

It is justified by a global context marked by at least four major phenomena: (I) the commercial and productive internationalization of companies, (II) the forming of regional trade blocks and the acceleration of the process for economic, political and cultural integration between, and among, blocks (NAFTA, MERCOSUL, European Union, ASEAN, etc.); (III) the radical and swift technological change brought about by the advent of the new Communication and Information Technologies (CIT's), the frontline products of which are the Internet, mobile telephony and the transition to the platform of digital convergence between computing and telecommunications apparatus and equipment which, in conjunction, change the way in which people and companies live, work and produce, and (IV) in the quest for competitiveness in the CITs, trans-national companies have sought out the emerging economies to house their factories, in the attempt to ensure cheaper labor, lower taxes and other attractive advantages offered by the governments of each emerging economy.

This being so, private and/or public logistics models constitute an integral part of the solutions packages offered to companies, regions and countries for equalizing or overcoming the conditions of current market competition. In public and private economic agendas, Logistics have come to stay.

Considering the Matrix of Uncertainty Supply Chain Model: how transportation fits and supports global competition of these matrices and subsidiaries, since the source of raw material supply is far from manufacturing industry?

As companies switch from being local to being trans-national, the logistics challenge becomes increasingly bigger. If at the start of the development of modern industries logistics was an activity aggregated to Sales and marketing, as of the

http://www.ijmp.jor.br v. 5, n. 2, February – May 2014.
ISSN: 2236-269X
DOI: 10.14807/ijmp.v5i2.167

1960s, logistics became a fundamental activity for the survival of companies through control of storage, stocks and the transpiration of materials. (BALLOU, 1993)

Within this environment, the logistics strategies for the companies were developed in such a way as to identify the best forms of management for their respective supply chains.

Logistics Strategies: an exploratory approach

The literature regarding Industrial Logistics underlines a number of decision categories that need to be articulated between each other, in such a way that companies are able to achieve the objectives with lower costs and optimized services.

According to WANKE (2003), companies need to consider the following categories:

Coordinating product flow: should product flow be pulled, that is, set in motion by the link closest to the end consumer, or pushed, that is, coordinated by the link closest to the initial supplier?

Production policy: should a company produce for stock, based on future sales forecasts, or produce to order, always attending the real demand, only when the client places the order?

Stock allocation: should stocks be centralized in a single location, or decentralized in a number of installations?

Size of the installation network: how many installations should a company have, where should each one be located and which products and markets should be attended by each installation?

Choosing Modes of Transport: should a company operate with slower and cheaper modes of transport, such as railways and ships, or faster and more expensive, such as road and air? Should it seek to consolidate transport or express delivery?

The answers to these questions will define the logistics strategies to be adopted by each company, taken individually, and, based on this, it would appear

http://www.ijmp.jor.br v. 5, n. 2, February – May 2014.
ISSN: 2236-269X
DOI: 10.14807/ijmp.v5i2.167

valid to seek an adaptation of the variables mentioned above to define the logistics strategies for agglomerations such as Regional Economic Centers.

According to DORNIER et al (2000), the traditional financial performance measures (sales and profitability, for example) are complemented by a set of operational variables that provide for better understanding of how the logistics system should be analyzed. These operational variables are: cost, quality, service and flexibility.

This article presents an analysis of the state of art of the Supply Uncertainty Model (SCUM) categorizing their supply chains, methodology and case study, and even clusters model used as a research source - Manaus Industrial Center (MIC) and agile supply chain used as a sample, and the results as well as to answer the question posed.

2 THE SUPPLY CHAIN UNCERTAINTY MODEL (SCUM)

The Supply Chain Uncertainty Model (SCUM) was presented to the academic community for the first time in 2002, and its uncertainty matrix was used to characterize the processes for the supply of raw materials and of demand (consumer market), via certain intrinsic characteristics of each product. In general terms, the uncertainty model allows for the fact that that there are some products that given their characteristic of stability (demand and supply) will have a more simplified logistics strategy, and that there are some products that, given their characteristics of instability (demand and supply), very short life cycle and high aggregated technology, will require special logistics strategies management.

Figure 1 reproduces the Uncertainty Matrix published in the article entitled Aligning Supply Chain Strategies with Product Uncertainties, in the California Management Review for the Year of 2002. This study considered the supply chains of the products considered to be functional and those considered to be innovative, in other words, products on the cutting edge of technology. For each one of these products, a different management proposal was presented, making it clear that products on the cutting edge of technology have unstable processes from the point of view of demand (consumer market) and supply (raw material), thereby giving rise to the Uncertainty Model.

INDEPENDENT JOURNAL OF MANAGEMENT & PRODUCTION (IJM&P)
http://www.ijmp.jor.br v. 5, n. 2, February – May 2014.
ISSN: 2236-269X
DOI: 10.14807/ijmp.v5i2.167

		Uncertainty of Demand	
		Low (Functional Products)	High (Innovative Products)
Uncertainty of Supply	Low (Stable Process)	Candies, basics, common apparel, foodstuffs, oil and gas	Fashion apparel, computers, audio, video
	High (Development Process)	Hydroelectric apparatus, some food segments	Telecom, high-end computers, semi-conductors

Figure 1: The Uncertainty Matrix
Source: Lee, (2002)

This being so, the products considered to present low uncertainty of supply and low uncertainty of demand are those that aggregate little technology in their production, in other words, the life cycles of these products are usually longer and their manufacture depends on to 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 are represented by hydroelectric apparatus (electrical power generating equipment, equipment for hydroelectric power stations, cables and connections and mining equipment, for example) and some food segments that aggregate 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.

INDEPENDENT JOURNAL OF MANAGEMENT & PRODUCTION (IJM&P)
http://www.ijmp.jor.br v. 5, n. 2, February – May 2014.
ISSN: 2236-269X
DOI: 10.14807/ijmp.v5i2.167

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, telecommunications products, largely represented by mobile telephony, have a 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 manufacture. Any economic agglomeration (cluster, industrial district, technopolis) 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.

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

Figure 2, presents a summary of the supply chain classifications:

Supply		Low (Functional Products)	High(Innovative Products)
	Low (Stable Process)	Efficient Supply Chains	Sensitive Supply Chains
	High (Development Process)	Supply Chains with Risk Coverage	Agile Supply Chains

Figure 2: Supply Chain Strategies
Source: Lee, (2002)

3 SUPPLY CHAIN UNCERTAINTY MODEL AND ITS MAIN VARIABLES

According to Grieger (2002), the most important variables to be analyzed for the Supply Chains in the SCUMs are: a) Fast Product Life Cycle; b) Just in Time Production; c) Cost leadership; and d) Global Competition.

The matrix for the uncertainty model classifies the products as being innovative or traditional. The object of this study is the innovative products), which are those with a short life cycle, high degree of technological innovation and fashion

http://www.ijmp.jor.br v. 5, n. 2, February – May 2014.
ISSN: 2236-269X
DOI: 10.14807/ijmp.v5i2.167

contents, in other words, fashion related characteristics and/or components that represent unpredictable demand. (LEE, 2002)

Table 1 presents a comparison, available in the literature, between a company with a product considered to be Functional/Traditional and a company with a product considered to be Innovative.

Table 1: Product characteristics classified according to the SCUM: Functional versus Innovative

Functional Product	Innovative Product
Low Uncertainty in Demand	High Uncertainty in Demand
More Predictable Demand	Hard to Predict Demand
Stable Demand	Unstable Demand
Long Life Product	Short Selling Season
Low Inventory Cost	High Inventory Cost
Low profit margin	High profit margin
Low product variety	High product variety
High volume per “pre-assembled kit”	Low volume per “pre-assembled kit”
Low cost for “lack of stock”	High cost for “lack of stock”
Low Obsolescence	High Obsolescence

Source: Lee, 2002

A functional product may be represented by a color TV, for example. A traditional color TV, in other words, with a conventional image tube, does not suffer major oscillations in demand, classifying it as more predictable. An innovative product may be represented by the mobile telephone. This product has an unstable consumer market (demand), a very short life cycle (from six to eight months) and a high level of obsolescence, since it aggregates new technologies very quickly. The profit margins are high, since this product has high aggregated value, and this fact represents a high value for the inventory to be managed.

Agility is understood as being the speed with which a process can be concluded. One good example is the process of the unloading of merchandize for customs inspection. An agile process will be concluded in two hours, as occurs in some parts of Brazil, and in some models of international economic agglomerations.

INDEPENDENT JOURNAL OF MANAGEMENT & PRODUCTION (IJM&P)
http://www.ijmp.jor.br v. 5, n. 2, February – May 2014.
ISSN: 2236-269X
DOI: 10.14807/ijmp.v5i2.167

Table 2, below, demonstrates, very simply, how the variables discussed here are encountered in the different models of agglomerations between countries:

Table 2: Variables for the Uncertainty Model in Industrial Agglomerations

	Brazil	Mexico	China
Cost	High	Medium	Low
Agility	Low	High	High
Obsolescence	High	High	Low

Based on the behavior of the variables exposed above, it is possible to understand why Brazil has been facing difficulties in managing the Uncertainty Chain, in comparison with its global competitors, for example.

The high level of obsolescence among these companies in Brazil is largely justified by the low agility in responding to this logistic chain, either to receive (import) raw materials, or re-export those raw materials unused in the productive process, which explains the high cost involved in a slow and overly bureaucratic supply chain.

4 METHODOLOGY

Among the many models already identified by the literature for classifying the supply chains, the SCUM is used to characterize the industries whose products present uncertainty in demand and uncertainty in the supply of raw materials as a fundamental characteristic. Here we underline the universe of these companies in such a way as to identify how this model may fit the reality of an industrial center (geographical delimitation), and of the current customs legislation in this country, or in their respective particularities.

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 Center (MIC). All of the variables involved in the process for defining a consigned stock model for the MIC were an integral part of this universe: a) reduction of inventory cost; b) agility in the processes for importing raw materials and exporting finished goods, c) reduction in international transit time, agility in attending to the uncertainty models and d)

http://www.ijmp.jor.br v. 5, n. 2, February – May 2014.
ISSN: 2236-269X
DOI: 10.14807/ijmp.v5i2.167

identification of the different logistics strategies for the companies installed in the MIC so as to categorize this model of agglomerations.

The sample of the companies surveyed used the parameters of their participation in the global indicators for the MIC in terms of revenues, exports, imports and direct jobs and by their classification according to the categories of the SCUM, these being stable processes and innovative processes in the supply chains for functional and innovative products.

The data was collected via: a) Bibliographical research in books, specialist magazines, articles, theses and dissertations on the chosen subject. All of the data required for the theoretical basis was collected; b) Interviews with the people involved in the supply chain management processes for the companies covered in the uncertainty model examined in this study; c) Direct analysis of real times, based on the measuring of processes involved in the logistics management chain, such as, transit time, customs dispatch time and simulations of adapted models, based on the proposed Brazilian customs legislation.

Analysis of the data included: a) tabulation of the real times obtained in the companies analyzed, especially those working with Telecommunications, based on the need for adapting the MICS and in such a way that this data could be compared with that for the other companies; b) Comparison between the times obtained within the companies analyzed and the concept described in the supply chain management strategies, available in the literature analyzed, in such a way as to demonstrate whether the practice is in accordance with the concepts; c) Adaptation of the models suggested by the literature, and also by the governing legislation in Brazil, to the supply chain management models existing in the companies studied, in the aim of seeing the improvements based on the development models available and approved by the Brazilian regulatory agencies.

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

http://www.ijmp.jor.br v. 5, n. 2, February – May 2014.
ISSN: 2236-269X
DOI: 10.14807/ijmp.v5i2.167

legislation, and improving the processes already identified as being promising by the case study for the Brazilian customs authorities: The Manaus Industrial Center (MIC).

5 CASE STUDY: THE MANAUS INDUSTRIAL CENTER (MIC)

The Manaus Industrial Center (MIC) is the result of the Model Free Trade Zone of Manaus (ZFM), created by the Federal Government and made effective in 1967, with a geopolitical focus based on fiscal incentives for production, and supervising three sectors: Industrial, Commercial and Farming, based on the reduction of the logistical disadvantages inherent to the Western Amazonian region. Its tax benefits (IPI industrialized products tax, Import Tax and the ICMS goods and services tax) extend, according to different regimes, to the States of Amazonas, Acre, Roraima, Rondônia and the Free Trade Zones of Macapá and Santana, in the State of Amapá. This model, administered by the Superintendence of the Manaus Free Trade Zone (SUFRAMA) for the last 40 years, attracted more than 450 industries to the MIC, many of which are internationally known brands (some of these brands are NOKIA, GILLETTE, COCA-COLA, SAMSUNG, LG, HONDA, SONY, PANASONIC, VIDEOLAR, SIEMENS, PHILLIPS, etc.,) which jointly represent around US$ 4.0 billion in accumulated fixed investments to date, and cover a number of sub-sectors, the foremost of which are electro-electronics, information technology, two wheeled vehicles (bicycles and motorcycles), chemistry, thermoplastics and watch making.

The recent performance of the MIC can be seen in Table 23:

Table 3: Recent performance indicators for the Manaus Industrial Center (MIC)

INDICATOR	PERFORMANCE IN 2007
1. GLOBAL REVENUES OF THE COMPANIES	US$ 11.,5 billion
2. DIRECT JOBS GENERATED	115 thousand jobs
3. ESTIMATE INDIRECT JOBS	510 thousand jobs
4. EXPORTS	US$ 0.855 million
5. TOTAL TAX GENERATED	US$ 2.8 billion
6. COMPANIES CERTIFIED VIA ISO 9000	251

From the importance of the SCUM for the Amazon region, and considering that the main supply chains of raw materials and inputs that feed this industrial agglomeration, are in the East, and the basis for reception and processing of these

http://www.ijmp.jor.br v. 5, n. 2, February – May 2014.
ISSN: 2236-269X
DOI: 10.14807/ijmp.v5i2.167

materials is in the West, which requires a transport logistics management, despite the distance and dependence on more efficient transportation, we must be a global competitor.

Thus the figure four proposed mode of transportation that best suits their supply chains, in the quest for efficiency proposed in the original model.

Uncertainty of Supply	Low (Functional Products)	High(Innovative Products)
Low (Stable Process)	Efficient Supply Chains *Sea Transport*	Sensitive Supply Chains *Sea-Air Transport*
High (Development Process)	Supply Chains with Risk Coverage *Sea Transport*	Agile Supply Chains *Air Transport*

Figure 3: Supply Chain Strategies and Transport
Source: Lee, (2002)

Reading the matrix it is possible to confirm two parameters: Functional Products are adaptable to sea transport with lower transport costs and Innovative Products are much more adaptable to Air Transport with higher transport costs.

Lower Transport Costs *versus* Higher Transport Costs is a question been made all over the world on each model of supply chain management. Transport is one of the most import supports of supply chains, especially when considering 1/3 of total costs are transports (Oliveira, 2009)

MIC is formed by different supply chain models and its characteristics, which considers innovative and functional products in a proportion of: functional products 55% and innovative products 45% of total revenue. This means MIC needs to be global competitor for both: innovative and functional products.

Reconciling the current customs legislation with the process for making procedures more agile has been the greatest difficulty faced in effectively implementing this Consigned Stock Model in the MIC. While the agile management

http://www.ijmp.jor.br v. 5, n. 2, February – May 2014.
ISSN: 2236-269X
DOI: 10.14807/ijmp.v5i2.167

model predicts just a few hours for the unloading of international merchandize, the MIC works with a number of working days for the complete transportation and unloading of imported merchandize, if it uses the consigned stock model.

There is a need to consider, however, that the strategy of consigned stock in the Manaus Industrial Center was required given the type of company, with innovative products and unstable demand. The need to attend the market, with greater speed and variety in comparison with the other companies, led to the development of a management model that makes the imported raw materials available close to the factory, with a view to fast action in the case of sharp changes in demands.

On the other hand, simply increasing the security stock is also not a solution, since the cost involved in storing raw material is impracticable and the aggregated value of the raw material held in stock is very high. This is why there is a need to adapt logistics strategies and customs legislation for this type of product, if we intend to keep investments of this type of company in the MIC.

However, when we analyze the supply chains in the uncertainty model, with all its need for agility in the processes and knowing that good logistic chain management is one of the pillars for the good development of an industrial unit, we ask whether the factors of fiscal tax attractiveness are enough, or whether the benefit of logistical agility is equally vital to the attractiveness and good development of the industrial model for uncertain supply chains.

6 CONCLUSIONS AND RECOMMENDATIONS

The difficulty in supply chain management for the representatives in the Uncertainty Model was the reason for this article, which sought to discuss how transport could be adapted the Uncertainty Supply Chain Model and how it would help to develop MIC to be a global competitor even far from supply basis, for example west versus east.

In this sense, air transport is a fundamental pre-requisite for attending the supply chains in the uncertainty model, for innovative products which are 45% of total revenue for this model.

http://www.ijmp.jor.br v. 5, n. 2, February – May 2014.
ISSN: 2236-269X
DOI: 10.14807/ijmp.v5i2.167

It needs to have an improved infrastructure and guarantee the agility and attractiveness of this model of high aggregated technology also in the Manaus Industrial Center (MIC).

With the MIC being one of the foremost export centers in Brazil, there is a need to improve the services and infrastructure for air transport as a fundamental support for developing high technology production and, consequently, products on the cutting edge of technology, which could contribute greatly to the level of Brazilian exports, given their high aggregated value.

REFERENCES

BALLOU, R. H. (1993) **Logística Empresarial**. São Paulo: Atlas.

DORNIER, P-P.; et al. (2000) **Logística e Operações Globais**. São Paulo: Atlas.

FIGUEIREDO, K. F.; et al. (2003) **Logística e Gerenciamento da Cadeia de Suprimentos**. São Paulo: Atlas.

FLEURY, P. F.; et al. (2000) **Logística Empresarial**: uma perspectiva brasileira. São Paulo: Atlas.

GRIEGER, M. (2000) Electronic Marketplaces: a literature review and a call for supply chain management research. **European Journal of Research**.

LEE, L. H. (2002) Aligning Supply Chain Strategies with Product uncertainties. **California Management Review**, v. 44, n. 3.

OLIVEIRA, F. (2009) **Gerenciamento das Cadeias de Suprimento no Pólo Industrial de Manaus (PIM)**. Manaus.

SUPERINTENDÊNCIA DA ZONA FRANCA DE MANAUS – SUFRAMA, (2008) Indicadores Industriais. Manaus: SUFRAMA, acessado em: agosto de 2008, acessado em: http://www.suframa.gov.br.