

Methodologies of Modeling for Decision Making in the Supply Network/Chain Management (SN/CM) in the Context of Uncertainty*

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Abstract

The target this document is to show the process of Decisions Make in the different stages of the SN/CM, from the point of view of a structure Decentralized vs. Centralized (different grades). It's obviously a simplification and there are many clarifies that they have to see with the type SN/C, where they have to see his different Stages and Hierarchic Levels. In the SN/C it's difficult to detect and to transmit the Information that it finds dispersed and fragmented that goes from the Supplier of raw material up to the final consumer. For which it tries to study in depth the Methodologies of Modeling in the Hierarchical Planning of the SN/CM and in particular to propose a Preliminary Methodology for the Supply Chain Hierarchical Planning in the Uncertainty Context. More specifically, it:

- 1. considered decisional visions in the Hierarchical Planning of the Supply Network/Chain*
- 2. performed a literature review of the uncertainty in the Supply Chain*
- 3. studied sources of uncertainty along the Supply Chain*
- 4. took into consideration models of classification for the Hierarchical Planning in the Supply Network/Chain under uncertainty*
- 5. designed a preliminary methodology for the Hierarchical Planning of the Supply Network/Chain.*

Keywords: Supply Network/Chain, Methodology, Decisional, Uncertainty, Model.

1. Introduction

The present Preliminary Methodology tries, by means of a series of steps, to obtain a model that serves as a tool for the Supply Chain Management. This document subdivides in five sections wich include: Decional Visions in the Hierarchical Planning of the SN/C in particular (paragraph 2), current Literature of Uncertainty in the Supply Chain (paragraphs 3 and 4), Classification of the Models for the Hierarchical Planning in the Supply Network/Chain in the

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Uncertainty Context (paragraph 5), Preliminary Methodology for the Hierarchical Planning of the SN/C in the Uncertainty Context (paragraph 6) and Conclusions (paragraph 7)

2. Decisional Visions in the Hierarchical Planning of the Supply Network/Chain Management

The Hierarchical Planning arises as a robust and powerful option, to solve the problem of Supply Network/Chain Management (SN/CM). The Hierarchical Planning is based on a structure of disaggregation-aggregation of the projects and the resources, at different hierarchical levels, in which, the highest hierarchical levels present the most aggregated dates, with longer time horizons and the hierarchical low levels are more detailed and with shorter horizons. Every hierarchical level is formed by stages, by entities and its attributes and a problem of decision-making. In this document will be worked with two hierarchical levels. In this case those levels remain and are used continuously, in order to check the proper decisions to each of them, as inherited from the Superior levels, generating an ambience of feedback. First of all, in this document is given priority to the Extension of the Supply Network in the Decisional Vision in the Hierarchical Planning in the Uncertainty Context; alluding to the Artificial Intelligence (Artificial Neuronal Networks (ANN) and Fuzzy Logic (FL)). All this bearing in mind these three authors Schneeweiss (2002), Stadler (2000) and Burton (1995). Schneeweiss (2002), is based on Systems of Distributed Decision Making (DDM) on the Supply Chain. Many approaches of these systems have developed in different disciplines. In fact, in the SN/C one speaks, of Production and Operations Management, Logistics, Operational Research, Artificial Intelligence and Economy. On the other side Stadler (2000), it's based on a Hierarchical Planning System of the SN/C that to support on the following five elements: decomposition and hierarchical structure, aggregation, hierarchical coordination, models construction, models resolution. And finally Burton (1995), his theory is based on a conceptual method for the design of Hierarchical Structures. In particular, this one is capable of classifying Hierarchical Systems and of revealing interdependences between different fields of application, showing different options to structure hierarchical mutual influences and to provide a better comprehension in the process of design. From Schneeweiss (2002), Stadler (2000), and Burton (1995), has born in mind a Decisional Vision proper for this document. These authors refer two Hierarchical Levels. Every author used different terms for these levels. In this document we will call it a Tactical Level and Operative Level. The Decisional Vision which contributes the most to this document, is the one Schneeweiss (2002), since it propose a structure of more consolidation for the SN/C.

2.1. Decisional Vision Own

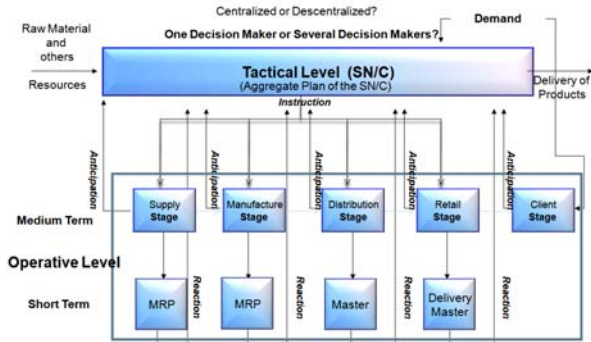


Figure 1. Decisional Vision (Lario, 2007).

Figure 1, shows two Hierarchical Levels of Decisions Making along the SN/C. This helps to have a better Vision on the Organization. In fact, two Vertical Hierarchies (Tactical -

operative) show that the Tactical Level is the one that gives the orders at the Operative Level. This by means of an Instruction, which happens after realizing an Anticipation (to find a feasible decision, the Tactical Level considers the excellent characteristics of the Level Operative). When the Instruction is given to the Operative Level, in case the Operative Level is in situation to react on the instructions realized by the Tactical Level, which is an Operative - Tactical influence him being called a Reaction (In fact, a reaction can be considered to be an influence of feedback in contrast to the anticipation). In this Hierarchical System we must keep in mind in which field of decisions making we direct, whether it's centralized or decentralized (based on the fact there is one decision maker or several decision makers). From the Aggregate Plan (Tactical Level), that generates all the hierarchical activity in the SN/C. We keep in mind the relation of Planning that exists in the Operative Level which is in short and medium term in every stage of SN/C. The essence is that each of these stages knew his Planning Systems. Of particular interest in the context of the SN/C, nevertheless, are these systems DDM of Scheneeweiss (2002), between every stage. In medium term the above mentioned stage is: Supply, Manufacture, Distribution or Retailer. In this case as an example, refer to the Distributor who informs the Retailer of the possibly needed capacity whereas in the short term the Retailer specifies the current demand. In the time the Retailer can adapt as far as possible (by means of his Vertical Hierarchical), his aptitude to satisfy the demand in the short term. Three systems DDM are always of different nature.

For the proper Decisional Vision of this investigation it is necessary to keep in mind:

- All the Stages of the SN/C we need for decision making.
- We must define the Hierarchical Levels of the SN/C (Strategical, Tactical and Operative) with want to work.
- In what type which we of the decisions making will be worked? Centralized or Decentralized.
- Already bearing in mind if the decision making is Centralized or Decentralized, we will know what quantity of decision makers will take parts the process of decision making.
- To identify the Hierarchical Levels of Interdependence in The SN/C (Schneeweiss, 1995).

3. Literature review of the uncertainty in the SC

Analyzing the Supply Chain Management we can see that it is difficult to realize several sources of uncertainty and complex interrelations between the stages of the SN/C. Above that, the cycle of life of a product is reduced and the constant increases of the expectations of the clients also are more difficult to see in the SN/C, especially for new products. The Planning of the SN/C, especially the planning of the time of his execution, is one of the critical points that it must be considered to be at the time of planning. In turn, one of the principal aspects that they must be treated in the Planning of the SN/C is that of the variability of the factors and the risks that influence his achievement. In this document a perspective of skills tries to be had at present available to take in account the uncertainty and the formulation of plans of risk in the Planning of the SN/C, emphasizing his applications and his commercial implementation in Companies.

3.1. How to define Uncertainty?

The concept of uncertainty has been a central component of a number of theories about Organization and Strategy. March and Simon (1958), identified the uncertainty as a key variable of the Organizational Behavior. Thompson (1967), suggested that the first tasks of organizations face the risks of the external environment. Pfeffer and Salancik's (1978), suggest that the theory of the dependency structures his external relations in response to the

result of uncertainty for the dependency on the elements in the external environment. According Omta and De Leeuw (1997), the conceptualization of the uncertainty is not yet very clear in the literature.

3.2. In the Literature review Uncertainty is defined as:

Galbraith (1977), defines uncertainty as a task, which is the difference between the quantity of information needed to develop a task and the quantity of information that really is possessed for the above mentioned organization. This definition begins from the assumption in which the uncertainty is caused by the absence of information and the clarity about the relations causes effect. Sheombar (1995), makes a distinction between the uncertainty of unexpected phenomena called perturbations (deviations of something awaited), and the uncertainty of the awaited phenomena, which have stochastic patterns like uncertain demand. The uncertainty creates the dynamics since the changes anticipation are more difficult. Daft and Lengel (1986), distinguish two types of uncertainty: the uncertainty, of which is not known when a success will occur, and the uncertainty of which not known how to answer to an event when this one happens. Miles and Snow (1978), make the distinction between change according to the environment and the change in the predictability; they define this as a uncertainty. Mason y Mitroff (1973), make the distinction between two types of problems, structured from the Lack of Certainty. With the Decisions under perturbations, the Decisions Making does not have any certainty of its results from its actions, but they will know the set of possible results and its probabilities of events. With the Decisions under Uncertainty, the Decision Making does not know its probabilities in the results but they look for alternatives for these. In reality the limit between Risk and Uncertainty is an important subject of university studies. Generally a Manager is capable of determining the possibility of results with more probability and relevancy; and the associate to know the probability from these obtained results Leutscher (1995). In this work we will not take in count the difference between Risk and Uncertainty. The focus of this Research is the Uncertainty in the Supply Chain (SC) and his actions for the Decisions Making, based on the requests of the SC.

4. Sources of Uncertainty along the Supply Chain

The SC Uncertainty Context is a reference to situations where Decisions Making must be made in the SC in which the Decisions Making has a lack in the effectiveness in the control of events or incapability in the forecast of events in the behavior of a system due to the lack of:

- Information of the environment of the SC.
- A consistent model of SC that presents relations between variables and Performance Indicator of the SN/C.

The Uncertainty is more related to the process, that's where uncertainty Persson (1995), occurs. The presence of the Uncertainty in the SN/C stimulates the decision maker to create buffers of safety in the time, Capacity or Inventory to to present the SC from wrong indicators. These buffers restrict Operational Indicators and suspend competitive advantages. Example of Uncertainty in the SC Krajewski (1987), announces a discovery of a project which has as objective to determine what factors in the environment of production have a big impact on development. This one was found: in the variability of the weekly demand; reliability in the delivery of the seller; in the average time of waiting for the seller and in the variability of these times of waiting; lacks of capacity; losses of production; fail in the machinery and duration of unavailability; report of errors in the deal of inventories and size of these errors; times of prosecution and times for unit of stage. The results of simulation suggested of the selection of a system of production/inventory might be less important than

the improvement of the industrial environment itself. Different authors in the literature have classified the possible presence of uncertainty in the SC of different form. Davis (1993), classifies the uncertainty in three categories: Uncertainty Demand, of the Process and in the Supply. The Uncertainty Supply is caused by the variability of the functioning of the provider due to the defective or backward deliveries that it realizes. The Uncertainty of the Process results from the absence of reliability of the process of production. Finally, the Uncertainty Demand is the most important of the three. It appears in volatile form or of inaccurate forecasts. Davis (1993), proposes different metrics to measure three definite types of uncertainty. Lee and Billinbgton (1993), identify also these sources of uncertainty in the SN/C: The Demand, the Process (production, breaks of machines, reliability of the transport), and the Supply (qualities of the pieces, reliability in the deliveries).

5. Models of Classification for the Hierarchical Planning in the SN/C under Uncertainty

There are a big number of methods of modeling SC that have been proposed. Beamon (1999), classified a multi-stage model under analysis and design of the SC, dress four categories in analytical and mathematical approaches. And they qualify this way:

- Analytical Determinists Models,
- Analytical Stochastic Models,
- Economic Models, and
- Simulation Models.

Min and Zhou (2002), they add two more categories to the modeling of SC; a Hybrid Model and the Models Information Technology (IT). Also bear in mind the Determinists and Stochastics Models with more detailed way. The Deterministic Models are composed by one or multiple targets and to understand the difference of these targets between partners of the SC the Stochastics Models are sub classified under Optimal Control Theory and Dynamic Programming Models. In addition to the classifications based on mathematical structures, Min and Zhou (2002), create a model for the SC as for Scope and Area of Application of the problem. The Scope of the problem of the model focuses across the SC. This is because only these models can cover the different functions of the SC. These models are implied by multi-functional topics as localization/rounting, production/distribution, inventory control/localization, transport/inventory control, and selection of suppliers/inventory control.

6. Preliminary Methodology for the Hierarchical Planning of the SN/C

From the expositions identified in the previous paragraphs, we can determine the base for this Preliminary Methodology if make us able to develop, in the dissertation future the models that think about how to give solution to the exposition of the problem. thinking about the ceramic sector context, emphasizing the selection of certain models that serve as reference and the theoretical essentials capable of being made use to solve the proposed problem. By virtue of the development of the models, the practical ratification is needed for what it propose to identify those technical solution skills (paragraph 6.4) that allow the application of the models and obtaining the results, for which the deduction of the conclusions will allow to examine the performance of the models themselves, to analyze with major depth the problems, to corroborate the questions of investigation, to check the implications for the theory, the practices and the political ones of management, as well as to identify the limitations and future lines of research.

The figure 2 shows the development of the Preliminary Methodology before described.

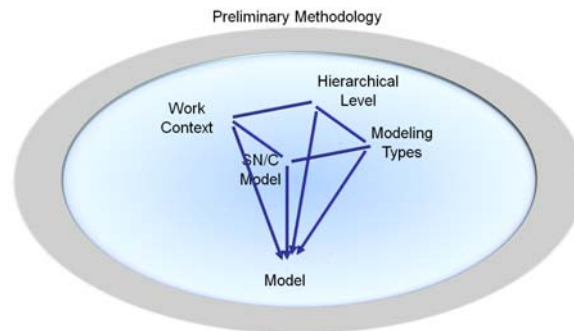


Figure 2. Approaches of the Preliminary Methodology of the Hierarchical Planning in the SN/C.

The preliminary methodology, it's presented as a base, defined by Beamon (1999), and Min and Zhou (2002), which in his classification of models for the SN/C, identifies different approaches of classification, for which I come to four approaches to be able to determine the Preliminary Methodology and which subdivides in the following items:

1. Work Context
2. Hierarchical Level
3. SN/C Model
4. Modeling Types

To identify the different items of classification in each of the four approaches, an analysis of the literature has been realized to know the previous works in relation with each of the above mentioned approaches. Figure 2 shows how each one of the four approaches interact, to be able to obtain the awaited model. In the following paragraphs it alludes to these items.

6.1. Work Context

Nowadays the problems of the SN/C are based on the decisions making which can be qualified in two categories:

- Deterministics Contexts.
- Uncertainty Contexts.

This item carries away a lot of attention because at the time of proposing in which scenario of the SN/C the above mentioned model will be developed, we must determine what will be the context of work.

6.1.1. Deterministic Context

In the Deterministic Contexts, are good decisions needed and these are base on its good results. The wished results are by an obtained "deterministic" way that is to say, free of risk.

6.1.2. Uncertainty Context

In case of the Uncertainty Context, it depends on the influence that the uncontrollable factors could have, in the determination of the results of a decision and also in the quantity of information about that the decision maker has to control the above mentioned factors.

This document is mainly based on the Uncertainty Context and wants to handle about at a future at an environment of Decisions Making centralized which makes more difficult the methodology.

6.2. Hierarchical Level

In the Hierarchical Level of this Preliminary Methodology paragraph two, about the Decisional Visions is born in mind in the Hierarchical Planning in the SN/C. There the emphasis is at the Operative-Tactical Levels not being considered to be the Strategical Level. The Hierarchical Level, it is a robust and powerful option, to solve the problem of SN/CM. The Hierarchical Level bases on a structure of decomposition - aggregation of the projects and the resources, at different hierarchical levels, in which, the highest levels present the most aggregated information, with horizons of long term and the low levels are more detailed and with shorter time horizons. Every Hierarchical Level is formed by stages, by entities and his attributes and a problem of decisions making.

In this document works with two Hierarchical Levels, in this case the Hierarchical Levels remain and are used continuously to check the proper decisions to each of them, as inherited from top levels, generating an environment of continues feedback.

First of all, in this document it's possible to see the SN/C Extension in the Decisional Vision in the Hierarchical Levels in Deterministic Context. Secondly we put emphasis on the Extension of the SN/C in the Hierarchical Levels in Uncertainty Context which performs big importance in this paragraph.

6.3. Network Model

The network models represent graphically the SC as it is shown in the Figure 3. The network is represented by nodes and unions. The nodes generally represent plants, distribution centers, suppliers or clients, while the unions represent the transport. Due to the complexity of representation of a SC with networks of this class, the analyses of the SC often reference to a focal company, together with his suppliers and clients for a limited number of steps to the length of the SC. The key topics to represent a model might include typically:

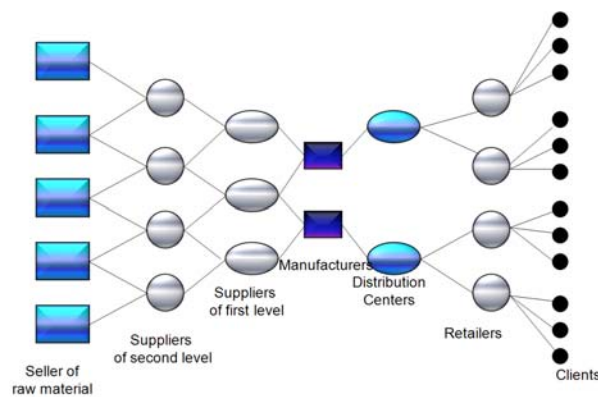


Figure 3. Supply Network

- Identification of the suppliers who can offer a given material or component
- Lead time of manufacturing for article, including his grade of variance
- Time needed to transport materials or components, including his grade of variance
- Minimal order constraint for the size of the model
- The costs of a material or components, from every source, including the cost of transport
- Reservation level of completed goods that is typically a help in every node inside the model
- The needed time to deliver an order

6.4. Modeling Types in the SN/C

First that every a model can consider to be an entity that captures the essence of the reality without the presence of the same one. Photography is a model of the reality illustrated in the image. The blood pressure can be used as a model of the health of a person. A campaign pilot of selling can be used as a model of the response of the persons to a new product. Finally, a mathematical equation can be used as a model of the energy contained in a certain material. In every case, the model captures some aspect of the reality that it tries to represent. The most usually used techniques for models of resolution of problems of the SN/C are: the Analytical Models, Simulation Models and those who are referenced more in this study the Artificial Intelligence Models. Each of these is described in the following parts. Since there was seen at the beginning of the paragraph 5 the classification of the type of model it differs with regard to the type Work Context, Hierarchical Level and SN/C Model. In this work more reference to the technical's of modeling in the Uncertainty Context.

6.4.1. Analytic Model

The Analytical Models for the SN/C base on different technical's of the Operational Research. Between them it is necessary to enunciate the Linear Programming, the Mixed Integer Linear Programming, Dynamic Programming, Stochastic Programming, Games Theory, etc. Between the above mentioned Analytical Models, there are considered those which are applicable to Deterministic contexts, as for example Linear or Mixed Integer Entire Programming, and those who are applicable to uncertainty contexts, since it could be the Dynamic or Stochastic Programming Beamon (1988).

6.4.2. Simulation Model

The simulation is the process of design and creation of a model of a proposed or real system, using abstract objects in an effort to reproduce the behavior of his equivalent ones in the real world. The simulation is thought as one of the most powerful technical's to apply inside an environment of SC Terzi and Cavalieri (2004), they argue that the increasing popularity of the simulation as a tool in the Supply Chain Management stems from his force in the systems of evaluation of variance and interdependences. This allows a decision maker to do changes in different parts of the SC and they visualize the impact of those changes in other parts of the system, and finally in the general interpretation of the SC. The simulation has been used to model SC's in several industrial sectors even in mobile communication systems Persson and Olhager (2002), in Food SC Reiner and Trcka (2004), of clothing Al-Zubaidi and Tyler (2004), and in the aerospace industry Bilczo and Al- (2003).

6.4.3. Artificial Intelligence Models

The definitions of Artificial Intelligence (AI) have evolved such it is so the authors as Rich and Knight (1994), Stuart (1996), who define in general form the AI as the capacity that have the machines to realize tasks that in the moment are realized by human beings; Other authors as Nebendah (1988), Delgado (1998), have more completed definitions and define how the field of study that focuses in the explanation and emulation of the intelligent conduct according to processes computing based on the experience and the knowledge continued of the environment. The models based on Artificial Intelligence apply themselves to solve different problems of the R/CS. In general, these skills are used more frequently to solve problems planning of Demand for his big suspense. Between these skills those of more relevancies are the neuronal networks, genetic algorithms, systems of diffuse logic,

programmable automatons and hybrid systems of artificial intelligence. It is considered that the SN/C in our days can be much supported in the new technologies, since it is the artificial intelligence be already like a support for a more effective decisions making or in the help of works, tasks, which demand big of time or represent a high grade of risk in business.

7. Conclusions

In conclusion, this Preliminary Methodology explains detailedly the necessary steps to determine a model of SN/C in the Uncertainty Context. At this case one tries to be employed with Artificial Intelligence Models, especially at the Decisions Making; being these decisions those that cause often the Uncertainty in the SN/C. The Artificial Intelligence Models that try to be used for this model are those of Artificial Neuronal Networks and Fuzzy Logic for his well performances in Uncertainty Contexts. All this bearing in mind Decisional Visions in the Hierarchical Planning of the SN/C, current Literature of the SC Uncertainty, Uncertainty Sources along the SC and Classification of the Models for the Hierarchical Planning in the SN/C Uncertainty Context.

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