Optimization of the Production Planning in the Supply Chain (Market-Sawmill-Harvest) using a Game Theory Approach

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Abstract

This paper presents the study of one optimization of the production planning model in the supply chain wood Industry: market, sawmill and harvest, multiperiod and a planning horizon of two years, which means of maximizing the profitability of a mix of wood products, incorporating an approach of game theory. This approach would incorporate the decisions of corporate governance the trade-off of the value chain of products.

To develop the integrated model, is studying the behavior of prices for timber products in the market place. It chooses a mix of products, whose market prices are simulated, incorporating location data of customers, purchase orders and quantities and qualities of products required.
The mix of wood products chosen, must be assigned to different sawmills to be produced using a distribution model, based on the principles of game theory. Sawmills are characterized by production capacity, facilities location, technologies, cost, storage capacity, patterns and cutting, diameter and geographic location log.
Once given the mix of products to sawmills, will develop a simulation model that allows generate patterns cuts for mix products. This model delivers the demand for logs for the forestry companies. The demand logs will be assigned to different sites harvest, which

are characterized by quantity resource, price, availability and allocation forest, using a model with approach of game theory.

It hopes to develop a model that considered the overall objectives of the business unit and not the individual players in the supply chain.
Using principles of game theory, allow incorporated into the model, situations where players make choices in a context of interaction and a pre-defined framework, which allows comply with the strategic decisions of enterprises.

Key words: Optimization in Sawmill, Production planning market-sawmill-harvest, Game theory, Supply Chain management.

Introduction

In most of the real problems of engineering, requires the simultaneous optimization of factors, some conflicting with each other, so that various conflicting objectives must be met simultaneously.
In recent decades this situation has been more evident and complex, due to the strategic importance of integrating the various businesses that make up the value chain of a product: supplies, and manufacturing clients (Reck and Long, 1988; Freeman and Cavinato, 1990; Hammer and Champy, 1993). The opportunity to use process integration across functional boundaries is now considered a key to competitive success (Birou et al, 1998). The goal is to create and coordinate manufacturing processes seamlessly across the supply chain in a manner the most competitor cannot very easy match (Anderson and Katz, 1998; Lummus et al, 1998)
The interactions of these synchronized local value chains create a value chain that can become global. The challenge is to capture the value generated along the chain, based exploit the information that goes up and down along the chain, to create business models.
Supply chain is network of logistic and process industry. The sequence of this network, downstream, is generated with the customer's purchase order against a particular product. There begins the relationship between the different agents involved in the value chain of product, each playing a specific role. The performance of a supply chain depends on the structure of its production-distribution, industrial context and relationship customer-distribution-production-resource.

The supply chain in wood industry (Fig.1) is made up of timber forest enterprises, industrial plants primary and secondary processing, whether these plants sawmill, boards of plants, plants remanufactured; sales, etc.., say, are regarded as members of the chain all businesses that relate to the business unit and whose purpose is to ensure that the product reaches the customer. We consider the flow of raw materials, products, information, etc.

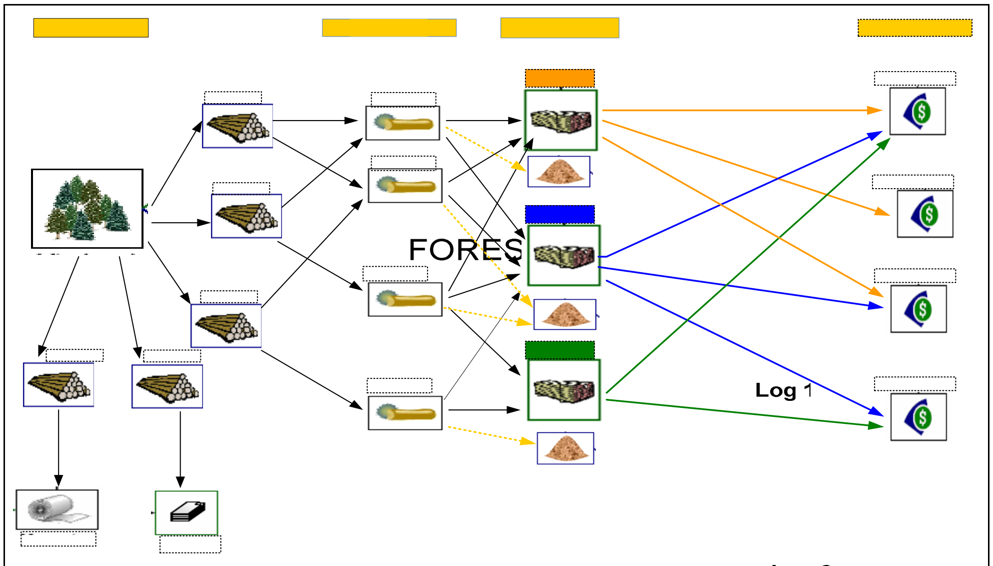

Figure1: Supply chain in wood industry

Within this context models of production planning, play a decisive role in business and profitability in the value chain, because they are tools that support decision-making, are proposals to assist the business at different levels of the organization. Therefore, the non-integration of the supply chain generates losses associated with waiting times, higher inventories and higher storage products and raw materials, among others (fig.2).

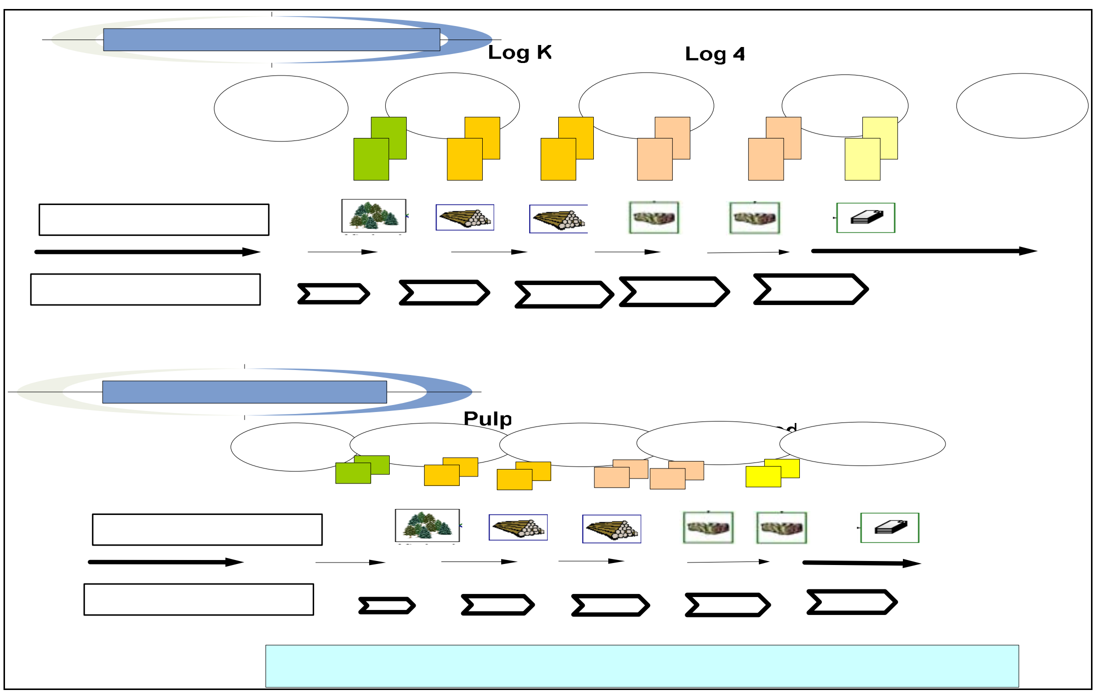

Figure 2: Integrated and non-integrated supply chain

Among the various agents in the chain there are strategic interactions, which are the result of management decisions, considering the behavior of fluctuating markets and the environment, rather decisions are trade-offs that are assumed by managers and heads of different companies, which will make the difference between a company and another.
Linear Programming and Mixed integer linear programs have been used forest and wood planning since the 60's to support decision making on forest harvesting and management. Further, new environmental concerns, such as resource sustainability and wildlife protection, impose that increased attention be paid to activities carried out on the ground and market (Weintraub, Church, Murray, Guignard, 2000).
Optimization models and methods have been used extensively in the forest industry. These cover planning periods from a fraction of a second to more than one hundred years. The problems are modeled using linear, integer and nonlinear models. Solution methods used depend on the required solution time and include for example dynamic programming, LP methods, branch & bound methods, heuristics and column generation. The importance of modeling and qualitative information is also discussed (R¨onnqvist, 2003).

There are different models of production planning in the industry have Wood report how to minimize cost, maximize capacity and maximize profit: As in our previous work: One model the sawmill production process in terms of two transformation stages and two inventory stages. The authors then extend the model to account for supply chain decisions consisting of timber transfers among plants. They apply the model at 11 Chilean sawmills to evaluate whether they can benefit from operating in a more integrated manner. An investigation into how a number of sawmilling companies working together can profit from their distinctive competitive advantages, and which proved successful in challenging one company's business paradigms (Singer and Donoso, 2007). Other models developed by integrating the problem parts of the supply chain, such as: A linear programming-based multiple period production planning system responds to expected changes in product value or market demand by changing policies regard to sawing patterns and log consumption (Maness and Norton; 2002) and incorporate environmental criteria and indicators for the resolution of these models, using multi-objective scenario (Maness and Farrell, 2004). Other work present a generic methodology to design the production-distribution network of divergent process industry companies in a multinational context, using a mathematical programming model to map the industrial process is defined by a directed multigraph of production and storage activities (Vila, Martel, Beauregard; 2006. For secondary manufacturers in the forest products industry face a complex production planning process. Lineal programming (LP)-base applications have addressed this production planning issue (Farrell and Maness, 2005)

On the other hand, the theory of games is studying the behavior of individuals and organizations in situations of strategic interaction. To do so, uses a type of model called the game, which consists of a set of players, their alternatives for action, the information available, the chance to influence the outcome and the costs and benefits that each player gets in each of the possible outcomes. (Singer 2008) Many strategic mistakes can be avoided by applying simple concepts of game theory. The success of agents in their strategic interaction is largely the result of the correct choice for their actions

This approach is usually used in economics, in exchange models such as negotiation and auction at an intermediate level of aggregation, in the field of labor economics or the financial economy, in the field of international economics, foreign policy overall (Gibbon,1992).

A commonly accepted classification of the Game Theory distinguishes between: Games Cooperative and Cooperative not or cannot be established as binding agreements between players. Since its inception the Game Theory has not had a strong cooperative interaction with operational research.
However, the implementation of models of the Game Theory Cooperative to such problems is more recent and its study is known as Games investigation (Borm et al., 2001). Problems Research operations that are formulated and solved using the Theory Games are for example: Problems Connection, Problems routes, Problems Sequencing.
Some of the work done in this area has said the relationship with the process of radical change in the Finnish forest industry over a certain period of time and to make the course of events more comprehensible with the help of the gamesmanship framework. (NÄSI, 2006). The beer game was applied to pulp plant (Moyaux, D'Amours , Chaib, 2004)

One Model production planning in the Chilean Wood Industry

In wood industry the companies have developed different models and optimization tools that support for decision-making in the planning; this is strategic, tactical and operational. However, currently all optimization models are local, i.e. considered a member of the supply chain and not the integration of parts or all of this. (There are models for forest planning, planning for the sawmilling, which maximize the profitability of each company rather than the profitability of the chain integration or any part thereof). This means that each member of the chain believes its profitability individually, to the detriment of the overall profitability of the business, which leads to inefficiencies related to transfer pricing, misallocation of logs, inventory costs, degradation of wood, etc. (Sanchez, 2007).

This paper present the study of one optimization of the production planning model in the supply chain wood Industry: market, sawmill and harvest, multiperiod and a planning horizon of two years, which means of maximizing the profitability of a mix of wood products, incorporating an approach of game theory.

Methodology:

a) ***Agents and information flow:*** It identifies the agents involved in the supply chain for the timber industry. To do this we analyze the agents and information flows that exist at different levels of planning-timber forest enterprises and the relationship between them (fig.4)

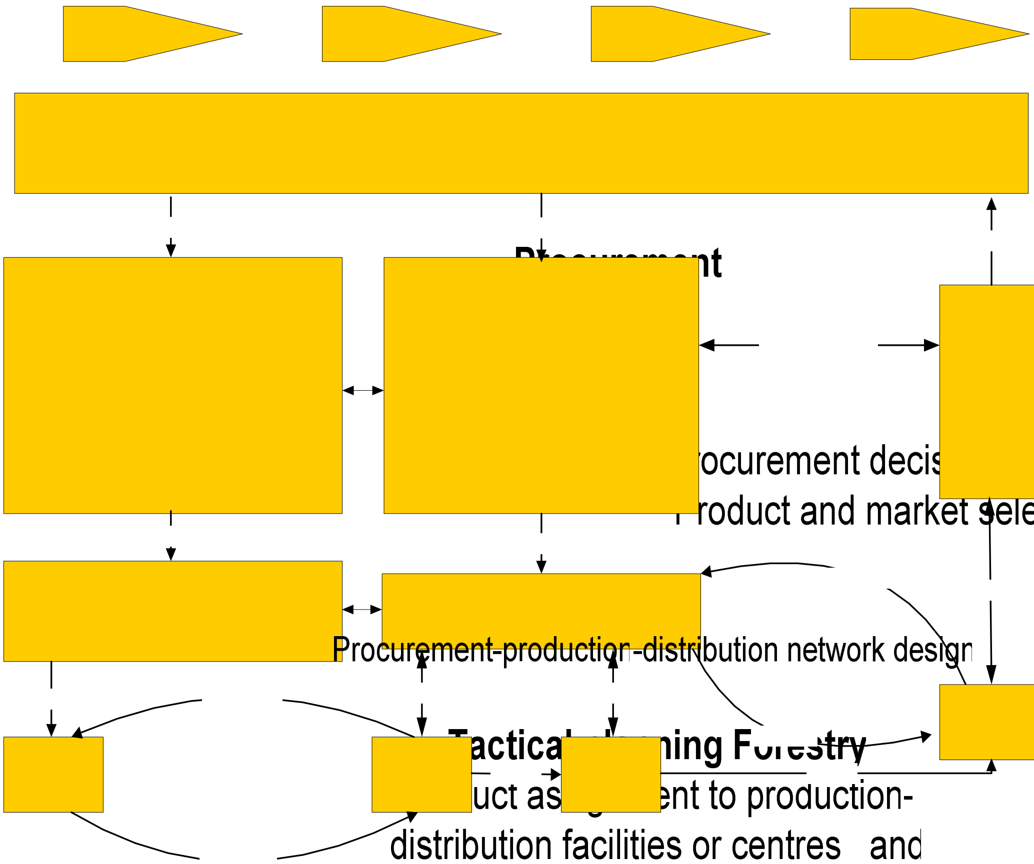

Figure 3: Planning decisions in the Forestry and Sawmill industry

b) Creation of the logical model (fig 4) there are different agents involved in model and proposals for tackling the problem.
There is work in the following areas:

- Simulation of commodity prices in the market. (Market)
- Coordination of distribution of products required in the market (products-sawmill), assignments of products to different mills, which are located in different geographical areas. (Assigned products-sawmills) (Game Theory).
- Simulation cutting patterns for the optimal mix of products, selected in order of production, taking into account characteristics of sawmills, which are classified by skills, pattern and cutting diameter log. (Sawmill-Simulation Model)
- The need for optimal raw materials (logs), should be allocated to different sites harvest from the forest, which are characterized by type of log, age, location and availability, harvesting equipment. (Game theory)

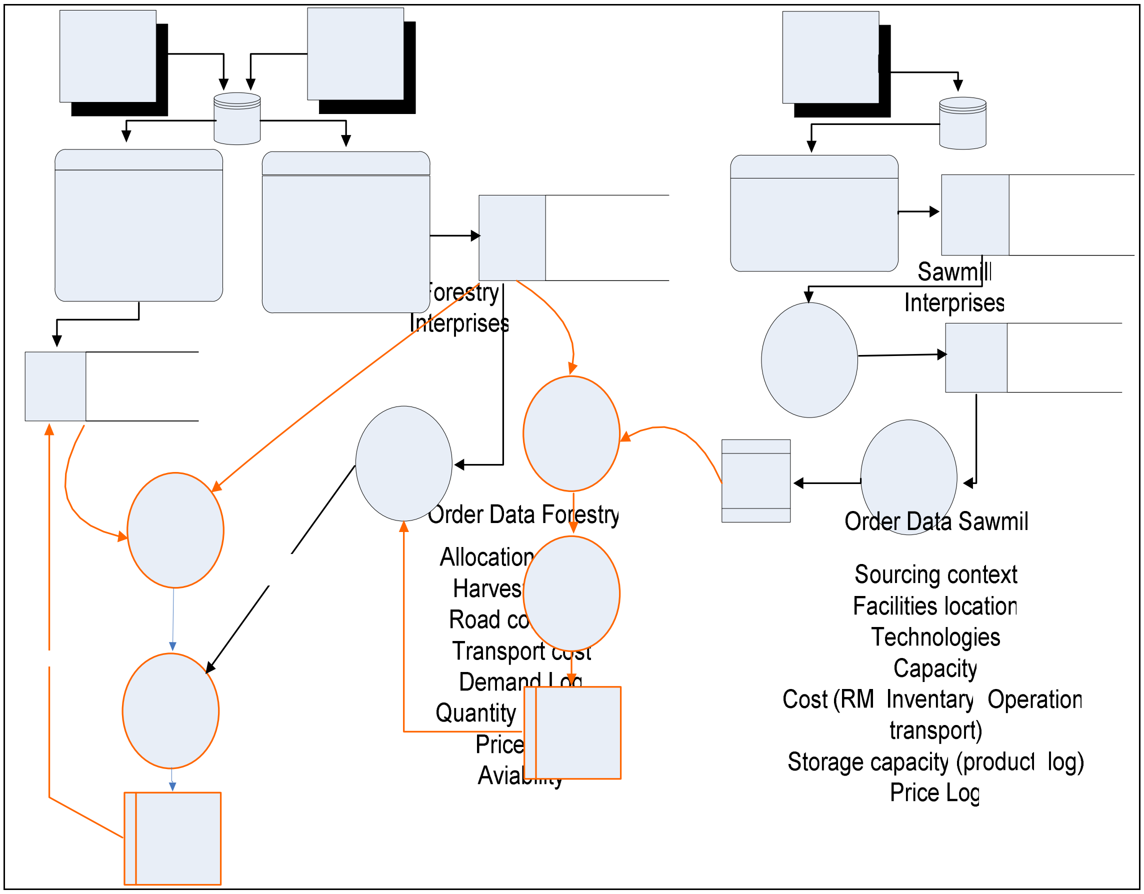

Figure 4: Logic Model

Conclusion

Using game theory is a valid proposal to find an optimal in the integration the supply chain, because this approach allows us to incorporate the trade-off of strategic decisions in the timber industry, which relate to movements markets and random components, given by the criteria and perceptions of staff members eligible for one or another strategy

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