**WP 2 - Supply Chain Planning**

**D 2.2 - ALGORITHMS FOR INVENTORY MANAGEMENT AND CONTROL**

The European Chemical Industry Council (CEFIC) and the European Petrochemical Association (EPCA) have recognized that to remain competitive in export markets and minimize import penetration into the European chemical market, enterprises producing chemicals must continue reducing their costs. As the scope for further reductions related to equipment technology is limited, given the size and age of European plants, performance improvements should come from an enhanced Supply Chain Management (SCM). Hence, in order to preserve its condition and persist as a vital sector in the European economy, the chemical companies are depending on the performance of their global Supply Chain (SC) networks.

Many proposals have emerged from the chemical industry for SC improvement. One of them is the necessity of improving the degree of functional coordination, it has been noticed that closer coordination between logistics and other functional units can improve overall business performance. In addition, it has been proposed the relocation of production capacity in the long term as a manner to significantly enhance chemical industry efficiency. Undoubtedly, both abovementioned proposals pose the challenge of developing efficient tools and methodologies so as to obtain innovative solutions for the operation and design of chemical SCs. From another standpoint, the Process System Engineering (PSE) community also recognizes that an optimum management of the SC offers a key opportunity for preserving and improving firm’s value.

Certainly, there exists an economic trend that is changing the nature of business enterprise. Nowadays businesses are increasingly boundaryless, meaning that internal functional barriers are being removed in favor of horizontal process management; externally, the gap between vendors, distributors, customers and the firm is gradually closing. As result of realizing this shift, academics as well as practitioners are focusing efforts on developing holistic frameworks which are capable of supporting the cross-functional decision making process required to remain competitive under the current complex and dynamic business environment.

The concept of Supply Chain refers to the network of interdependent entities (i.e., retailers, distributors, transporters, storage facilities and suppliers) that constitutes the processing and distribution channels of a product from the sourcing of its raw materials to its delivery to the end consumer. Subsequently, Supply Chain Management can be defined as the management of material, information and financial flows through a SC that aims at producing and delivering goods or services to consumers. The main objectives are to achieve the desired consumer satisfaction levels and the maximum financial returns by synchronizing and coordinating the SC members activities. The need for such coordination grows out of several trends in the marketplace. One of them is the so-called Globalization which has led to the availability of a vast set of alternative sources of materials and other inputs as well as a wider set of potential customers. This evidently expands the SCM scope to embrace the consideration of international issues. In addition, customers’ changing expectations regarding value of goods and services, combined with advances in technology and the availability of information, have driven the formation of these “new forms” of networks.

Since its appearance in the nineties, the conception of SCM has evolved from the primary idea that was to align the forecasting, distribution, and manufacturing processes. Nevertheless, the original mission and essence which is to break down “walls” still remains and continue expanding.

Recently, the term Integrated Supply Chain Management has been formally introduced, in order to encompass in a unified manner strategic and tactical decisions such as raw material procurement contracts, routing to plant sites, capacity planning and lead time management, routing of finished products, warehouse positioning, network inventory management and marketing strategies.

Integrated SCM is understood as an enhanced concept that attempts to break down “walls” by integrating the decision making across three dimensions:

         Diverse geographically distributed facilities and organizations;

         Different hierarchical levels of decision-making (strategic, tactical and operational);

         Various business functionalities (e.g., operations, finances, research and development, marketing, environmental management).

Furthermore, business environment current trends need to be pondered when developing a SC decision support system. Specifically, SC managers need to consider the dynamics of a rapidly changing market environment, such as variability in demand, cancellations and returns, as well as the dynamics of internal SC operations, such as processing times, production capacity pitfalls and the availability of materials. Evidently, market dynamics and uncertainty and internal business operations make it difficult to synchronize the activities of all SC echelons; this causes significant deviations from previous objectives and plans. Therefore, for a SC to be efficiently managed it is important to systematically review variability and to explicitly take it into account in decision making. These actions search for a flexible response to changes in the business environment, increase the decisions accuracy and robustness, and improve business performance. For these reasons, an integrated framework should include the explicit consideration of SC uncertainties and dynamics.

The research goal posed in the PSE community is to integrate all these aspects into a model which would ultimately serve as the core of a SC decision support system.

It is also important to mention that Enterprise Wide Modeling and Optimization (EWMO) has emerged as a new promising research field. Likewise, one of its key features is the integration of the information and decision making among the various functions that comprise the SC of a company and across different decision levels as well. In EWMO the emphasis is on the manufacturing facilities with a major focus being their planning, scheduling and control which often requires specific knowledge of process engineering. Here, the Integrated SCM application is devoted to the chemical process industry for which it is necessary to recall particular knowledge of process engineering as it occurs in EWMO.

Supply Chain performance is an outcome of the decisions made in order to synchronize the materials, information and cash flows along the SC partners. The decisions encompassed in a SC model depend on its scope. However, some of them are listed next.

         *Location:* They involve determining where to place new SC facilities.

         *Capacity changes:* These type of decisions determine where, when and what amount to expand or reduce SC capacity (i.e., equipment technology or workforce).

         *Flows magnitude:* They determine the volume of purchasing, production and distribution of each material.

         *Allocation:* They involve allocating resources to SC tasks (i.e., assignment, sequencing, and timing).

         *External links:* These decisions define which external suppliers should be utilized or phased out. They also include outsourcing decisions.

         *Inventories:* They determine the inventory control policies and safety stock levels.

**LINKING MARKETING AND SUPPLY CHAIN MODELS**

Nowadays, a supply chain management model incorporating business strategic components is becoming of paramount importance to gain a competitive edge in the market place. To be successful, the enterprise model has to contemplate not only the supply chain, but also the demand chain. Understanding the market and customer behavior is extremely crucial for developing a good business policy.

Typically, the business strategy is modeled as a hierarchical process in which functional strategies, such as operations, logistics, marketing, and finance are driven by a higher level strategy. A key element of the strategic framework involves coordinating functional level plans to work in concert so as to achieve the overall business strategy rather than to locally optimize outcomes for individual functions, business units, plants, or stores.

One of the primary challenges in implementing an effective strategy involves achieving consensus within the business organization. Undoubtedly, business functional decisions must be integrated and coordinated in order to tackle the critical decision of resource allocation among the different business activities. Unfortunately, while this concept is clearly sound on a conceptual level, actual implementation is typically very difficult.

One important strategic issue that needs more research is the integration of SC production-distribution operations and marketing activities. Marketing is the process of planning and executing the conception, pricing, promotion, and distribution of ideas, goods, and services in order to create exchanges that satisfy individual and organizational objectives. This activities, usually regarded as Marketing mix, refers to the primary elements that must be attended in order to properly trade a product or service. On the other hand, SCM’s focus is on the synchronization of production and distribution activities along the different entities comprising the SC network. The main objective is typically to minimize the total SC cost. Although several authors have highlighted the conflicting goals of SC and marketing managers, it is still typically assumed that under a decentralized decision making scheme, marketing decisions are made first; determining demand forecasts which are later considered by the SC model to support production-distribution related decisions. By deploying this sequential procedure, the firm may be significantly under-estimating its overall performance. Integrating marketing and operations is a challenge in any business, since there is a natural tension between these two functional areas. At best, the tension between these two functions results in a dampening of marketing’s tendency to over-promise to lure customers and a push on operations to move beyond an internal focus on reducing costs without a clear vision of end-consumer needs.

Usually, the primary objective of marketing function is maximizing revenues creation by satisfying customers through the products and services offered. On the other hand, SCM’s objective is to minimize the total SC cost as previously mentioned. In general, conflicts arise between marketing and SC because of these contrasting performance indicators which eventually are used to develop incentive structures for managers and their corresponding employees. For instance, one classical conflict between these two functions is the one associated to the inventory management. SC managers strive to keep low stock levels, while marketing managers long for high stock levels to guarantee that most of customer orders are met, thus improving revenue generation. Nevertheless, the enterprise main goal is to create and maximize shareholders value which actually is a function of revenues, cost and other economic factors. Consequently, business managers are in need of an integrated analytical decision support tool that is capable of appraising the trade-off between operations and marketing while evaluating and maximizing shareholders value.

Nowadays, there are more and more companies that are continuously searching for competitive advantages in order to get a better position in markets. One way of doing so may be by aligning functionalities strategic/tactical decisions towards the optimization of the overall business performance metric. In this chapter, it is presented a novel approach to address this challenge. Here, it is developed a MINLP model that tackles SC network design and marketing strategic decisions in tandem. Then, such model is coupled with the financial formulation, Enhancing Corporate Value in the Design of Supply Chains, which allows calculating shareholders value by means of the discounted-free-cash-flow (DFCF) method.