A Strategic Multicriteria Decision Support System to Assess the Best Supply Chain Distribution Strategy and Characterize the Bullwhip Effect

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ABSTRACT

The attention on optimal management of production systems has increased, thus the control of production with local control of the coordination of an entire chain of production and distribution (Supply Chain Management). The aim of this work is to analyze some issues relating to new types of production realities based on the Supply Chain, to show the multiple causes of the change in demand along a Supply Chain, the reasons that cause the Bullwhip Effect and the techniques to improve it. From this point of view the authors have developed a strategic multicriteria decision support system based on the Analytic Network Process with which the authors can analyze the criticality throughout the supply chain process. Definitively this paper introduces a conceptual framework for evaluating different supply chain structures in the context of Bullwhip Effect. The authors also illustrate the applicability of the resulting framework through a specific model applied in an automotive industry.

Keywords: Analytic Hierarchy Process, Bullwhip Effect, Business Management, Decision Support System, Multicriteria Model, Supply Chain Management

INTRODUCTION

Organizations that operate in rapidly evolving sectors should have the ability to build networks of supply, distribution and alliances in order to create a well designed supply chain that can offer great benefits in managing activities of organizations and pursue the main objective order of a policy, that is, keeping production and demand close while maintaining stock and productive capacities to the minimum acceptable level (Tyana et al., 2003).
A strategic alliance is identified by Marien (2000) as one of the key supply chain enablers. Strategic alliances are concerned with how external companies (customers, suppliers, and logistic-service providers) are selected as business allies and how inter-company relationships are built and managed.

However, evidence shows that the variability of demand within the supply chain grows as you move away from the final consumer. This effect called the “Bullwhip Effect” creates serious problems in planning and managing the supply chain. The first recognition of the Bullwhip Effect can be traced back to Forrester (1965). Other earlier papers including Daganzo (2004), Ouyang (2007), Zhang (2004) analyze this effect.

In this context, a critical element for organizations is the ability to forecast technological evolutions and effectively manage a different competence identifying new development opportunities in a market where competitive forces change very quickly. To contrast the Bullwhip Effect in the supply chain you must first identify and analyze its causes, identified the causes, the management will take the necessary decisions (Kim et al., 2006). In the past the main problem, researchers studied was to find mathematical models for optimization that were intended to coordinate the supply chain. Monolithic optimization models have been proposed based on linear programming and binary integer variables that provide an optimal solution to problems such as allocation of production capacity (capacity planning), and the location of establishments (multi-unit plant location), etc. The criticism raised by this way of proceeding is that it has little practicality.

A new approach in which the various nodes of the supply chain are seen as “the agent” linked by information, material and goods, flow, acting on the basis of an individual utility function is fundamental. In this context, the problem can be traced to decision-making based on the competitiveness of the actors with a multi-agent approach (Salomon et al., 2007). Each stakeholder must establish his strategy to determine a set of decision variables in order to maximize its benefits by taking into account the constraints set. The expanding scope of decision making across temporal, geographical, value chain and functional dimensions provides companies with a sustainable competitive advantage in terms of cost, quality, innovation and delivery performance (Ernst et al., 2000).

The present work analyzes the criticality of the Bullwhip Effect and proposes a multi-criteria based approach for evaluating performance of the whole supply chain. The aim is to support managers in the decision making process. The approach is based on the well known Analytic Hierarchy Process (AHP) and its generalization Analytic Network Process (ANP) model (De Felice, 2012). This techniques are still widely used in the literature to deal with the supply chain problem (Bayazit, 2006; Chan, 2003; Chan et al., 2004; Chin et al., 2006; Gencer et al., 2007; Levary, 2007; Wu et al., 2008).

In particular the proposed approach aims to optimize the development of the ANP/BORC (Benefits, Opportunities, Risks, Costs) model to identify significant factors for the management of supply chain; in this way, the ANP model could supply effective information about critical factors/area in the whole supply chain in order to reduce the Bullwhip Effect.

VALUE CHAIN ANALYSIS AND BULLWHIP EFFECT

Recent research has shown the importance of improving the supply chain competitiveness by means of strategic alliances. The core objective of supply chain management is to minimize system wide costs while satisfying service level requirements (Tayan et al., 2003).

One of the main causes of additional costs within supply chains is the Bullwhip Effect (Lee et al., 1997). Proper operation of the Supply Chain allows the achievement of the objectives of those who take part, with the only constraint that all must seek the same result. The selfish policy of one or more stakeholder can lead to poor operation and very bad coordination of the supply chain.
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