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Reconciling sales and operations management with distant suppliers in the automotive industry: A simulation approach

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ABSTRACT

A challenge for car manufacturers is to adjust rapidly and efficiently the production capacities with a volatile market demand and despite distant suppliers. In this paper, we consider a sales and operations planning problem based on the actual situation of Renault, a French global automobile manufacturer. The issue is to find the best trade-off between sales requirements and industrial constraints while limiting inventories, emergency supplies and keeping delivery lead times reasonable for customers. A new planning method based on flexibility rates is presented. The flexibility rates are defined to limit orders of a given type of vehicles, during a certain period. A simulation model is introduced and captures the dynamics of the sales and operations management. A numerical study has been performed by using industrial data. Results highlight factors that improve system performances and several policies are compared. This research also has relevance for other industries that face long procurement lead times in an uncertain environment.

1. Introduction

For a long time, the automotive industry has been facing a volatile and changing market demand (Elkins et al., 2004; Childerhouse et al., 2008). Forecasting becomes more and more difficult because of, among others, the cyclic environment and the increasing competition between car manufacturers. Moreover, customers ask for more individualized vehicles. If the product variety provides a competitive advantage for automakers (Ramdas, 2003; Aoki et al., 2013), it also complicates forecasting and supply chain management for vehicle subparts (e.g. engine types, options and equipment). To deal with these issues, car manufacturers took up the challenge to shift from mass production to mass customization (Brabazon et al., 2010). Since the nineties, automobile manufacturers have given priority to build-to-order processes to manage their supply chain (Miemczyk and Holweg, 2004). Mass customization and build-to-order production have helped automakers to better synchronize their production with market demand (Volling and Spengler, 2011) and to master the increased exposure to demand variability (Holweg et al., 2005). Implementing build-to-order processes is challenging for many car manufacturers (Alford et al., 2000; da Silveira et al., 2001; MacCarthy et al., 2003; Howard et al., 2005) but it provides great advantages.

A new challenge appears in these last few years. Indeed, emerging countries and the globalization encourage carmakers to assemble vehicles and to supply parts in distant countries to reduce costs and to gain new markets. Nowadays, procurement lead times have significantly been increased and may take more than 2 months for some vehicle components. Long procurement can also be due to the transportation mode (e.g. sea shipments are slow but cheap and contribute to reduce dioxide emissions) and new production processes (e.g. batteries for electrical vehicles).

With many distant suppliers, build-to-order supply chains begin to show several limitations, especially in the automotive industry with the increasing competition between automakers. Indeed, on one hand, sales dealers are looking for short delivery lead times with the opportunity to order any vehicle as late as possible to satisfy the customers. And on the other hand, vehicle assembly plants need to order many parts several weeks beforehand, based on unreliable forecasts, when the actual demand is unknown.

There are not many options to manage this issue. One may increase vehicle delivery lead times but it is discouraged since sales dealers are facing a very competitive environment and customers would not wait for more than a month (Elias, 2002; Holweg et al., 2005). Encouraging customers to buy from vehicle stocks is possible but has limitations, especially in markets where car buyers prefer individualized vehicles. The other possibility is to increase safety stocks to hedge against demand uncertainty but it may be very costly, especially for heavy and expensive components. Using emergency supplies (e.g. shipping parts by airplanes) may be possible but this is also very costly.

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Therefore, a trade-off has to be determined between two opposite requirements: the sales department asks for more flexibility and supply planners ask for less changing demand and more visibility. Coordinating sales and supply chain remains a serious challenge because of numerous differences and conflicts in terms of objectives, responsibilities and management (Hahn et al., 2000).

The automobile manufacturer Renault has launched an exploratory project to improve its sales and operations planning process to manage plants with distant suppliers and that serves mainly build-to-order (and impatient) customers. The aim is to offer more flexibility for sales dealers while limiting logistic costs due to inventory and emergency supplies, and keeping delivery lead times reasonable. To do so, new flexibility rates and safety stock margins have been created and their specificities are described in this paper. Since processes are new, supply chain and sales departments do not know how to set up efficiently these parameters. Managers lack insights into the dynamics between these decision variables and their impact in terms of logistic costs and customer satisfaction.

The research objectives are, first, to provide a relevant quantitative model that captures the dynamics of sales and operations planning of the automobile manufacturer. Based on this model, the second objective is to compare several policies to manage flexibility and stocks, and to give practical recommendations for sales managers and supply planners. We have decided to use a simulation approach because of the complexity of the industrial situation and to obtain initial recommendations which can be easily applied and can quickly provide gains for the company.

This research is motivated by concrete and recent industrial issues: the growing importance of emerging markets for car manufacturers, the increasing number of distant suppliers and the difficulty to match sales requirements with supply chain constraints in a global, uncertain and competitive environment. This research and results we obtained also have relevance for other companies and industries that lack visibility on future demand and want to improve their sales and operations planning.

The contribution of this paper is, first, the detailed description of a new planning model for reconciling sales and operations management with long procurement lead times. We introduce a new planning method with flexibility that can help companies, especially in a build-to-order environment, to better coordinate sales and operations to reduce supply chain costs while controlling the customer satisfaction and sales requirements. Second, we present numerical results based on a simulation model that captures and understands the system dynamics. The simulation model has been used to evaluate quickly and efficiently several policies to manage stocks and inventory. Third, we provide a comparison of several policies and show their performance in terms of costs, lost sales, delayed orders and delivery times. Finally, managerial insights, practical recommendations and further research are discussed. We also present the benefits of this new planning method and how to implement it in build-to-order companies.

The paper is organized as follows. A relevant literature is presented in Section 2. The industrial problem is described in Section 3. Section 4 introduces the simulation model with the assumptions, the notations and the system dynamics. Policies used to manage stock and flexibility are presented in Section 5. Numerical results and managerial insights are detailed in Section 6. Finally, a summary of findings and further research directions are discussed in the concluding section.

2. Literature review

In this section, we present the related research to the problem described in this paper.

2.1. Supply chain globalization

A first general aspect related to our problem is the globalization that increases procurement lead times and makes the supply chain more vulnerable to demand variability. The importance of supply chain internationalization has been discussed in, among others, Levy (1995, 1997). Humphrey (2003) studies the development of automotive industry in emerging countries and highlights the complex sourcing strategies in this new environment. As stated in Tang (2006), globalization makes more vulnerable supply chains to various disruptions (uncertain demand, economic cycles etc.). The author presents several perspectives in supply chain risk management. He shows that for gaining market share and reducing costs, firms favor outsourced manufacturing and offer higher product variety. This is effective in a stable environment but in an uncertain environment, the supply chain management becomes very complex. Prater et al. (2001) argue that, in international supply chains, it is difficult to promptly react to demand because of long procurement times due to sea shipments. Ambe and Badenhorst-Weiss (2010) emphasize that changing business conditions during these last few years and the global economic meltdown have increased the pressure on automotive managers to reduce cost and supply chain vulnerability.

2.2. Production planning with uncertainty

The issue of production planning with uncertainty is a rich area of research since this domain is vast and leads to various and numerous models with different assumptions and objectives. An exhaustive literature review on this research area is given in Mula et al. (2006). As the authors show, most of the analytical models address only one type of uncertainty, and assume a simple structure of the production process. For more complex situations, methods based on artificial intelligence and simulation are favored. Graves (2011) discusses how uncertainty is handled in production planning. The author details current practices and suggests possible improvements. The problem we address in this paper is directly linked to the research area of production planning with uncertainty since we consider the production plan of finished goods with uncertain demand and customer impatience. The specific characteristics of planning processes, customer impatience and demand arrivals of our industrial problem are detailed in the rest of the paper.

2.3. Sales and operations planning

The sales and operations planning is the process that links strategic plan to daily operations plans, and balances demand and supply (Grimson and Pyke, 2007). It differs from the pure production planning since it has to take into account the sales objectives and the related constraints. Typically, the planning horizon ranges from 6 months to over 3 years but this may vary by industry and product. Generally, sales and operations planning concerns product families rather than finished goods but there are few examples of situations that operate at the stock keeping unit level (de Kok et al., 2005). A large review on sales and operations planning is provided in Grimson and Pyke (2007), who note that little has been published on this topic up to now. They develop a framework for a better integration of the sales and operations planning and they provide recommendations for moving to more mature and advanced processes. More recently, Thomé et al. (2012) provide a comprehensive literature survey on the highly dispersed research about sales and operations planning. The authors highlight its considerable impact on firm performance and show that this topic has a growing interest since the last decade.