Supply Chain Simulation for Determining Quantity of Delivery Batch

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Abstract

Supply chain planning problems encompass industrial production process design and improvement, inventory control policy, transportation management, supply procurement, and demand planning. The supply chain is due to a realization by most companies that maximizing performance of one department or function may lead to less than optimal performance for the whole company. In order to achieve high performance, supply chain functions must operate in an integrated and coordinated manner. As the modern high technology manufacturing systems can be extremely complex due to factors such as: multiple part types made in the same facility/line, numerous manufacturing, batch processing, multiple levels of subassemblies, just to name a few. The uncertainties in the supply chain network make manufacturing enterprises inefficient. The supply chain management should be concerned with the reduction or even elimination of uncertainties. Simulation is a practical methodology for understanding the high-level dynamics of a complex manufacturing system. Keywords—Supply Chain Management; simulation; delivery batch;

1 Introduction

Modern manufacturing companies need to collaborate to design and produce their products with their business partners, such as vendors, retailers, and distributors. They must continually review their strategies and restructure to optimize their business, fabrication processes, and procedures. Owing to the recent trends in international procurements, new information technologies, increasing pressure from customers on responsiveness and reliability and the globalization of operations and markets, supply chain management has become a challenge and an opportunity (Bowersox & Closs, 1996). Supply chains are real world systems that transform raw materials and resources into end products that are used by customers. Supply chains encompass a series of steps that add value through time, place, and material transformation. Each manufacturer or distributor has some subset of the supply chain that it must manage and run profitably and efficiently to survive and grow A. Hicks (1999).

Interest in supply chain management has steadily increased since the 1980s when firms saw the benefits of collaborative relationships within and beyond their own organization R. R. Lummus (1999). The popularity of the supply chain concept has been stimulated from many directions including the quality revolution, notions of materials management and integrated logistics, a growing interest in industrial markets and networks, the notion of increased focus, and influential industry-specific studies I. Chen (2004).

During the 1990s, companies made huge ef-
2 Literature Review

Modern manufacturing companies need to collaborate to design and produce their products with their business partners, such as vendors, retailers, and distributors. They must continually review their strategies and restructure to optimize their business, fabrication processes, and procedures. Owing to the recent trends in international procurements, new information technologies, increasing pressure from customers on responsiveness and reliability, and the globalization of operations and markets, supply chain management has become a challenge and an opportunity D. J. Bowersox (1996).

Each manufacturer or distributor has their own supply chain system which must be managed and run profitability and efficiently to survive and grow. Managing the flow of material from supply sources to the ultimate customers involves the design, planning and control of the supply chain. Efficient and effective SCM leads to fulfilment costs and time reduction, better quality and service levels, and helps the company to keep achieving profitability (Bandinelli et al, 2006). This means eliminating unnecessary costs and waste on production and distribution which need to be addressed.

2.1 Supply Chain Management

The supply chain management (SCM) literature offers many variations on the same theme when defining a supply chain. Supply Chain Management (SCM) is “an integrating philosophy to manage the total flow of a distribution channel from supplier to ultimate customer”. Morgan and Monczka (1996) state that “integrated supply chain management is about going from the external customer and then managing all the processes that are needed to provide the customer with value in a horizontal way”. They believe that supply chains, not firms, compete and that those who will be the strongest competitors are those that “can provide management and leadership to the fully integrated supply chain, including external customer as well as prime suppliers, their suppliers, and their suppliers’ suppliers”.

Supply Chain Management (SCM) is the management of material and information flows both in and between facilities, such as vendors, manufacturing and assembly plants and distribution. A supply chain is a network of organisations involved, through upstream and downstream linkages, in executing different processes and performing value added activities to produce products and services Christopher (2005). From these definitions, a summary definition of the supply chain can be stated as: all the activities involved in delivering a product from raw material through to the customer including sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, delivery to the customer, and the information systems necessary to monitor all of these activities. The materials flow from upstream members to downstream members and finally arrive at customers as the products. Meanwhile, the demands information (orders) flows from downstream members to upstream members in information flow. The concept of supply chain management is shown in Figure 1. Effective and efficient SCM leads to fulfilment cost and time reduction, better quality and service level, definitively competing to achieve and keep on profitability.

Concept of supply chain management (Lee, Cho, Kim, & Kim, 2002).
2.1.1 Supply Chain Modelling Approaches

Generally, modelling approaches in SCM can be categorized into five broad classes.

First method is supply chain network design method. This method determines the location of production, stocking, sourcing facilities, and channels the products take through them.

Second method is Mixed-Integer Programming (MIP) optimization modelling. This includes most models for vehicle routing and scheduling, facility location and sizing, shipment routing and scheduling, freight consolidation and transportation mode selection. Mixed-integer models are often difficult to optimize, as there can be an exponential number of possible decision alternatives.

Third method is stochastic programming and robust optimization methods. Stochastic programming deals with a class of optimization models and algorithms in which some of the data may be subject to significant uncertainty. Uncertainty is usually characterized by a probability distribution on the parameters. Such models are appropriate when data evolve over time and decisions need to be made prior to observing the entire data stream.

The other method is heuristic methods. Heuristic is another important class of methods for generating supply chain alternatives and decisions. A heuristic is simply any intelligent approach that attempts to find good or plausible solutions. Generally, mathematical programming methods are used to solve strategic and higher levels of tactical supply chain planning.

The last one is simulation based methods. This is a method by which a comprehensive supply chain model can be analyzed by considering both its strategic and operational elements. This method can evaluate the effectiveness of a pre-specified policy before developing new ones. The dynamic nature of supply chains makes the simulation methods necessary for studying the time-varying behaviour of supply chains.

2.1.2 Supply Chain Simulation

Supply chain performance can be improved by reducing the uncertainties. It is clear that there is a need for some level of coordination of activities and processes within and between organizations in the supply chain to reduce uncertainties and add more value for customers. This requires that the inter-dependence relations between decision variables of different processes, stages and organizations to established. These relations may change with time and are very difficult to analytically model, if not impossible. However, the simulation provides a much more flexible means to model the dynamic and complex networks. Simulation is considered the most reliable method to date in studying the dynamic performance of supply chain networks. Simulation also provides an effective tool to evaluate supply chain reengineering efforts in terms of performance and risk.

The use of simulation as a vehicle for understanding issues of organizational decision-making has gained considerable attention and momentum in recent years (Malone and Benton 1997). Simulation techniques is using to evaluate effects of various supply chain strategies on demand amplification. Researcher utilized a combined analytical/simulation model to analyze supply chains. The other utilized a simulation to study the effect of sharing supplier’s available-to-promise information. The need to simulate and redesign supply chain processes to allow decision makers to explore various options and scenarios that are customer and value driven has been recognized M.Hennessee (1998). Simulation has been identified as one of the best means to analyze supply chains D.Schunk (2003). Simulation involves the development of descriptive computers models of a system and exercising those models to predict the operational performance of the underlying system being modelled Smith (2003).

Simulation is an effective analysis tool for dynamically changing internal supply chain variables. Moreover, simulation can work for the global optimization of planning an entire supply chain with finding local optimum values within each component. Researchers use simulation techniques to evaluate the effects of various supply chain strategies on demand amplification. The strategies investigated are as follows:

1. Eliminating the distribution echelon of the supply chain, by including the distribution function in the manufacturing echelon.

2. Integrating the flow of information throughout the chain.

3. Implementing a just-in-time (JIT) inventory policy to reduce time delays.

4. Improving the movement of intermediate products and materials by modifying the order quantity procedures.
5. Modifying the parameters of the existing order quantity procedures.

One of the major issues in the creation of supply chain simulation is the level of detail at which each of the links in the chain should be modelled. In any simulation study, the level of detail modelled depends on the purpose of the effort. With the focus on supply chain performance, the level of detail for the manufacturing stages varies among different efforts.

Simulation models lend themselves to incorporating additional details about the manufacturing system and therefore often give more accurate estimates of manufacturing system behavior than the simpler models mentioned above, but usually at the cost of more computation. In general, simulation is a practical methodology for understanding the high-level dynamics of a complex manufacturing system. According to E. Yucesan (2000), simulation has several strengths including:

- Time compression – the potential to simulate years of real system operation in a much shorter time,
- Component integration – the ability to integrate complex system components to study their interactions,
- Risk avoidance – hypothetical or potentially dangerous systems can be studied without the financial or physical risks that may be involved in building and studying a real system,
- Physical scaling – the ability to study much larger or smaller versions of a system,
- Repeatability – the ability to study different systems in identical environments or the same system in different environments, and
- Control – everything in a simulated environment can be precisely monitored and exactly controlled.

2.2 Manufacturing Systems

As the modern high technology manufacturing systems can be extremely complex due to factors such as: multiple part types made in the same facility/line, numerous manufacturing steps (300-500 steps is not uncommon), batch processing, very complex equipment which leads to high levels of preventive maintenance and downtime, multiple levels of subassemblies, just to name a few.

3 Methodology

A methodology is simply a series of steps to follow. The use of such a methodology ensures a valid simulation result and helps the modelling stages in the development of the model. General methodology for applying simulation to problem solving (Rossetti, 2008):

The first phase is problem formulation, this step defines the problem to help ensure that the model solves the right problem. Established measure of performance for evaluation helps to ensure that the problem was solved for the right reason.

The second phase is model building, in this phase easy conceptual models that capture the basic aspects and behaviour of the system is made for the start. After developing a solid conceptual model of simulation, alternative system design configurations are developed based on the previously conceptual model.

After the model has been verified and validated, the software performs experiments that investigate the goals and objectives of the project. In the model deployment phase, the main area for efficiency improvement is in executing the model. The simulation model is then altered to conform to a potential scenario and re-run to generate comparative statistics. This process is continued, cycling through suggested scenarios and generating comparative statistics to allow evaluation of alternative solutions. In this manner, objective

4 RESULT

From the supply chain simulation model that has been made, each project has a different result. In the beginning of the modelling process, simulation without validation is made. Through comparison between the supply chain simulation with and without validation, it can be see that the design process takes as much time as the manufacturing process.

4.1 Discussion and Conclusion

This research result made is based on the parameter average time in the system and the average time in operation. From the current simulation models, average time in operation can be known and this time is used as based to make modelling decisions. The average time in operation for each alternative model had time constrain or not being less than the time in the current model. This parameters showed that the number of deliveries per project was problematic e.g. in some cases one delivery equalled one waveguide.

From this project, some conclusion can be made based on the result of simulation. Some of these are:

- The validation process is one bottleneck on the waveguides supply chain system
• The average time of product in the systems and average time of the product in operation could be improved by changing the number of waveguides per batch.

• The recommended for delivery batch is 25 parts and that delivery cost are reduced.

• The way that the order is processed at the supplier. So that products with similar complexity are manufactured in order and by batches.

References


