Nowadays, manufacturers face the challenge of reducing manufacturing cycle time, delivery lead time and inventory reduction. Every organization has its own objectives and its own way of decision making processes. Because of the conflicts among the objectives of each organization and non-integrated decision making processes, there has been a need for a new mechanism, which help to resolve those conflicts and to integrate processes. In the early 1990s, management is a process of integrating and utilizing suppliers, manufacturers, warehouses and retailers, so that goods are produced and delivered at the right quantities and at the right time while minimizing costs as well as satisfying customer requirements. Managing the entire supply chain becomes a key factor for the successful business. Organizations now realize that non-integrated manufacturing processes, non-integrated distribution processes and poor relationships with suppliers and customers are in adequate for their success. The supply chain areas are affected by the organization’s plan. The organization plan’s impact on the supply chain areas cannot be predicted before its execution. Simulation paves way to evaluate the performance of plans before the execution of the plan. This paper describes the effort of developing a simulation model for the supply chain management in an industry. This article discusses the requirement of supply chain simulation modeling.

1. Introduction And Literature Review
The structure of a typical of a supply chain is shown in the figure 1. It consists number of organization beginning with suppliers, who provide raw materials to manufacturers for production. The manufactured products are kept in warehouses and sent to the distribution centers that ship the products to the retailers. The customers then buy products from retailers. The structure of the supply chain network differs for different organizations. This paper deals about the review of the function and benefits of the supply chain management and the
necessity of simulation for the supply chain modeling [1]. Finally the procedures for data requirements were suggested. The subject organization for this study is a large logistics and distribution operation that provides logistics services for a large customer base distributed across all 50 states and about 27 countries, at over 500 sites located close to and partnered with customers and suppliers. It maintains two main channels for meeting customer demand. A majority of the parts are maintained in inventory at its own distribution centers and supplied to customers from these centers on demand. Another channel is based on vendor managed inventories with the vendor shipping the products directly to customers based on the vendors on the orders communicated to them through the organization. The SCOR (Supply Chain Operations Reference) model, developed by the Supply Chain Council, measures total supply chain performance. It is a process reference model for supply-chain management, spanning from the supplier's supplier to the customer's customer. It includes delivery and order fulfillment performance, production flexibility, warranty and returns processing costs, inventory and asset turns, and other factors in evaluating the overall effective performance of a supply chain.

![Figure 1. Structure of a typical of a supply chain](image)

2. Literature Review

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 supply chain should be modeled. In any simulation study, the level of detail modeled depends on the purpose of the effort. With the focus on the supply chain performance, the level of detail for the manufacturing stages varies among different efforts. Chan, Chung and Wadhwa (2005). Christopher (1992) states that a suitable definition of supply chain is a network of organizations that are involved through upstream and downstream linkages in different process and activities that produce value in the form of products. Davis (2000) [1] points out that even with availability of high resolution model; the need for abstraction still exists due to the curse of dimensionality. The level of detail of the model has to be carefully defined based on the objectives of the effort. 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 by Hennessee 1998 [2]. Schunk and Plott, 2000 [3], identified simulation as one of the best means to analyze supply chains. Heita(1998) models manufacturing stages as having constant capacity and a fixed throughput time in supply chain simulation. Umeda and Jones(1998)
model manufacturing facilities in detail down to cell level with associated control logic simulations in a test bed system for supply chain management. Multiple manufacturing cells, buffers and material handling operations are modeled. A tightly integrated supply chain studied by Frohlich (2002) leads to superior performance and improved competitiveness for each firm in the supply chain and many innovative firms have adopted SCM and its integrating mechanisms as top strategic priority. Jain et al (1999) highlight the criticality of modeling the detail in semiconductor supply chain simulation for planning. A number of commercial supply chain simulation tools have become available in recent years (For examples Barnett and Miller, 2000 and Phelps, Parsons and Spirelle, 2000 [4]. The abstraction method is usually based on the modeler’s heuristics and experience. In some cases, a sensitivity analysis is used to determine the key parameters for inclusion in a meta model. McGraw and McDonald (2000) present algorithms for identifying insignificant component input variables in engineering and engagement level simulations. The process of selection of factors to be modeled and the level of detail for each of them to be modeled is the abstraction process. The goal of the abstraction process is to capture the essence of the behavior of the real life system. Correct execution of the abstraction process enables generation of directionality correct results with the right level of effort.

3. Need for Simulation

The bullwhip effect on the supply chain occurs when changes in consumer demand causes the companies in a supply chain to order more goods to meet the new demand. The bullwhip effect usually flows up the supply chain, starting with the retailer, wholesaler, distributor, manufacturer and then the raw materials supplier. This effect can be observed through most supply chains across several industries; it occurs because the demand for goods is based on demand forecasts from companies, rather than actual consumer demand. The Bullwhip effect results in a poor plan for the supply chain network. This results in excessive inventory, poor product forecasts, unbalanced capacities, uncertain production plans, severe and high backlogs costs, poor customer service and lost sales [5]. Supply chain management solutions provide lots of benefits to industries but it is too costly to use those solutions for academic research. The simulation permits the evaluation of operating performance prior to the implementation of a plan. It permits the comparison of various operational alternatives without interrupting the real system, permits time compression and to perform powerful what-if analysis for better planning decisions. Instead of real time decision making tools which are directly linked to control system, the simulation tools are designed as interactive tools. Simulation tools aid human planner to make a right decision by providing information provided human interpretation is included to modify the plan in order to achieve better supply chain performance. The supply chain simulation helps to understand the overall supply chain processes and characteristics, uses probability distribution it can model the unexpected events in certain areas and their impacts on the supply chain plan and minimizes the risk of changes in planning process. Also, with the help of what-if simulation various alternatives can be tested.

4. Modeling of Supply Chain

Decisions taken in supply chain networks are classified as strategic, tactical and operational. Strategic decisions are related to the company’s long term strategy (2-5 years) with the involvement of the most partners in the supply chain. Tactical decisions are midterm decisions and operational decisions are short term decisions related to the day-to-day activities of the organization [6]. Of these three decisions the tactical and operational decisions are taken in the plant and warehouse areas of the supply chain network.
Issues in demand, procurement, production, warehouse and distribution were analyzed. The following procedural steps were suggested for SCM simulation study [4].

1. Understanding the supply chain processes and planning processes
2. Design aspects of the SCM network
3. Data collection
4. Performance measures
5. Identifying optimal target and its definition
6. Supply chain policy or strategy evaluation

The simple supply chain model and example data requirements for the supply chain modeling is shown in figure 2 and table 2.

Figure 2. Supply chain model

Table 1. Example data requirements for a supply chain

<table>
<thead>
<tr>
<th>S.No</th>
<th>Data Requirements</th>
<th>Supply chain areas for information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Data of manufacturing process like process time, queue time, setup time, number of machines in each process and alternate route</td>
<td>Manufacturing process</td>
</tr>
<tr>
<td>2.</td>
<td>Shift information, holiday information, preventive maintenance information</td>
<td>Calendar data</td>
</tr>
<tr>
<td>3.</td>
<td>Number of machine, mean time to failure, mean time to repair, alternate resources data, preventive maintenance time and Bill of material structure</td>
<td>Machine data</td>
</tr>
<tr>
<td>4.</td>
<td>Supplier lead time, lot size, supplier capacity, procurement horizon and procurement time</td>
<td>Procurement and Logistics</td>
</tr>
<tr>
<td>5.</td>
<td>Reorder point, safety stock level, Inventory level of finished products, raw material and intermediate parts and any stock location in shop floor</td>
<td>Inventory control policy</td>
</tr>
<tr>
<td>6.</td>
<td>Due date, start and end data, demand pattern and priority</td>
<td>Demand</td>
</tr>
<tr>
<td>7.</td>
<td>Dispatch and order control policies</td>
<td>Policies/Strategies</td>
</tr>
</tbody>
</table>
By using simulation the following areas can be analyzed [7]

1. Which supplier policy is robust under demand fluctuations and achieving the best delivery performance under given demand pattern.
2. Which is the most Cost saving inventory policy for a given demand.
3. Improving profit by adding more capacity.

Many researchers are investigating the possibility of creating a simulation based real time scheduling system that will be able to monitor the system status and make decisions in real time [8]. To have the capability, it is desirable to have capability to interface with legacy databases to obtain information, hardware and software processing capability to run simulation within very short time and capability to interface with the control system to assign tasks and receive feedback on system status and performance.

5. Functionalities of Supply Chain Management

Table 2. Functions of supply chain management

<table>
<thead>
<tr>
<th>S.No</th>
<th>Functions</th>
<th>Supply chain areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>It is to reduce forecast error, to suggest buffers considering demand variability and to improve accuracy of forecasting</td>
<td>Demand Planning</td>
</tr>
<tr>
<td>2</td>
<td>To provide multi-site planning. It is based on material, capacity, transportation and other constraints.</td>
<td>Master Planning</td>
</tr>
<tr>
<td>3</td>
<td>To model vendor capacities, costs and lead times resulting in superior plans.</td>
<td>Procurement</td>
</tr>
<tr>
<td>4</td>
<td>To generate dynamic transportation requirement and optimizing transportation plan.</td>
<td>Transportation</td>
</tr>
<tr>
<td>5</td>
<td>To provide a plan considering material, capacity and other constraints which impact on manufacturing.</td>
<td>Manufacturing</td>
</tr>
</tbody>
</table>

6. Benefits Of Supply Chain Management

Expected benefits of supply chain management are as follows.

- Cycle time reduction
- Inventory cost reduction
- Optimized transportation
- Order fill rate increase
- Customer responsiveness increase
- Predict propagation of disturbance to downstream
- Real time visibility across the supply chain routings
7. Conclusions

The objective of the supply chain management is to meet the customer demand for delivery of high quality and low cost with minimal lead time. To achieve this objective, organizations need to have a better visibility into the entire supply chain of their own plans as well as those of their suppliers and customers. Companies today should be agile enough to adjust and rebuild plans in real time to take care of unexpected events in the supply chain. These needs have propelled the application of discrete event simulation for analyzing entire supply chain process. In this paper, we reviewed the benefits, functionalities and data requirements of the supply chain which needed to prepare for the modeling of supply chain simulation. Efficient supply chain management can be achieved through careful consideration of capacity and material information. Companies today reduce the inefficiencies in their processes and to redesign their processes in order to achieve world class business performances. Some of the inefficiencies can be found from the industry, some of them are caused by their suppliers and some of them are caused by both suppliers and industry. Simulation can help companies become more aware of their supply chain dynamics and efficiency. When developing simulation models of a supply chain first of all a good understanding of the overall supply chain is most important. Good understanding of performance measures, make to stock or make to order is also essential since every industry has different business characteristics and supply chain management processes. It is better to focus on the problem area based on the specific scenario. Setting proper performance measures is another important task.

8. Reference


