# A System Dynamics Model to Analyze Behavior of Manufacturing in Supply Chain

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## Abstract

This research offers. The system dynamics study of supply chain processes in the manufacturing industry. The production is made-up of make to order from the building stock and flow with the fourth cycle and parameters define to test the behavior by using Vensim program to simulation situation by the time 50 weeks showed that the response to increases in the order of 20% in the production process made the amplification behavior. The process resulted in levels of inventory bog down. The reduction of inventory conflicts with the desire to keep the inventory caused by delays of customer change. The organizational behavior is not balance, the products backlog and made the level of order fulfillment ratio lower than 100%

**Keywords:** System Dynamics, Supply Chain, Inventory

## 1. Introduction

Supply chain is an organization or company-owned or processes to operate as an integrated together. In a manner linked from upstream to downstream that cause the flow of value to respond the needs of customers and competitiveness, causing profits. In the operation of the supply chain, the efficiently is very important. Therefore, to manage the complex supply chains that is more complex every day. That needs to understand the behavior of the supply chain in the holistic view of all elements that how to affect to each other. The methodologies research by using system dynamics as a model to study the behavior of production processes in supply chains by production make to arising from stock and flow building with the following cycle four cycles

The objective of this paper is to study the behavior of the process of manufacturing in supply chain, how it happened, using a system dynamics model for the study.

## 2. Related research

From case paper study in the past, the problem of supply chain in strategic level are involve to the decisions on location, capacity planning, distribution, new product development, delivery of raw materials, suppliers selecting and set price. Tactical level problems are involved to inventory control, cooperation and coordination distribution, transfer material and the operation level problems will cover on transport schedule, work schedules, record, and package [1,2]. The application of supply chain strategy can make all levels of inventory low without customer service decline; as if the lead time decrease, the customer service can increase by maintaining the level of inventory is not as high as possible [3]. The problem of supply chain in the process of organization is related to production rates and rate of the last customer demand in appropriate to increase the ability of response to customer service. The key of inventory management and production control is a decision to order fulfillment that is assigned on inventory based and production schedules with forecast demand [4]. The fundamental of supply chain need to operations in the optimization position. Therefore, strategy will play an important role when there is an uncertainty demand that will make the response of the supply chain lowered [5]. The variance in demand. The bullwhip effect is the most normally dynamic in supply chain that is often happened, if the demand or the demand more than the products in the source of the supply chain, the little change will result in the Company's demand is on the destination. Stir up on and on [6].

This paper studies focuses on the behavior of supply chain, which has changed over the time using a system dynamic to study. Forrester began the system dynamic used by building the model and simulation for analyze and decision in dynamic industrial and problem management, which later applied to a variety of policies and strategic problem [7]. Minegish, D. [8] has developed a system dynamic for food supply chain and described the complex behavior of Logistic flow and use Generic Model to simulation

situation the type of difference between the variable order of the client, Georgiadis P.[9] use system dynamic as a means of analysis for Multi - Echelon in the supply chain of food and Holistic Model to simulation the situation to specific an efficient policies and Optimal Parameters is a strategies used for problem decisions.

## 3. Regulation

The methodologies research by using system dynamics as a model to study the behavior of production processes in supply chains by production make to arising from stock and flow building with the following cycle four cycles

Loop B1 WIP Control, production start rate from desired production and adjustment for WIP being done production rate and the product. This increase is associated with manufacturing cycle time.

Loop B2 Inventory Control, started at desired production start rate that loop B1 and B2 are together relationship that came from expected order rate.

Loop B3 Stockout, related to shipment rate start at desired shipment rate and order fulfillment ratio.

Loop B4 Order Fulfillment, relate to order fulfillment rate from the desired shipment rate mean backlog to the target delivery delay.

**Table 1 Parameter for the production of food**

| Parameter | Week |
|---|---|
| Minimum Order Processing Time | 2 |
| Safety Stock Coverage | 2 |
| Manufacturing Cycle Time | 8 |
| Inventory Adjustment Time | 8 |
| WIP Adjustment Time | 2 |
| Time to Average Order Rate | 8 |
| Target Delivery Delay | 2 |

Rate Equation (Stock) [4]

Stock=INTEGRAL(Inflow-Outflow, $Stock_{to}$) (1)

Tocreate the equation Stock 4 equations

Work in Process Inventory = INTEGRAL (Production Start Rate – Production Rate, $WIP_{to}$) (2)

Inventory=INTEGRAL (Production Rate – Shipment Rate, $Inventory_{to}$) (3)

Expected Order Rate=INTEGRAL (Change in Exp Order, Expected Order $Rate_{to}$) (4)

Backlog = INTEGRAL (Order Rate – Order Fulfillment Rate $Backlog_{to}$) (5)

## 4. Overall result

The implementation model of parameters test as shown in Table 1 to be defined in the production process. Using Vensim Program to simulation situation and analyze behavior of the production process in supply chain as shown in Figure 1 production models of the Stock and Flow then behavior analysis from the following chart.

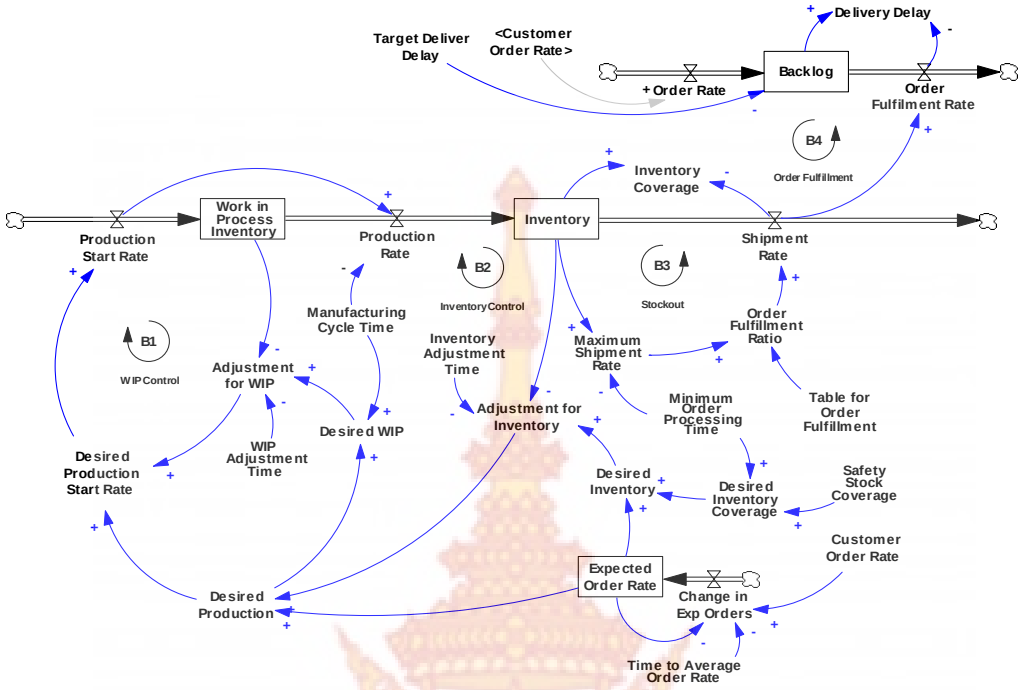


Fig. 1 Production models of the Stock and Flow

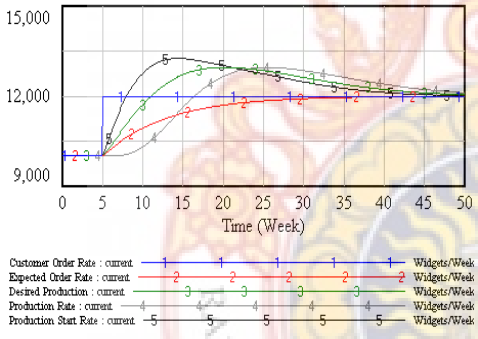


Fig. 2 Production process behavioral

The behavior analyze of production mold begin from the response of an increase in orders by 20% and the order rate was 10,000 items per week from Figure 2 graphs showed that the behavior of production process of response rate to production start rate will be peak in the starting weeks fifths and then high up then decreased until 45th week and parallel to the horizontal axis of time. This is called amplification rate by 2.12 because the changing delays of customer order.

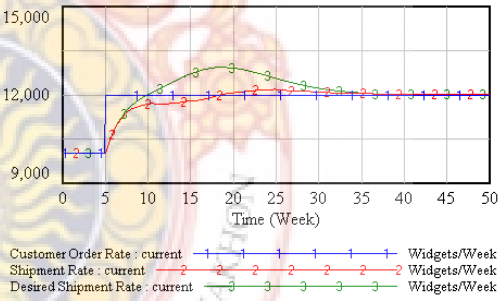


Fig. 3 Transportation Behavior

The behavior of desired shipment rate from figure 3 graphs the rate is more than shipment rate that the lost order will occur in the fifth week onwards, it was lower than the rate of customer orders and will raise up until the time axis parallel of the orders rate in the 35th week onwards.

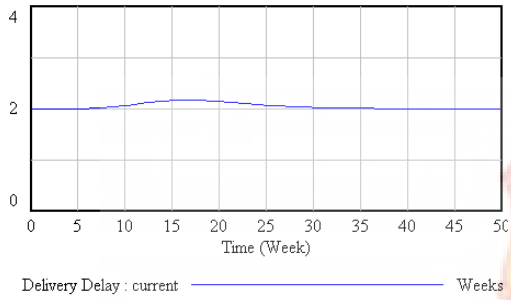


Fig. 4 Behavioral delivery delays

Behavioral delivery delay from chart Figure 4 is related to the product backlog as a result of the difference between order and delivery in the target delivery delay. We define rate in two weeks found that the increasing order of 20%, resulting increase service delays

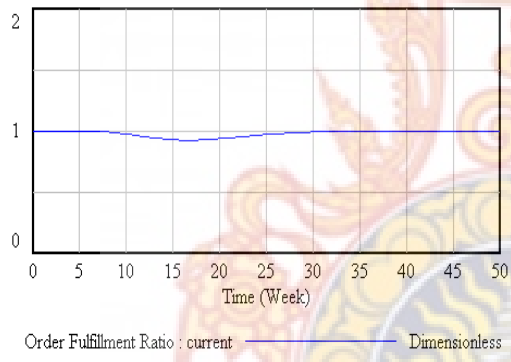


Fig. 5 Order fulfillment ratios behavioral

From the order fulfillment ratios behavioral in graph figure 5 was not balance. When the product backlogs, then the level of order fulfillment ratio lower than 100%

## 5. Summary

This paper studies the researcher presents the system dynamic to study the behavior of production processes in supply chains. The production is made-up of make to order from the building stock and flow with the fourth cycle and parameters define to test the behavior by using Vensim program to simulation situation by the time 50 weeks showed that the response to increases in the order of 20% in the production process made the amplification behavior. The process resulted in levels of inventory bog down. The reduction of inventory conflicts with the desire to keep the inventory caused by delays of customer change. The organizational behavior is not balance, the products backlog and made the level of order fulfillment ratio lower than 100%

Research continues to develop in the future. It should be analyzed to try to develop scenarios to get answers of long-term operation in the supply chain, overall costs and profits.

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