Modeling Lean Supply Chain Using Simulation

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Abstract. Due to variability on the time and in the quantity of demand, as well as the variability in the supply side, manufacturing firms are reluctant in adopting pull system or just in time. The study aims to model and evaluate the lean supply chain of a job shop. It uses simulation modelling to understand the managerial practices, technology used and decision process in implementing pull system. The study designs two approaches in lean, which are the Just in Time approach and Kanban approach. The performance measures investigated in the study are Average Time in System, Production Throughput, Work in Process and bottlenecks and based on the results of the simulation model, Just in Time approach is best for companies with few processes. While kanban approach is best for companies with several to many processes.

Keywords: Lean Supply Chain, Simulation Modeling, Pull System, Just in Time, Kanban

1. INTRODUCTION

Taiichi Ohno, founder of Toyota Automobile Company in Japan, developed Lean Philosophy. Toyota was able to beat Ford Company in 1990s. In that case, most of the companies around the world were interested to find out the strategy of Toyota Company. Taiichi Ohno shared their strategy to all who came into their factory. That was the start of the tem “lean”. Lean Philosophy is a continuous process of striving for perfection and it leads an organization to a world-class operational excellence (Papadopoulou & Ozbayrak, 2005). Managing lean means “doing more with less” (Rymaszewska. 2014) which focuses on waste identification and organizing operations around value stream (Liker 2004). Many studies and journals indicated the effectiveness of lean strategy; however, it is widely implemented in large and medium enterprises. Small enterprises have been ignored for a long time and special investigation about this topic are rarely (Matt, D., Rauch, E. 2013). It is for this reason that the study conducted a simulation modeling for a small enterprise business using pull system as tools in implementing lean enterprise.

2. METHODOLOGY

2.1 Modeling Lean Supply Chain

The strategy to implement lean supply chain is to apply pull system in the production process. A pull system is a system wherein a workstation will produce parts only on downstream demand. In a typical job shop, where it manufactures metal parts 2 jobs are being processed in a cellular production layout. It consists of multi-functional machines. One machine for forming and the other automatic machine is for cutting. Job 1 must be process first on the forming machine and then cutting machine. Job 2 must be process only on the cutting machine. All jobs are being process on a first in first out basis.
Supplier x is the vendor for the case study company and produces all their raw materials for them. Forging are produced every day in 5 batches. The study designs a lean enterprise for the job shop company. In order to simulate the production process of the case study company. Six locations were identified: Forming machine, Cutting Machine, Forging, Order Q, Forming Machine Q, and Cutting Machine Q. Four entities; Product 1, Product 2, Orders 1 and Orders 2 are defined. Performances of the proposed lean enterprise were measured
Table 1 shows the overview of simulation model. Figure 1 is the details of the location syntax and entities syntax entered in the promodel software. The study designs a lean production enterprise for a typical job shop. It uses two types of lean approach, Just in Time(JIT) approach and Kanban Approach in terms of its production throughput, bottleneck operations, and work in process and average time in system.

The simulation is for 240 hours, which is the company’s total available hours per month with one replication. Table 1 shows the overview of the simulation model which presents the entities, arrivals , locations and processing activities of the supply chain of a job shop.

Table 1- Overview of Simulation Model

Entities	Gear 1 , Gear 2 , Product 1 , Product 2 , Kanban
Arrivals	Gear 1 , Gear 2 , Product 1 , Product 2 , Kanban
Locations	Forming machine, Cutting Machine, Forging, Order Q, Forming Machine Q, Cutting Machine Q.
Performance measures	System Throughput (Ave. Time in System), bottle-neck operation, Work In Process, Average Time in System

Figure 1 is the details of the location syntax and entities syntax entered in the promodel software. The study designs a lean production enterprise for a typical job shop. It uses two types of lean approach, Just in Time(JIT) approach and Kanban Approach. Figure 2 shows the graphic layout for JIT where the actual customers demand triggers the production of the products with no inventories to be carried out in the production. The study would compare just in time approach and kanban approach in implementing pull system. The Just in Time approach is a pull system where there is no inventory in the finished products produced. While, the Kanban approach is a pull system where there is a minimum units of inventories in the finished products produced.

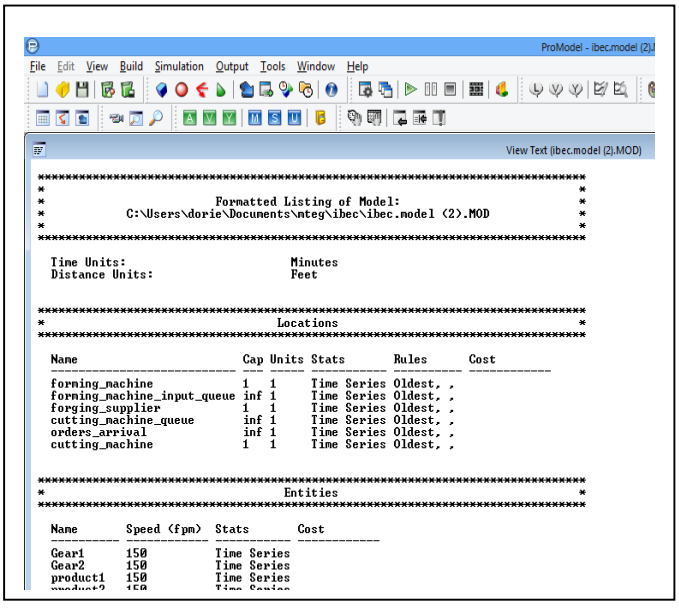

Figure 1 – Locations and Entities

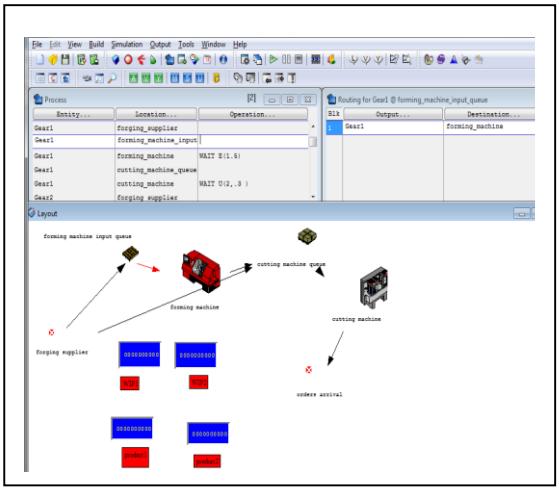

Figure2 Graphic Layout of Pull System

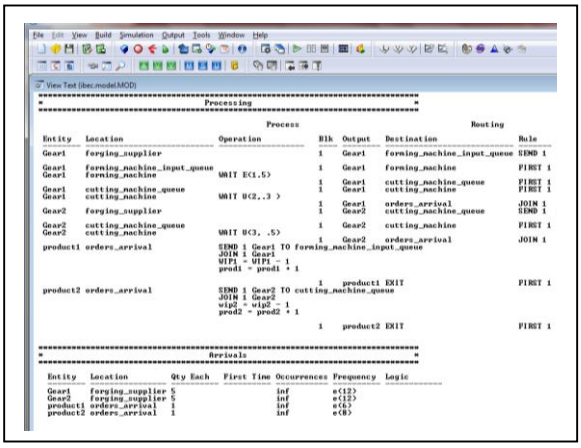

Figure 3 – Proceesing and Arrivals of Pull System (Just in Time Approach)

Figure 3 shows the process flow of the production of product 1 and product 2 using pull system in supply chain.

3. RESULTS AND DISCUSSION

Table 2 shows that the system throughput or average time in system for product 1 is 0.85 hours and product 2 is 0.46 hours using Just in Time implementation. With Kanban approach , the throughput or the average time in system for product 1 is 0.88 hours and product 2 is 0.47 hours. The throughput as measured by the average time in system is from the time the orders arrived in the job shop company up to the delivery to customers. This throughput includes the following activities : order arrival to the job shop company, job shop company order raw materials to suppliers, supplier's arrival of materials, production process and delivery of finished products to clients.

Table 2 – Simulation Results

Pull System	Throughput (hrs)	Total Exits (Unit)	Work In Process	Bottleneck
(Just In Time)				
Product 1	0.85	2,404	2.77	Order arrivals
Product 2	0.46	1,775	1.59	11.99
(Kanban)				
Product 1	0.88	2,390	2.67	Order
Product 2	0.47	1,772	1.41	arrivals 12.31

The monthly production units as measured by the total exits or total production units for product 2,404 units and for product 2 is 1,775 units with Just In Time implementation. On the other hand, with Kanban implementation production units measured on the total exits or total production units for product 1 is 2,390 units and for product 2 is 1,772 units.

In a month the average work in process in JIT approach for product 1 is 2.77 units and for product 2 is 1.59 units, while in Kanban approach, product 1 has 2.67 units and for product 2 has 1.41 units. The bottleneck in the system with JIT implementation is the orders arrival with 11.99 orders waiting to be processed, while with Kanban implementation the bottleneck is also in orders arrival with 12.31 orders waiting to be processed.

4. CONCLUSIONS

The study models a job shop company into becoming lean supply chain where pull system approach is used. Lean enterprise is considered as an advance strategy to improve the efficiency of the company. The scope of the model is from the supplier's production up to the customer's (client) job shop production; hence, lean enterprise was used as a term in the study because it includes the supplier's production activities. The simulation model provides information on how pull system works in production. Pull system is one of the several tools to implement lean enterprise and the study designs two approaches in lean, which are the Just in Time approach and Kanban approach.

The performance measures investigated in the study are supply chain throughput, average monthly yield (production units), work in process and bottlenecks.

Based on the results of the simulation model, there is no significant differences on the performance measures of Just in Time approach and Kanban approach. This means that the set minimum units of finished products inventory of 5 units for product 1 and product 2 is the optimum inventory level since it replicates the performance of Just In Time approach.

Furthermore, Just in Time approach is best for companies with few processes. While kanban approach is best for companies with several to many processes as reflected on the results of simulation model.

The applications of my study is for the job shop company to implement lean enterprise where they could apply pull system into their production plan and coordinate with their suppliers in order that the material will arrived Just In Time, not too early, not too late. This will benefit their company as seen in the study with regards to the performance measures of the pull system approaches.

Future work to look at is to include the logistics and distributions of the finished product into the transformation of the company to a lean enterprise.

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