SCM 환경에서의 실용적 모듈 생산 시스템분석의 시뮬레이션 연구

- A Simulation Study on Efficient Modular Production System Analysis in Supply Chain Management -

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Abstract

By successful establishment of Supply Chain Management System they should make the supply chains speedy and combine production information system with the outcome system and thus they reinforce the competition of the production system of local enterprises in accordance with the rapid decision making. Supply chain coordination improves if all supplier of chain take actions that together increase total supply chain profits. To design of Modularity by the grouping supplier, the proposed method is to develop the most appropriate production system models through the reflection of JIT system in the Supply Chain Management which is necessity of the times and its importance. The objects of this study is to develop the most appropriate production system Model and optimal profit model in the process line and to provide the enterprises with the models which are based on the Supply Chain Management.

Keyword : Modular Production System, Supply Chain Management, Just In Time

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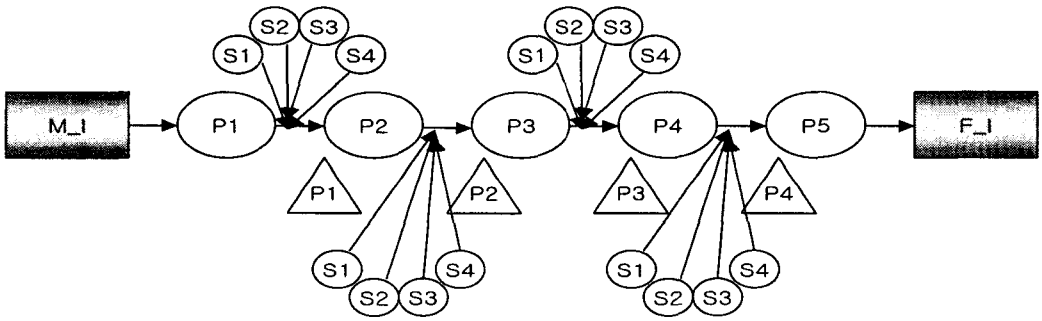
1. Introduction

A supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes the manufacturer and suppliers, but also transporters, warehouses, retailers, and customers themselves. Furthermore, with growing focus on supply chain management, firm realize that inventories across the entire supply chain can be more efficiently managed through greater cooperation and better coordination. Accordingly, this paper proposes a model to study and analyze the benefit of modular production system model related JIT (Just-In-Time) which are based on the SCM. The SCM impacts to industry are as follows ; (1) The advance of Logistics like express business make efficiency up, because of widely used to internet. (2) The automobile industry separate to component industry, make best strong supply chain by concentrate to competency and systemize to virtual organization like one company with SCM system. (3) ERP to SCM, it is very speedy change to SCP(Supply Chain Planning). The modularity make change total production system, it is expected to direct cost and indirect cost both large amount of cost down using change of the modularity. The advantages of modularity with include : (1) less number of process using Modularity (2) less inventory carrying cost since less inventory (3) less Equipment and maintenance cost (4) less cost of technical development (5) less line in the Production line (6) less fixed cost since less Main line (7) improvement on operation efficiency (8) Simplification of SCM. First, this study is development of optimal production system model by application of JIT system in SCM. The development of optimal production system model in SCM is considered to various constraint like parts supply system, production rate of production system, scheduling, inventory, and solve to optimal production system model. The production system of production planning, scheduling system and inventory system, and the supply chain to sales, logistic, production planning make one system, then it is find to best compatible production system model at total system. Secondly, the study of development of optimal production system model using the applied to module production system related JIT in SCM. And this study is focused to strategic variable of the inventory and production lead time of production system, specially at manufacturing cooperation. By this method, largely reduce to production lead time, and apply to multi cycle production system by production smoothing.

2. Optimal Production System Model related JIT in SCM

The role at each field must be reenforced for improvement of over all Supply chain, and the reason of inefficient time loss existing in the production system must be eliminated and also the role of realizing the improvement of revenue as well as the efficiency at the parts of design and production must be completed. To accomplish the above object, JIT(Just-In-Time) production done at the SCM corresponds with minimum inventory, they must establish the plan with reviewing the possibility of production scheduling with the SCP(Supply Chain Planning) in the form of simulation.



< Figure 1 > Inventory model of production system model in SCM

2.1 Assumption

Raw material inventory and finished good inventory still remain as the average inventory in the production system while some quantities of WIP are maintained.

2.2 formulation

Amount of total inventory

= (1/CT) (Raw material inventory + Supplier inventory + Finished good inventory) + Work in Process

$$IQ = \frac{1}{CT}\left(\frac{M\_I}{2} + \sum_{i=1}^{n}\frac{S_i}{2} + \frac{F\_I}{2}\right) + \sum_{i=1}^{n} P_i I \qquad (1)$$

where

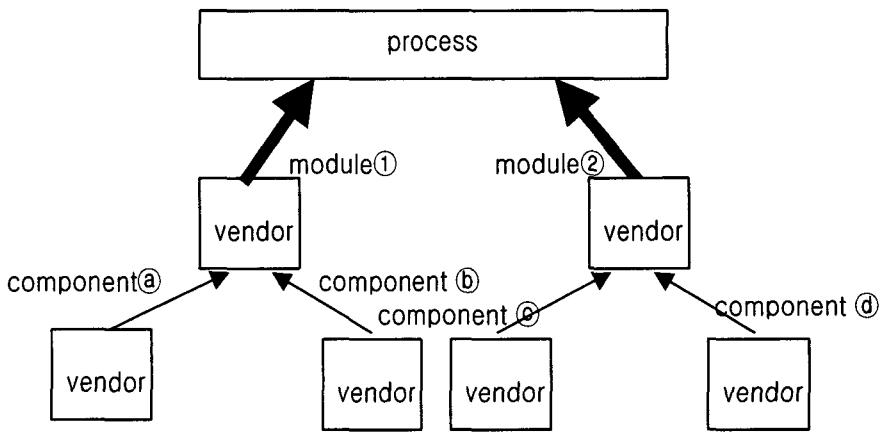
Si : Cooperation Inventory (i=1~n)

(Si)/2: Supplier Average Inventory (i=1~n)
M_I : Raw Material Inventory
F_I : Finished good Inventory
PiI : Work In Process (WIP)
IQ : Total Inventory
CT = Number of Cycle

< Table 1 > Type of Inventory

Type of Inventory		Average inventory	
Raw material inventory M_I		(M_I)/2	
Finished good inventory F_I		(F_I)/2	
WIP (Work In process)	P1~P2	P1I	
	P2~P3	P2I	
	P3~P4	P3I	
	P4~P5	P4I	

Therefore, raw material inventory, supplier inventory, and finished good inventory will be reduced according to the number of cycle. Average inventory of raw material inventory are (M_I)/2, and average inventory finished good inventory are (F_I)/2. Also, to appear that average inventory of supplier are (Si)/2



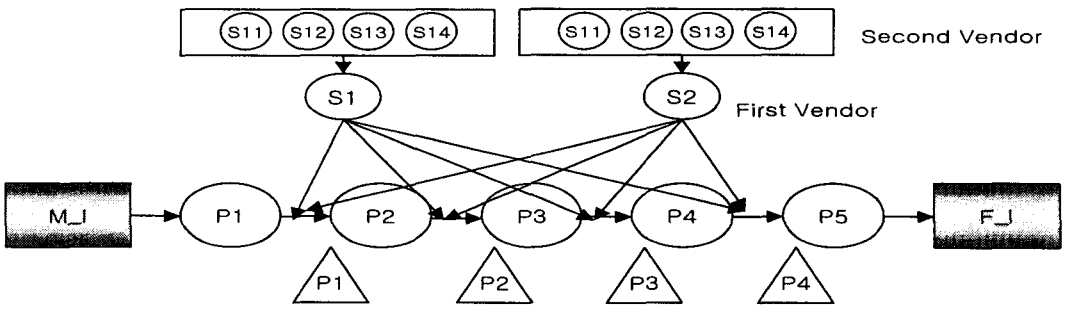
< Figure 2 > Modularity for Cooperation

3. Optimal Modular Production System Model related JIT in SCM

These day, it is focused to modularity production system, it is make group by functions. For example, the case of automobile industry make module by lamp or buffer, radiator, clear components. Introduction of modularity concept in supplier of components to main process at Figure2, then the effects are as follows : (1) less production lead time (2) less main cycle time of main line, (3) less maintenance cost since less cooperation, (4) less production cost, and (5) less inventory. With JIT Production in the SCM accomplished in the production system, they may better correspond to the requirement of market with minimum inventory through the modularity of the suppliers providing the material.

3.1 Assumption

We assume the amount of production is same before accepting Assumption of Optimal Production System Model related JIT in SCM. Therefore, in the formula of (1), the raw material inventory and finished good inventory are not reduced, and only supplier inventory and WIP are reduced as same as the number of first vendor so, Optimal Modular Production System Model related JIT in SCM can be developed.



< Figure 3 > Inventory model of modular production System in SCM

3.2 formulation

Amount of total inventory

= (1/CT) [Raw material inventory + (m/Sx)Supplier inventory + Finished good inventory] + (m/Sx)Work in Process

$$IQ = \frac{1}{CT}\left(\frac{M\_I}{2} + \frac{m}{Sx}\sum_{i=1}^{n}\frac{S_i}{2} + \frac{F\_I}{2}\right) + \frac{m}{Sx}\sum_{i=1}^{n} P_i I \qquad (2)$$

where

m: number of module

Sx: number of supplier

Therefore, raw material inventory, supplier inventory, and finished good inventory will be reduced according to the number of cycle, supplier inventory and WIP will be reduced according to the number of first vendor. . Average inventory of raw material inventory are (M_I)/2, and average inventory finished good inventory are (F_I)/2. Also, to appear that average inventory of supplier are (Si)/2

4. Simulation Study on Modular SCM Inventory Model related JIT

The operation of the modular production system related JIT as described a above is simulated using the ARENA software. In all simulation experiments carried out, supply at the start of the line was assumed always available while the demand intervals for finished products from the output of the line were fixed according to the average production cycle time. One of the most important aspects of simulation modeling is choice of appropriate distributions to describe operating time at process and the operation times at process. The operation times at process are generated randomly using the appropriate distribution. Burgin(1975) indicates that operating time distributions should have the following characteristic :

(1) They exist only for non-negative values
(2) As the operating time variability decreases, the form of the distribution changes from monotonic decreasing to unimodal distributions heavily skewed to the right and finally to normal type distribution truncated at zero.

Truncated normal, gamma and the Erlang distribution, which is a special case of gamma, meet the criteria outlined. And then, in this study, we prefer to use gamma, Erlang, normal and Exponential distributions, which have the follow forms, to describe the operation times at processes.

$$\text{Gamma} : f(x) = \frac{\beta^{-\alpha} x^{\alpha-1} e^{-\frac{x}{\beta}}}{\Gamma(\alpha)}, \quad x > 0 \qquad (3)$$

$$\text{Erlang} : f(x) = \frac{\beta^{-k} x^{k-1} e^{-\frac{x}{\beta}}}{(k-1)!}, \quad x > 0 \qquad (4)$$

$$\text{Normal} : f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}, \quad -\infty < x < \infty \qquad (5)$$

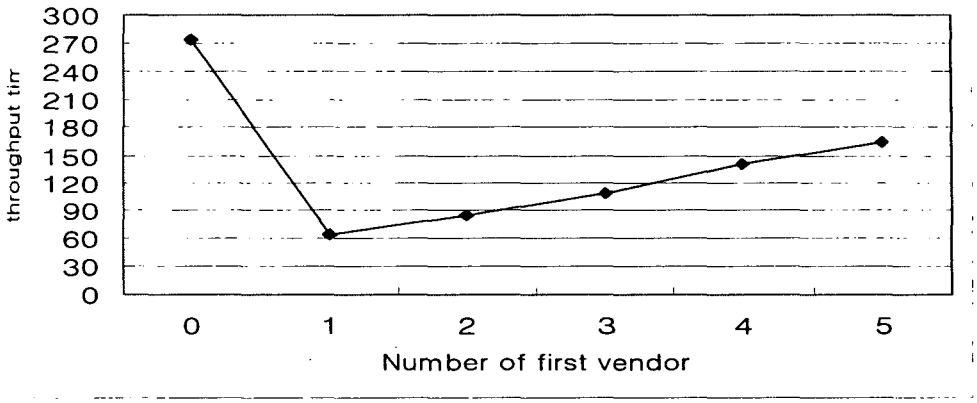
$$\text{Exponential} : f(x) = \frac{1}{\beta} e^{-\frac{x}{\beta}}, \quad x > 0 \qquad (6)$$

In each simulation experiment carried out the follow two performance measure were calculated and evaluated :

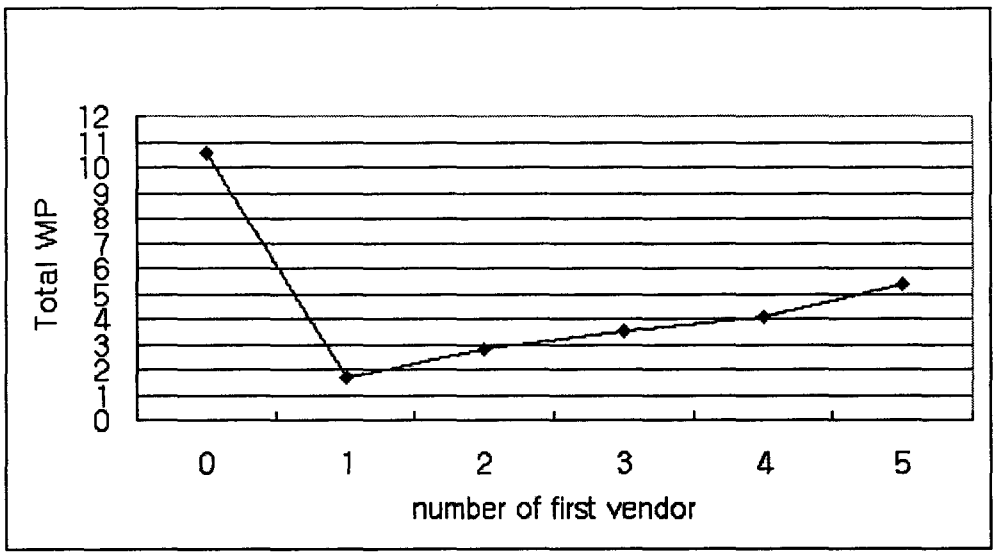
(1) Throughput Time
Which is defined as the number of units produced during simulation periods of on process (1,440 minutes)
(2) Total Work In Process (WIP) level
Which is defined for each process as the number of working and waiting.

As mentioned in the second and third chapter, there are two basic production systems : production system model related JIT and modular production system model related JIT. Both systems pertain to movement of the material from suppliers to process. And then we have to simulation modeling and explain to make first vendor for suppliers. System parameters assumed in the simulated line were as follows :
(1) The production line consisted of 10 processes.
(2) The production line had 20 suppliers and make number of first vendors.
(3) Operating times were distributed with the parameter as described above.

Figure 4 shows comparison of the six systems (production system model related JIT (PSJ), modular production system model related JIT divided to one first vendor(MPSJ1), two first vendors(MPSJ2), three first vendors(MPSJ3), four first vendors(MPSJ4), and five first vendors(MPSJ5)) with respect to the throughput times. As the variability of number of first vendor increases, the throughput time increases except it hadn't first vendor.



< Figure 4 > comparison of the six systems about throughput times



< Figure 5 > comparison of the six systems about total WIP

Figure 5shows comparison of the six systems (PSJ, MPSJ1, MPSJ2, MPSJ3, MPSJ4, MPSJ5) with respect to the total work in process (WIP). As the variability of number of first vendor increases, the total WIP increases except it hadn't first vendor.

As the result, efficiency of MPSJi system better than PSJ system in the throughput time and total WIP level. And better efficiency of minimum number of first vendors than maximum number of first vendors.

6. Summary and Conclusions

In this study, we try to develop the optimal production system model through the study on applying the JIT System to the SCM. At SCM, we acquired the optimal production system mode by considering the rate of production of supply of component and production system, scheduling and numbers of restraint conditions for the development of optimal production system model and then we developed the optimal production system model through the study on application of the JIT System to SCM. And we suggest the way of reducing the production period followed by the effect of reduction of WIP and supplier inventory. And also, in this study, we considerably reduce the production lead time by developing the optimal production system model and applied the production smoothing that is the monthly multi-production system.

But, in this study, we may suggest the following factors to be supplemented and required for accomplishing the optimal module production system. (1) Increases of assembly time and management cost imposed to the first vendor (2) The difficulty in cash flow the new second vendor may have for the accomplished relationships between first vendors (3) Compensation to be made for the increased new roles of the first vendors. Therefore, we must keep studying in this direction.

7. References

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