

Reformation of Production System Based Upon Demand Forecasting

Hirotake Yamashita¹ and Kazuhiro Takeyasu²

Abstract

In recent years, competition among companies became hard under the circumstance of the globalization. Cheap materials are imported from abroad or assembled in abroad using cheap labor. Lead time of manufacturing in Japan tends to be prolonged, which causes the increase of stocks. To cope with this, correct demand forecasting becomes inevitable and reformation of production system is required. In this paper, critical success factors in supply chain management are arranged and concrete grappling with these issues in sanitary materials manufacturer is described. Such trials should be expanded in various fields hereafter.

¹ Chubu University. E-mail: hr-yama@chubu.ac.jp

² Tokoha University. E-mail: takeyasu@fj.tokoha-u.ac.jp

Mathematics Subject Classification: 90B30; 90B50; 90B90

Keywords: forecasting; lead time; stock; sanitary materials; production planning; supply chain management; critical success factor

1 Introduction

Recently, market is now under the condition that suppliers' capacity exceeds demand. Suppliers must meet the market needs of various products with small quantity, short period lead time and/or special specification of products, otherwise they will be defeated. Moreover, competition among companies became hard under the circumstance of the globalization. Cheap materials are imported from abroad or assembled in abroad using cheap labor. Lead time of manufacturing in Japan tends to be prolonged, which causes the increase of stocks. Competition among companies requires streamed integrated system over different business line from customer to suppliers, which faces following problems.

- Specifying number of product is required in manufacturing, but rare is the case in sales planning. Establishing the total sales amount for the group of products often become the aim of salesperson. Deliberate sales forecast is not severely pursued.

- The real number of inventory often does not coincide with the number in the memory of computer. This would happen if worker forget to make input in computer. This is the fatal problem in utilizing computer.

- There are many manufacturing process disturbing requirement from customer in production planning and rapid making and remaking of production planning is often required.

- Coordination among production, sales and distribution department is difficult. As is often the case with coordination among departments, each department has its own way. Sales department want to meet the user needs however difficult it may be. Manufacturing department, on the contrary, prefers big production size, long term lead time to meet the user needs. Though they have to meet the users' demand finally, they must pursue a best way to coordinate among departments.

Reviewing past papers, there are many researches made on this. Goto (2013) [1] analyzed the possibility of management information including production and logistics information. Kase (2012) [2] discussed about the cooperation with the discrete event simulator for Manufacturing-Logistics and other software. Inohara (2012)[3] made an investigation on adaptive management from the view point of Whitehead's philosophy of environment. Izumi and Sawaguchi (2012)[4] developed practical cost reduction method based on TRIZ. Konno (2012)[5] developed the cost model and analyzed in the production planning. There are related papers as above.

We have analyzed the critical success factors of integrated system of production, sales and distribution before (Takeyasu (2005)), [6]. In this paper, we develop further based upon this with the new application to the sanitary materials

manufacturer. It utilizes the newly developed forecasting method by us and thereby it bears the new method that has not appeared so far.

The rest of the paper is organized as follows. In section 2, Critical Success Factors of Integrated System of Production, Sales and Distribution is described. In section 3, means for solution is stated. In section 4, concrete grappling with these issues in sanitary materials manufacturer is described, which is followed by the conclusion of section 5.

2 Critical Success Factors of Integrated System of Production, Sales and Distribution

2.1 CSF in sales department domain-Elaborate sales planning

There are two ways of manufacturing. One is production by forecast and the other is production by order. Here we assume the former case. Needless to say, roughly made production planning may lead to the lack of products or dead stock of products. These cases are often caused by the rough sales planning. Furthermore, sales forecast is rarely done in elaborate manner. Why does this happen?

① There are too many items to forecast for each product sales. There is often the case that they make sales forecast by only calculating the total amount of money for each group of products.

② Salesperson are often evaluated by total sales amount.

③ There is often the case that the number of stock is not correct which give arise difficulty in calculating material quantity to supply.

④ Even if we can get shipment information, it is hard to get all warehouses' and retail shops' stock number.

⑤ Past sales records do not guarantee future sales of similar goods or services.

⑥ It seems to be difficult to master forecasting method. We must upgrade forecasting sensitivity at any rate.

2.2 CSF in production department domain-Rapid making and remaking of production planning

We have to deal with market needs which change rapidly.

How should we do when following state of affairs happen?

---When urgent order is accepted, how does it make ill effect to the other orders?

---When the working members are not full, how can we maximize production quantity and minimize shipment time delay?

---How can we schedule which minimize the time of exchanging production work tools?

etc.

To cope with these, cunning system will be required.

2.3 CSF in departments' combination-Coordination among production, sales and distribution department

Coordination among production, sales and distribution department often arise under the recent market circumstance of flexible manufacturing with short period lead time and/or special specification of products. Coordination among departments must be done smoothly by setting up an appropriate agent. Coordination is required under following conditions.

- Decision support of the choice between production total amount and preferential production of strategic products.
 - Re-arrangement of schedule in the case of sudden breakdown of equipment.
- etc.

3 Means for solution

3.1 Order-made sales forecasting system

We found the following characteristics are in common in many company (especially in Japan).

① Seasonal characteristics

Big deal is done before the end of the year, buddhist summer holidays (there is a soul healing event in the midst of the summer for the dead persons), consecutive holidays in May and it declines greatly on the following days.

②Month-end half compulsory makers’ sales to wholesale

In order to keep monthly sales amount, makers’ salesperson often requests wholesalers of stock-keeping purchase.

③Forecast using the sales data of past two or three months

If sales time series have a seasonal characteristics, the last year’s same month’s sales data are to be watched, but it is not prevailing.

④Several patterns by products characteristics

- newly growing products
- long life stable products
- declining products
- big sales change by claim

There are two methods in sales forecast.

One is the method which use structured model, and the other is the method which doesn’t use it.

The latter is classified as follows (Figure 1).

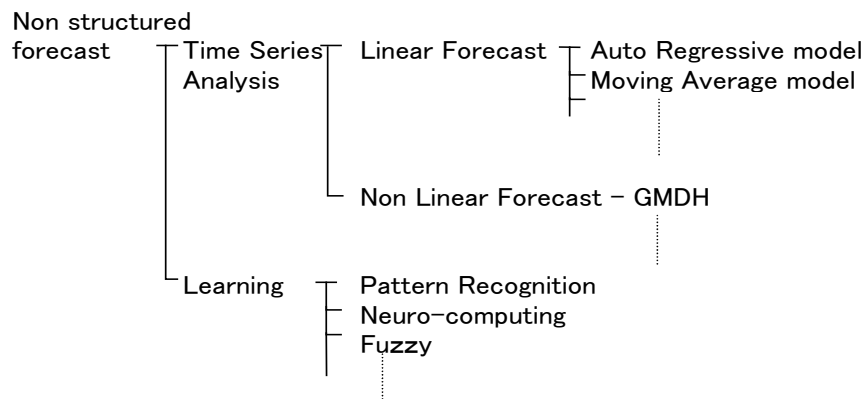


Figure 1: Classification of sales forecast methods

There are many non-structured forecast methods. But simple application of methods does not bear good result. For example, linear forecasting method was successfully used in the past, the present result may not be so good. Because these methods are based on the assumption that the time series is under the stationary stochastic process.

Sales data does not always satisfy this assumption. If we want to upgrade forecasting accuracy, we have to eliminate structural noise stated above, and build order-made sales forecasting method considering characteristics of products and customers of each company.

We devised the best fit model for each company. Those examples are summarized at Table 1.

Table 1: Application of sales forecast

Type of industry	Issues	Improvement	Effect
<ul style="list-style-type: none"> • Sales amount 			
Manufacture of medical products 15 billion yen	<ul style="list-style-type: none"> • Eliminate excessive stock • Defend lack of products • Increase sales 	<ul style="list-style-type: none"> • Regression analysis using moving average sales of quarter year with the effect of decreasing monthly fluctuations. 	<ul style="list-style-type: none"> • Forecast error decreased to within $\pm 20\%$ • Elimination of excessive stock • Less lack of products

	<p>productivity</p> <ul style="list-style-type: none"> • Reduce distribution cost 	<ul style="list-style-type: none"> • Make quarterly forecast by multiplying quarterly index • Make monthly forecast using the average of past each month's share within the quarter 	
<p>Manufacture of plastic food vessel 70 billion yen</p>	<ul style="list-style-type: none"> • Eliminate excessive stock • Defend lack of products • Reduce distribution cost 	<ul style="list-style-type: none"> • Method is nearly same with above 	<ul style="list-style-type: none"> • Make forecast for every sales office concerning main A rank products • Forecast error decreased to within±20% • Elimination of excessive stock • Less lack of products
<p>Restaurant chain 22 billion yen</p>	<ul style="list-style-type: none"> • Support the order making from each shop to center • Analyze sales trend 	<ul style="list-style-type: none"> • Use week day index and monthly index to count consumption quantity at each shop • Build analyzing method of shop POS data in the model 	<ul style="list-style-type: none"> • 30% of shop's stock was proved to be possibly reduced by simulation • POS system be reconstructed

3.2 Production planning system and production planning simulator

Production planning system is a computer-based system for production planning which include assigning plan of each manufacturing lot to equipment, outsourcing plan, man-machine assignment plan, maintenance plan etc. Production planning simulator determines detail production schedule, and outputs summary or analytic reports. Production planning simulator is used as decision support system.

If we build the model simulating the real manufacturing process and trace the effect caused by the input of urgent order, we can see the influence of the event. This means to build production planning simulator (Table 2).

Table 2: Aims of production planning simulator

- | |
|--|
| <ul style="list-style-type: none">① Decrease of the delay of the delivery time② Decrease the quantity of work in process③ Appropriate workers' assignment④ Decrease the time of exchanging production work tools⑤ Save energy⑥ Rapid rearrangement in case of disturbing events |
|--|

Generally, operational restriction at the factory is so complicated that it is hard to find best theoretical solution. Therefore production planning simulators

using heuristic logic are often constructed. Recently, constructing the one using AI is also becoming popular. As it is a simulator, user can examine the results of the many varied conditions.

A. The way to use production planning simulator.

The example of production planning simulator the author developed before is exhibited in Figure 2.

This makes monthly plan by scheduling each manufacturing lot at seamless pipe manufacturing plant of a steel company. If delay of the delivery would arise or many exchange of production work tools would be caused, simulation would be done again by (for example) changing operational condition. If good result is obtained, the plan is executed. When urgent order comes, simulation is done. Judging from the influence it makes, manager decide whether they accept it or not.

B. Example 1

a. In company X which has chemical batch plant, many business works has long been computerized. This company had following difficulties. Production lead time is long and that caused huge stock. Much energy is needed to make production planning and the change of plan was also difficult. Company X decided to build production planning system along with production management system.

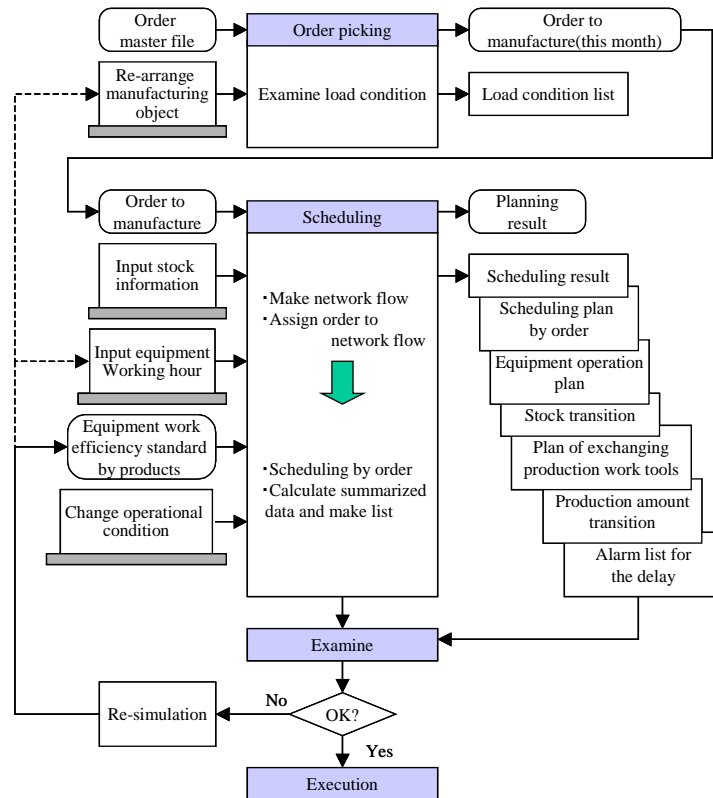


Figure 2: Example of production planning simulator

b. The aim of developing production planning system is as follows.

- Decrease stock to $\frac{2}{3}$ of the present
- Shorten production lead time to $\frac{1}{2}$ of the present
- Decrease manpower of production planning to $\frac{1}{2}$ of the present
- Rapid re-arrangement when change of the production plan necessary
- Rapid answer to the inquiry for delivery

c. How to build logic was difficult

The production planning process was so complicated. A product is assembled from a set of components that are again composed of parts and materials. A component may be used to make a variety of products. The nest structure of product-component-parts is handled by the computerized Material Resource Planning (MRP) system. However, how many parts and components are produced in each month is not uniquely determined. That is, the production quantity of parts and components for the specified production of a product has inevitably same flexibility. Theoretically, this problem is deemed to be the case of two patterns (pattern with procedure relation and the one without it) in n job m machine parallel shop problem.

For this problem, a method for obtaining approximate solution with strict constraints attached is proposed, but this method could not be applied to the problem. Therefore we have developed heuristic logic. For the convenience of maintenance, we developed system such that the logic is controlled by parameter. For example, conditions for priority are set in table.

C. Example2

Company Y constructed an integrated system of production, sales and distribution to keep competitive edge to another company. Sales forecasting system and production planning system take an important role among them. Production planning has been done by human work, so it took long lead time, and it was hard to change plan quickly. By introducing production planning system

and production management system, the lead time is shortened to 3/5 of the before. Stock is also decreased. Formerly, material stock forecast was done two months before the production, after the introduction of the system, it is shortened to one month before, which improved the accuracy of the material stock forecast a great deal.

3.3 Utilizing production planning simulator and setting up a coordination center

Thus, a tremendous level up of the process management could be realized by utilizing production planning simulator and coordination among departments could be done easily possible. Furthermore, setting up a coordination center which coordinates production, sales and distribution department make the simulator work more fully (Figure 3).

If a short lead time order is brought from sales department, the influence to the production line could be examined utilizing production planning simulator. If it does not bear good result, whether the delivery time can be postponed or not for example, is sounded to user by salesperson. If this coordination is operated in an organized manner at the coordination center, efficient decision can be made (Table 3).

In the Example 2, this coordination center was set also and bore stated results.

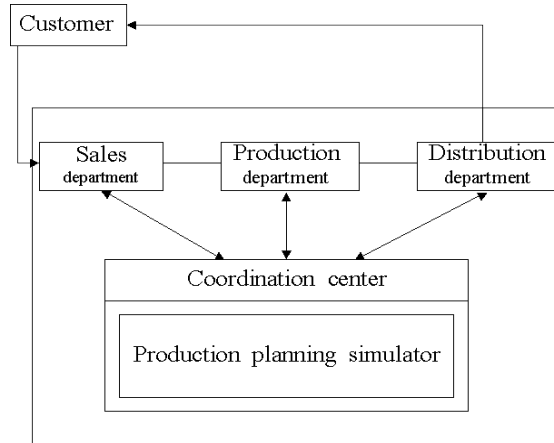


Figure 3: Utilizing production planning simulator and setting up a coordination center

Table 3: Function of a coordination center

<p>Whenever the change or disturbing events may happen, coordination center works with the following function.</p> <ul style="list-style-type: none"> ▪ Re-Sales forecast ▪ Re-arrangement of production scheduling ▪ Coordination among departments such as sales, manufacturing and distribution ▪ Re-arrangement of delivery time
--

4 Sanitary Materials Manufacturer’s Case

4.1 Outline of Sanitary Materials Manufacture

Outline of Sanitary Materials Manufacturer (Company A) is as follows.

/ Business Domain: Production and sales of Sanitary Materials

/ Business Department and Product:

A. Medical Department

absorbent gauze, absorbent cotton, products for maternity clinic, products for gynecological department, products for surgery

B. Consumer Department

hygiene cotton, products for nursing and nursing care

/ Base:

A. Headquarter

Nagoya

B. Sales Base

10 places in Japan

Shanghai

C. Factory

3 factories in Japan

Indonesia (Affiliated)

/ Number of Product Items: 3943 (Real Moving one: about 1600)

/ Lead Time for the Production:

A. Sterilized Product: 10~12 days

B. Non Sterilized Product: 5~7 days

/ ABC Analysis in the Sales Amount (September 2011 through August 2012)

Total items: 3943

Rank A items (Upper 70%) 577

Rank B items (Upper 90%) 727

Rank C items 2639

4.2 Problems and Issues

Under the severe competition with other companies, Company A has taken every means in order to reduce cost. The methods they took are as follows.

/ Increase Sales Base so as to respond to the customers' needs

/ Increase distribution center

/ Increase purchase from abroad

/ Build factory in abroad

Partially, these made contribution of cost reduction, but caused disadvantage of the increase of stocks and prolonged lead time.

Imported parts from abroad consist of nearly 20 % and these take more than one month's lead time, which causes increase of stocks. Each department made every effort in each department and that did not make any optimization in the total.

There are several means for the total optimization. Among them, correct forecasting is inevitable in the total supply chain management.

4.3 Basic Ideas for Constructing the New Planning System

In building the new system, it is examined by the following 3 viewpoints.

/ Strengthen the cooperation inside the company

/ Strengthen the cooperation between companies

/ Utilize Demand Forecasting Software

(1) Strengthen the cooperation inside the company

It is often observed that the cooperation between sales department and the production department is poor and thereby causes the lack of sharing of information such as customers information that sales department holds or production schedule that production department holds. Production department cannot decide the priority of customers and causes lack of products, while sales department cannot answer the delivery date to the customer. Supervising department is required to cope with these. Demand forecasting is inevitable for this basis.

(2) Strengthen the cooperation between companies

In order to make total optimization, cooperation between companies is essential (Figure 4).

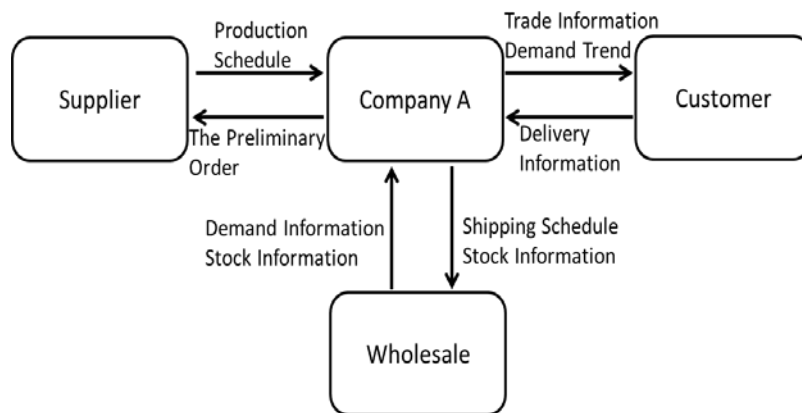


Figure 4: Strengthen the cooperation between companies

(3) Utilize Demand Forecasting Software

The number of product is nearly 400 only at Factory I in Company A. Information system is required in order to handle daily operation. Demand forecasting software should have the function to get the data automatically from the host computer. The forecasting results are the basis data and the procedure to the final execution of planning is exhibited in Figure 5.

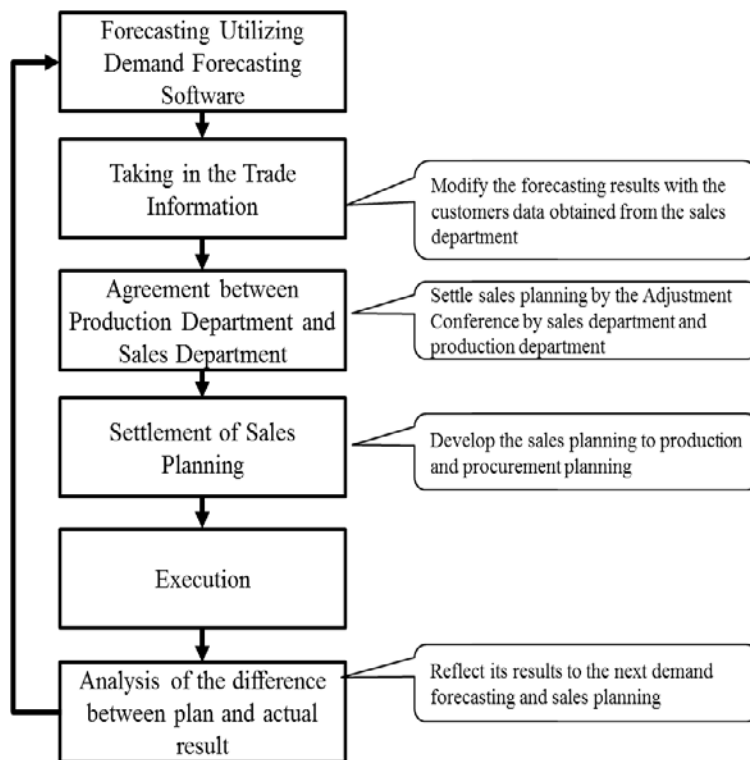


Figure 5: Utilize Demand Forecasting Software

4.4 Outline of the New Planning System

The outline of the new planning system is as follows.

- / Set up Integrated Planning Department
- / Make Long Term Production Plan
- / Strengthen the adjustment function for sales and production
- / Utilize Demand Forecasting Software
- / Make preliminary order to the factory in abroad

(1) Set up Integrated Planning Department

In order to make total optimization, overall supervising planning section is required. Therefore, they have organized “Supervising Department for Sales and Production”. It is set so as to strengthen planning function, to make rapid answer of delivery date, and to strengthen the cooperation between sales department and production department. It deals with the procurement from abroad as well as making monthly plan and long term plan.

(2) Make Long Term Production Plan

Supervising Department for Sales and Production makes demand forecasting for forthcoming 4 months by every month and makes long term production plan and monthly plan. This enables leveled production, long term maintenance plan and keeps appropriate manpower.

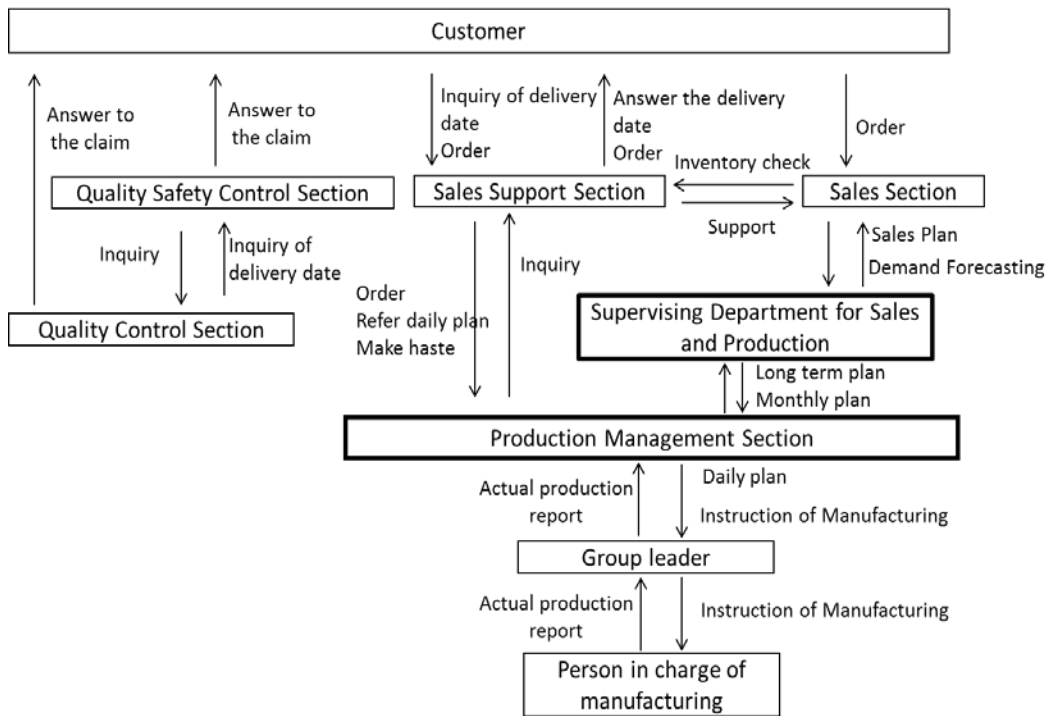


Figure 6: The New Organization and the Flow of the Business

(3) Strengthen the adjustment function for sales and production

Demand forecasting is executed based upon the last 3 years shipping results (Figure 7). Long term plan is discussed at the “Adjustment Conference by Sales Department and Production Department” promoted by “Supervising Department for Sales and Production”. In that conference, person in charge of development presents development plan and abolition items, while person in charge of sales presents sales plan. After the conference, the long term plan is fixed. After that, sales department makes sales plan and Supervising Department for Sales and Production make preliminary order. Detailed sales volume by item is not discussed in this Adjustment Conference by Sales Department and Production

Department. It is a kind of S&OP (Sales and Operations Planning) typed conference, which is held once a month.

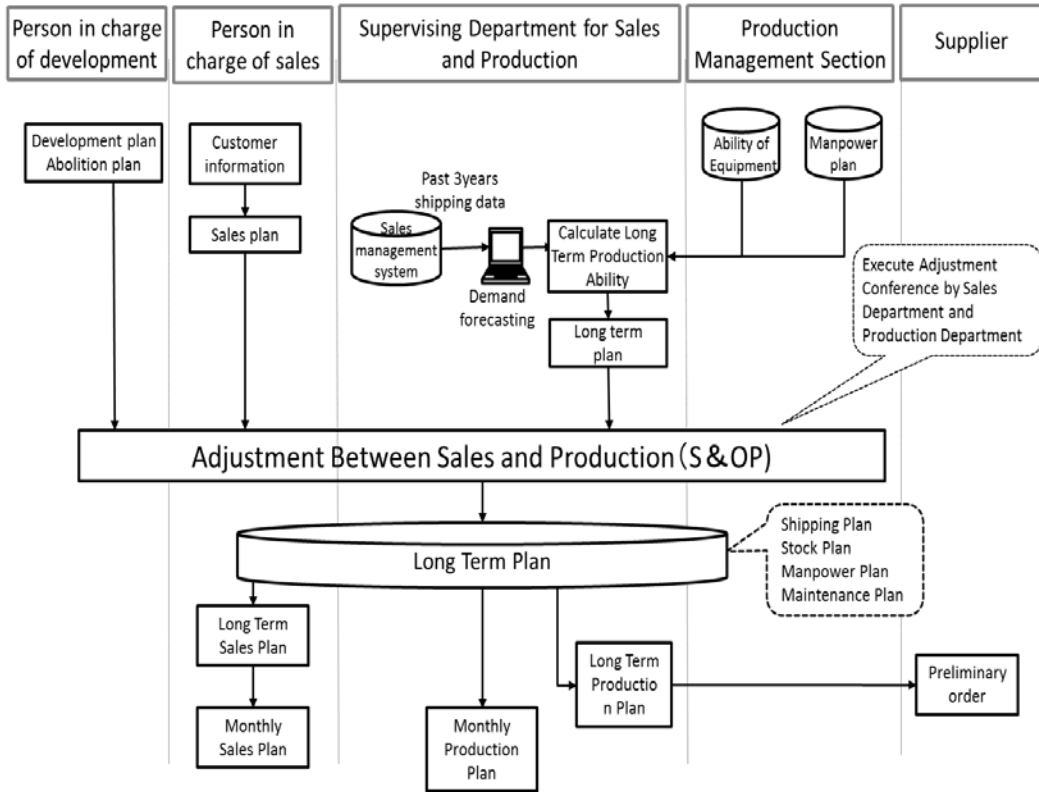


Figure 7: Strengthen the adjustment function for sales and production

(4) Utilize Demand Forecasting Software

The stream of demand forecasting is exhibited in Figure 8. Supervising Department for Sales and Production makes forthcoming 4 months demand forecasting utilizing demand forecasting software based upon the past 3 years shipping results. They modify the data using the customers' information. Related department can refer the forecasting database. Based upon this, sales department

makes sales plan. Supervising Department for Sales and Production makes procurement plan in which due date exceeds 1 month, and makes a preliminary order.

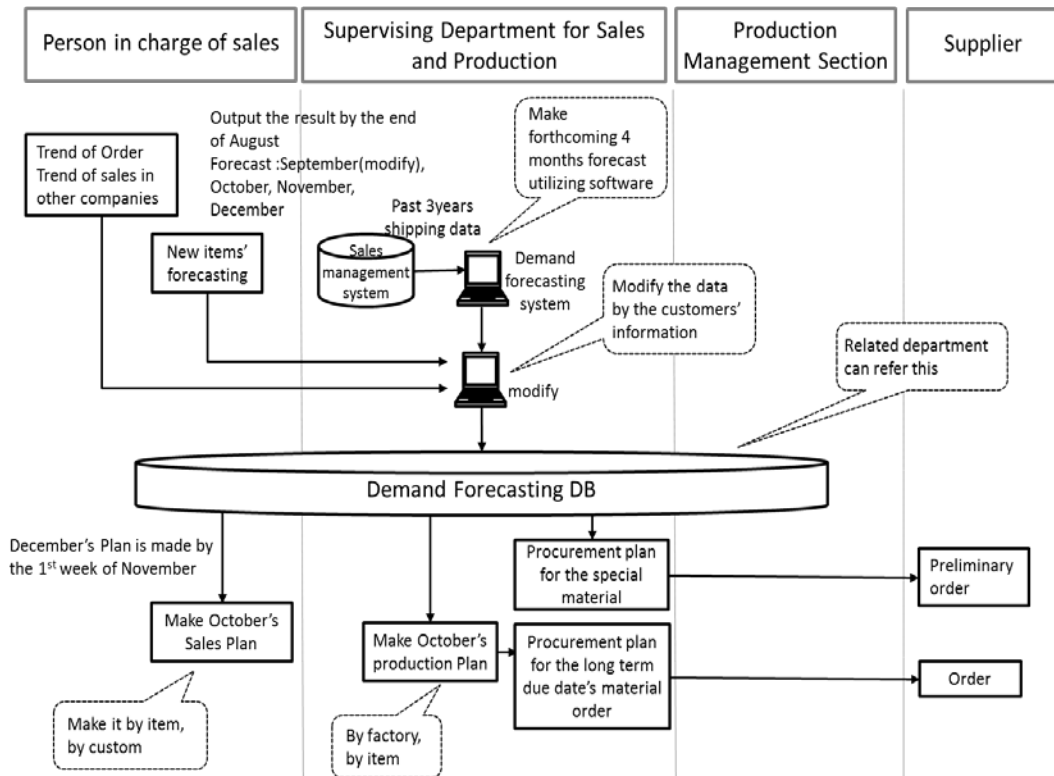


Figure 8: The stream of demand forecasting

(5) Make preliminary order to the factory in abroad

Company B is a subsidiary of Company A at Indonesia and produces the materials of set product for birth. Lead time is long compared with the suppliers in Japan and they tend to have overstocks. They make speculative order of materials (August). Therefore materials' overstocks and/or lack of stocks often happen.

In the new business process (Figure 9), Supervising Department for Sales and Production makes demand forecasting for forthcoming 4 months (September through December at August) and makes procurement plan. They make preliminary order to Company B based on this. Then production plan and stock plan is made in September and production is started at October. There is a fixed order from Supervising Department for Sales and Production at November. After inventory reservation, it is shipped and it arrives at Factory C in December. Stable supply by Company B enables cost reduction by reducing stocks.

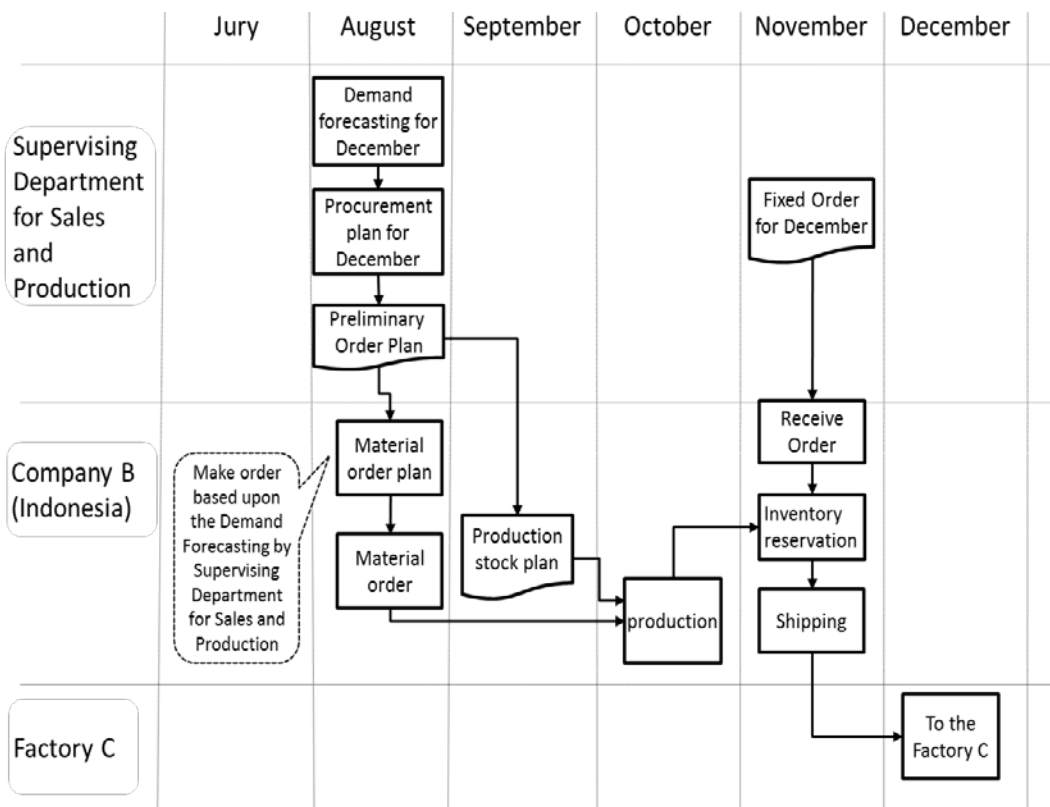


Figure 9: The stream of preliminary order based upon Demand Forecasting

5 Conclusion

The market needs have urged the production system to shift from mass production to flexible manufacturing with short period lead time and/or special specification of products. In order to meet these requirements, integrated system of production, sales and distribution is needed. Three critical success factors below are pointed out for the success of this system.

① More elaborate sales planning

...Generally, sales is too roughly planned and it causes rough production planning.

② Rapid making and remaking of production planning

...Changing of production plan takes much time and it is not easy to coordinate departments.

③ Coordination among production, sales and distribution department

...As is often the case with coordination among departments, each department has its own way and makes trouble with customers by inconsistent reply.

To cope with these difficulties, following schemes would be useful.

a. Order-made sales forecasting system

...Construct elaborate sales planning system using order-made sales forecasting system

b. Production planning system using production planning simulator

...Utilizing production planning simulator enables rapid making and remaking of production plan

c. Utilizing production planning simulator and setting up a coordination center

...By these, departments can be coordinated rapidly and smoothly

Thus, critical success factors in supply chain management are arranged and concrete grappling with these issues in sanitary materials manufacturer is described.

Such trials should be expanded in various fields hereafter.

Acknowledgements. We appreciate Mr. Norio Funato for his helpful support of our study.

References

- [1] Masayuki Goto, Research Area of Management Information and its Future Prospect in Industrial Engineering and Management, *JIMA Management System*, **23**(1), (2013),48-57.
- [2] Norifumi Kase, Cooperation with the Discrete Event Simulator for Manufacturing-Logistics and Other Software, *JIMA Management System*, **22**(1), (2012), 28-32.

- [3] Seiji Ihar, A Study of the Management Theory: A View from Whitehead's Philosophy of Environment, *Journal of Japan Association for Management Systems*, **29**(1), (2012), 9-18.
- [4] Heikan Izumi and Manabu Sawaguchi, Practical Cost Reduction Method based on TRIZ, *Journal of Japan Association for Management Systems*, **29**(2), (2012), 95-104.
- [5] Tsutomu Konno, Cost Model and Solution in Product Planning, *International Journal of Japan Association for Management Systems*, **4**(1), (2012),17-29.
- [6] Kazuhiro Takeyasu, Critical Success Factors of Integrated System of Production, Sales and Distribution, *Journal of Economics, Business and Law-Osaka Prefecture University*, **7**, (2005), 31-41.