## Impact of Information Sharing in Supply Chain Management

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### Abstract

It has been pointed out that a vital element of SCM systems is the sharing of information such as sales figures and delivery plans between multiple companies or between different divisions of a company. However, the potential benefits of SCM for individual companies that actually share information has yet to be properly investigated.

In view of this, the present study modeled company activities in a way that considered decision-making not just over the execution-level, but also over the tactics- and strategy-level. Simulation was then used to investigate the impact of information sharing on company gross profits.

In this study on supply chains in the electronics industry, we confirmed that sharing information such as product plan and procurement plan between a component manufacturer and assembly manufacturer can lead to improved gross profits for all companies involved. We demonstrated that the benefit of sharing strategy-level plans is greater than in the case of sharing execution- and tactics-level information. The increase in gross profit was seen to be particularly large in the case of declining demand. In addition, while earlier studies evaluated the impact of information sharing by looking at inventory levels, this study confirms that reducing inventory does not necessarily lead to improved gross profits, thereby highlighting the importance of gross profits as a measure for assessing the impact of information sharing.

### 1. Background and objectives

Supply Chain Management (SCM) systems for integrating and controlling entire chains of supply processes - from suppliers to manufacturers to wholesalers to retailers and through to customers - have drawn a lot of attention in recent years.

It has been pointed out that a vital element of such systems is the sharing of information such as sales figures and delivery plans between multiple companies or between different divisions of a company. However, the potential benefits (management impact) of SCM for individual companies that actually share information has yet to be properly investigated.

The present study therefore examines SCM in the electronics industry, with the aim of investigating the impact of information sharing between manufacturers.

## 2. Positioning of the study

This study focused on assembly manufacturers,

component manufacturers and parts manufacturers involved in the production of electronics goods such as personal computers, mobile phones and digital home appliances. From the results of a survey of such companies, their supply chain-related activities can be classified into the three categories listed below.

- Supply activities: How to sell/supply products
- · Transform activities: How to make products
- Procurement activities: How to purchase raw materials and production capacity

Generally speaking, supply chain is the chain of those activities over company, and each company assumes demand and uses it for decision-making, exchanging or adjusting plan information between activities as shown in Fig.1. However, it has been recognized that this independent demand model is easy to cause the bullwhip effect that each demand is amplified along the upper stream of supply chain and excess inventories arise.



Some earlier studies have quantitatively analyzed the effects of information sharing in supply chains [1][2]. Most of these studies have simulated companies using simple inventory models, to forecast demand using information such as inventory on hand at preceding companies in the supply chain (e.g. for suppliers, manufacturers), sales figures and buffer inventory as shown in Fig. 2. These forecasts are then used to determine inventory replenishment levels. Thus, these studies have demonstrated how information sharing can improve inventory efficiency and eliminate lost sales opportunities.

However, these studies have examined only the benefits of information sharing (reducing inventory and lost sales opportunities) for decision-making over the execution- to tactics-level, as shown in Table 1.

They have not investigated the benefits of information sharing on tactics- to strategy-level decision-making for determining optimum use of production resources (increasing utilization efficiency of production resources). Furthermore, they have not shown the impact of SCM on company gross profits.



Fig. 2: Information sharing model of current SCM

| Га | b | le | 1: | P. | lanni | ing | level | and | posi | tion | ing | of | thi | S S | tud | y |
|----|---|----|----|----|-------|-----|-------|-----|------|------|-----|----|-----|-----|-----|---|
|----|---|----|----|----|-------|-----|-------|-----|------|------|-----|----|-----|-----|-----|---|

|                    | Planning<br>Period                 | Time<br>Bucket | Planning<br>Cycle  | Aim  | Effect of<br>Info.Share   |               |
|--------------------|------------------------------------|----------------|--------------------|--|---|---------------|
| Strategy<br>Level  | 6 months<br>to<br>Several<br>years | Months         | Monthly<br>/yearly | Planning suitable<br>equipment and<br>human resources                          | Improved<br>ROI   | Study         |
| Tactics<br>Level   | 1-3<br>months                      | Weeks          | Weekly<br>/monthly | Planning within<br>the possessed<br>resources and<br>ensuring raw<br>materials | Improved<br>ROA<br>(The rate<br>of<br>Operation)                        | dies This     |
| Execution<br>Level | 1-14<br>days                       | Days           | Daily<br>/weekly   | Planning<br>day-to-day<br>operations   | Reduced<br>inventory<br>levels<br>/ loss of<br>sales oppor<br>-tunities | Previous Stuc |

Dependent demand model that each plan information is calculated by MRP based on the demand of the lowest reaches of the supply chain as shown in Fig. 3, is recognized as the model in which each company shares the tactics- to strategy-level information.





However, this dependent demand model manages whole supply chain as one enterprise, and each company has no right to decide their own plan. Therefore, it is hard to apply it except a company group that has a capital relation each other.

We propose a new supply chain model as shown in

Fig.4. In this e-Community Model, the demand and supply information service center is set up. The service center feeds back demand /supply information which is calculated based on the latest plan information that is provided by each member company in this community. Each company can use that demand / supply information for their own decision-making of plan and provide the updated plan for the service center again.



The features of this e-Community Model is as follows; 1) Each company can keep independency

2) Each company can share all plan information over whole supply chain through the service center

Especially in 2) above, each company can share tactics- to strategy-level information. The upper stream company can get demand information calculated based on the procurement plan of the lower stream companies, while the lower stream company can get the supply constraints calculated based on the supply plan of the upper stream company.

As the first step in our analysis for proposed e-Community Model, the present study modeled company activities in a way that considered decision-making not just over the execution-level, but also over the tactics- and strategy-level. Simulation was then used to investigate the impact of information sharing on company gross profits.

### 3. Modeling company activities

Based on the above supply chain-related activities that is supply, transform and procurement - we developed a model to describe the activities of a typical company in the manufacturing industry. We then created a framework (Fig. 5) for the essential planning and decision-making activities of such a company, i.e. sales planning, production planning and procurement planning.

Activities were defined as planning activities (strategy-level, tactics-level execution-level), and instruction and results management activities, and logistics activities. An outline of each of these types of activities is given in Table 2.



Fig. 5: Essential company activities for SCM

|                    | Tuble                  | 2. I humming accelences   |  |  |  |
|--------------------|------------------------|---|--|--|--|
|                    | Market Plan            | Make forecasts of future demand for<br>applicable products based on long-term<br>perspectives                         |  |  |  |
| Strategy<br>Level  | Product Plan           | Develop a production prospect for<br>applicable products over the relevant<br>time frame on the basis of market plan. |  |  |  |
|                    | Capacity Plan          | On the basis of product plan, plan for the necessary production capacity (equipment and human resources)              |  |  |  |
|                    | Sales Plan             | Forecast sales volume from medium-term<br>perspective Sales Plan  |  |  |  |
| Tactics<br>Level   | Production<br>Plan     | Create a production plan in accordance<br>with the sales plan, within the limits of<br>capacity plan.                 |  |  |  |
|                    | Procurement<br>Plan    | To achieve the production plan, calculate<br>the quantity of parts and materials needed<br>for relevant periods       |  |  |  |
|                    | Delivery<br>Schedule   | Determine product delivery dates, according to received orders.   |  |  |  |
| Execution<br>Level | Production<br>Schedule | Determine manufacturing volume and dates according to the delivery schedule and production plans.                     |  |  |  |
|                    | Receiving<br>Schedule  | In accordance with the production<br>schedule, determine the delivery quantities<br>and dates for parts orders placed |  |  |  |

### Table 2: Planning activities

## 4. Profit and loss evaluation model

In order to investigate the effect of information sharing on company gross profits, we created a profit and loss evaluation model (as shown in Fig. 6). The model breaks down costs into variable and fixed components and takes into account sales (according to received orders) and expenses for a given period. The unit prices for products, parts and labor used in calculating profit and loss are set on the basis of a product cost price structure (proportion of sales income for fixed costs such as direct material costs and labor costs)......: For all product orders received for the period



Fig. 6: Profit and loss evaluation model

### 5. Information sharing models

We consider that information sharing between an assembly manufacturer and component manufacturer would work as shown in Fig. 7 below. In this study we investigated an information sharing system in which a component maker utilizes information from an assembly maker for forecasting demand



Fig. 7: Shared information flow between companies

#### 5.1 Information from the assembly maker

The assembly maker creates strategy-level and tactics-level plans of its operations. Thus, when the component maker needs to forecast demand for its products, it can utilize not only execution-level information from the assembly maker, such as inventory in hand and sales figures, but also tactics- and strategy-level planning information, as shown in Fig. 8. Examples of strategy-, tactics- and execution-level information used in this study are given in the table 3.



## Fig. 8: Information from an assembly maker for use in demand forecasting by a component maker

The component maker can improve its capacity plan using the product plan of itself and monitoring the strategy-level product plan of the assembly maker, thus making more efficient use of production resources. In addition, by keeping track of the of assembly maker's procurement plan, the component maker can improve the efficiency of its own parts and materials ordering.



Table 3: Examples of information used in this study

# 5.2 Demand forecast method, using information from the assembly maker

In this study, we performed a demand forecast based on the assembly maker information listed in Table 3. Specifically, we did this using the market plan (strategy-level activity), sales plan (tactical-level activity) and delivery plan (execution-level activity). (See Fig. 4.)

The market plan quantity of component maker uses the product plan quantity of assembly maker as it is, while the sales plan quantity of component uses the procurement plan quantity of assembly maker as it is. Furthermore, the delivery schedule quantity of component maker is predicted based on the assembly maker's sales figures and inventory on hand. Now, if the component maker does not make use of information from the assembly maker, it must determine plan quantities by making predictions based on orders received in the past.

# 6. Analysis of the impact of information sharing on gross profit

### 6.1 Outline of analysis

- · No information: Information is not shared
- Execution-level information sharing: Only short-term information is shared
- Tactics-level information sharing: Tactics- and execution-level information is shared
- Strategy-level information sharing: Strategy-, Tacticsand execution-level information is shared

We analyzed how gross profits of the component maker and assembly maker vary with each of the above information-sharing methods.

#### **6.2 Experimental conditions**

This experiment was conducted based on the conditions below.

<Experimental conditions>

- 1 product = 1 component = 1 part
- Each maker operates by assembling and processing products after receiving orders.
- Evaluation period is 48 weeks (12 months)
- Capacity planning involves forecasting for human resources only, i.e. "equipment" capacity is assumed to be fixed.
- The costs of each maker as a percentage of revenue are assumed to be as follows: direct material costs 70%; labor costs 10%; other fixed costs 15%

The experiment was conducted for all four cases below, each representing a different demand pattern for the assembly maker. As shown in Table 4 below, each of the demand patterns is defined by monthly demand change rate, volatility and cycle.

## Table 4: Demand patterns and parameters

| Demand Mo<br>Pattern C | nthly Demand<br>Change Rate | Volatility | Cycle                              |  |
|------------------------|-----------------------------|------------|------------------------------------|--|
| 1. Up trend            | +5%                         | 10%        | None                               |  |
| 2. Down trend          | -5%                         | % 10% N    |                                    |  |
| 3. Cyclical trend      | ±5%                         | ±5% 10%    |                                    |  |
| 4. No trend            | 0%                          | 10%        | None                               |  |
| Demand qty.            |                             | 1. Up      | No trend<br>2. Down trend<br>trend |  |
|                        |                             | (month     | 1)                                 |  |

Fig. 9: Demand patterns

#### 6.3 Impact on component maker gross profits

We analyzed how different information sharing methods (execution-, tactics- and strategy-level) affected the gross profits of the component maker.

The graph in Fig. 10 confirms that all three information sharing methods increase the gross profit of a component maker. In addition, for all demand patterns except "no trend" the impact on gross profit increases with the length of the planning period. The benefit of strategy-level information sharing is particularly large in the case of a "down trend" demand pattern. As shown by Fig. 11, this is due to the fact that strategy-level information sharing greatly improves resource utilization efficiency (=gross profit/ (labor cost + other fixed costs).

Clearly, the reason that strategy-level information sharing exerts very little effect on gross profits and resource utilization efficiency in the case of a "no trend" pattern is that demand can be predicted quite accurately without information sharing, since there is essentially no change in demand.



Fig. 10: Impact of information sharing on component maker gross profits



Fig. 11: Influence of strategy-level information sharing on resource utilization efficiency

### 6.4 Impact on assembly maker gross profits

We analyzed how different information sharing methods (execution-, tactics- and strategy-level) affected gross profits of assembly makers.

Although the increase in gross profits for the assembly maker is less than that of the component maker, Fig. 12 shows that information sharing provides benefits even to the side supplying the information (the assembly maker in this case). The benefit is particularly large for the case of "up trend" demand.

As Fig. 13 shows, information sharing tends to reduce the order loss rate for the assembly maker. Thus, by providing its planning information to the component maker, the assembly maker can ensure a reliable supply of parts and materials and therefore reduce lost sales opportunities. This explains how benefits are gained from providing information.

Furthermore, despite the fact that tactics-level information sharing results in increased gross profits for the component maker (Fig. 10), average inventory has actually increased for this case (Fig. 13). This shows that even if average inventory is reduced, it does not



Fig. 12: Impact of information sharing on component maker gross profits



Fig. 13: Influence of information sharing on average inventory and lost order rate ("up trend" demand pattern)

necessarily follow that gross profits will increase. From this, we can conclude that the impact of information sharing needs to be evaluated by looking at gross profits not inventory.

### 7. Conclusion

In this study on supply chains in the electronics industry, we confirmed that sharing information such as product plan and procurement plan between a component manufacturer and assembly manufacturer can lead to improved gross profits for all companies involved.

We demonstrated that the benefit of sharing information is greater in almost liner fashion as long as sharing information level is deeper from execution- and tactics- to strategy-level.

The increase in gross profit was seen to be particularly large in the case of declining demand. In addition, while earlier studies evaluated the impact of information sharing by looking at inventory levels, this study confirms that reducing inventory does not necessarily lead to improved gross profits, thereby highlighting the importance of gross profits as a measure for assessing the impact of information sharing.

## References

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