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SCM Innovation for Business Globalization Based on Coupling Point Inventory Planning

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1. Introduction

We introduce a new SCM (Supply Chain Management) solution based on Coupling Point Inventory Planning theory for the repetitive products. This solution has been achieved three-way optimums; quick response to order, the available inventory level flatly, and the multi-items replenishment under the limited capacity.

The new SCM solution is organized to combine three methods. The first method is the Coupling Point establishment for quick response to order when the demand lead time is shorter than the supply lead time. Coupling Point (CP) is defined where the position of demand and supply lead-times are equal on the supply chain process.

The second method is the re-order calculation to control the inventory level flatly without demand forecast. It plans the theoretical necessary inventory including safety stock under the demand fluctuation, and calculates the re-order quantity. The re-order quantity is calculated by the difference of the theoretical necessary inventory and the measured actual stock.

The third method is the multi-items replenishment by the margin stock ratio under the limited capacity when the supply capacity and the demand quantity are different. The margin stock ratio is calculated by the theoretical necessary inventory and measured actual available inventory.

The organization of this paper is as follows: In chapter 2, the problem of the recent SCM is stated. In chapter 3, the concept of the coupling point inventory planning theory is stated. In chapter 4, the method of the coupling point establishment is introduced. In chapter 5, the method of the re-order quantity calculation for inventory level flatly without the demand forecast is introduced. In chapter 6, the method of the multi-items replenishment by the margin stock ratio under the limited capacity is introduced. In chapter 7, the expected effect by the coupling point inventory planning method is described. In chapter 8, the application of coupling point inventory planning method is introduced.

Finally, the paper will be concluded in chapter 9 with the brief discussion of the result.

2. Problem of recent SCM

2.1 Problem of global SCM

Increasing number of international companies have been employed SCM based on demand forecast in recent years. However, in the global SCM, because of the various processes and procedures in transportation (such as, custom clearance, container handling, ocean transportation, physical transportation) of the parts and the products could take anywhere from a week up to four weeks. Further more, various parts (or the products) are often made in different areas of the world to be assembled and sold all over the world. As the total supply lead-time is necessary 4 ~ 5 months, the demand forecast before the laps of lead time is inaccurate.

In case of the supply lead time is long, the inventory management method is used the fixed-cycle ordering system in some companies. Figure 1 shows one of the characteristics of the fixed-cycle ordering system. As this system absorbs the demand fluctuation by the inventory, the inventory level becomes to fluctuate. Then, international companies have the difficulty with excess or shortage inventory (Lagodimos & Anderson, 1993, Shacham, 1993).

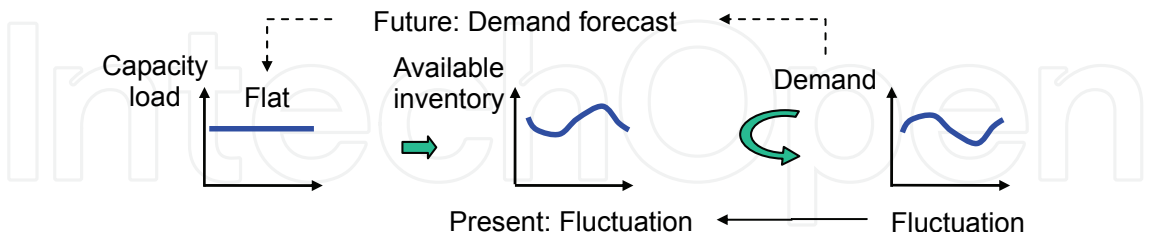


Figure 1. characteristics of the fixed-cycle ordering system

2.2 Problem of domestic SCM

On the other hand, companies of using SCM in domestic can shorten supply lead-time and decrease on hand stock by controlling the balance between demand and the supply as well as shortening the time and the process. It takes to communicate the demand information between downstream (such as, cus-

tomers, consumers) and upstream (such as, materials, parts) companies. However, the shortening planning cycle becomes small bucket size of the production capacity.

In case of the supply lead time and the ordering cycle are short, the inventory management method is used the fixed-size ordering system in some companies or Just-In-Time system. Figure 2 shows one of the characteristics of the fixed-size ordering system. As this system controls the inventory level flatly, the capacity / load level becomes to fluctuate. Then, domestic companies have also the difficulty with excess or shortage inventory (Kimura & Terada, 1981, Huang & Kusiak, 1996).

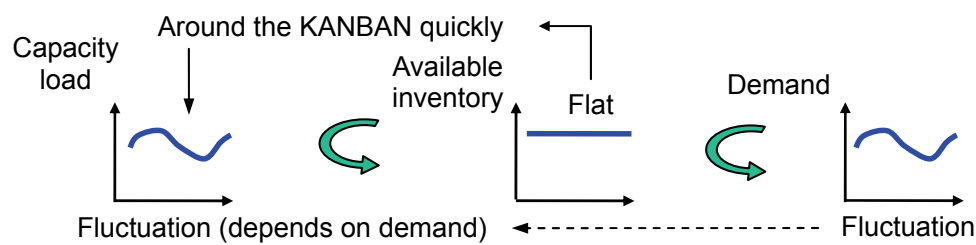


Figure 2. characteristics of the fixed-size ordering system

2.3 Reasons of inventory occurrences

As just described, we are able to recognize two reasons of the inventory occurrences. Figure 3 shows the first reason is the imbalance between the demand and the supply lead time.

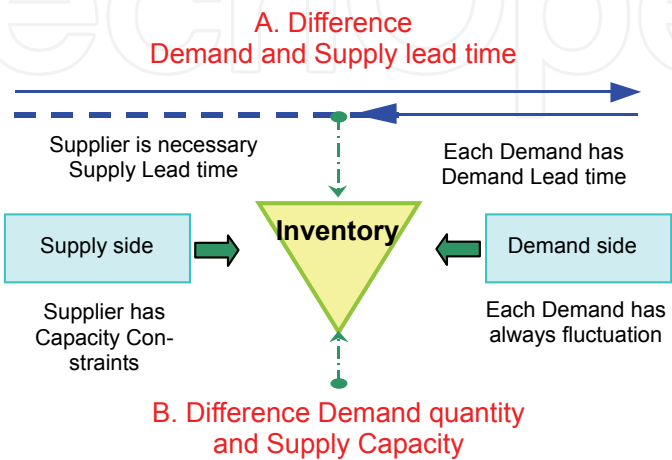


Figure 3. Elucidation of inventories occurrence factor

For example, the transportation lead time is too long in the global SCM. The second reason is the imbalance between the demand quantity and the supply quantity or capacity. For example, the bucket size or capacity is small in the domestic SCM.

3. Concept of Coupling Point Inventory Planning

3.1 Recognizing of physical phenomenon

The reasons of inventory occurrences are described by Figure 4. The expecting and the excess inventory situations are related by two reasons on the matrix. In the first situation, excess inventories do not occur when the demand lead time is longer than the supply lead time or when they are equal, because production based on order is possible. But it can not cope with the case when the demand lead time is shorter than the supply lead time. Manufacturing and stockpiling are taken to prevent the loss of sales opportunities. This is called Production based on demand forecast. In the second situation, surplus inventories do not occur when the demand quantity is equal to the supply quantity. Inventories occur as their difference when the supply quantity is greater than the demand quantity.

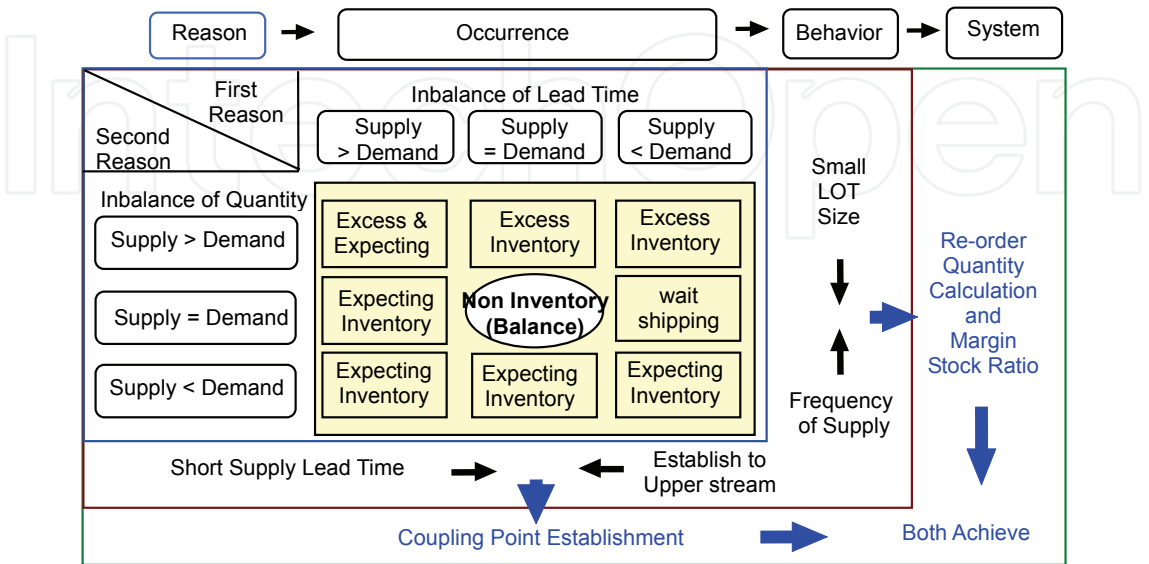


Figure 4. Concept of coupling point inventory planning.

This difference causes a shortage when the supply quantity is smaller than the demand quantity. In this case, both current production and inventories are used up to prevent the loss of sales opportunity. Seasonal products are the good examples.

In some cases, inventories are caused by the imbalance of the lead time. In the other cases, surplus inventories are caused by the imbalance of the quantity or capacity. The former is called Expecting inventories, and the latter is called Excess inventories. Consequently, inventory occurrences are recognized to occur on the physical phenomenon.

Some SCM software based demand forecast method controls the excess or the shortage inventory. Although these methods are useful for production planning and management, the situation of the excess or the shortage inventory does not clear. Because, in the explanation of the inventory is necessary the inventory theory.

3.2 Definition of Coupling Point Inventory Planning

We have been proposed to solve combine the two reasons of inventories occurrence. The bottom and the right side in Figure 4 shows, the first solution is the coupling point establishment for quick response to order when the demand lead time is shorter than the supply lead time. The second solution is the re-order quantity calculation for inventory level control flatly. The third solution is the multi-items replenishment by the margin stock ratio under the limited capacity when the supply capacity and the demand quantity are difference.

The new SCM solution is organized to combine three methods. We give a generic name 'Coupling Point Inventory Planning Theory' to three methods (Mitsukuni et al., 1997, 1999, 2002, 2003).

4. Method of Coupling Point establishment for quick response to order

4.1 Definition of Coupling Point

The view point of the supply chain lead time is shown Figure 5. CP is determined by demand and supply lead time. Supply lead time is defined as the time it takes to send products from a certain position in the process to a customer. For example, the supply lead time at the position of supplier is the sum of the time of all the sub-processes (such as parts maker, set maker, and deliv-

ering etc).

Demand lead time is defined as the time it takes for customers to receive products from ordering. Demand lead time is determined by the customer requirement.

Using these two kinds of lead time, Coupling Point (CP) is defined as follows: the stock positions where the supply and the demand lead times are equal. Then, total supply lead time is divided at CP, and we are able to quick response to order on the downstream side. Then, we are aware the new lead time from upstream to CP.

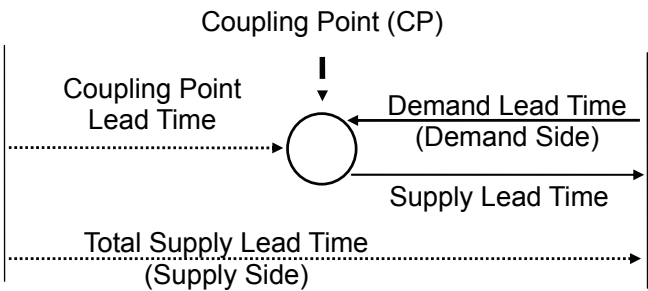


Figure 5. Definition of Coupling Point

Equation of Coupling Point definition is shown Figure 6, and the Coupling Point i^* is shown in the equation (1). In this equation, $P(i)$ denotes the processing time of a sub-process i , where $i = 1$ to n increasing from demand side to supply side.

The stock position situated at the entering position of sub-process i is also defined to be i . Ld is the demand lead time which depends on customers' requirement.

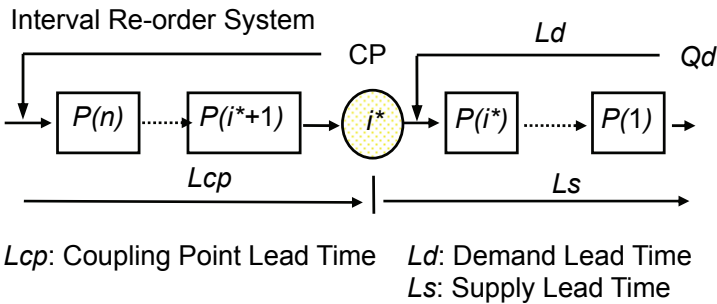


Figure 6. model of Coupling Point

$$i^* = \left\{ \max_{1 \leq i \leq n} i \mid \sum_{j=1}^i P(j) \leq Ld \right\} \quad (1)$$

The new supply lead time from sub-process i to customer Ls is denoted by equation $(\sum_{j=1}^i P(j))$. The coupling point lead time from sub-process $p(n)$ to CP Lcp is denoted by equation $(\sum_{j=i^*+1}^n P(j))$.

4.2 Necessary Inventory of Coupling Point

We assume that the replenishment system of CP to be an interval reorder system, and that the demand is under normal distribution. The necessary stock of inventories In is shown as equation (2). In this equation, Qd is the mean value of demand size per unit period, σd is the standard deviation. Lcp is the coupling point lead time, C is the re-order interval, k is the coefficient of safety stock (depends on service level).

$$In = Qd(Lcp + C) + k\sqrt{(Lcp + C)} \cdot \sigma d \quad (2)$$

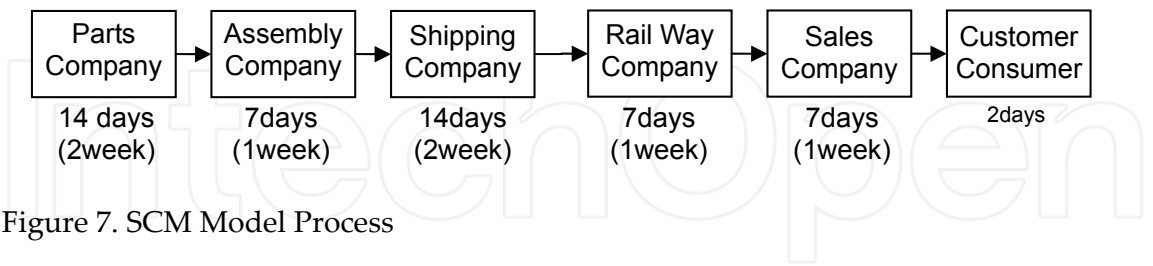
Next, we assume that the process consists of n stage sub-processes, in which inventories are stocked exclusively at the stock position of CP i^* . Lcp is substituted by $(\sum_{j=i^*+1}^n P(j))$. Then necessary stock of inventories $In(i^*)$ is equation (3).

$$In(i^*) = Qd\left(\sum_{i=i^*+1}^n P(i) + C\right) + k \cdot \sqrt{\left(\sum_{i=i^*+1}^n P(i) + C\right)} \cdot \sigma d \quad (3)$$

If CP is established where position is near the upstream side, the expecting inventory becomes to decrease. On the opposite, if CP is established where position is near the downstream side, the expecting inventory becomes to increase. Consequently, the expecting inventory is depending on the position of CP.

4.3 Example of coupling point establishment

An example of the supply chain model process is shown Figure 7. The supply chain model process has 5 companies. The most of the upstream company is a parts manufacturing, and supply lead-time is 14days (2week).



Similarly, each company is placed on the supply chain process from the upstream to downstream. The second company is an assembly manufacturing, and lead-time is 7days (1week). The third company is a shipping and railway transportation, and lead-time is 21days (3weeks). The forth company is a sales, and lead-time is 7days (1week) to customize and package. The most of the downstream side is customers or consumers, and required delivery lead time is two days.

An example of the establishing Coupling Point (CP) is shown Figure 8. As Customers require 2 days deliver, CP is established at the exit of the sales company for quick response to orders. Consequently, the coupling point lead time from the parts to CP is 49days (7weeks).

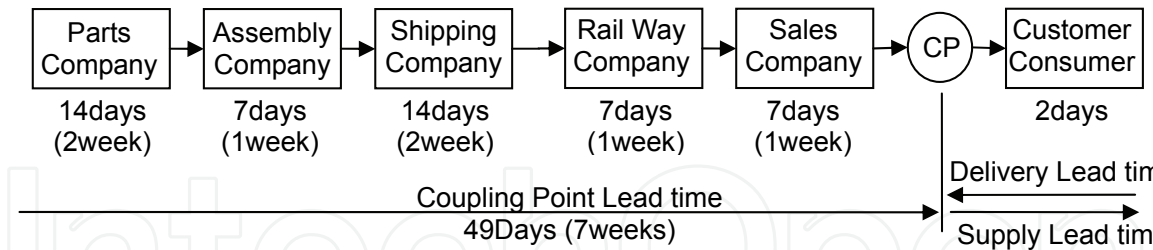


Figure 8. Example of Establishing Coupling Point

5. Method of Re-order Quantity Calculation for inventory level flatly

5.1 Definition of re-order quantity

We should consider the anticipation inventory of the upstream side of CP. The method of re-order quantity determination is shown Figure 9. On each item, each planning period, the total inventory is defined theoretical necessary inventory *In*.

The theoretical necessary inventory is planed by the lead-time of the supply chain process, planning cycle, average demand quantity and its standard deviation. I_n includes the safety stock.

On the other hand, as the actual stock on supply chain process and the actual stock on hand are measured by the fact and are reported to inventory planning. The total of measured actual stock of each item is defined available inventory I_a . When the available inventory is less than the theoretical necessary inventory, the difference quantity is the shortage.

Thus, the difference quantity should be replenished. Then the difference quantity of available and theoretical necessary is defined re-order quantity. When the available inventory is greater than the theoretical necessary inventory, the difference quantity of excess is the over. In this situation, the replenishment is unnecessary.

Consequently, the total inventory becomes flat by the theoretical necessary inventory. And the out-of-stock situation becomes to decrease by the safety stock.

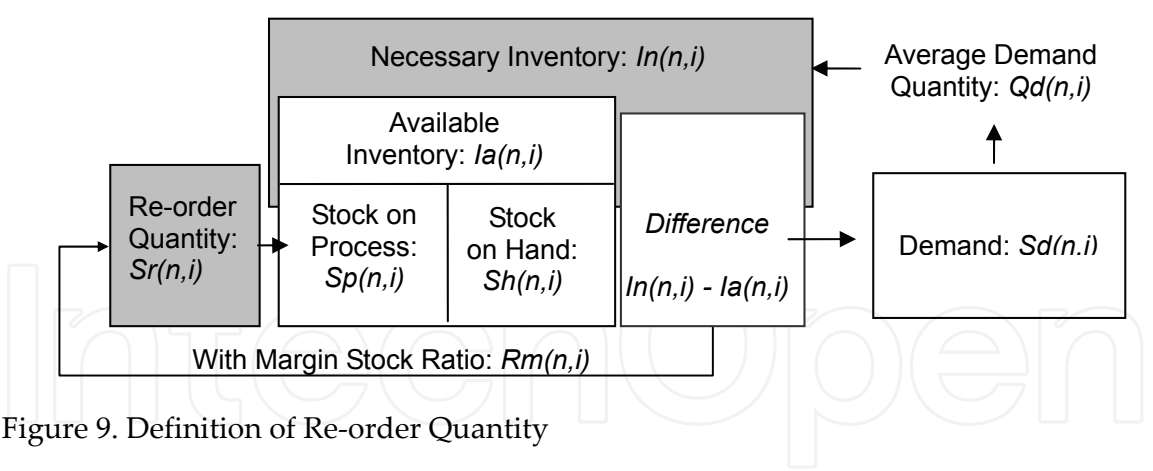
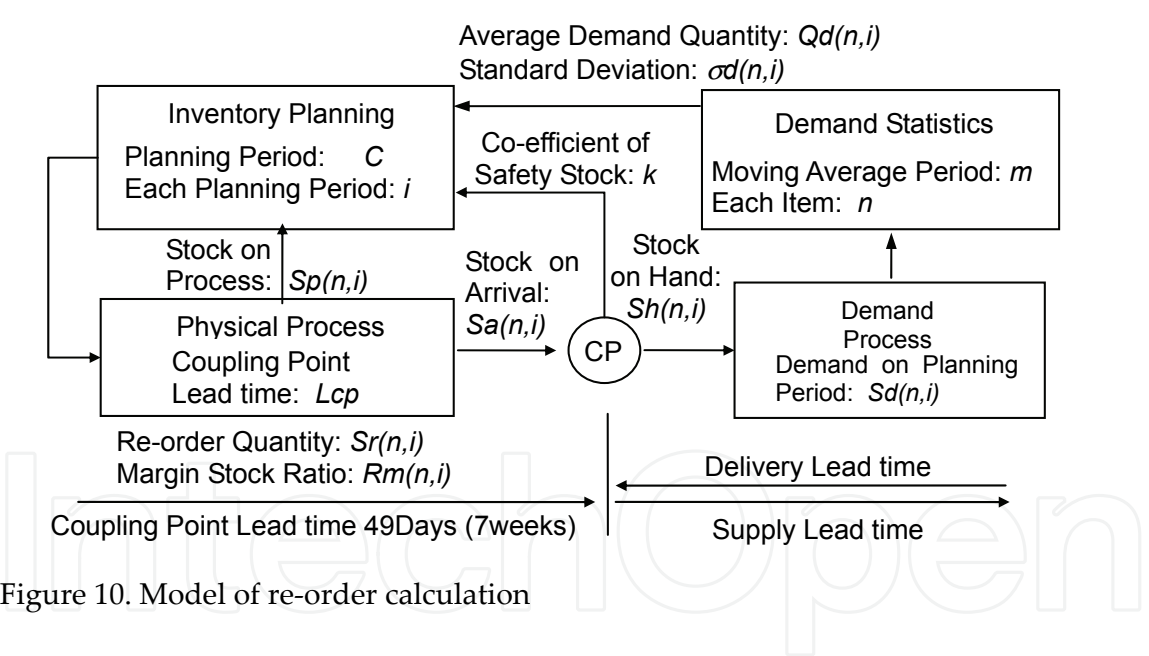


Figure 9. Definition of Re-order Quantity

5.2 Model of Re-order Calculation

An example of the supply chain logical model is shown Figure 10. In this model, between the parts manufacturing and the sales company are denoted by the abstraction of one logical supply chain process. The inventory planning is considered at CP. Each item denotes n . The coupling point Lead-time of each item denotes $L_{cp}(n)$ (week). The inventory planning cycle denotes C (week), and each planning period denotes i .

At CP, on each item n , each planning period i , the actual demand quantity (out) denotes $Sd(n,i)$ (unit), the actual arrival (in) quantity denotes $Sa(n,i)$ (unit), the result of on hand stock quantity after in / out denotes $Sh(n,i)$ (unit). $Sh(n,i)$ is measured by the fact, and is reported to inventory planning. The coefficient of the safety stock denotes $k(n)$. The moving average demand quantity under the moving average term m denotes $Qd(n,i)$ (unit/period), and its standard deviation denotes $\sigma d(n,i)$. $Qd(n,i)$ and $\sigma d(n,i)$ are calculated by the actual demand quantity $Sd(n,i)$. The actual stock on the physical supply chain process denotes $Sp(n,i)$ (unit). $Sp(n,i)$ is measured by the fact, and is reported to inventory planning. The re-order quantity denotes $Sr(n,i)$ (unit) and the margin stock ratio denotes $Rm(n,i)$. Then, the inventory planning directs $Sr(n,i)$ and $Rm(n,i)$ to the physical supply chain process.



5.3 Algorithm of re-order calculation

The demand quantity $Qd(n,i)$ in moving average term m of each item n , each planning period i is calculated by equation (4). And its standard deviation is calculated by equation (5).

$$Qd(n,i) = \frac{\sum_{x=i-m}^{i-1} Sd(n,x)}{m}$$

(4)

$$\sigma d(n,i) = \sqrt{\frac{\sum_{x=i-m}^{i-1} (Qd(n,i) - Sd(n,x))^2}{m-1}} \quad (5)$$

The moving average term m is determined to consider by the products life cycle, seasonable demand, and trend of each item n . The moving average term m is recommended greater than 40~50 as a population of the demand data. For example, in case of actual sales term is 1 year, the planning period is divided a week, the result of moving average term m is 52. Then the seasonal variation is able to include the standard deviation, because the influenced of seasonal dispersion is calculated by the 52 weeks including maximum / minimum data in the year.

The theoretical stock on supply chain process of each item n , each planning period i denotes $Fp(n,i)$ (unit), and is calculated by equation (6). $Fp(n,i)$ is multiplied by average demand quantity $Qd(n,i)$ and Coupling Point lead time $Lcp(n)$.

$$Fp(n,i) = Qd(n,i) \cdot Lcp(n) \quad (6)$$

The theoretical on hand stock of each item n , each planning period i denotes $Fc(n,i)$ (unit), and is calculated by equation (7). $Fc(n,i)$ is multiplied by average demand quantity $Qd(n,i)$ and planning cycle C (week).

$$Fc(n,i) = Qd(n,i) \cdot C \quad (7)$$

The theoretical inventory of re-order interval of each item n , each planning period i denotes $Fd(n,i)$ (unit), and is calculated by equation (8). $Fd(n,i)$ is a total of $Fp(n,i)$ and $Fc(n,i)$.

$$Fd(n,i) = Fp(n,i) + Fc(n,i) = Qd(n,i) \cdot (Lcp(n) + C) \quad (8)$$

The theoretical safety stock of each item n , each planning period i denotes $Fs(n,i)$ (unit), and is calculated by equation (9). $Fs(n,i)$ is calculated by the coefficient of safety stock k , standard deviation of the average demand $\sigma d(n,i)$, process lead-time $Lcp(n)$, and planning cycle C .

$$Fs(n,i) = k(n) \sqrt{(Lcp(n) + C)} \cdot \sigma d(n,i) \quad (9)$$

The theoretical necessary inventory of each item n , each planning period i de-

notes $In(n,i)$ (unit), and is calculated by equation (10). $In(n,i)$ is a total of $Fd(n,i)$ and $s(n,i)$.

$$In(n,i) = Fd(n,i) + Fs(n,i) = Qd(n,i) \cdot (Lcp(n) + C) + k(n) \sqrt{(Lcp(n) + C)} \cdot \sigma d(n,i) \quad (10)$$

The available inventory of each item n , each planning period i denotes $Ia(n,i)$, and is calculated by equation (11). $Ia(n,i)$ is a total of actual stock on supply chain process $Sp(n,i)$ and actual stock on hand $Sh(n,i)$.

$$Ia(n,i) = Sp(n,i) + Sh(n,i) \quad (11)$$

The re-order quantity of each item n , each planning period i denotes $Sr(n,i)$ (unit), and is calculated by equation (12). $Sr(n,i)$ is subtracted from the theoretical necessary inventory $In(n,i)$ to the available inventory $Ia(n,i)$. The margin stock ratio $Rm(n,i)$ is calculated by equation (13) and will describe in Chapter 6.

$$Sr(n,i) = In(n,i) - Ia(n,i) \quad (12)$$

$$Rm(n,i) = \frac{Ia(n,i)}{Fd(n,i)} \quad (13)$$

5.4 Flow of re-order calculation

The flow of the re-order quantity calculation is shown Figure 11.

Step1~Step3 are initialize procedures of inventory planning. In Step1, the planning cycle C and the moving average term m are established. In Step2, the Coupling Point lead time Lcp , the co-efficient of safety stock k , and the past demand Sd of each item n are established. The co-efficient of safety stock k is determined by the service ratio. For example, $k=1.64, 1.96, 2.25$, and 3.27 are depending on the service ratio 90%, 95%, 97.5%, and 99.9%. As the past demand Sd is established between $(i-m)$ to $(i-1)$ of the moving average term m , current period i is established $m+1$.

Step4 is a statistics procedure of the demand. The average demand quantity and the standard deviation between $(i-m)$ to $(i-1)$ is calculated by equation (4) and (5), then the results are established at position i .

Step5 is a calculation procedure of the theoretical necessary inventory In , and In is calculated by equation (6)to(10), then the result is established at position i . Step6~7 is a calculation procedure of available inventory Ia , and Ia is calculated

by equation (11), then the result is established at position i .

Step8 is a calculation procedure of re-order quantity Sr and margin stock ratio Rm . Sr is calculated by equation (12) and Rm is calculated by equation (13), then results are established at position i .

Step9 is a direction procedure of the re-order quantity Sr and the margin stock ratio Rm to physical supply chain process. When the planning period becomes next, the planning period is 1 up. The re-order quantity Sr at the prior period is moved to the actual stock on supply chain process Sp at the current period.

Similarly, the arrival from the actual stock on supply chain process Sp at prior period is moved to the arrival quantity Sa at current period. In the management of the work shop, the manager should be doing action for the abnormal when the manager finds the difference of the calculated and the actual quantity.

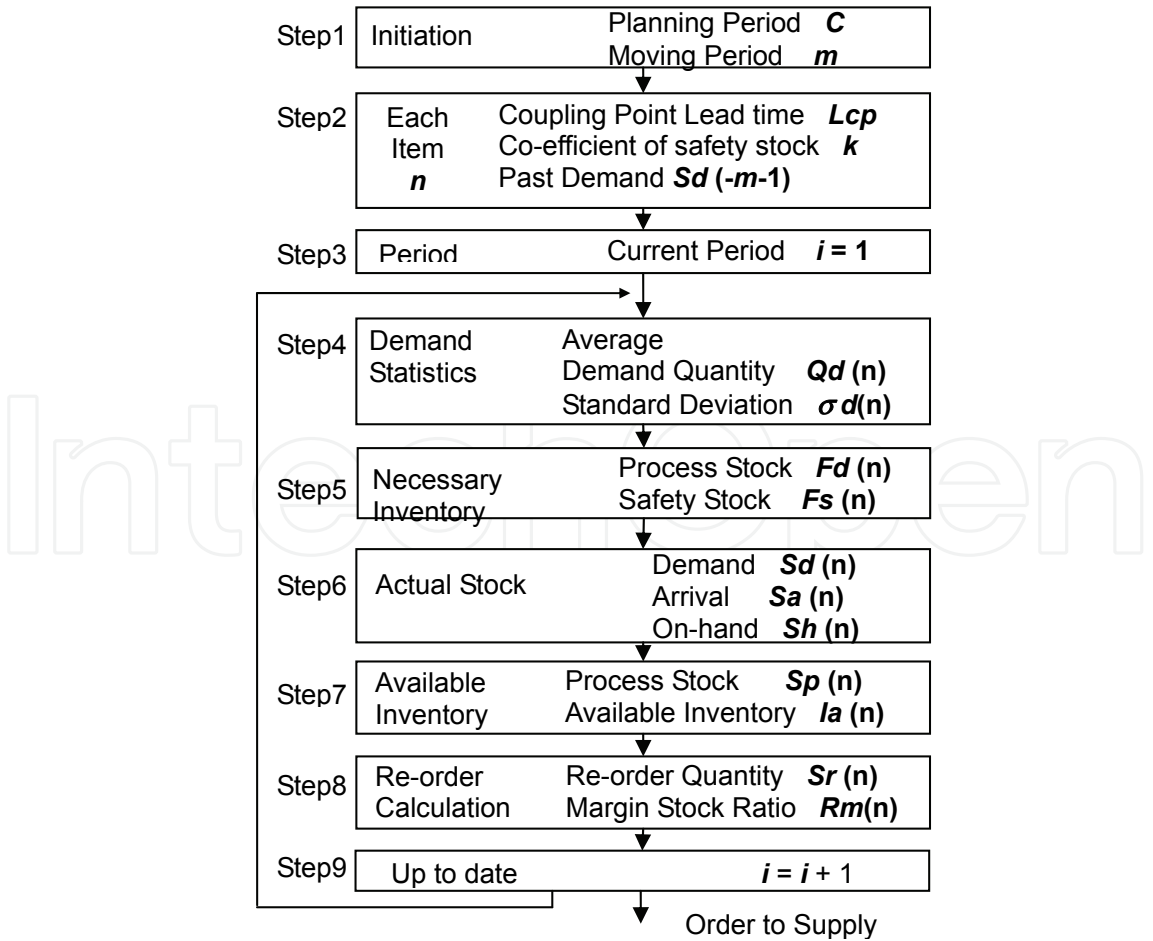


Figure 11. Flow of Re-order Quantity calculation

5.5 Example of inventory level control flatly

The effect of the inventory level control is shown Figure 12. The model process is shown Figure 8. The country of the sales company is U.K., the country of the factory is China. The average demand quantity Q_d is 1702, and the standard deviation σ_d is 894.

At first, they have used the demand forecast. However, they were worried the excess inventory. Then we proposed re-order quantity calculation. We have been designed pilot items and have been tried the pilot running.

As a result, the re-order quantity is able to calculate without demand forecast, and the total inventory of supply chain process becomes flat by theoretical necessary inventory. We were also sure to decrease the total inventory.

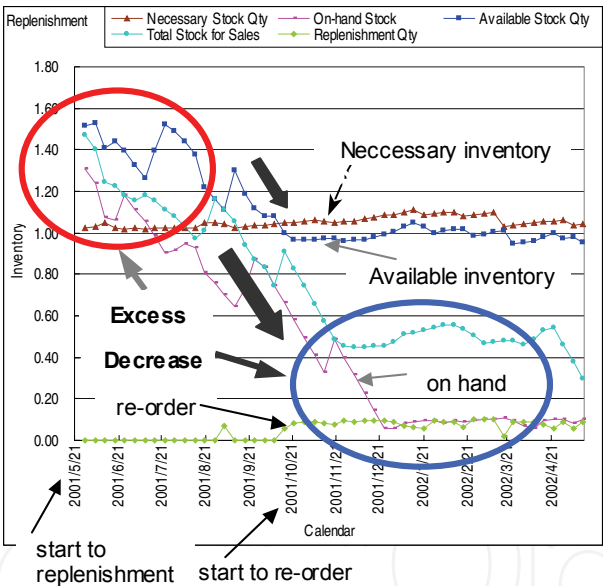


Figure 12. Example of inventory level control

6. Method of multi-items replenishment by Margin stock ratio

6.1 Definition of Margin Stock Ratio

Figure 13 shows the margin stock ratio means the estimation of the out-of-stock situation occurrence. The margin stock ratio is able to calculate by the theoretical necessary inventory except safety stock and measured actual available inventory.

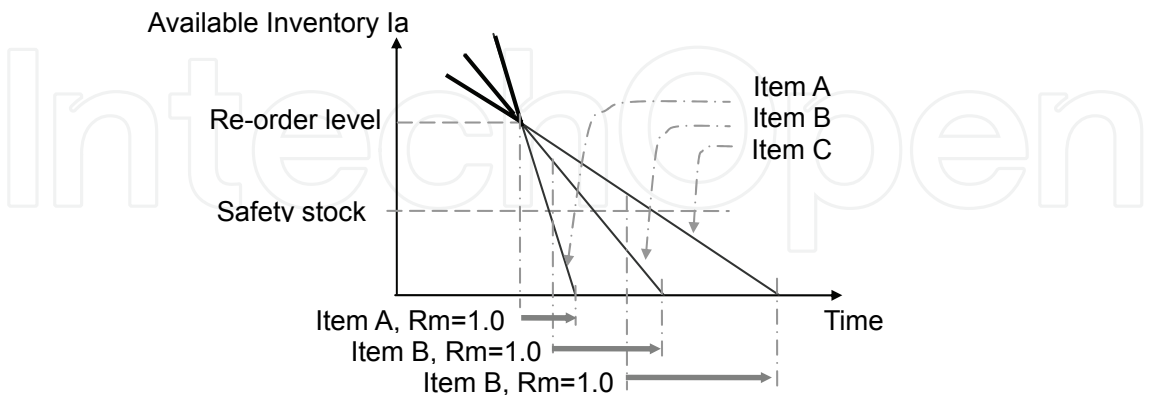


Figure 13. Definition of margin stock ratio

The margin stock ratio $Rm(n,i)$ is defined by the theoretical inventory of re-order interval period $Fd(n,i)$ and available inventory $Ia(n,i)$, denoted by equation (13).

When the available inventory is empty, the margin stock ratio Rm denotes zero, and this value means to occur the out-of-stock situation. When the available inventory is holding a lot, the margin stock ratio is bigger than one. While the margin stock ratio increases, the out-of-stock situation decreases. Thus, we are determined to assign the production capacity depending on margin stock ratio.

6.2 Determination of Replenishment Items

We are able to recognize two cases of the limited process capacity E . In the first case, the total replenishment quantity exceeds the limited process capacity E . In this case, we should determine the priority of the replenishment items. In the second case, the total replenishment quantity is below the limited process capacity E . In this case; we consider the remaining capacity for the precedence of the replenishment items.

Under the limited capacity, the choices of reorder items among multi-items is determined by the prediction of the out-of-stock situation called margin stock ratio $Rm(n,i)$.

Figure 14 shows, the replenishment items j is arranged by the margin stock ratio $Rm(n,i)$ in an ascending order.

The replenishment quantity is summarized by each item while the total replenishment quantity is equal or less than the limited capacity. It is denoted by

equation (14). Thus, we get the replenishment item’s number x^* , and determine the replenishment items $j = 1$ to $x^* + 1$.

Furthermore, although the last item x^*+1 exceeds the limited quantity, it is carried over to the next planning.

$$x^* = \left\{ \max_{1 \leq x \leq m} x \mid \sum_{j=1}^x Sr(j) < E \right\}$$

(14)

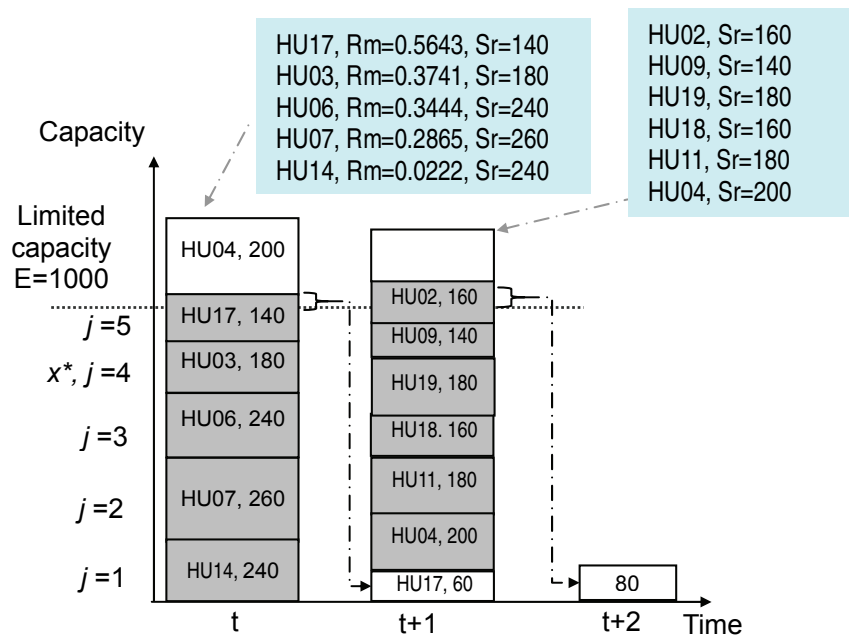


Figure 14. Determination of Replenishment Items

6.3 Calculation example of margin stock ratio

The determination of replenishment items by margin stock ratio are calculated by three steps.

Step 1 is the calculation of the margin stock ratio $Rm(j)$ with each item by equation (13) and makes its list. Table 1 shows the calculation example of the margin stock ratio $Rm(j)$.

Step 2 is the arrangement of the margin stock ratio $Rm(j)$ in an ascending order. Table 2 shows the example of the arrangement.

Step 3 is the determination of the replenishment items under the limited capacity E by equation (14). The replenishment items j are determined from 1 to

x^*+1 . For example, in Table 2, when the limited capacity E is 1000 unit / day, x^* is 4, then the replenishment items are HU14, HU07, HU06, HU03 and HU17. The last item is x^*+1 . Furthermore, the exceeded limited capacity (60 units) carries forward to the next planning, and the limited capacity of next planning E is 940. Similarly, the limited capacities E are 1400 and 1800, as shown in Table 2.

Item	Qd	Lcp	C	Fd	Ia	Rm	Sr
HU01	70	1	1	140	124	0.8857	140
HU02	80	1	1	160	140	0.8750	160
HU03	90	2	1	270	101	0.3741	180
HU04	100	2	1	300	173	0.5767	200
HU05	110	2	1	330	439	1.3303	220
HU06	120	2	1	360	124	0.3444	240
HU07	130	3	1	520	149	0.2865	260
HU08	140	3	1	560	764	1.3643	280
HU09	70	1	1	140	121	0.8643	140
HU10	80	1	1	160	153	0.9563	160
HU11	90	2	1	270	171	0.6333	180
HU12	100	2	1	300	350	1.1667	200
HU13	110	2	1	330	456	1.3818	220
HU14	120	2	1	360	8	0.0222	240
HU15	130	3	1	520	539	1.0365	260
HU16	140	3	1	560	617	1.1018	280
HU17	70	1	1	140	79	0.5643	140
HU18	80	1	1	160	105	0.6563	160
HU19	90	2	1	270	211	0.7815	180
HU20	80	1	1	160	221	1.3813	160
Total	2000			6010	5045		4000

Table 1. Calculation Sample of Margin Stock Ratio

Arranged					E=		
Order	Item	Rm	Sr	Σ Sr	1000	1400	1800
1	HU14	0,0222	240	240	*	*	*
2	HU07	0,2865	260	500	*	*	*
3	HU06	0,3444	240	740	*	*	*
4	HU03	0,3741	180	920	*	*	*
5	HU17	0,5643	140	1060	x^{*+1}	*	*
6	HU04	0,5767	200	1260		*	*
7	HU11	0,6333	180	1440	x^{*+1}		*
8	HU18	0,6562	160	1600			*
9	HU19	0,7815	180	1780			*
10	HU09	0,8643	140	1920	x^{*+1}		
11	HU02	0,8750	160	2080			
12	HU01	0,8857	140	2220			
13	HU10	0,9562	160	2380			
14	HU15	1,0365	260	2640			
15	HU16	1,1018	280	2920			
16	HU12	1,1667	200	3120			
17	HU05	1,3303	220	3340			
18	HU08	1,3643	280	3620			
19	HU20	1,3813	160	3780			
20	HU13	1,3818	220	4000			

Table 2. Determination Sample of Replenishment Item

6.4 Example of multi-items replenishment under the limited capacity

The effect of the capacity constraints replenishment by margin stock ratio is shown Figure 15. We have used the metal cutting center, the center was organized 4 machine lines, and kind of products is 6. The limited capacity of the center is 5800 (unit/day). In the upside of the figure, total re-order quantity is over the limited capacity. We make an inventory planning by the margin stock ratio every day. As a result, in the downside of the figure, the capacity / load became to flat by the margin stock ratio.

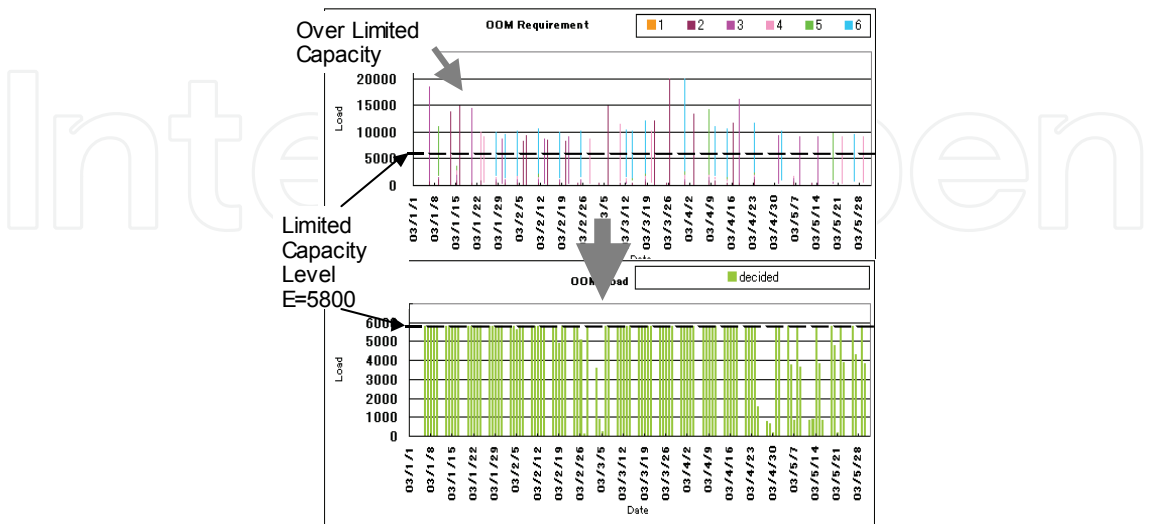


Figure 15. Example of multi-items replenishment under the limited capacity

7. Expected effect

We have been sure the expected effect of Coupling Point Inventory Planning.

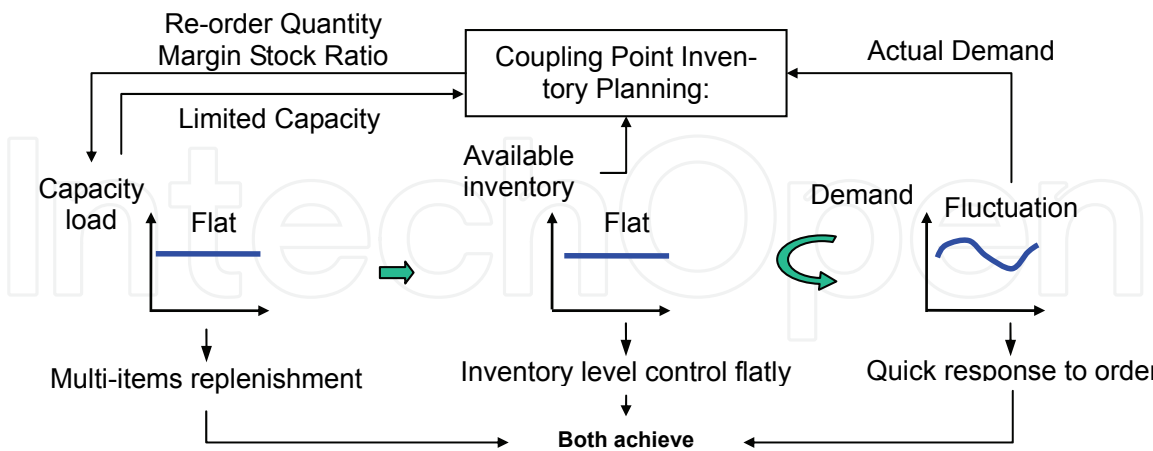


Figure 16. Expected effect of proposed method.

Figure 16 shows this method contributes to achieve three-way optimums;
(1) Quick response to order by CP establishment, as in Figure 8,
(2) To control the available inventory level flatly by the re-order calculation, as in Figure 12,

(3) The multi-items replenishment under the limited capacity by the margin stock ratio as in Figure 15.

8. Application of global SCM

We have some applications of global SCM shows Table 3. In this paper, we introduce to apply J Company.

J Company is the manufacture of electronics stationary to build the global SCM. The parts are made in Japan, the products are assembled in China, and the products are sold in the U.S.A, France, U.K, and Germany. Figure 17 shows they should consider the shipping logistics. We thought on boat means to equal the moving warehouse. Then we have been decided to apply Coupling Point inventory theory in 2001.

At first, we have been designed to apply on 100 main items in the number of all 1000 sales items, and have been chosen to pilot 2 devices and 3 accessories. The introduced method has been used 1 year on the pilot running. The inventory and the Shortage-ratio levels were the expectation, and the inventory became to decrease about 3 million US dollars in the global operation of 5 items. The introduced method was successfully applied.

Then, after the pilot, they have been spread to apply 40 items, and currently, they are sure to decrease inventory about 18 million US dollars in the global operation.

from 1993 to 2004		
Corp	Kind of products	Effect
A	Window frame	Inventory reduce 25%, delivery 5 days
B	Computer Storage	Inventory reduce 25%, delivery 2 weeks
C	Electronics parts	Inventory reduce 85%, delivery 7 days
D	Communication device	cash reduce 28Mus\$, delivery 7 days
E	Car navigator	Inventory reduce 25%, delivery 3 days
F	Personal computer	ROA up to 3.2, delivery 3 days
G	Semi conductor	cash reduce 28M.us\$, delivery 7 days
H	Home electric	cash reduce 95M.us\$, delivery 3 days
I	Window frame sales	cash reduce 57M.us\$, delivery 7 days
J	Electronics stationary	cash reduce 18M.us\$, delivery 2 days
K	Foods can	cash reduce 47M.us\$, delivery 7 days
L	Chemical 5 divisions	Inventory reduce 15~25%, delivery 7~15 days
M	Chemical plastics	Loss reduce 5%, delivery 7 days
N	Motor car parts	Inventory reduce 25%, 1 day delivery

Table 3. Applications of global SCM

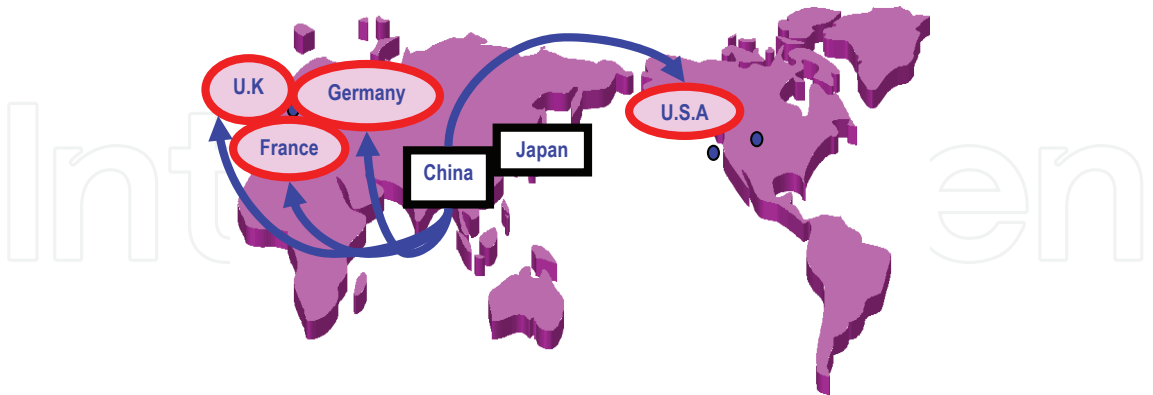


Figure 17. Application of global SCM

9. Conclusions

In this paper, we introduced a new supply chain solution based on Coupling Point Inventory Planning. The introduced method has been developed by Hitachi, Ltd., in 1993. This method has been achieved three-way optimums; quick response to order, the available inventory level flatly without demand forecast, and the multi-items replenishment under the limited capacity. The introduced method was successfully applied to decrease inventory in some cases. We are also successfully applied to replenish without demand forecast and bull whip.

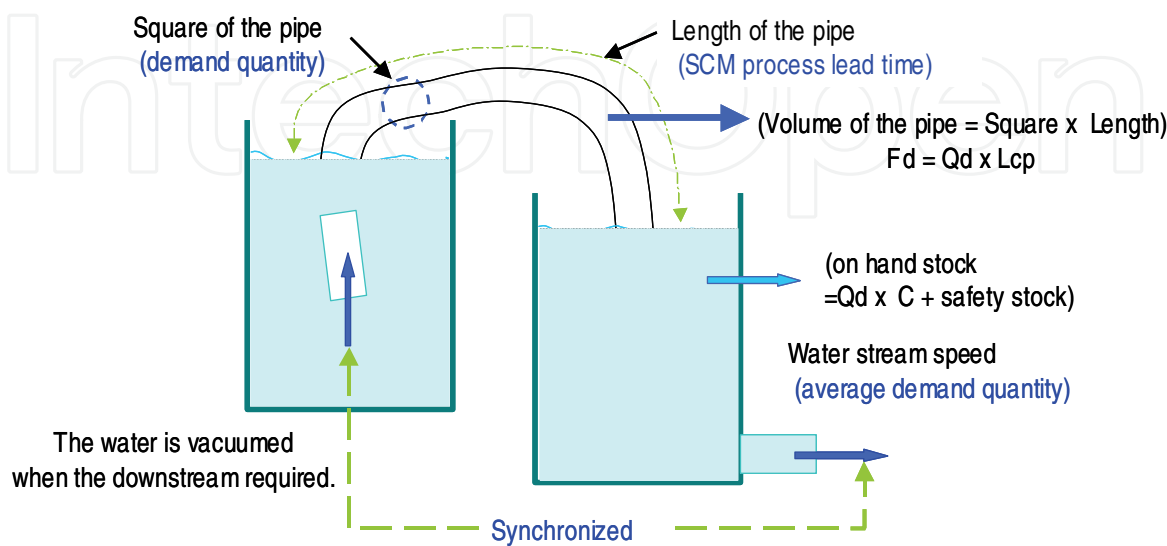


Figure 18. Understanding by siphon (analogy)

We also apply to combine the production system based on order and demand forecast in case of non-repetitive products, to experience the various situations of demand and supply, and to spread in the global SCM.

Lastly, we are able to easily understand the Coupling Point Inventory Planning theory. Figure 18 shows that the siphon is an analogy of SCM based on Coupling Point Inventory Planning. The water flows from upstream to downstream by using siphon without the pump. The volume of the pipe is able to calculate by using the length and square of the pipe. The water at the upstream is vacuumed depending on synchronized demand when the water of the downstream is used. The water stream has a lead time between from the upstream to the downstream. However, the siphon is not using of the future demand forecast after the laps of lead time.

Furthermore, we should challenge much more to use for Global Just-In-Time by Coupling Point inventory theory.

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