Inventory Control System by Using Vendor Managed Inventory (VMI)

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Abstract. The inventory control system has a strategic role for the business in managing inventory operations. Management of conventional inventory creates problems in the stock of goods that often runs into vacancies and excess goods at the retail level. This study aims to build inventory control system that can maintain the stability of goods availability at the retail level. The implementation of Vendor Managed Inventory (VMI) method on inventory control system provides transparency of sales data and inventory of goods at retailer level to supplier. Inventory control is performed by calculating safety stock and reorder point of goods based on sales data received by the system. Rule-based reasoning is provided on the system to facilitate the monitoring of inventory status information, thereby helping the process of inventory updates appropriately. Utilization of SMS technology is also considered as a medium of collecting sales data in real-time due to the ease of use. The results of this study indicate that inventory control using VMI ensures the availability of goods ± 70% and can reduce the accumulation of goods ± 30% at the retail level.

1 Introduction

Market changes demand complex business processes. Business complexity issued to answer questions about how businesses deal with daily changes, what business actions can predict and prepare businesses for change [1]. In line with technological developments with faster and cheaper information exchange, business processes especially for controlling inventory can grow rapidly.

The right inventory system can be used for tracking, recording, and providing information related to the product. The inventory system has an important role in monitoring the condition of the product [2]. One of the methods that governs inventory is the Vendor Managed Inventory (VMI). VMI grants full right to the suppliers to control inventory and manage amounts of products inventory for stores. VMI performs transparency of sales data and stock levels to the suppliers [3-4]. VMI offers benefits to the stores due to the high availability of the product and provides an opportunity for distributors to improve the efficiency of their product marketing, and is able to maintain the availability of fluctuating demand and demand uncertainty [5]. VMI responds quickly and efficiently in meeting customer needs as well as being a decisive factor for business survival and development of business prediction [6].

Scheduled inventory management is not based on the high sales of goods but is carried out with a fixed delivery period. This results in a shortage of inventory under high sales conditions and excess inventory under declining sales conditions at the retailer level. This researches one solution to solve business complexity to control inventory for distributors in the delivery of the appropriate goods. The inventory control system built can maintain the stability of goods availability that refers to the level of sales at the retailer level.

2 Vendor Managed Inventory (VMI)

Vendor Managed Inventory is an inventory and procurement approach, in which the supplier is responsible for managing and updating stock. This seems to contradict the principle of pull scheduling, since the previous process (production) deciding how much and when it will be sent to the store/retailer. In practice, the information reference lies with the store / retailer through sales information. Within the VMI, suppliers have to monitor sales and inventory, then information will be generated when the procurement is done [7].

The implementation of VMI in the supply chain simplifies the steps that occur when the purchase information made by the last consumer can be accessed directly by the distributor / supplier. Thus the feedback to determine the speed of the flow of goods can be known. The supply chain in the VMI is shown in Fig. 1, the firm line represents the material flow from the factory to the last consumer opposite the dashed line indicating the information flow. By applying VMI, the sales information at stores/retailers to suppliers, can be simplified, so that information can be immediately known.
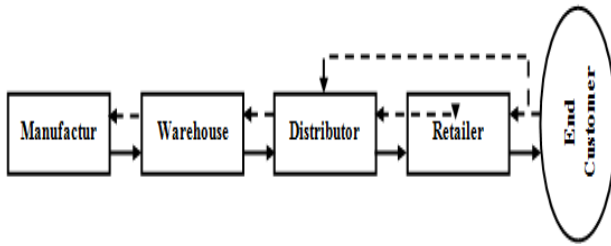
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Fig. 1. Supply chain of VMI [8]

The material flow and information flow on the VMI supply chain is shown in Figure 2, the dotted line indicates how the VMI system controls the transactions in the store / retailer, procurement of goods is processed based on sales data input and stock levels. After that, the delivery of goods is set to ensure the availability of goods.
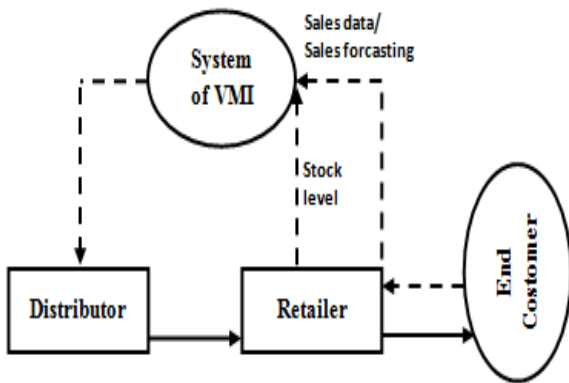

Fig. 2. Material flow and supply chain information of VMI [3]

VMI performs data transparency in the form of sales data and stock levels to suppliers [3]. Implementation of decision support systems on VMI, generating profit in the form of dramatic developments in customer service levels as well as a significant increase in inventory turnover [9].

3 Inventory Control

Inventory control is performed to maintain the stability of the availability of goods in accordance with the high low sales of goods. Inventory control is performed by passing the calculation of *safety stock* associated with time and amount of sales that are not constant. The estimation of sales variation in the N period is shown in Figure 3, so the modeling estimation of safety stock based on the standard deviation of sales as given in Figure 3 produces the calculation of sales standard deviation Equation 1. And *safety stock* in Equation 2.

$\sigma_t(i, j)$ is standard deviation of the sale of goods j in store j by walk t calculated in the period N, N is fixed in accordance with the period that has been running. In one distribution period it is estimated to be sold out within 14 days, thus using the period N = 14. Meanwhile, ST as *safety time* is the estimated time of safe distribution of

the product up to the store in days and SS as the *safety stock* which is the estimated safe stock in the unit Pcs.
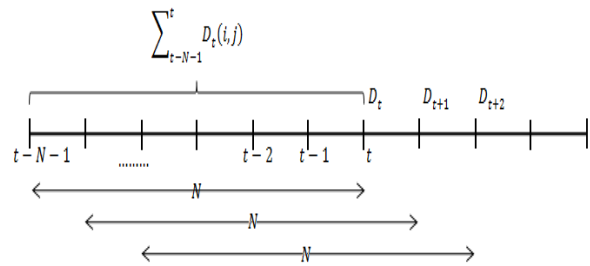

Figure. 3. Estimation of sales based on N period

$$\sigma_t(i, j) = \sqrt{\frac{\sum_{t-N-1}^{t} D_t{}^2(i,j) - \frac{\left(\sum_{t-N-1}^{t} D_t(i,j)\right)^2}{N}}{N-1}} \qquad (1)$$

$$SS_t(i, j) = \sigma_t(i, j) . ST \qquad (2)$$

4 Estimation of Re-Stock Updates

The estimation of re-stock updates is performed to meet the need of demand for using *reorder point* (ROP). Stock changes will be made if the current stock position is smaller than the ROP, and then, the products will be sent on the difference between the current stock position and the required stock. The calculation of *reorder point* based on the average sales in a certain period of time plus *safety stock*, then stock renewal will be done based on the number of *level reorder* that must be achieved using Equation 3 and Equation 4.

$$r_t(i, j) = LT. \frac{\sum_{t-s-1}^{t} D_t(i,j)}{S} + + SS(i,j) \qquad (3)$$

$$R_t(i,j) = \frac{\sum_{t-s-1}^{t} D_t(i,j)}{S} + + r_t(i,j) . \qquad (4)$$

$$Q_t(i,j) = R_t(i,j) - IP_t(i,j) . \qquad (5)$$

The calculation of *reorder point* is performed monitoring periodically with period S, then R as the number of product that becomes the target number of product inventory j in store i, IP is the current stock position, and Q is the number of product j that will be sent back to shop j so the position Product inventory reaches level R [9].

5 Methodology

Research that has been conducted has stages to be done in the information system built. These stages start from the determination of input, storage, process, and output.

The form of system design is modeled in accordance with the purpose of this research: to build inventory control system using VMI method shown in Figure 4. The system explains the existence of two current flows that is flow of material and information. Material flow in the form of a firm line from suppliers to stores through the process of delivery of goods, while the flow of information from stores to suppliers starts from the amount of goods sales, then control is performed on the amount of inventory that is important for the supplier in the delivery of goods.
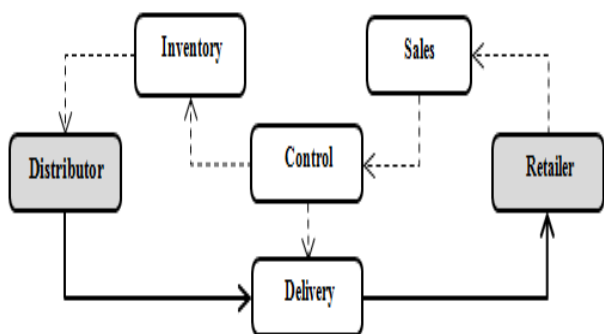

Fig. 4. Model of inventory control system

Changes in inventory due to a final buyer transaction on the store are monitored through a control system. Everyday, sales data in the form of goods code and the amount sold is sent by the shop owner via SMS facility on mobile devices. Data of the inventory changes and sales become system input that will be processed by the system.

Sales data stored on the system will be processed through the calculation of safety stock (SS) as in Equations (1) and (2) and ROP as in equation (3), and (4). The result of the calculation will be compared with the inventory quantity in the store using rule-based reasoning to determine the inventory status as shown in Table 1. Next, at the status of warning inventory, the amount of goods to be distributed is calculated as in (5). The output obtained in the form of product inventory status information in the store whether to re-distribute or not, so that it can be known immediately, when and the right amount for the goods distribution of each store.

Table 1. Rules for determining inventory status

No	Ruler	Status	Definition
1	IP < ROP	Secure	No delivery
2	SS<IP<ROP	Backup	Prepare of delivery
3	IP<SS	Alert	Immediate delivery of goods according R level

6 Results and Discussion

The monitoring of the store's stock of products is generated from the safe stock and ROP calculation through the implementation of Equation (2) resulting in

the safe stock of the product, Equation (3) resulting in the number of product ROP and Equation (4) generating the number of goods to distribute. Based on product sales data, inventory control in the form of safe stock amount is obtained, ROP and level R as shown in Table 2.

Table 2. Total safe stock, ROP, and Level R

Date	IP	D	SS	ROP	R level
1-Jun	53	33	31	48	53
2-Jun	58	21	33	52	58
3-Jun	37	25	36	57	64
4-Jun	64	20	36	57	64
5-Jun	44	0	36	57	64
6-Jun	44	0	36	57	64
7-Jun	44	0	36	57	64
8-Jun	44	28	39	66	75
9-Jun	86	30	41	75	86
10-Jun	56	19	41	78	91
11-Jun	96	20	40	82	96
12-Jun	76	0	40	82	96
13-Jun	76	0	40	82	96
14-Jun	76	0	40	82	96
15-Jun	76	21	37	76	89
16-Jun	55	30	39	80	94
17-Jun	90	17	37	77	90
18-Jun	73	12	37	75	88
19-Jun	61	11	35	76	89
20-Jun	50	10	34	76	90

Inventory control is performed daily on the amount of inventory available in the store through the safe stock calculation and ROP in equation (2), (3), and (4) based on the input of goods sales data. Table 2 shows that on June 20, 2016 the number of safe stock was 34 pcs, ROP was 76 pcs and level R was 90 pcs which would be compared to the last inventory at the store.

The rules of inventory status determination in Table 1 provides convenience in monitoring the inventory status of the goods on the store as given in Figure 5. This provides information for suppliers to determine whether or not to re-ship the goods in controlling the store's inventory. The alert status is interpreted as a warning to immediately deliver the goods in accordance with the needs.
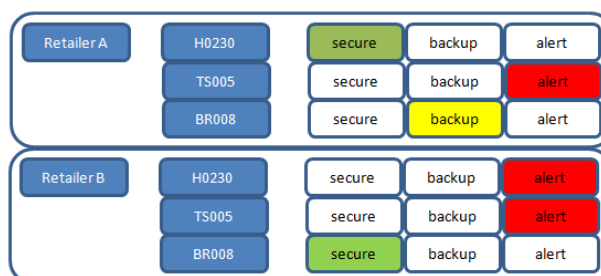

Fig. 5. Monitoring of goods inventory at stores

Based on the monitoring of goods performed by suppliers, the goods can be delivered in accordance with the store needs. Inventory control using VMI is shown in Figures 6 and 7 in the period from 1st to 20th of June 2016, the amount of inventory follows the high sales.
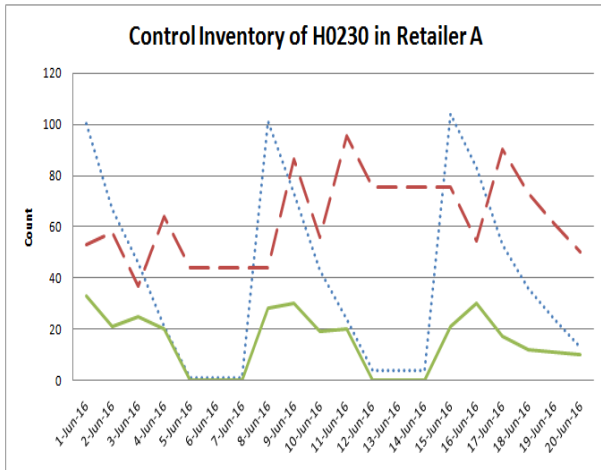

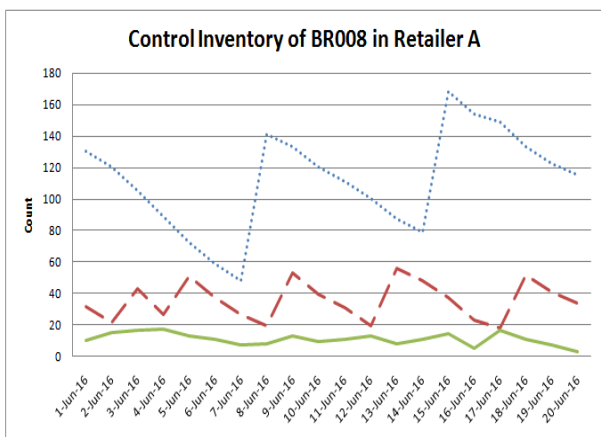**Fig. 6** Control Inventory of H0230 inventory in retailer A

Fig. 7 Control Inventory of BR008 in retailer A

In Figure 6, a firm line shows the number of sales, the dotted line indicates the number of scheduled inventories and the dashed line represents the amount of inventory using the VMI. It is said that the level of availability of H0230 products on Store A through VMI's inventory control is more secure because of safe stock calculation and stock renewal so that stock can be stable. The stability of the goods inventory in the period 1st to 20th of June 2016 was fulfilled with the lower limit of 37 pcs and the upper limit of 96 pcs. This was not found in scheduled stocks because of the void of goods supply for several times. Safe stock estimation that is always updated daily allows sales transactions to be done more with inventory of existing products on the store. Monitoring the inventory status of the goods in the store can provid inventory information before the inventory amount is running out, so the delivery of goods can run again in accordance with the needs of the store.

Figure 7 shows that BR008 on Store A is experiencing low sales, but has a high inventory in scheduled stock. Inventory control using VMI follows the sale transaction of the goods. The sales transaction of the goods BR008 that is relatively low has resulted in low inventory of BR008 as well. The inventory status monitoring also provides information that the inventory is still sufficient so that no deliveries are returned to the store. This can reduce the amount of the product BR008 stock accumulation in Store A so that it can anticipate the return of large quantities of products to the suppliers.

7 Conclusion

The inventory control system that uses VMI equipped with sms technology can be used to monitor inventory of goods in accordance with the needs of retailers. Inventory control can be done through the calculation of safety stock and reorder point based on the data of daily good sales. The monitoring of inventory status is also given in detail because a similar item in different stores has different sales levels as well, moreover if the different items are at different stores. The result of using the system gives benefit for the store in the availability of goods as shown in the higher product availability level on H0230 product at shop A by ± 30%. The distribution is done based on the needs of the store by looking at the condition of the product inventory as in BR008 product in store A so as to reduce the risk of return of the product in the future by ± 70% due to the accumulation of unsold products in the store. Inventory management by using VMI maintains inventory stability by balancing the amount of supply with the sales.

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