Vendor Managed Inventory Practices: A case in Manufacturing Companies

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***Abstract*— The implementation of the Vendor Managed Inventory (VMI) in the Malaysian manufacturing sector can be viewed as a solution to mitigate the increment of operational costs and low performance in customer services. Many factors contributed to the performance of the VMI programme, but only a few attempts was made to determine the contribution of the VMI elements on VMI performance. The objectives of this study were to investigate the level of VMI practices, organizational factors and VMI performance; and to examine the influence of type of product on VMI element and VMI performance. The study used qualitative approach, which data were gathered from semi-structured questions through interview process. There are 4 manufacturing companies listed in the Federation of Malaysian Manufacturers were selected for data collection purpose. The findings showed that high information sharing, moderate level of inventory control, close inventory location to customer premises, inventory ownership, mutual decision on inventory replenishment are among VMI practices in manufacturing companies. The respondents also confirmed that the influence of type of product characteristic onto VMI performance only to a limited extent. As a recommendation, supplier and customer must design their VMI program, which suit to product characteristics. Another important part is VMI agreement should be balanced between the need of supplier's authority in controlling customer's inventory and current capability of supplier. They should consider the flexibility of VMI system, especially the capability to reduce cost on behalf of the supplier and to provide better service to the customer.**

***Keywords*—** *VMI elements, types of product, manufacturing companies*

1. Introduction

VMI was first popularized by Wall-Mart and Procter Gamble in the late 1980s in the retail industry. Successful VMI initiatives have also been trumpeted by many companies such as Whitbread Beer Company, Barilla, Johnson & Johnson, Kodak Canada Inc. and Campbell Soup. Presently, VMI was also being implemented by automotive, machinery services, chemicals, packaging, and wood and furniture industries [1], [2] but variety of industries which comprise range of products, accessories, and raw materials had also practiced VMI [3].

In VMI programs, customers authorised suppliers or vendors to generate orders based on the shared information provided by the customers such as forecast, point of sales data, and production schedule. A good collaboration between customers and suppliers through information sharing lead to better responsiveness to the customers' inventory needs in terms of quantities and locations to be replenished. Therefore, supplier can make decisions that are more accurate on customer's inventory replenishment, which then give many benefits to the members in supply chain.

Some of the advantages of VMI implementation, generally mentioned in the literature [4]–[6] include reduction in the uncertainty of customers' demand, reduction of inventory level, reduction of stock out number and frequency, more flexibility in production planning and distribution, and improvement of customer services. According to [7], VMI can give benefits to both customer and suppliers including the increase of services level, inventory reduction, reduce of planning and ordering costs, ease in coordination supply process, and reduced transporters.

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2. Problem statement

Although many studies indicated that VMI program has effectively improved cost reductions and services, few studies shown contrariwise [1]. The different benefits, challenges and risks of VMI program were due to different design of VMI [8], [9]. Therefore, VMI design are crucial in ensuring that the VMI program is well understood and benefited to the companies especially manufacturers as suppliers, who are responsible to the customer's inventory.

Seeing the succeeding of the VMI program, hopefully it can also contribute to Malaysian manufacturing companies with significant and necessary advantage to compete both locally and globally. In addition, although VMI program has been recognized and implemented in most of the Malaysian manufacturing companies, literature review indicates that there were very limited studies conducted in supply chain collaboration strategies area especially VMI program. As a result, a study in Malaysian manufacturing companies would contribute significantly to this area. Therefore, it is crucial to understand the VMI practices in Malaysia manufacturing companies.

3. VMI components

3.1. Inventory Location

Among the important elements in VMI program is the inventory location [10]. [3] referred inventory location as inventory physical location, which is managed by vendor in VMI practice. Inventory location can be located in both the supplier's and the customer's premises [3]. This arrangement will enable the supplier to use it to buffer against short delivery cycle, unsynchronized production cycle, and respond quickly to demands or usage needs [3]. However, there is also incurrence of high inventory holding costs, given the need for storage, material handling and tracking, and given the threat and expense of inventory obsolescence, particularly when operating in highly volatile demand [11].

In the VMI practice, the inventory can also be located at the customer's premises in a distributed manner, for example, directly at the manufacturer's production line or at the retailer's shop floor (Hines et al., 2000). In this alternative, the vendor replenishes the inventories at all the consumption area, which includes store, production line, and machine. However, supplier will experience increment of workload in administrating inventory compare to the customer [3].

On the other hand, the supplier can deliver to a customer's central warehouse[3]. This approach will enable the optimization of deliveries of products or raw materials, which procured from several vendors to plants, stores, construction sites or other points of consumption [9]. In general, the more centralized an operation is, the lower the safety stock levels are, then will lower the total overhead cost, lower transportation cost, and achieve economies of scale [12].

Alternatively, the supplier can use and deliver to a third party warehouse. This alternative can also be an advantage when the customers do not have a physical presence in a certain market or have outsourced part or all of their logistics activities [3]. [13] added that this also provides the customer with flexibility. Particularly, if supplier does not have warehouse that near to the customer factory whereas customers desire it. This solution might also be suitable if the customer does not possess the expertise or special facilities for storing the products or raw materials such as chemicals, or if the customer does not have a physical presence in a certain market, or has outsourced parts of its operations such as manufacturing, sales or distribution [3].

As a conclusion, centralization of multiple inventory locations into a single location can reduce the cost through the optimization of deliveries. In addition, if inventory location is closer to the consumption location, the supplier can be more responsive to their customer's needs.

3.2. Inventory Ownership

Inventory ownership refers to the ownership of the inventory and when the invoice is being issued to the customer [3]. The literature discovered numbers of different mode of payment and transfer of inventory ownership in VMI. Owning the inventory meaning the company is accountable for the capital costs, obsolescence costs, and subject to a fluctuation in prices of inventory [11]. Managing the entire inventory system by one of the partners will allow the supply chain to be synchronized better according to both companies' cost characteristic [14].

Supplier can own the inventory at the customer's location and invoicing to the customer while the inventories were withdrawals from the storage, thereby increasing the supplier's inventory investment [15]. This approach can support supplier to increase the sales of the manufacturer's other product by pushing the new products to the market and to place special products in the main assortment of their retailer [9].

Another alternative is customer accountable on inventory ownership and the invoice was issued

when the inventories was received. However, the payment from customer to supplier was only made when customer withdrawal the inventories from the storage and with a pending based on agreement of payment [3]. This alternative may give customer the responsibility on the risk of holding the inventory such as the expense of storing, obsolescence, handling and tracking these purchased items, but supplier are [11]. Thus, risk-sharing was existed in this type of inventory ownership whereby supplier received the payment for all the inventories that have been delivered [3]. However, the supplier can experience opposing effect on their cash flow when customer had extended and suspended the payment [13] and subjected to price fluctuations [11].

In the other setting, the ownership of inventory was retained on customer upon delivery, and the customer receives the invoice from supplier once the shipment has been made [9]. This approach can be referred as a standard process of in a traditional order-delivery. In this circumstance, customer is responsible to all inventory investment cost and inventory holding cost, but they can protect themselves against future price increase.

3.3. Level of Demand Visibility

These elements concern with the type of demand information shared by customer to assist the supplier in controlling their inventory. There are many types of demand information shared in VMI program. Among the demand information that were visible to the supplier comprise of sales data, stock withdrawal, production schedule, inventory level, goods in transit, back order, incoming order, and return [2].With the increasing visibility of demand information the supplier will has longer timeframe for replenishment arrangement [4].

[16] argued that sharing sales data and inventory level can improve the supplier's production planning with more stable production plan. They added that supplier can use the data to understand the seasonal changes at the factory and know when critical times will occur. However, by using this type of data, the supplier may require extra time to compare the data of the required production with his own production capacity and to come to a decision regarding their own investments and productions.

In other alternatives, demand data contains the re-setting of forecasts based on actual market trends [3]. The data related to each month was updated week by week. The suppliers can take advantage of this information and plan their own production capacity based on the customer's requests [16]. Forecasts were also used in combination with the current allocations. This data is based on real quantities of produced and sold items (POS), orders received and bills of material, which is updated every week. The data, usually transmitted by using EDI, is used for the daily check of target stock, replenishment needs, and for updating the delivery plan [16]. Therefore, the accuracy of the data must be high and the time required to update the data must be quick before supplier uses the data [17]. Generally, the more the demand data shared between the customer and supplier the more benefits can accrued. When suppliers have sufficient information, they can make better planning and response to customer's demand in order to replenish the customer's inventory.

3.4. Inventory Control Limits

The inventory control limits in VMI program refer to how the supplier controls the inventory [3]. Normally, in the case of VMI, the supplier is responsible for maintaining a continuous stock level within the predefined limits. The inventory control limits were calculated based on the expected demand over respective replenishment lead times. The inventory control limits can be used to avoid extremes inventory [18]. By reducing the maximum level, average inventory levels can be reduced and thereby increase the turnover rate and reduce inventory carrying costs [2].

The minimum and maximum limits can also be used to protect product availability for the buyer [5]. In most cases of VMI practice reported the implementation of minimum and maximum limits for the inventory control are coupled with penalty costs for the suppliers who did not meet the requirement [2]. In order to make sure the availability of inventory, supplier uses safety stock to create slack in the supply chain, which in turn increase the customer service levels, but increase the inventory related costs.

[19] has also proven that setting the maximum limit is crucial to reap cost saving in production, replenishment and transportation, especially if the vendor owns the inventory. Although, there was inventory control limits, the supplier can still modified the suggested delivery plans to minimise transportation costs, give priority to the orders of customers in critical situations, or to satisfy additional orders falling in the frozen planning horizon as long as inventory level is within the limits [20]. However, [10] argued that in a true VMI, there are no minimum and maximum limits that enable the supplier to plan its own production and decide upon the replenishment schedule as long as the agreed customer service levels are met.

To conclude, the inventory control limits here can be referred as to what extent safety stock, penalty cost, minimum and maximum limits of inventory were applied in order to ensure the availability of

stock. Although setting control limits for managing inventory seems to be not a true design of VMI, the advantages of it have influenced many companies to implement it [10].

3.5. Replenishment Decisions

In VMI program, replenishment decision can be made and fully determined by the supplier [21]. where supplier has the authority to decide on both quantity, time for delivery [3], and location [13]. Rationally, it provides supplier with autonomy and flexibility in managing inventory on behalf of customer. With the supplier's authority, generated order will be more accurate and represent true demand in marketplace [13], improve and optimize manufacturing and distribution activities [21] and reduce out-of-stock cost by prioritizing the customer orders [17]. However, when the customer had the authority in deciding the delivery time and quantity of inventory to be replenished, the supplier unable to maximize distribution activities through the full truckloads. Especially, if the supplier is unable to synchronize the delivery frequency parallel to the optimal production and delivery cycles [10].

Therefore, we can conclude that there are more benefits if the supplier is responsible for replenishment process compared to the customer. Suppliers are known for their capability in determining when to replenish and how much to replenish customer's inventory based on the information provided by the customer. So, these elements can be referred as to what extent supplier is responsible to make replenishment decisions of inventory in term of when and how much. Based on literatures, the following hypotheses were developed.

4. Research Methodology

Case study research is chosen to increase the understanding of Vendor Managed Inventory practices. We believe that through direct observation and systematic interviewing, the case study methodology allows us to understand in-depth a new supplier-retailer collaboration program. In order to increase consistency and accuracy of case study approach, recommendation procedures from previous studies has been used [22], [23] to ensure the validity and reliability of this study.

Researcher has chosen four respondents, which involved in VMI program and act as supplier in manufacturing industry. According to [22] number of case must be more than three and below than ten cases are sufficient to generate strong empirical data and manageable. The selected respondents who volunteered to contribute their opinions on the results possesses as managers of manufacturing company from medium-sized and large-sized. They indicated that their firms involved with VMI program and managed their customer's inventory. Their customers were not only end-users and they may comprise of assemblers and distributors. In case A, C, and D, the company is a supplier to manufacturer that used their product in the assembling processes. For the case B, the company involve in retailing industry, which supplying finished goods to their customer whether as a distributor or retailer.

For the purpose of data collection, researcher has used semi-structured interview and direct observation with respondents. Construct validity was conducted on acquired data at two stage. At first stage, interview transcribed was sent to respondents in order to attaint validity of data prepared by researcher is similar what has been presented by respondent during interview session. At second stage, a summarized finding was sent once again to acquired opinion and critics whether the findings fulfilled actual respondent in practicing VMI.

5. Findings

The major findings in all cases appear to suggest that visibility of demand is a factor improving service performance in VMI program. Among the shared information includes: historical data; point of sales data; forecast from customer; production planning; inventory level; backorder; and goods in-transit. Although, in the case B shows that the information shared were less than other cases, they suggested that if more information were shared between customers, the VMI performance could be increased. Company in case B experienced more issue in availability of inventory at customers storage include shortage and excessive in supplying inventories to their customers. In addition, findings from case also noted that information system used is less compatible with their customers due high cost in installing good information and communication system. As for the future needs, they recommended that government should facilitate, especially SMEs companies to acquire information and communication infrastructure by providing a better fund scheme. In the other hands, inventory control limits also plays a significant role to ensure the availability of customer inventories. Case A, C, and D reported that they applied minimum and maximum limits for inventory control, except for case B. Most of company argued that the application of inventory control limits is policy bonded in the VMI contract.

In term of inventory ownership and replenishment decisions element, most cases reported a limited impact on VMI performance. Although, they have the possession of inventory, but most of the decision

regarding to inventory replenishment requires confirmation from their customers. The suppliers were not given enough authority to decide on inventory replenishment. Thus, the replenishment decisions are made mutually with their customers and failed to increase the performance of VMI. These situations can impede the opportunities of supplier to take advantage of VMI through ownership of inventory and replenishment decision.

Meanwhile, the proximity of storage location to customer location contributes to VMI performance only a limited extend. For an example in the case A, even though, they have an abroad VMI customer, but still capable to reduce the cost and improving services through the third party logistics and warehouses provider. However, they also noted that administration of inventories would be easier for the local customers due to less of business procedures compared to doing business abroad, which need to comply with procedure and government policy.

As these cases explicitly suggest type of products plays significant moderating role in promoting better performance. Both, innovative and functional product have significant role in promoting better performance of VMI program. In term of relationship between visibility of demand and VMI performance, both type of product shows important role but at the different level. For an example, the visibility of demand in case B helps them to manage the variety of product that offered to their customer more effectively. However, the advantage of sharing demand information is more obvious for functional product as in case A and D. The more predictable demand and low forecast error assist the company to optimize the transportation cost and ordering cost. On the other hand, the moderating effect of type of products shows minimal impact on relationship between inventory ownership by supplier, inventory location, inventory control limits, and replenishment decisions and VMI performance.

To conclude, the respondents validated that VMI elements contributes to VMI performance and confirmed the influence of type of product characteristic onto VMI performance only to a limited extent.

Table 1. Summary of Cases Finding

	Case A	Case B	Case C	Case D
Type of Industry	Electronics	Food related	Automotive	Chemicals
VMI implementation	Yes	Yes	Yes	Yes
Level of demand visibility	Historical data; point of sales data; forecast from customer; production planning; inventory level; backorder; and goods in-transit	Historical data; point of sales data; forecast from customer; inventory level; and goods in-transit	Historical data; point of sales data; forecast from customer; production planning; inventory level; backorder; and goods in-transit	Historical data; point of sales data; forecast from customer; production planning; inventory level; backorder; and goods in-transit
Inventory control Limits	Applied minimum-maximum limits and provide safety stock	No minimum-maximum limits; do not provide safety stock	Applied minimum - maximum limits and provide safety stock	Applied minimum-maximum limits but do not provide safety stock
Inventory Location	Storage location close to customer location, transportation lead time short	Storage location moderately close to customer location, transportation lead time moderately short	Storage location close to customer location, transportation lead time short	Storage location close to customer location, transportation lead time moderately short
Inventory Ownership	Own customer inventory, responsible to holding cost, exposed to price fluctuation	Own customer inventory, and responsible to holding cost, not exposed to price fluctuation	Own customer inventory, and responsible to holding cost, moderately exposed to price fluctuation	Own customer inventory, responsible to holding cost, exposed to price fluctuation
Replenishment Decisions	Supplier make replenishment decisions but subjected to customer confirmation in term of time delivery	Supplier make replenishment decisions in term of quantity and time to deliver	Customer propose in term of quantity and time to deliver	Supplier make replenishment decisions but most of time supplier need confirmation from customer in term of time delivery
Does type of product moderate the impact between VMI elements on VMI performance?	Yes, at minimal impact.	Yes, at minimal impact.	Yes, at minimal impact.	Yes, at minimal impact.

6. Conclusions

Visibility of demand, inventory control limits, and inventory location are three components of VMI elements. Sharing information and application of inventory control limits are crucial for VMI performance, especially in term of inventory availability. While proximity of inventory storage location is requires for reducing cost associated to inventory management. As every product will experience different stage of product life cycle, the characteristics of products may also change.

Therefore, changing in product life cycle should be accompanied with changes in VMI elements.

Therefore, supplier need to evaluate its VMI elements and characteristics of products supplied to the customer. This assessment also would assist supplier and customer in designing VMI, specifically on how it will operate to achieve firms' competitiveness. By continuously assessing their VMI program, VMI as firms' resources cannot be imitated; this in turn can sustain their performance.

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