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FACILITATING INFORMATION FLOW OF VENDOR MANAGED INVENTORY VIA THE INTEGRATION OF ELECTRONIC DATA INTERCHANGE AND ADVANCED SHIPPING NOTICE

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ABSTRACT

Vendor managed inventory is an advanced strategy in which responsibilities such as monitoring, planning and direct replacement of goods are assigned to the vendor by the customer. Such a strategy is based on a close relationship between the vendor and customer and demands the establishment of a targeted flow of information. The outcome of this strategy is the reduction of costs and the increase in the service level for both parties (win-win strategy). In this article, we try to study how the vendor managed inventory system works, and what is the role of electronic data interchange system in its implementation, how to reduce costs and increase the service level and what obstacles and problems are posed during the implementation. Also, how the incoming commodities are monitored through advance ship notice (ASN). Two case studies of the effects of vendor managed inventory in the steel and electrical equipment industries are addressed as well.

***KEYWORDS*:** Vendor Managed Inventory, Information Flow, Advanced Shipping Notice, Electronic Data Interchange

1. INTRODUCTION

The term Vendor Managed Inventory (VMI) was coined by Wal-Mart in the United States in the early 1990s. At that time, Wal-Mart as a supplier and Prester & Gamble as a distributor in the retail industry based their partnership on vendor managed inventory. In fact, improving supply chain efficiency by targeting inventory management was the philosophy behind the VMI strategy in the early 1990s (Gröning & Holma, 2007, McBeath, 2003). This strategy is a continuous commodity exchange program in which the responsibility for all decisions to replace customer inventory is given to the supplier, who is sometimes the vendor, the manufacturer, or a distributor. In fact, vendor managed inventory, instead of pressuring the supplier to deliver the goods on time, gives him full responsibility and authority in managing the entire customer inventory replacement process. In the meantime, the exchange of information that exists between the customer and the supplier causes the right product to be provided for the customer in the right number and at the right time (Fig. 1).

Therefore, considering the key and sensitive role of VMI and the importance of exchange value and information sharing in supply chains and consequently in the vendor managed inventory, we intend to examine the information flow in the vendor managed inventory. This is conducted through elaborating the integration of the two technological tools, i.e., EDI and ASN in the context of providing practical information flow paradigm. Section 2 provides a suitable context for the purpose of this article by stating the research background. In Section

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3 by proving some benefits of vendor managed inventory, we conclude that better information flow between the parties leads to change and success of the system. At the end of this section, we review the results of the Electrical Industry Supply Chain Association's survey on the motivation of organizations to use VMI. In the next section, referring to the fact that information and communication technology is a tool for creating and implementing strategy in the organization, the data exchange system and Advanced Shipping Notice (ASN) is mentioned as a tool for data transfer in the implementation of vendor managed inventory strategy. Then we examine their application in the vendor managed inventory structure. By examining the information that is exchanged between the customer and the supplier, two different information flow models in the VMI system are presented within Section 5. Section 6 considers obstacles and problems in vendor managed inventory. In this section, by enumerating the VMI obstacles, we explain the reason for the failure of this system in some projects. Section 7 investigates the effect of vendor managed inventory in the real world while Section 8 concludes the paper.

2. RESEARCH LITERATURE

Despite extensive research on supply chain integration and emphasis on recent advances in information technology as a factor in performance improvement, limited research has been conducted on information flow integration in the supply chain (Nakandala et al., 2017). VMI has become a competitive supply chain tool used by retailers, suppliers and manufacturers to reduce inventory management costs. The basic premise of VMI is that suppliers (sellers) are responsible for re-storing customer inventory when supply is low (Beheshti et al., 2020). Implementing VMI method in the inventory control system gives the supplier transparency of sales data and inventory at the retail level. In Sabila et al., (2018), an inventory control system that can maintain the stability of product availability at the retail level is proposed. Sainathan & Groenevelt (2019) examines the coordination of a supply chain when inventory is managed by the vendor (VMI) and describes a mathematical model that can be used to analyze contracts under the VMI.

Although VMI is a collaborative tool, the relational factors in VMI have not received enough attention due to the challenges in accessing buyer-supplier data in addition to the existing focus on analytical approaches. The purpose of Yalcin et al., (2018) is to examine post-implementation relationship factors in order to extract relevant insights. An information fractal structure (IFS) model to facilitate communication and collaboration between centralized inventory and vendor management (VMI) and timely production to optimize inventory and logistics costs across the supply chain is proposed in Saad & Bahadori (2019). New technologies have also been used in this field. The relationship between VMI and the Internet of Things (IoT) is examined in Liu & Sun (2011) and Fang & Chen (2021).

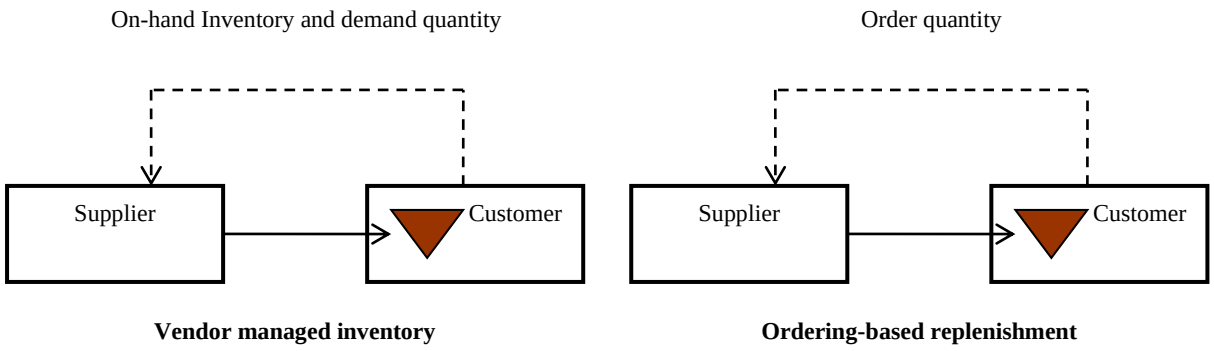

Fig. 1. Classical ordering-based replenishment versus vendor managed inventory (Gröning & Holma, 2007)

The benefits, achievements, and improvements in supply chain performance resulting from VMI partnerships have been well documented in the form of analysis, simulation, and case studies (Pohlen & Goldsby, 2003, Simchi-Levi et al., 2000). According to this research, more transparency and a better view of market demand, obtained as the result of increasing information flow in the VMI approach, is the main source of the benefits in this approach. Transparency in demand is achieved when the customer provides the appropriate demand data and the supplier utilizes it purposefully for production planning (McBeath, 2003, Kulp, 2002). An approach that encourages the customer to send information like inventory level and sales electronically to the supplier and the supplier on the other hand calculates the order point by performing the necessary calculations for each product and finally inform the customer of the shipment on the way by ASN. This mechanism is the same information flow in the VMI approach. Therefore, in the following sections of the article, we will examine the information and tools needed to perform this mechanism.

3. MOTIVATION TO BENEFIT FROM VMI

Vendor managed inventory has revolutionized the business processes of small and medium-sized enterprises. In today's highly competitive world, institutions are increasingly seeking to reduce their costs and inventory levels to maximize profits. Effective management of supply chain demands fast and appropriate transfer of information in the supply system. Vendor managed inventory is designed to facilitate the transfer and reduce costs for both the customers as well as the suppliers.

In fact, success in supply chain management directly depends on the relationship between inventory costs and the level of presenting services to the customer (Waller, 1999). These are the most important functions and roles fulfilled by the vendor managed inventory in supply chains. Carl Hall also believes that an efficient vendor managed inventory is achieved by more and better information flow between the parties (Hall, 1998). Therefore, in the first part of this section, the effect of vendor managed inventory on reducing costs and improving the level of service in supply chains is mentioned. In the second part of this section, we review the results of a survey on the motivation of the electrical industry to use the VMI system.

3.1. Cost Reduction

Demand fluctuations, whose insufficient control causes irreparable damage to the service level of services and financial income, are one of the major problems in supply chains. In traditional small and medium supply chains, this demand-setting policy used to be determined by the management. For this reason, many suppliers use VMIs to minimize the risk of demand fluctuations. In the traditional way, buyers forced manufacturers to store large volumes of final product inventory in their warehouses to increase service levels, while VMIs specifies minimum and maximum demand values and makes a small amount of inventory buffer available (Jalali et al., 2017).

With VMI, the replacement rate usually increases from one month to one week, which benefits both parties. The supplier sees less fluctuations in production. This factor leads to cost reduction and a better use of production resources and means of transportation and thus the need for large amounts of buffer is not felt.

3.2. Service Level Upgrade

From an agent perspective, service is generally measured by product availability. This concept means that whenever a customer goes to a seller and is faced with a shortage of goods, a sale is lost (Yao et al., 2008). VMI assists the service level by coordinating the registration of orders and deliverables to customers.

With VMI, a balance of safety stock can be achieved for customers who return products to the supplier. When the service level increases for customers and consequently for suppliers, it will have two consequences: first, smaller crises are occurred, and second, when crises occur, there will be no inflation for customer orders for the supplier and the supplier will have a better view of the demand, which will lead to an increase in the service level.

Without VMI, the cargo to be sent are usually returned by the distributors because there are some relationship gaps between the central purchasers and the distribution centers. With the help of VMI, the supplier plans the inventory replacement dates and the delivery items and he can even predict the item delivery date.

3.3. Empirical survey results

In an interesting attempt that lasted six months, the Electrical Industry Supply Chain Association (ESCA) surveyed 60 factories over the Internet to examine the root causes of customers and suppliers turning to the VMI partnership system. The results of this study are shown in Fig. 2.

According to this survey, the customers believed that besides the reduction in delivery time and the improvement of the service level, the main reasons for VMI partnership are the increase in inventory flow, and the reduction of the capital involved with the inventory. The suppliers also believed that although financial incentives played a more important role in improving operational performance in their tendency towards VMI, satisfying customers' desire for cooperation through VMI partnership system was their most important goal in using this system.

4. THE ROLE OF DATA TRANSFER IN VMI FUNCTION

The successful implementation of VMI in the organization demands the efficient and proper use of communication and information technology. Levi believes that the application of information and communication technology in supply chains is closely related to the discussion of data transmission tools and their frequency. In the meantime, the use of advanced information systems is more important (Simchi-Levi et al., 2003). In fact, using advanced technologies and the partnership relationship between supplier and retailer, VMI facilitates information flow throughout the supply chain.

EDI simply is a technological-based facilitator for exchanging the documents between business partners. Therefore, according to Fig. 3 the electronic data interchange as a manifestation of information technology is one of the most important elements in the structure of VMI (Klapita, 2021).

First of all, it is necessary to explain that the Uniform Communication Standards (USC) has defined specific codes to standardize transactions (Guggenberger et al., 2020).

- Product activity data is provided through USC 852 transactions.
- USC 855 is used to inform the customer of the orders issued by the supplier.
- USC 856, which is used to inform the status of shipments on the way.

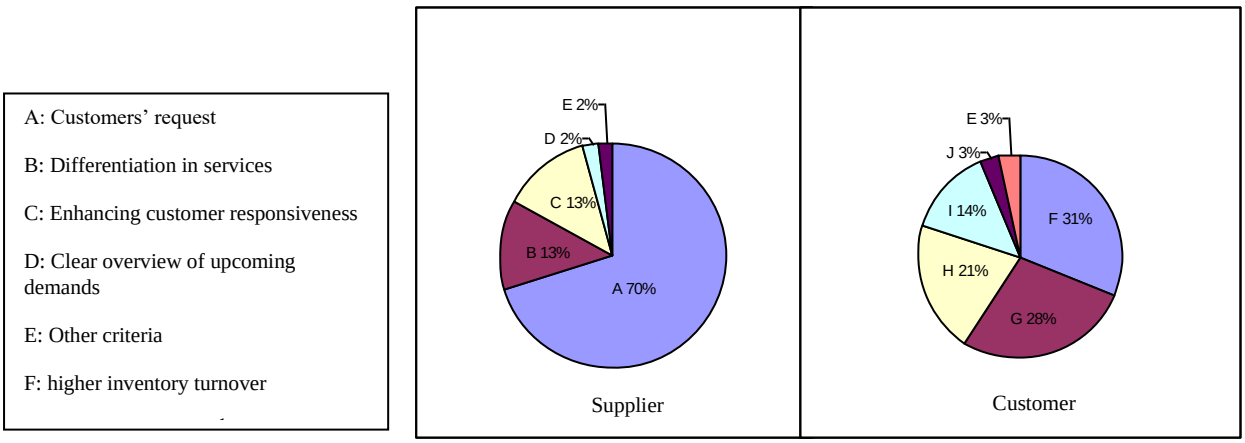

Fig. 2. Motivation behind using VMI from customers and suppliers' perspectives for electronical industry (Blackhurst et al., 2006)

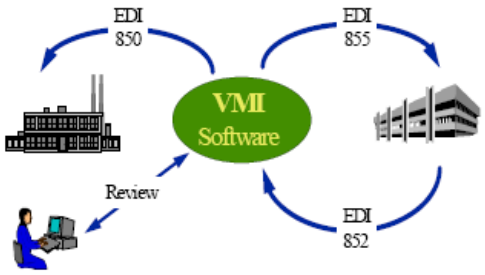

Fig. 3. EDI position in VMI

There are two EDI transactions in the VMI roaming ventricle. The first is transaction 852, the registration of product activity. Product activity means changes in the customer's inventory status. In fact, this transaction contains sales information and customer inventory. Of course, inventory data is presented in different groups such as inventory on hand, on the way and delayed. The 852, which is sent by the customer according to a predetermined schedule (usually daily), is actually the backbone of the VMI. After reviewing this data, the supplier decides to place an order. This review of data varies by supplier and software used, but many things are fixed in this review.

- The first step is to verify the data as accurate and usable information. This is done by software.
- In the second stage, the software calculates the re-order point for each product (in case of changes in inventory and sales data) according to the schedule.
- In the third step, the software makes a comparison between the amount of inventory available to the customer and the point of re-ordering each product, if necessary, an order is issued.
- In the last step, the order amount will be calculated according to the capacity of the boxes and transaction costs.

The second VMI transaction notifies the customer of the supplier's products. This operation itself can be performed by two transactions. USC 855 is the most common of them, which contains information regarding the number of products and the amount of orders issued by the supplier to the customer. But USC 856 is based on Advanced Shipping Notice (ASN) technology, which notifies customers of orders and shipments on the way. This transaction differs from USC 855 in both time and content. 856 is sent after shipment while 855 is sent during generating order. Meanwhile, in 856, only the number of shipments and information such as the name of the shipping company and the bill of lading information are mentioned (Ozpolat & Dresner, 2018).

5. INFORMATION FLOW IN VMI

In the previous section, we learned about the mechanism and position of data transfer tools. In this section, we want to see what information should be exchanged between the customer and the supplier to create a targeted information flow. In fact, figure 4 demonstrates a summary of this section.

5.1. Information to be given to the vendor by the supplier

In the research on what information should be sent by the customer to the supplier, a total of 8 items are recommended.

- Inventory level: Perhaps it is the most important data because according to VMI philosophy, the supplier is responsible for managing the customer's inventory and therefore tracking the customer's inventory moment by moment is vital for him. Of course, this principle is influenced by three factors: orders on the way and withdrawal of inventory, goods in the flow between customer warehouses and overdue orders as well as the returns.
- Goods in transit: Refers to goods that are flowing between the customer's warehouses while on the way orders that have been sent to the customer by the supplier are not in this category. Because the supplier is

fully aware of the number of goods he has sent to the customer and the goods on the way, but what is important to supplier is the report on the shifts in the customer's warehouse that informs him of the arrival or non-arrival of the shipment.

- On-the-way orders and inventory withdrawals: Both are similar responses to demand. For each order on the way, it is expected that withdrawal from inventory occurs in the near future. Now, depending on whether the customer is a retailer or a manufacturer, the time between ordering and withdrawing inventory is less and more, respectively.
- Production planning: In fact, based on future inventory consumption, it needs to be replaced. Providing this information to the supplier allows him to have more time to plan the replacement of goods by having a long-term horizon of the customer ordering program and can show the appropriate reaction to the withdrawal of inventory in the near future by the customer.
  As sown in Fig. 4, Pohlen & Goldsby (2003) believed that production planning and ordering were the most valuable way to predict supplier demand. They also stated that supplier decisions vary according to the customer's strategy, be it warehousing or ordering.
- Overdue orders and returns which have a direct impact on inventory levels.
- Sales data: The most important benefit of point-of-sale information is reducing the bullwhip effect in the supply chain.

Furthermore, the supplier must inform the customer of the shipments in various ways (via EDI 855 or ASN). In fact, the number, specifications, time of sending the order and bill of lading information of the sent shipments are the most important data that must be provided to the customer.

The bullwhip effect is one of the main causes of supply chain inefficiency and means that changes from the customer to the supplier increase. In other words, strengthening the variability of demand from the upstream and downstream supply chain.

The transfer of point of sale (POS) to the supplier (located at the top of the chain) allows real demand throughout the chain to be considered and gives them a clear horizon of commodity replacement planning. Sales forecast is also used when demand volatility is high.

In general, in addition to the inventory level, which is extremely valuable to the supplier, there are two approaches to information exchange.

- When the customer is the producer and his product is the final product, the transfer of production planning information and inventory withdrawal information is essential. However, order data on the way and POS can be provided to the supplier to improve the forecast (Fig. 5).

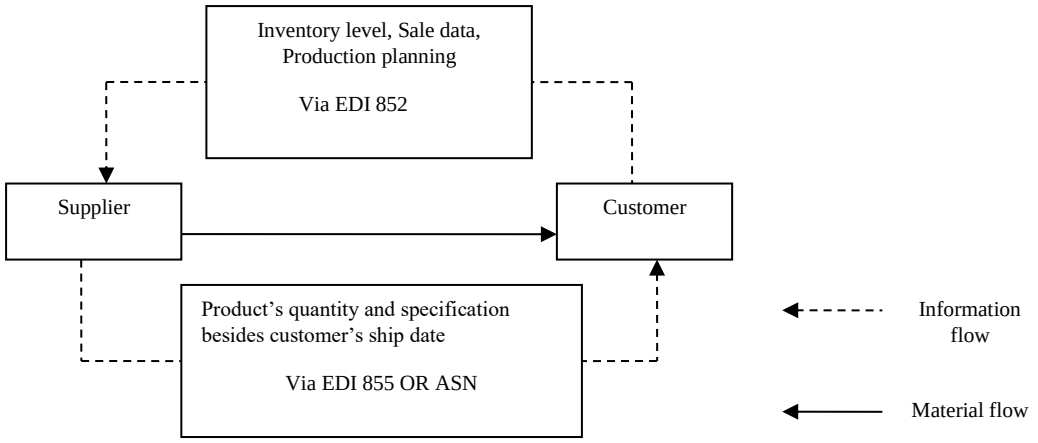

Fig. 4. A general view over information and material flows of VMI

- If the general customer is a seller or a manufacturer who has not stored orders on the way and orders for another customer who is also a retailer, the information of orders on the way must be passed to the supplier. And sending POS information, inventory withdrawals and production planning to better control the situation can be useful (Fig. 6).

In addition to the two main strategic and operational problems, inefficiency in supplier performance has been the cause of failure of some VMI projects. For example, in 1995, despite reaching a service level of 99.5%, K-Mart decided to reduce the number of suppliers from 300 to 50 in the VMI partnership, due to an increase in inventory by 70%, above the set amount. They found that many manufacturers did not make

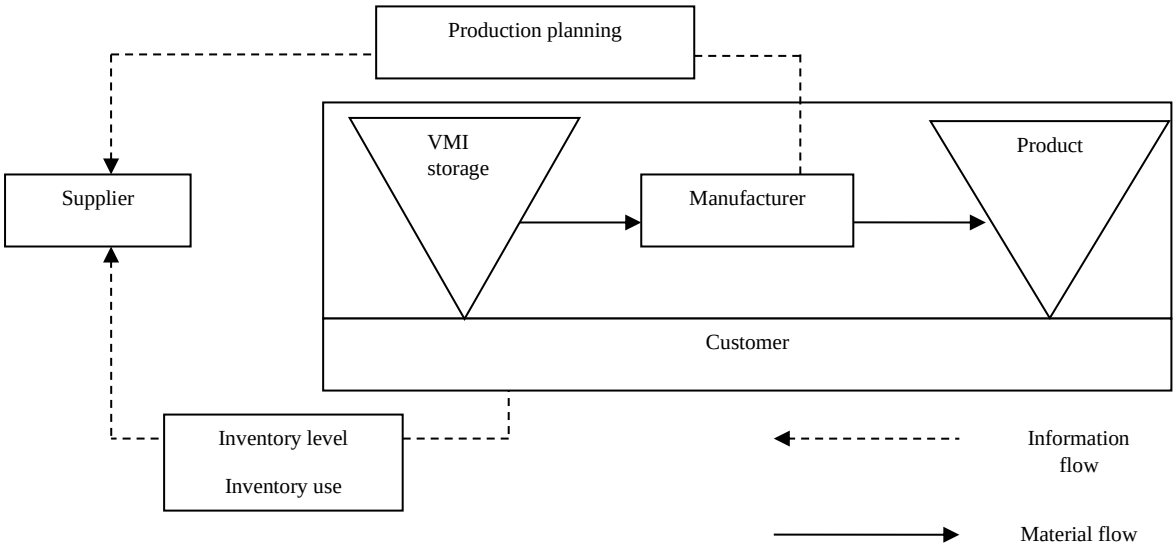

Fig. 5. Information and material flows considering downstream of the supply chain as the final customers (Vigtil, 2006)

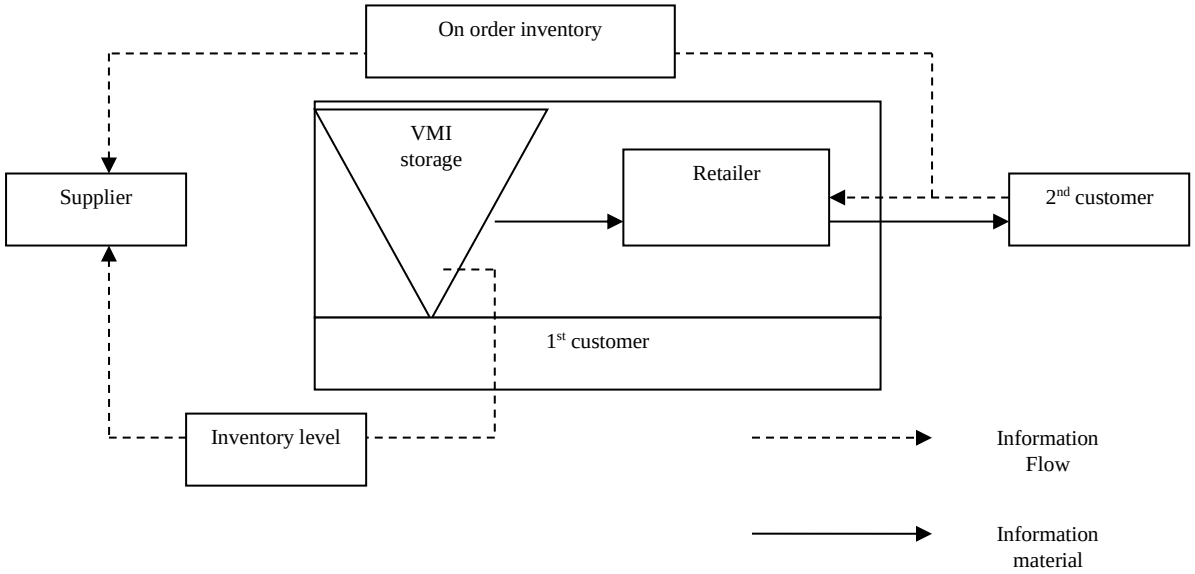

Fig. 6. Information and material flows considering downstream of the supply chain as the retailer (Vigtil, 2006)

good demand forecasts. And they reduced their inventories that we could manage our inventory better than our suppliers. However, K-Mart executives said that losing control of the shipment schedule to the factory also had a significant effect on the decision (Marquès et al., 2012).

6. Obstacles and Barriers on The Way to VMI

There are two major obstacles to implementing VMI, one strategically and the other operationally. Strategically, most distributors refuse to provide private information to suppliers because they believe that this will provide the supplier with direct access to the distributor's customers and will therefore eliminate the distributor from this cycle.

Basically, the VMI partnership philosophy, which is based on the trust between the distributor and supplier, considers this exchange of information to lead to the improvement of the distributor. In fact, in the coming years, the successful distributor will be the organization that brings the most value to its customer and supplier . From an operational point of view, organizations in general are afraid of change. And any fundamental change in the operations of the organization requires cultural adaptation and reorganization of each job duties (Burke, 1996).

Culturally, many organizations have not yet realized the importance of tight collaboration the supply chain, and therefore do not give the necessary authority and power to managers in this area and do not make the necessary investment to implement it. The new culture should make it clear to senior executives that customer satisfaction is the ultimate goal, and that the supply chain is an environment to achieve this goal, in which collaboration between suppliers and distributors is essential.

Therefore, the role of the supplier in the VMI system is extremely vital. If he acts poorly at any stage of the VMI implementation process, including poor anticipation and replacement, the effects of his disastrous actions will be reflected throughout the supply chain.

7. Case Study

Herein, the following two case studies are indicated. The case studies show how the two giant companies could boom their businesses by adopting the information flow of the VMI concept.

7.1. BHP Steel Industry

The company, which manufactures a variety of steel sheets for the automotive industry, is located in Australia, Sydney. The company has 12,000 employees in 20 countries and 9,000 in Australia. Its approximate sale is $ 5 billion and its net worth is $ 3.5 billion.

Despite BHP's prominent position in the Australian steel industry, the policy of lowering the price of products by competitors on the one hand, and customers' concerns about the high capital involved in inventory on the other, puts the company at risk of losing a major market share.

Therefore, the company's board of directors decided to implement VMI as a suitable solution to achieve these goals in order to differentiate itself from competitors and also to bring added value to customers.

After implementing VMI, every day customers send a file containing the previous day's consumption information and current status of their inventory through the advanced messaging system and this system transfers the file to VMI software. This software performs statistical calculations to forecast the demand for the coming days and according to this forecast determines a value for the level of customer safety stock. Now, by comparing the current situation of the customer's inventory and the level of safety stock determined for him, if necessary, the company will issue an order by sending the level of safety stock determined to the internal ordering system.

After the implementation of VMI, the company was able to reduce its inventory level and, consequently, the amount of capital involved in the inventory by 50%. VMI also increased the annual inventory turnover from 8 to 18 to 25. Finally, BHP was able to capture the entire 100% market share. Bob Howard, BHP's Marketing

Director, says VMI has changed our understanding of the supplier-customer relationship by establishing a coherent information exchange between us and the customer. And this is something that can not be priced (Anand et al., 2021).

7.2. IBM company

A case study of IBM (a manufacturer of electrical equipment and appliances) shows that the company earns about 65 to 85 percent of its revenue through its products. The company has a service level of 96%, which responds to 66% of its customers' requests electronically, 33% by sending an application form and 10% by creating a subscription (permanent member). All this evidence indicates the existence of strong relationships between all parts of the company's supply chain.

Coordination between different parts of IBM can be a model for other companies. Due to the widespread need of customers for the company's products, this need was felt to reduce the response time to customer demand. So, to achieve this goal, IBM implemented the VMI system in 1997 in all its branches in South America, which led to dramatic effects on customer access to the product and greater coordination with customers. Success in supply chain coordination by increasing information exchange with the customer has resulted in faster customer responses, higher profits, and higher return on investment and lower costs (Jalali et al., 2017).

8. CONCLUSION

Vendor managed inventory has presented a new strategy for the partnership by changing the relationship between the customer and the supplier and taking them out of the isolated decision-making environment. From the point of view of this strategy, the customer and the supplier should create a purposeful information flow by using information transfer tools in order to maximize profits, reduce costs and increase the level of service. The customer must send inventory level information, on the way orders, overdue orders, returns, inventory withdrawals, and production planning and sales data daily to the supplier via EDI. So that supplier can have a good view of the inventory situation and customer demand to plan the replacement of goods in a desirable way and reduce the bullwhip effect throughout the supply chain. On the other hand, the supplier must send the number, specifications, and time of sending the order and bill of lading information to the customer through ASN. The supplier also needs different information to formulate the replacement of goods according to the customer's strategy in storing or ordering goods for another customer in the supply chain. In general, if the customer is the ultimate producer in the supply chain, inventory information and customer production planning are extremely effective. And if the supplier is a retailer, on the way orders will be an influential factor in supplier planning.

In this article, in addition to examining the information flow and tools needed to perform this operation, we have analyzed some successful VMI experiences. And we came to the conclusion that in successful experiences, reducing inventory costs, increasing the level of service and giving a new nature to the customer and supplier partnership has been the main reasons for implementing the VMI system. After examining unsuccessful experiences, we found that trust in the customer-supplier relationship, re-engineering in the organization's culture, and efficiency in supplier performance are key factors for successful VMI implementation.

There are future directions in VMI concept for researchers. Retailers, instead of paying attention to past demand data, could send future demand data such as their order and sales forecast to their suppliers. Warehouse robotics, artificial intelligence and machine learning can make a huge evolution in the VMI industry. Finally, Available-to-promise (ATP) can be the right approach, VMI solutions with ATP capabilities ensure that suppliers do not over-commit.

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