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Sami Sarpola*

ABSTRACT

The increased emphasis placed on the management of supply chains during the last decades has given rise to a large number of initiatives and collaborative practices in the area of inventory and demand management. One of the prominent practices in the area is Vendor Managed Inventory (VMI) systems, in which the responsibility for the management of customer's inventory is reallocated from the customer to the vendor. From the literature as well as practice, many collaborative practices and partnerships can be identified that significantly differ from one another, yet have been labeled as VMI systems. For us to be able to study and manage the different types of VMI systems, measures enabling their evaluation, categorization, and comparison with each other are needed. To address this need, this paper first proposes and defines six elements that are considered as the main dimensions differentiating VMI systems from one another, which are: inventory location, distribution model, inventory level monitoring and demand visibility, role of information systems, replenishment decision, and inventory ownership. After this the elements are combined together to propose an evaluation framework for VMI systems to facilitate the research as well as the management of VMI systems.

Keywords: Vendor managed inventory, Continuous replenishment, Supply chain management, Supplier-buyer collaboration, Inventory management

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* Correspondence: Sami Sarpola, Department of Business Technology, Helsinki School of Economics, P.O. Box 1210, 00101 Helsinki, Finland, tel. +358-(0)50-5410621, email. sami.sarpola@hse.fi. The author gratefully acknowledges the funding provided by the Foundation for Economic Education of Finland.

1. Introduction

Vendor Managed Inventory (VMI) is one of the many initiatives that strive towards closer cooperation between the members of supply chains in the area of inventory and demand management. Other initiatives or concepts closely associated with VMI include Continuous Replenishment, Quick Response, and Efficient Customer Response (ECR) (e.g. Daugherty *et al.*, 1999; Simchi-Levi *et al.*, 2000, pp. 131-140). These initiatives share a common goal of accomplishing deeper integration and collaboration between the members of supply chains in order to cope with the ever decreasing time windows for product and service fulfillment, and the requirements for the improvement of operational efficiency.

Benefits often cited to result from the adoption of VMI systems include lowered inventory levels, faster inventory turns, reduced ordering and administrative costs, increased sales, and reduced out-of-stock costs among others (see e.g. Angulo *et al.*, 2004). Meanwhile, setting up of a VMI system has been proposed to be facilitated by the willingness to share data, use of integrated information systems and standard procedures, and being restricted by issues such as inaccurate data, unwillingness to invest in information systems, lack of standard procedures, and seasonal products (Harrison and Hoek, 2005, pp. 178-182). However, it should be acknowledged that under the label of VMI, different types of collaborative practices and partnerships can be identified that significantly differ from each other. As a result of the differences between the VMI systems implemented, benefits, risks and challenges for both the customer and the vendor may differ significantly. As a consequence, for us to be able to study and manage VMI systems, measures that enable their evaluation, categorization, and comparison with each other are needed. To address this need, the objective of this conceptual study is to propose and describe the main elements of VMI systems and to propose framework for their evaluation.

Variety of definitions has been proposed for VMI in the literature, in addition to which it has been associated with a number of other concepts and initiatives. For the purposes of this study VMI is defined as a continuous process in which the vendor assumes responsibility for the management of customer’s inventory. This definition is broader than those proposed in the prior literature (e.g. Harrison and Hoek, 2005, p. 177; Hines *et al.*, 2001, pp. 335-355; Kuk, 2004; Lysons and Gillingham, 2003, p. 302) in order for it to capture also such collaborative engagements and partnerships that might not fit within the narrower definitions of VMI. This provides possibility for the examination of a multitude of practices in the area of inventory and demand management. Next a brief review of the different concepts and initiatives associated with VMI is presented after which the definition of VMI will be discussed in more detail. This is followed by the presentation of the main elements proposed for VMI systems. After this, the presented elements are combined together to form a framework for the evaluation of VMI systems. In the final section, summary of the paper is provided.

2. VMI and related concepts

In the area of inventory and demand management, a large number of concepts and initiatives have been introduced, many of which are associated with VMI. Waller *et al.* (1999), for example, consider Continuous Replenishment and Supplier-managed Inventory as synonyms for VMI. Lysons and Gillingham (2003, p. 302), in turn, argue that acronyms for VMI include Continuous Replenishment Programs (CRP), Supplier Assisted Inventory Management (SAIM), Supplier Assisted Inventory Replenishment (SAIR), Efficient Customer Response (ECR), and further argue that the VMI can be considered as the extension of Distributed Requirements Planning (DRP). Kulp *et al.* (2004) consider Continuous Replenishment Process (CRP) similar to VMI and suggest that other terms reflecting a similar replenishment strategy include Continuous Product Replenishment (CPR) and Vendor Managed Ordering (VMO). Simchi-Levi *et al.* (2000, pp. 132; 137) note that VMI is sometimes called Vendor Managed Replenishment (VMR), but differentiate VMI from Quick Response, Continuous Replenishment, and Advanced Continuous Replenishment. Meanwhile, Daugherty *et al.* (1999), Sabath *et al.* (2001) and Angulo *et al.* (2004) group Continuous Replenishment Planning (CRP) and VMI under the umbrella term Automatic Replenishment Programs (ARP) and suggest that industry specific ARP solutions include Quick Response in the apparel industry and Efficient Customer Response (ECR) in the grocery industry (see also Fiorito *et al.*, 1995). To conclude, there is a bundle of closely related terms and concepts in the area of inventory and demand management that have not been used systematically in the literature.

As to the definitions proposed for VMI, for example Kuk (2004) defines VMI as a supply initiative where the supplier assumes responsibility of the tracking and replenishment of the customer's inventory. Lysons and Gillingham (2003, p. 302) define VMI as a JIT technique in which inventory replacement decisions are centralized with upstream manufacturers or distributors. In addition to these, alternative definitions have been provided by, for example, Harrison and Hoek (2005, p. 177) and Hines *et al.* (2001, pp. 335-355) of which particularly the latter have put in effort to produce a working definition for VMI systems. While the definitions proposed for VMI differ from each other, they all emphasize the reallocation of the inventory and demand management responsibility from the customer to the vendor. For the purposes of this study, we choose to define VMI as a continuous process in which the vendor assumes responsibility for the management of customer's inventory. This definition is broader than those proposed in the prior literature in order for it to capture also such collaborative engagements and partnerships that might not fit within the narrower definitions of VMI. This provides possibility for the examination of a multitude of practices in the area of inventory and demand management.

To conclude, although different definitions for and concepts associated with VMI are abounding, our interest should be directed to the common theme that they share. Hence, instead of focusing to the individual definitions or concepts our interest should be directed to investigating the phenomenon of increasing reallocation of inventory and demand management responsibility from the customer to the vendor that is taking place in different industries. As a consequence, the elements proposed and described and the framework proposed in this paper should be considered valuable in the evaluation of a wide variety of collaborative practices and partnerships in the area of inventory and demand management and their use should not be restricted to the examination of only those practices labeled as VMI systems.

3. Elements of VMI Systems

In this section the main elements of VMI systems are proposed and described. The main elements that are considered here to differentiate VMI systems from one another are *inventory location*, *distribution model*, *inventory level monitoring and demand visibility*, *role of information systems*, *replenishment decisions*, and *inventory ownership*. For the purposes of evaluating VMI systems in practice the elements can also be presented in the form of six questions, which are:

- Where is the inventory located?
- How is the distribution of products or raw materials accomplished?
- How is the inventory level monitored and how visible is the customer's demand to the vendor?
- What role do information systems play in the facilitation of the VMI system?
- Who and how makes the inventory replenishment decisions?
- Who owns the inventory?

The questions address the six elements that are considered here as the most important dimensions differentiating VMI systems from one another. It should be noted here that the products included in the VMI system are considered here as given. Hence, the suitability and selection of products to be included in the VMI system, discussed for example by Hines *et al.* (2001, pp. 335-355), is not consider in this study and the focus is on the evaluation of the design and implementation of the VMI system for the given products.

Next the six elements of VMI systems are discussed in more detail. For each element, a continuum illustrating the different alternatives in the implementation of the element is provided. In addition, the interdependencies between the elements are discussed. After this, based on the proposed elements a framework for the evaluation of VMI systems is constructed.

Inventory location

The physical location of the inventory managed by the vendor is a significant element of VMI systems. The inventory may be located at the customer's premises in a distributed manner, for example, directly at a manufacturer's production line or at a retailer's shop floor. Here the vendor replenishes the sub-inventories located at each production line, machine, store or other point where the products or raw materials are consumed. However, the vendor may also manage the customer's inventory in a centralized manner by making sure that the inventory levels at the customer's central warehouse are withheld within set limits. Alternatively, the customer's inventories may be managed by the vendor within its own or third party's premises. However, the degree to which a system where the inventory is located at the vendor's premises can actually be considered a VMI system is questionable, particularly if the inventory is not owned by the customer. In Figure 1 the continuum representing alternative inventory locations in VMI systems is presented.

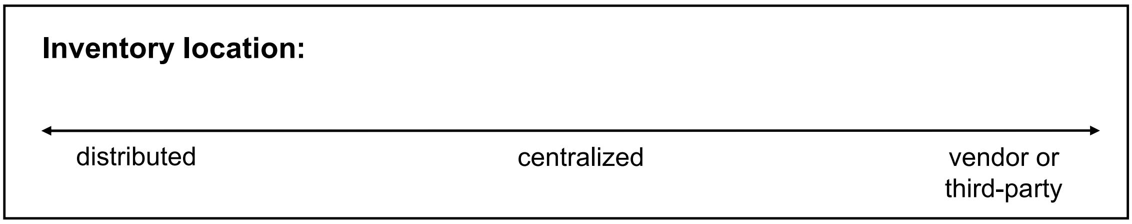

Figure 1: Inventory location continuum

As for the implications of the different choices regarding inventory location, customers may prefer the vendor managed inventories to be located in a distributed manner directly at the point where raw materials or products are consumed. This way the administrative tasks related to the inventory management are minimized for the customer. However, in other occasions the customer's interests are best served by locating the vendor managed inventory in a centralized manner in order to, for example, enable the optimization of deliveries of products or raw materials procured from several vendors to plants, stores, construction sites or other points of consumption. For example construction companies may prefer vendor managed inventories to be located in a terminal from which the materials are delivered to construction sites just in time in truckloads containing materials from several vendors. The rationale behind this is the need to minimize the number of deliveries and vendor visits to construction sites as they interrupt and interfere with the work at the sites. Furthermore, construction companies wish to minimize the amount of materials stored at construction sites as extra materials obstruct the work being done, and time is wasted in moving the materials around the site as the work progresses. Finally, the solution where inventories are located at the vendor or third party premises might be suitable if the customer does not posses the expertise or special facilities for storing the products or raw materials such as chemicals, or if the customer does not have physical presence in a certain market, or has outsourced parts of its operations such as manufacturing, sales or distribution.

Distribution model

The distribution model element addresses the physical distribution of the products or raw materials in a VMI system. The main issue considered here is whether the distribution activities are performed by the vendor itself or are outsourced to a third party by the vendor. Important questions to be addressed here is the importance of interaction between the vendor and customer representatives during the distribution process and how important it is for the vendor to gain influence to the placement and display of products in the customer premises. For example Wurth, a supplier of fixing and assembly materials and a VMI systems pioneer, utilizes in its business model interaction between its field sales personnel and customer representatives. The Wurth sales personnel may act in a consultative role for customers in order to help them find new products or materials to meet their needs or the needs of the customer's new product development. Meanwhile, in more stable environments such as grocery retailing where the decision making typically takes place higher up in the hierarchy, the role of vendor representatives may be less important and it may be sensible to outsource the distribution activities to a third party who typically can perform them more economically by taking advantage of the economies of scale. Further, it should be acknowledged that in VMI systems the vendor may gain benefits by being able to take advantage of full truck-loads and to decide when and how much to deliver and thereby, to optimize distribution as long as the inventory remains within the agreed limits (Angulo *et al.*, 2004; Axsäter, 2001; Cetinkaya and Lee, 2000; Disney *et al.*, 2003). The continuum presenting the different distribution models of VMI systems is presented in Figure 2.

Figure 2: Distribution model continuum

A relationship is proposed here to exist between the *distribution model* and the *inventory location* of VMI systems. More specifically, if the inventory is located in a distributed manner in the manufacturer's production line or at the retailer's shop floor, it is presumed to be more common that the distribution is handled by the vendor representatives and that the vendor overall retains more control of the distribution activities. Meanwhile, if the vendor managed inventory is located in a centralized manner or at the vendor or third party premises, it is presumed that it becomes economically viable for the vendor to outsource part or all of the distribution activities to a third party. In other words, if there is no interaction between customer and vendor representatives and no benefits accrue to the vendor of gaining access to the customer's production line or shop floor, the outsourcing of distribution activities to a third-party should be contemplated.

Inventory level monitoring and demand visibility

Inventory level monitoring and demand visibility refer to the amount of visibility provided to the vendor regarding the customer's current inventory levels and future demand. The benefits from improved inventory level monitoring and demand visibility accrue particularly to the vendor in the form of minimized bull-whip effect – also called Forrester effect – and the reduced adverse effects of demand uncertainty (Cachon and Fisher, 2000; Fisher *et al.*, 1994; Kulp *et al.*, 2004; Lee *et al.*, 1997a; Lee *et al.*, 1997b; Lee *et al.*, 1999). The customer on the other hand does not gain as much benefits from the improved inventory level monitoring and demand visibility, even though decreased out-of-stock and inventory costs, and improved sales and inventory turnover (e.g. Simchi-Levi *et al.*, 2000, pp. 137-138) as well as increased vendor competition (Mishra and Raghunathan, 2004) are often cited. Consequently, Lee *et al.* (2000) suggest that vendors should offer their customers incentives such as lead time reductions to engage them in information sharing to improve visibility. It has also been identified that information sharing alone is not sufficient but that collaborative initiatives such as VMI and collaboration over new products and services need to be coupled with it in order to achieve above average profit margins (Kulp *et al.*, 2004). What is more, the importance of demand visibility has been argued to be lower in situations with stationary demand and standard products with long life spans, than in the case of new or seasonal items, items that are often promoted, and in situations where the items face new competitors (Angulo *et al.*, 2004). The inventory level monitoring and demand visibility continuum is presented below in Figure 3.

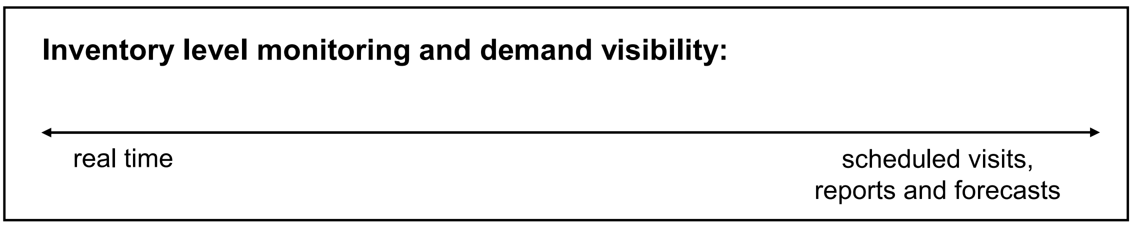

Figure 3: Inventory level monitoring and demand visibility continuum

In practice, inventory level monitoring can be accomplished via scheduled visits to the customer's premises, regular reports of the product consumption such as shared point-of-sale (POS) data, or by real time monitoring of the customer's inventory levels. For example Suomen Rehu, a livestock feedstuff producer, has in collaboration with its customers had sensors installed to customers' feedstuff silos located in farms so that feedstuff levels are automatically updated to the company's Enterprise Resource Planning (ERP) system. In this VMI system, feedstuff orders are automatically generated by the vendor's ERP system when the feedstuff levels drop below designated levels in the silos.

As for providing the vendor visibility to the customer's future demand, in some occasions this may be accomplished by sharing demand histories of the products with the vendor. In other occasions, however, when the demand characteristics of the products are not as stable, the frequent and continuous sharing and updating of demand forecasts by the customer assumes increased importance.

When analyzing the provision of visibility via information sharing in VMI systems, also issues of information accuracy and delay should be considered (Angulo *et al.*, 2004; Raman *et al.*, 2001; Whipple *et al.*, 2002). The inaccuracy of information – errors in information caused by customers poor inventory integration and/or poor planning and forecasting practices – can be considered more harmful for the customer while the information delay – the wait time that shared information experiences before it is used by a vendor's internal supply chain functions – is more critical for the vendor (Whipple *et al.*, 2002). Further, Kulp (2002) argues that the ability to benefit from information sharing depends on the information precision and reliability, and that traditional inventory management practices may dominate VMI systems if the information environment is not sufficiently precise or reliable.

Role of information systems

Role of information systems means here the extent to which information systems are used to facilitate the VMI system between the customer and the vendor. The successful implementation of VMI systems has been argued to often depend on computer platforms, communication technology, and product identification and tracking systems (Waller *et al.*, 1999), and for example Simchi-Levi *et al.* (2000, pp. 133-134) list advanced information systems on both the customer and the vendor side as a prerequisite for VMI. Also the importance of Electronic Data Interchange (EDI) for enabling efficient information exchange between customers and vendors has been widely emphasized in the literature (e.g. Lee *et al.*, 1999; Raghunathan and Yeh, 2001; Simchi-Levi *et al.*, 2000, p. 133). However, Waller *et al.*, (1999) maintain that information systems should be considered as an enabler, not as a requirement, for VMI. Particularly in pilot projects it may be beneficial to postpone investments in information systems until their cost-effectiveness has been demonstrated, as VMI systems can also be implemented with rather modest information systems support (Holmström, 1998; Waller *et al.*, 1999; Yang *et al.*, 2003). The role of information systems may also be less important, if only a small number of stock keeping units are managed in the VMI system (Daugherty *et al.*, 1999). In addition, there are many situations where investments in information systems can not be considered necessary for the effective operation of a VMI system. In these cases, for example demand uncertainty or the value and turnover of the products are low. Examples of simple VMI systems that do not require information systems support include different types of two-box systems, where a box is replaced with a full box as it runs out. The role of information systems in VMI systems is presented in a continuum in Figure 4.

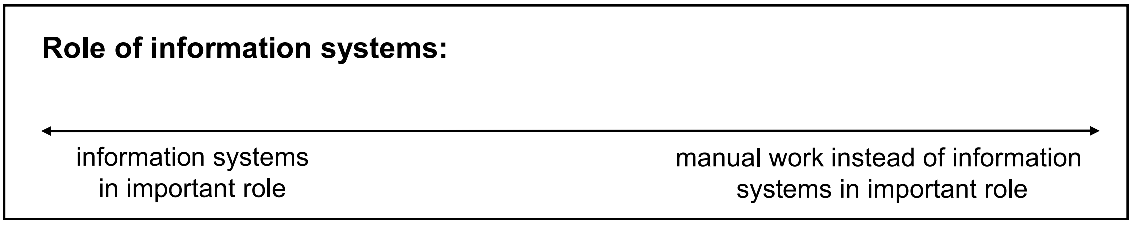

Figure 4: Role of information systems continuum

In the prior research the role of information systems in the facilitation of efficient information exchange between the customer and the vendor for the purpose of inventory optimization has been emphasized (e.g. Cachon and Fisher, 2000; Lee and Billington, 1992). In the case of VMI systems, the role of information systems can be illustrated through the information processing theory (Galbraith, 1973; Premkumar *et al.*, 2005), which emphasizes that two basic strategies are available for companies to cope with uncertainty: (1) the building of buffers to reduce the effects of uncertainty, and (2) the implementation of structural mechanisms and information processing capability to enhance information flows and thereby, to reduce the uncertainty. In other words, in order to cope with demand uncertainty companies can either build inventory buffers or improve the flow of demand information in the supply chain – a task to which information systems provide a powerful tool. It has also been emphasized in the literature that the adoption of information systems to facilitate information exchange between companies should be merged with the redesign of interfirm processes (e.g. Clark and Stoddard, 1996; Davenport and Short, 1990) and specifically that the implementation of VMI and adoption of information systems together provide significantly greater improvements than either of these implemented independently (Clark and Hammond, 1997; Kulp *et al.*, 2004; Lee *et al.*, 1999).

A relationship can be argued to exist between the *role of information systems* and the *inventory level monitoring and demand visibility* elements. That is, the greater the need for timely monitoring of customer's inventory levels and for gaining visibility to customer's demand, the more important the role of information systems. On the other hand, if there is less need for timely visibility to the customer's inventory levels and to future demand, the role of information systems can be expected to be less important.

Replenishment decisions

Replenishment decision addresses the issue of authority to make decisions on inventory replenishment. Allocation of the authority of replenishment decisions to the vendor benefits the customer by relieving the customer of much of the expense related to ordering. This may be a significant benefit particularly in the case of low-value items such as maintenance, repair, and operating (MRO) supplies (Lysons and Gillingham, 2003, p. 303). For the vendor, the benefits accrued from this arrangement are even more significant as it gains means for improved optimization of its manufacturing and distribution (Axsäter, 2001; Cetinkaya and Lee, 2000) as well as for minimization of out-of-stock expenses through possibility to prioritize customer orders (Waller *et al.*, 1999). Further, Simchi-Levi *et al.* (2000, pp. 132-133) note that in the initial stages of VMI adoption, replenishment proposals made by the vendor are typically approved by the customer, but that eventually the goal of many VMI programs is to eliminate the customer oversight on specific orders. The replenishment decisions continuum is presented in the Figure 5.

Figure 5: Replenishment decisions continuum

To guide replenishment decisions or proposals, the vendor may have been allocated minimum and maximum levels within which the inventory should be maintained or the customer may provide the vendor with forecasts and expect the vendor to manage inventory accordingly based on them. Alternatively, particularly retailers may confine to the expertise of manufacturers to estimate appropriate inventory levels as manufacturers may possess better knowledge of the demand for their products. This may be the case for example with pharmaceuticals (Simchi-Levi *et al.*, 2000, p. 137). Finally, Simchi-Levi *et al.* (2000, p. 134) argue that the replenishment decision is a major decision in VMI and one closely related with the decision on inventory ownership. This is the proposition of this study as well, and interdependency is presumed to exist between the *replenishment decision* and the *inventory ownership* elements.

Inventory ownership

The question of who owns the inventory is relevant because the owner is responsible for the capital costs, including the obsolescence costs, accumulated by the inventory. In industries such as electronics manufacturing, inventory obsolescence is a significant problem. In this kind of environment, if the inventory is owned by the vendor, risk sharing typically takes place in the forms of, for example, guaranteed quotas the customer promises to buy, or the splitting of obsolescence costs. In Figure 6 the inventory ownership continuum is presented.

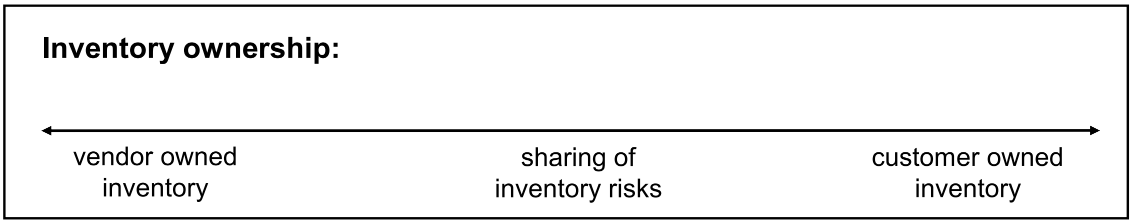

Figure 6: Inventory ownership continuum

For the customer the benefits of vendor owned inventory – also called consignment inventory – are clear, as the inventory carrying costs are allocated to the vendor. The benefits of vendor owned inventory to the vendor, in turn, have been argued to be somewhat unclear, but for example in the case of Wal-Mart, the suppliers have no choice in this matter as the market dictates this kind of arrangement (Simchi-Levi *et al.*, 2000, p. 134). Further, proposing a difference between domination and collaboration based VMI systems, Hines *et al.* (2001, pp. 335-355) argue that in the worst case VMI may be manifested as dominative attempts by the customer to reduce inventory management costs by pushing inventory upstream and offloading the inventory management burden onto the supplier. This, according to them, can not be considered as true VMI. Optimally the decision on inventory ownership should be based on the ability of the customer and the vendor to control and carry the risks involved with the inventory ownership. Accordingly, in many VMI systems it can be considered rational to retain the inventory ownership with the customer.

The inventory ownership may also be a strategic decision for the vendor. For example manufacturers may want, by owning the inventory, to guarantee that their retailers hold large inventories of their products to ensure the availability of these products to end customers (Mishra and Raghunathan, 2004). Inventory ownership may also be a way for the manufacturers to place special products such as top of the line watches or fashion to their retailer's assortment that then boost the sales of the manufacturer's other products. For retailers purchasing such items might pose a significant risk and prove unprofitable due to their low stock turn and high value, and the inventory holding cost of such items may be much lower for the manufacturer than for the customer (Mishra and Raghunathan, 2004). The vendor owned inventories may also be a good channel for pushing new products to the market. While retailers may be hesitant to purchase new products that have not yet proven themselves in the market, they may be persuaded to include these products into their assortments if the risks of new product introduction are carried by the manufacturer. Moreover, it should be noted that the inventory ownership can be differentiated between the financial and custodial ownership of the inventory, with the latter basically referring to "if you brake it, you have bought it" (Andel, 1996). Finally, as discussed earlier, a relationship is assumed here to exist between the inventory ownership and the replenishment decisions elements.

4. Evaluation Framework for VMI Systems

When the main elements of VMI systems presented above are combined and the interdependences between the elements are taken into account, a framework for the evaluation of VMI systems emerges (see Figure 7). In the framework, the gray areas symbolize the proposed interdependencies between the elements. For example, it is proposed that the *inventory ownership* is related to the authority to make the *inventory replenishment decisions*. Similarly, it is proposed that the *inventory level monitoring and the visibility of the customer's demand* to the vendor is related to the role that information systems play in the facilitation of the VMI system. The *inventory location*, then, is proposed to be related to the *distribution model* used in the VMI system.

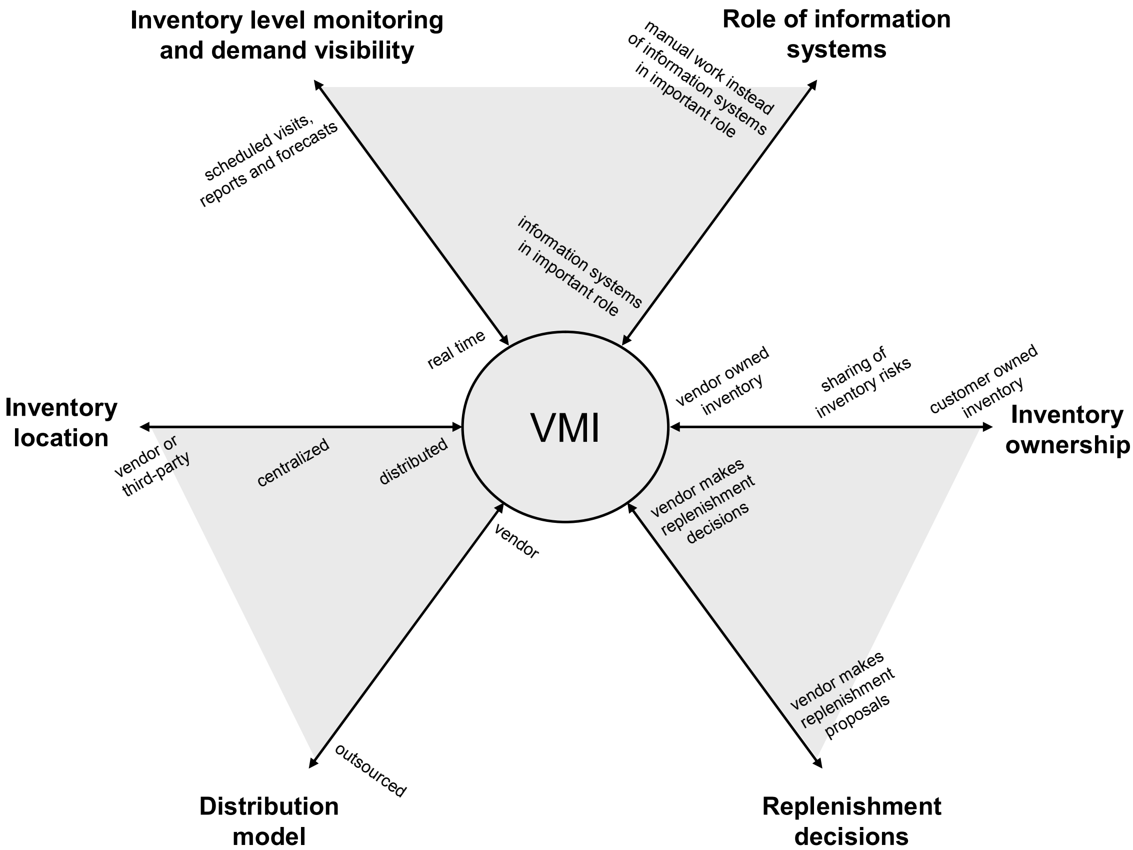

Figure 7: Evaluation framework for VMI systems

Examples of the implications of the proposed interdependencies between the elements include the following. First, if the inventory level is monitored and demand information is exchanged between the companies in real time, it is anticipated that the role of information systems is more important in the facilitation of the VMI system. Second, if the inventory in the VMI system is owned by the vendor, the vendor is expected to have more autonomy in making the replenishment decisions. Third, if the inventory is located in a distributed manner in the customer's premises, the role of the vendor representatives in the distribution is typically expected to be greater than when the inventory is located in a centralized fashion or in third party or vendor premises. Finally, it is proposed that if in any of the three pairs of interdependent elements, the elements are found to be located in the different ends of their respective continuums, the optimality of the VMI system implementation may need careful examination.

An important aspect regarding the relationships between the elements is the type of interdependency between the elements. More specifically, while information systems can be considered as a prerequisite or tool for achieving the real time inventory level monitoring and demand visibility, the relationship between the replenishment decision and the inventory ownership can be considered more of a reciprocal two-way interdependence. Inventory location, in turn, can be considered to typically influence the distribution model rather than the other way around. It should also be noted that if the empirical measurement of the elements is attempted, a number of operationalizations can be found in the prior research (see e.g. Daugherty *et al.*, 1999; Fiorito *et al.*, 1995; Kuk, 2004; Sabath *et al.*, 2001).

5. Summary

The objective of this paper was to propose and describe the main elements of VMI systems and to propose a framework for their evaluation. The main elements proposed to differentiate VMI systems from one another are *inventory location*, *distribution model*, *inventory level monitoring and demand visibility*, *role of information systems*, *replenishment decisions*, and *inventory ownership*. Further, it was proposed that of these different elements, the *inventory ownership* and the *replenishment decisions* are related to each other. Similarly it was suggested that a relationship exists between the *inventory level monitoring and demand visibility* and the *role of information systems*, as well as between the *inventory location* and the *distribution model*. Taking into consideration the proposed relationships, the six elements were combined together to construct an evaluation framework for VMI systems.

This study contributes to both research and practice by proposing concepts and the framework for measuring, categorizing, and comparing of VMI systems. What is more, the elements and the framework provide a basis for future investigations on VMI systems. For practitioners, the study at hand offers tools for the assessment of the current status of collaboration in buyer-supplier relationships and for the planning of the future development of collaboration in the area of inventory and demand management.

Finally, as a conceptual examination was reported in this paper and thus, the propositions presented are not yet empirically founded, empirical research is invited to test the validity of the proposed interdependencies between the elements, as well as the robustness of the proposed framework as a basis of empirical explorations. Further, it should be acknowledged that in addition to the elements proposed for VMI systems in this study there can be seen to be also other elements, such as benefits sharing and incentives alignment, which in some cases may be important for differentiating VMI systems from one another. This limitation should be taken into consideration in future studies on VMI systems by recognizing that the proposed elements may have to be complemented by additional elements in order to better capture the context of a specific research setting.

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