IMPACT OF VENDOR MANAGED INVENTORY ON SUPPLY CHAIN COSTS IN HOSPITALS: AN EMPIRICAL STUDY

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ABSTRACT

Healthcare has become a key everyday resource to provide an improved quality of life but requiring extensive training and resources to achieve effective delivery and outcomes. To meet these requirements providers must be trained, equipped and ready, in part through maintenance of adequate stocks of supplies. Vendor Managed Inventory (VMI) can be a part of this reconfiguration of responsibilities, freeing up employees to focus on core competencies and ensuring availability of supplies in hospitals and healthcare facilities. We identify several key performance indicators that affect the cost and service of healthcare providers when a VMI system is employed. We propose to conduct an empirical research for several hypotheses that provides evidence of VMI creating an improved performance of hospitals and associated suppliers.

Keywords: Vendor Managed Inventory, Healthcare, Survey

Introduction

Healthcare has become a resource system with a limited capacity to provide care based upon available man-hours of the professionals (Doctors, Physician Assistants, Nurses, technicians and administrative staff) working for the company. According to the US Congressional Budget Office (CBO) estimates, the Patient Protection and Affordable Care Act will add 31 million more patients to insurance rolls (CBO, 2009). This increase represents a 12 per cent growth to the required capacity of the current national health system. The challenges inherent further increase the impact since availability of care in underserved communities and distances a patient will be required to travel for receiving care are not addressed. The impact to healthcare of those scenarios in a provider shortage environment is not addressed. Likewise the increased patient care time demands placed upon providers will allow less time to manage required supplies. According to the Health Resources and Services Administration (HRSA) of the US Department of Health and Human Services (HHS), there is currently a shortage of over 17,800 primary care practitioners across 6,422 designated Health Professional Shortage Areas that contain a population of 66.8 million people (HRSA, 2011). The HRSA estimates a requirement of over 17,000 additional primary care providers to fill current shortages; the 2010 ACA will add 31 million additional patients to the number of insured seeking care, further stressing a system already near capacity. Similar shortages are recognized in Dental and Mental Health delivery areas as well as Nursing (HRSA, 2011).

Maximizing the patient contact time of providers in order to achieve optimum utilization of these scarce resources in the healthcare system (characterized as increased wait times for appointments
or reduced contact time with a provider) is a critical component for success. Current practices often have workers skilled in providing care (such as phlebotomy, taking vital signs, administering tests such as EKGs, etc.) performing supply, administrative or data entry functions. Although Gruber (2011) states that the wait times in Massachusetts (MA), currently the only state with nearly the same all-inclusive healthcare plan as proposed by the ACA, have remain statistically unchanged since the MA health care law was introduced, it is unclear if these findings from a population of 6.5 million (2.1% equivalent sample) in Massachusetts extrapolate to the larger US population of 304 million. It is also unclear if those findings would remain constant during a larger implementation of such a program. Another unresearched factor is the attitude and acceptance of these wait times versus patient care expectations and whether overall outcomes are improved.

Although the impacts to service providers and patients alike may be dramatic, there has been little research done on the impact of reducing the amount of skilled providers executing supply functions at the user level to optimize workloads in critical healthcare function areas.

**Literature Review**

The literature of Vendor Managed Inventory as a specific method began in the mid 1990s. Early work (Langley & Holcomb, 1992; Sanchez & Mahoney, 1996 and Waller et al. 1999) explored the concept of a third party managing a firm’s inventory. Within a short amount of time, additional academic works as well as practitioner accounts began appearing (Cetinkaya & Lee, 2000; Fry et al, 2001; Byrnes, 2003). In due time the idea of VMI was discussed in textbooks (Simchi-Levi et al., 2004). The findings have generally shown that firm goals of increased inventory turns, increased sales and decreased costs have been met (Simchi-Levi et al., 2004), but additional research should be conducted to expand the findings further. In the following decade, practitioner discussion and successful utilization increased within a limited scope from multinational firms and across several industries. Roger’s (2003) Diffusion of Innovations work may explain part of a wider acceptance, as Laggards wait for favorable results from Early Adopters. Additional research may uncover the reason for limited adoption of the VMI technique. Other factors delaying more far reaching adoption may include the failure or absence of key management champions or a lack of strong desire to differentiate, that is, a firm’s complacency with market position. Some literature suggests a deeper acceptance of the methodology (Sui et al., 2010) but additional research should be conducted to include relevant multi industry case studies and empirical research as well as focused case studies and simulations of the complex healthcare supply chains that would best implement this strategy.

Vendor Managed Inventory (VMI) is defined as a system where “the supplier decides on the appropriate inventory levels of each of the products (within previously agreed-on bounds) and the appropriate inventory policies to maintain these levels (Simchi-Levi et al., 2004). APICS’ definition of VMI states it is “A means of optimizing supply chain performance in which the supplier has access to the customer’s inventory data and is responsible for maintaining the inventory level required by the customer. This activity is accomplished by a process in which resupply is done by the vendor through regularly scheduled reviews of the on-site inventory” (Strategic Marketplace Initiative, 2009). VMI as a method to provide supplies to a customer has been used primarily in distribution and manufacturing settings, with some notable adoption by
the grocery industry (Achabal et al., 2000; Marques et al, 2010, Niranjan et al., 2011), the pharmaceutical industry (Danese, 2004) as well as the food, apparel and computer industries (Waller et al., 2009).

A key point of implementation of VMI is the essential transfer of ownership of the customers’ inventory to the seller/supplier. Marques et al., (2010) further discuss how this relationship is one that, by design and integration, should last long-term. There are potentially many processes and technologies to be resourced, implemented, trained and maintained for VMI to be successful. This is in light of an evolving definition among practitioners and academics alike. A common theme through all of these descriptions is that implementation can be challenging, yet the rewards for successful implementation can lead to differentiation through improved supply chain response, reduced costs to both vendor and customer and through a customer’s ability to focus on core competencies (Simchi-Levi et al., 2004). Specifically the retailer/buyer may experience reduced stock outs, reduced inventory levels and reduced planning and forecasting costs. The supplier/seller may realize improved internal coordination utilizing the increased quantity of downstream data and the supplier can reduce transportation costs as shipments are able to take advantage of improved capacity utilization (Sui et al., 2010). This is exemplified by the shipper’s ability to determine the best quantity and mixture of products for delivery to multiple customers on a delivery route in light of available time, delivery resources and priority of shipment (Waller et al., 2009).

Other areas of challenge faced by VMI implementation include stochastic demand, such as that experienced in seasonal products, i.e. new styles or a new product launch. While VMI allows a supplier to smooth anticipated demands through access to point of sale (POS) data and subsequent analysis, it cannot yet allow an upstream manufacturer to quickly supply items for which there has been an inadequate forecast. This process of uncertain demand, and the subsequent supply and manufacturing responses, where each member in the supply chain makes its own decisions regarding required quantities and which can lead to either overstock or stock out conditions is referred to as the bullwhip effect (Coyle et al, 2013; Simchi-Levi et al., 2004). VMI seeks to smooth this demand, in part through more frequent deliveries, at least in a dyadic environment (Cottrill, 1997; Waller et al., 2009) to enable a more efficient supply chain. In turn, this smoothing effect has the benefit of reduced costs at the supplier level and superior customer service through available stock at the retail level (Waller et al., 2009). Competitive demands are a compelling force requiring manufacturers to focus on their internal core strengths and outsource non-core competencies when possible (Kaipia et al., 2006). This compelling force for acquiring advantage may extend to the retail level as well. Successful implementation of VMI, as experienced by Proctor and Gamble, Wal-Mart and others, are indicators that VMI, when introduced into a fast paced retail environment, can be successful (Cetinkaya & Lee, 2000). There are many parallels between such a retail environment, focused on velocity as well as profit and loss, and a hospital setting focused on velocity of patient care, accuracy, profit and loss and successful outcomes.

Since VMI is relatively new, most of the established literature deals with general business settings. There have been several instances noted of the supply chain field beginning to explore this approach in the healthcare arena for items as varied as blood shipments in Austria (Hemmelmayr et al., 2009) as well as implementation by a major healthcare product distributor.
(Newman et al., 2009) in the United States. Also, there are several anecdotal accounts of limited VMI employment in hospitals (Proctor & Miller, 2005; Byrnes, 2003) as well as limited national implementation in support of vaccinations in Thailand (PATH, 2011), employment at the US Department of Defense (Singletary, 2010) and in pharmaceutical support of a U.S. national emergency (Centers for Disease Control and Prevention, 2011) requiring the use of the Strategic National Stockpile.

In a general business context the issue of VMI implementation has received much scrutiny and examination. Discussion and simulation of inventory policy (Gou et al., 2008) and subsequent savings have been echoed by Kauremaa et al., (2009) who examined five case studies in multiple industries and suggest implementation may be more driven by unilateral rather than dyadic or supply chain wide interest. If all participants are not aligned with common goals, this could result in additional friction points and a subsequent negative impact on performance. Kauremaa et al. (2009) suggest the use of the case study method to further delineate the role of firm intention on VMI selection which they note has been rare in previous examination of this method. Byrnes (2003) brief examination of customer partnerships discussed partial implementation of VMI systems for multiple customers of a single retailer. The supplier used a smaller hospital implementation as a working case study to convince senior management of larger hospitals that the method was sound, but formal academic analysis was not undertaken. An Apple computer subsidiary in Ireland was examined as a case study in VMI from the point of view of the impact played by currency exchange fluctuation where it was found that such fluctuations benefitted the retailer with decreased costs and benefitted the supplier when there were economies of scale, but such studies remain rare (Lee and Ren, 2011).

Comparing the closely aligned processes of VMI and Supplier Managed Inventory (SMI) can assist decision makers in choosing the correct model. One simulation of joint planning yielded a 5 to 20 percent cost savings (Pohlen & Goldsby, 2003) when compared with a traditional (s, S) inventory policy where s is the reorder point and S is the maximum stock level (Arrow et al., 1951). Yao et al., (2010) examined the use of an incentive contract between VMI participants to increase market share. They examined both the manufacturer and supplier. Their results indicate that such an arrangement reduces loss of market share and backorders due to stockouts, expanding the usual examination of the supplier/retailer dyad further upstream.

As a technique, the recent interest of expanded use of VMI in multiple dyadic settings hopefully provides a glimpse of expanding realization of the utility of the method. Some researchers have viewed a further delineation of VMI as a method which can have two distinct implementations, one where the supplier retains the cost of the inventory and makes all replenishment decisions has been referred to as VMI+ and VMI- where the retailer retains ownership (Bernstein et al., 2006). In their examination, VMI+ appears to be more favorable across the supply chain. Their findings also define the concept of echelon operational autonomy where one player makes decisions affecting other players, such as a retailer, but with the goal of benefitting the entire supply chain, not merely their own firm, further defining the supplier/retailer relationship.

Sui et al., (2010) note that care must be taken when implementing VMI, but also note that newsvendor based rules coupled with the relatively easy use of spreadsheet programming to examine simulation outcomes and determine optimization are promising developments to
encourage wider examination. Regarding the use of new supply chain techniques in healthcare, the Health Sector Supply Chain Research Consortium’s 2011 list of supply chain trends in healthcare includes “escalating demand for evidence supporting outcomes, quality and value for products and processes at all points in the supply chain,” as well as “consideration of the need for new business models by supply chain trading partners”. These new business models can include strategic partnerships, such as VMI or other cooperative solutions, as well as mergers and acquisitions (Wilson, 2011). The latter may be a strategy to add a core competency to a firm that may lack it, especially with larger firms that may realize benefits from greater scalability of such an action.

Vendor Managed Inventory as a subset of an outsourcing strategy has been used intermittently due to the inherent challenges that participating firms may face. These may include changes in product identification coding, a refocused effort on core competencies and aversion to change (Kaipia et al., 2006). Additionally firms may struggle with the necessary first step of identifying a core competency and from there extrapolate how that may impact organizational structure and operations. Sanchez and Mahoney (1996) suggest that organizational structure flexibility, based on product design modularity, will allow firms to better utilize strategic learning and knowledge management leading to new levels of product variety and change. In the supply chain field, such an approach may lead to new strategic implementations of methods and systems and well as an ability to improve intra-organizational collaboration.

Langley and Holcomb (1992), have noted that use of a third party relationship for deliveries and training, exogenous to a retailer/ customer relationship, had helped Xerox refocus on core competencies, such as sales personnel selling versus training and is seen as a long-term competitive advantage. Likewise Proctor and Miller (2005) anecdotally report that VMI implementation in a hospital setting allowed staff to focus on core competencies in critical application areas such as the cardiac catheterization lab as well as in operating rooms. Their implementation was in line with other strategic firm goals which also included cost reduction and stabilization of logistics size and operation.

**Findings**

Vendor Managed Inventory has achieved a level of success and acceptance in certain applications and settings. The Strategic Marketplace Initiative, a practitioner focused group, has developed a Microsoft Access database tool to help firms determine if VMI is appropriate and to what extent they may see future success, with the caveat that close coordination is a requirement for any hope of success (Strategic Marketplace Initiative, 2009). Additional researchers have conducted case study and framework analysis to assign weights among factors indicating successful VMI implementation opportunities (Niranjan et al., 2011). Although many varied industries have chosen to use VMI, its implementation remains broad rather than deep, perhaps due to multiple independent or dependent factors previously mentioned, but the exact causes remain unclear. Some healthcare facilities have implemented VMI in limited critical applications and settings and several vendors as well as practitioner professional associations have begun exploration to help potential adopters find the correct method. Much work remains and, as with the definition of Supply Chain Management, many definitions of VMI are at play in the field.
Hypotheses

Several Key Performance Indicators (KPIs) were selected and the impact of VMI implementation on these indicators is summarized in Table 1. These KPIs are metrics which allow a measurement of the quality of an activity. Such a measurement will allow action to be taken when a value drops below a benchmarked threshold. Brief summaries and explanations of the impact of vendor managed inventory are below. It is assumed that the vendor will treat the customer fairly and will not seek a profit advantage, but will make decisions to benefit the dyadic supply chain relationship, in keeping with the concept of a relational versus transactional exchange. The impact we anticipate through VMI implementation will affect, among other areas, supply service outcome performance and profit performance. We anticipate an improvement in the listed metrics in a manner that favors a firm’s ability to provide supplies to its customer.

In all of the hypotheses discussed below, implementation of VMI refers to complete implementation at a hospital including all medical supplies, and the level of influence on all the KPIs change as the implementation level changes. For instance, VMI many not have significant impact on efficiency or percent of stock level with implementation of VMI confined to just a few medical products. VMI level in a hospital can be categorized as the following: i) No VMI existed ever, ii) partial VMI (15 to 20% of the products are managed by a vendor), iii) majority VMI (more than 50% of the products are managed by vendor), vi) full VMI (more than 80% of the products are managed by vendor). We propose impacts for both the vendor and customer as reflected in Table 1.

Table 1: Proposed KPI Relationship with VMI and Profit

<table>
<thead>
<tr>
<th>Key Performance Indicator</th>
<th>VMI Service Impact Vendor</th>
<th>Customer Profit Impact</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>Increase</td>
<td>Increase</td>
<td>Increase On time orders/ Fill rate</td>
</tr>
<tr>
<td>Spatial Complexity</td>
<td>Decline</td>
<td>Decline</td>
<td>Decline Number and distance of key suppliers</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>Increase</td>
<td>Increase</td>
<td>Increase Level of contentedness with performance and fit</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Increase</td>
<td>Increase</td>
<td>Increase Ability to provide customized, non-standard &amp; new products</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>Increase</td>
<td>Increase</td>
<td>Increase Transportation/ warehousing/ inventory costs</td>
</tr>
<tr>
<td>Depth of Collaboration</td>
<td>Increase</td>
<td>Increase</td>
<td>Increase Information exchange/ joint planning</td>
</tr>
</tbody>
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Efficiency in a logistics or supply chain operation is an important aspect to ensure proper utilization of limited resources to include time, personnel, and other firm resources. It is a means by which a firm can understand whether or not the resources it has assigned to a project or output are performing up to their potential (Koota & Takala, 1998; Mentzer and Konrad, 1991). Halley and Guilhon (1997) further discuss efficiency as “the contribution of logistics activities to the sale, turnover and profitability of the firm, to customer satisfaction, and to employee motivation.”

**H1a: Implementation of VMI at the customer (hospital) will result in higher efficiency for both the vendor and the customer**

**H1b: Higher efficiency for both the vendor and the customer via implementation of VMI will result in significant increase in financial performance**

Spatial Complexity can be a key factor in understanding the performance of a supply chain. Often firms are unaware of the complexities due to distance from in addition to the numbers of suppliers. This spatial complexity is further a factor when the number of shipments is taken into account. Reduction in spatial complexity, due to potential shipping efficiency benefits from VMI can be examined in several ways. At its simplest, a basic counting of operating locations can provide a gauge of supply chain complexity (Daft, 1989; Price and Mueller, 1986). However this approach fails to take into account the distance involved between nodes, which may have temporal implications if great distances or administrative barriers such as national borders must be navigated. The approach taken in this study is an examination of both number of suppliers as well as geographic distance to the customer following Choi & Hong (2002). While this has limitations in terms of exact measures of each supplier and barriers, such a detailed examination is outside the scope of this study and may be more appropriately addressed by future research. An area in which VMI is conjectured to provide benefit is through better transportation management from the supplier, thereby potentially reducing the number of shipments compared to non-VMI structures.

**H2a: Implementation of VMI at the customer (hospital) will result in reduced spatial complexity**

**H2b: reduced spatial complexity in the supply chain via implementation of the VMI will result in significant increase in financial performance**

Hayes and Wheelwright (1984) introduced a set of competitive priorities. Among these were price, dependability, quality and flexibility. They further introduced subsets of these attributes. This research examines the flexibility subsets of product and volume. Although focused initially on manufacturing, these concepts were further refined by Ferdows & De Meyer (1990), who noted flexibility as a strategically useful capability. This research explores the role of flexibility through the aspects of product, volume, launch and access flexibility capabilities. The ability of a firm to be flexible in response to customer demands without a negative impact on operational efficiency or profitability may be a competitive advantage. Vickery et al., (1999) also examined several aspects of supply chain flexibility as part of an examination of strategy within a firm. Their results suggest that, in a broad context, all the measured financial metrics they examined correlated with high supply chain flexibility. This study seeks similar corroboration in a more focused healthcare context.
H3a: Implementation of VMI at the customer (hospital) will result in increased supply chain flexibility
H3b: Increased supply chain flexibility at the hospital (customer) via implementation of the VMI will result in significant increase in financial performance

Satisfaction with a transaction or service has roots in the idea of equity/inequity. Often the concept of equity is based upon the buyer’s perception of the transaction and is in a way considered proportional to the investment that has been made. Oliver & Swan (1989) measured the satisfaction construct of new automobile buyers across six dimensions that included the customer being pleased, contented, satisfied, considered the transaction a wise choice, being happy and considering that the transaction partner did a ‘good job’. This research follows their model. With the understanding that satisfaction can be influenced by multiple discrete events, a bipolar scale of descriptive adjectives developed by Westbrook and Oliver (1981), spanning various research streams, is used here, following usage by Oliver and Swan (1989)

H4a: Implementation of VMI at the customer (hospital) will result in increased customer satisfaction
H4b: Increased customer satisfaction at the hospital (customer) via implementation of the VMI will result in significant increase in financial performance

Figure 1 provides a concise picture of hypothesis discussed in this paper.

![Figure 1: Relationship Summary](image-url)
Gaps

Most studies have examined the large scale implementation between sizable vendors and retailers. There are a great number of smaller settings where VMI, in limited fashion and with limited expense, may be implemented to best serve a larger number of customers, while taking advantage of a supplier’s expertise in this area. In healthcare, particularly in high cost, high velocity items, sizable acquisition, inventory and carrying costs may be reduced as a high profile example of the benefits of the program.

Follow up is required. Case studies of various configurations of hospitals, healthcare conglomerates, healthcare cooperatives and regional buying consortiums should be examined as the customer of single vendors under a VMI construct to determine the best product mix and service levels to achieve parity and lower costs where possible. Following identification of successful and unsuccessful implementations, empirical research should be conducted to provide a starting point for further refinement of VMI acceptance and processes in the healthcare industry.

Findings should be provided to practitioners through journal and magazine publication as well as through conference presentations. Feedback from these venues can help focus further modification for improvements.

Implications for Practitioners and Academics

Practitioners will benefit from exploration of VMI implementation in their facilities as it is a powerful technique to achieve multiple goals, if properly implemented. Studies have shown that both suppliers and buyers achieve financial benefits from implementation. Suppliers through demand visibility and buyers through reduced stock-outs and reduced loss sales may begin to reap benefits. Although there is a cost for implementation, which benefits from understanding and support at senior management levels, the gains in integration between firms, the improved levels of trust and improvement in supply chain operations may outweigh the costs in most implementations. The interconnectedness of this approach and its complexity allow for both great opportunities for firms to customize their own models as well as for academics to explore the underlying factors for success and failure.

Some research has been done with determining the correct pricing structure, delivery and route optimization and stock levels in individual and dyadic environments, but these can be expanded to include wider supply chain adoption as well as adoption within specific industries such as healthcare, which have received scant academic treatment.

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