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Success factors and performance outcomes of healthcare industrial vending systems: An empirical analysis

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ABSTRACT

A healthcare industrial vending system (IVS) represents a specific form of Vendor-Managed Inventory (VMI) solution that links healthcare supply network participants to each other. These networked systems are used by healthcare organizations to optimize the availability of items and minimize cost. This research investigates a series of success factors and performance outcomes associated with healthcare IVS, a current healthcare resource and materials management topic. A measurement instrument was developed based on earlier VMI work, and a sample of 91 users of healthcare IVS's was used to test the proposed structural model. The study results confirm, from a buyer's perspective, that the success of a healthcare IVS depends on the quality of the information generated by the system as well as the quality of the buyer-vendor relationship. Findings also indicate that the successful implementation of a healthcare IVS can result in improved inventory management, enhanced customer service levels, and reduced costs.

1. Introduction

Given the turbulent environment of the healthcare sector, new resource and materials management technologies and tools are critical to the continued viability of healthcare organizations (Xu et al., 2011; Rossetti et al., 2012; Hoeur and Kritchanchai, 2015). Healthcare industrial vending systems (IVS's), also known as automated drug distribution systems or medical supply dispensing systems, represent one of those technologies. These networked solutions are used by healthcare organizations to stock and dispense different items such as medical supplies, surgical tools, narcotics and other controlled substances. Healthcare IVS link supply network participants to each other by generating and transmitting information from a buying organization to a supplier (or vendor). These systems can keep track of inventory levels, record what items are being dispensed, as well as create reports in real time (Stapinsky, 2009; Melcer, 2000). Whenever the inventory runs low on a certain item, the system automatically places an order which must then be fulfilled by the vendor.

The use of industrial vending machines in healthcare settings is slowly becoming an increasingly important aspect of day-to-day operations for many healthcare organizations (Manrique and Manrique, 2015). The adoption of industrial vending solutions by organizations in the healthcare sector signals a change in priorities regarding inventory management (de Vries, 2011; Lee et al., 2011; Bhakoo et al., 2012). One reason for the emergence of this technology stems from the growing need of organizations to both control costly inventory and ensure the availability of critical items (Goodwin, 2011; Oztekin et al., 2010). Another reason for the development of IVS's is the fact that the majority of healthcare organizations do not have adequate systems in place to monitor the usage of those items, which may enable employees to create personal mini-stores or 'hidden stocks' to handle demand uncertainties (de Vries, 2011). Hidden stocks can result in inflated inventory costs while actual stockroom inventories fall below required levels. This issue could ultimately lead to stock-outs of critical items (Goodwin, 2011; Brandt, 2010). Stock-out situations in the healthcare sector could lead to serious injury or death (Nicholson et al., 2004) or may force healthcare organizations to maintain excess levels of safety stock (Bhakoo et al., 2012).

From a resource and materials management perspective, a healthcare IVS represents a specific form of Vendor-Managed Inventory (VMI). VMI has been defined as a collaborative initiative between a buyer and a vendor to optimize the availability of items and minimize cost to both network partners. In a VMI system the vendor takes responsibility for inventory management within a framework of mutually agreed targets which are constantly monitored to continuously improve the performance of the system (Hines et al., 2000). A healthcare IVS represents a unique solution in that it blends the benefits inherent to consumer vending systems (e.g., point-of-need convenience) with the benefits

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of traditional VMI initiatives (e.g., improved inventory availability) (Goodwin, 2011).

While different benefits of healthcare IVS's have been identified in trade journals that advocate the use of such machines, the topic of healthcare industrial vending systems has been largely ignored by the academic community. The purpose of this paper is to help address this shortcoming by developing a model to empirically investigate the relationships between a series of success factors, healthcare IVS success and different performance outcomes. To accomplish the research objective, a survey instrument was designed, data was obtained from 91 users of healthcare IVS's, and partial least squares structural equation modeling (PLS-SEM) was used to test the proposed model. The hypothesized model is grounded in Transaction Cost Economics (TCE) and is based on the traditional VMI model originally developed by Claassen et al. (2008). Changes had to be made to the original VMI model due to the different purposes of the studies and constructs of interest.

From a practitioner's perspective, this study provides healthcare resource and materials management professionals with current, up-to-date findings which should aid them in evaluating present and future healthcare industrial vending solutions. From an academic standpoint, this paper represents the first attempt to explore performance outcomes and success factors of healthcare IVS's. The study contributes to the VMI field in general and the healthcare industrial vending field in particular by presenting empirically tested results that confirm, from a buyer's perspective, a series of success factors and performance outcomes of healthcare industrial vending initiatives. The findings presented in this study thus provide a relevant starting-point for further empirical research on a relevant healthcare resource and materials management topic.

The study begins with an overview of the transaction cost economics literature which provides theoretical support for this research, and a review of the field of buyer-supplier collaborative relationships. Next, the authors present the proposed model and discuss the development of the research hypotheses before transitioning to the research methods and results sections. Managerial implications, conclusions, and directions for future research are also discussed.

2. Literature review

2.1. Transaction cost economics

The theory of TCE proposes that there is a cost associated with all business transactions that must be accounted for, and that companies attempt to minimize those costs while balancing the risks associated with each potential outcome (Tate et al., 2011; Williamson, 1986, 2008). TCE stems from the work of Commons (1932), Williamson (1979) and Coase (1993), among others, and has been successfully applied to many business disciplines (Barney, 1990; Heide and Stump, 1995), including the healthcare sector (Hajli et al., 2014; Stiles et al., 2001). This theory also attempts to explain why companies expand or outsource activities to external parties as part of their risk management efforts. TCE differs from other theories because it recognizes that certain situations require parties to engage in an ongoing relationship to complete a transaction (Grover and Malhotra, 2003). In this respect, healthcare IVS's involve the coordination of a buyer-vendor relationship and can be thought of as a transaction process with multiple interactions.

Two important assumptions related to TCE are the ideas of bounded rationality and opportunism (Grover and Malhotra, 2003; Rindfleisch and Heide, 1997). The first assumption, bounded rationality, suggests that decision makers have a limited ability to receive, store, process, and communicate information without error (Grover and Malhotra, 2003; Simon, 1957). The assumption of opportunism suggests that decision makers tend to act in their own interest. From a TCE perspective, opportunism can result in increased transaction costs due to the added expenses associated with the monitoring of relationships and the protection of company assets (Grover and Malhotra, 2003). In order to minimize transaction costs, firms react by adopting governance mechanisms. Healthcare organizations may, for example, seek new resource and materials management solutions in order to mitigate transaction costs (Stiles et al., 2001).

The two major components of transaction costs are coordination costs and transaction risks (Clemons et al., 1993). Coordination costs, include, for example, the expenses associated with the generation and transmission of information in the buyer-supplier relationship. These costs are also related to idea of asset specificity, which can be defined as the extent to which an investment made to support a transaction has a higher value to that transaction than the investment would have if redeployed elsewhere (Williamson, 1989). Asset specificity can help reduce coordination costs by creating a dependency between the buyer and the seller (Riordan and Williamson, 1985), and can also lead to numerous benefits (Dyer, 1997; Williamson, 1985). In the case of healthcare IVS's, the physical asset specificity of these specialized machines developed to assist with healthcare inventory management can create a strong bilateral dependency between a buyer and a vendor.

Transaction risks, the second component, include the potential for parties to misrepresent or withhold information, or to fail to perform the agreed responsibilities (Bunduchi, 2008). In this sense, the vast amount of information generated and transmitted by networked systems such as healthcare IVS's can help increase the level of information symmetry and make the buyer-supplier relationship more transparent (Clemons et al., 1993; Croom, 2001). As a result, these solutions can help reduce the potential for supply network partners to act in an opportunistic fashion, and help reduce both coordination costs and transaction risks (Tadelis, 2010; Sanders, 2007; Wiengarten et al., 2013).

2.2. Buyer-supplier collaborative relationships

Organizations in the healthcare sector face strong institutional and regulatory pressures to balance efficiency and effectiveness at different levels of decision making, including the area of resource and materials management (Bhakoo et al., 2012; Kelle et al., 2012). As a result, healthcare organizations have adopted alternative approaches to efficiently manage inventories and, simultaneously, improve patient care. Organizations in the healthcare industry have, for example, implemented a wide variety of Just-In-Time manufacturing concepts (Nelson-Peterson and Leppa, 2007). Lean thinking has been used to reduce waste and improve productivity (Joosten et al., 2009; Kollberg et al., 2006), while Kanban systems have been developed to reduce the number and volume of items to keep in stock as well as decrease the frequency of order errors (Aguilar-Escobar et al., 2015; Persona et al., 2008).

Buyers and suppliers in the healthcare industry have also engaged in collaborative initiatives such as VMI in order to optimize inventory availability at the most efficient cost (Hines et al., 2000; Danese, 2006). These relationships, which are characterized by the exchange of critical resources such as information, technology, and expertise, can help improve firm performance and create competitive advantage (Das and Teng, 1998; Fawcett et al., 2008).

In the context of healthcare supply networks, supplier collaboration has been found to positively affect organizational performance (Lee et al., 2011) as well as help reduce costs in healthcare product innovation (Burns et al., 2013). Similarly, Bhakoo et al. (2012) discussed how the application of collaborative arrangements can improve inventory management practices across the entire healthcare supply network. The impact of collaborative relationships and VMI agreements on healthcare inventory management has also been examined by Kim (2005) who discussed how real time information sharing can enable timely and cost-effective deliveries and, ultimately, help decrease the total supply chain cost of pharmaceutical products. Furthermore, the exchange of knowledge and integration of resources between healthcare supply network partners have also been found to improve supply network performance (Chen et al., 2013).

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