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Barriers and best practices for material management in the healthcare sector

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BARRIERS AND BEST PRACTICES FOR MATERIAL MANAGEMENT IN THE HEALTHCARE SECTOR

by

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ABSTRACT

For many years, the primary focus of the healthcare sector has been to provide patients with the best quality of care. Recently, with the escalating cost of supplies and the severe competition among healthcare providers, the pressure on material managers to operate more cost-efficiently without compromising the high patient care standards has significantly increased. While other sectors have experienced success through the deployment of supply chain management practices, the healthcare sector has not seen major improvements in this area. However, in spite of the uniqueness and complexity of the healthcare supply chain, opportunities for improvements are plentiful. Thus, this thesis provides an assessment of material management in the healthcare sector, by highlighting the areas of improvements, identifying barriers for implementing supply chain management practices and analyzing material management best practices. Results of this study shows that, while progress has been made, there are still many barriers that need to be overcome, and essential practices that need to be implemented in order to achieve a more efficient, yet customer focused supply chain.

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1. INTRODUCTION

A supply chain consists of all the elements, activities and processes required to deliver a product from raw material to a final customer. Such activities include, demand forecasting, resource allocation, production planning and scheduling, inventory management, and customer delivery. The success of a strong supply chain can be attributed to the effective implementation of supply chain management (SCM) practices, which include communication within the organization, support for supply chain management efforts and processes, information systems for data collection, analysis and sharing, and measurement systems to assess total supply chain costs and performance. Furthermore, collaboration and cooperation, along with information sharing, among upstream and downstream supply chain members have been cited as important SCM practices, which have recently become very attractive for many companies because of their power to improve efficiencies by reducing operating costs and providing higher service level. While SCM practices have been widely adopted in many sectors, the healthcare industry has not seen major improvements in the implementation of these practices (McKone-Sweet et al., 2005).

In the healthcare sector, the supply chain can be defined as a complex system that requires the flow of products, and services in order to satisfy the needs of those who serve patients (Schneller and Smeltzer, 2006). Within hospitals, the department responsible for the efficient management of supplies is often known as material management. Material management functions comprise procurement, distribution, purchasing, and inventory control of supplies with the intention of providing high quality of care at reduced cost.

In the past, healthcare providers were generally focused on providing high quality of care regardless of cost. However, with the skyrocketing cost of materials and the intense competition among healthcare providers, the role of material management has gained great importance for hospitals and healthcare providers. Today, healthcare managers and industry experts understand that the efficient management of materials can not only reduce operating cost, but increase the quality of care.

While it has been acknowledged that the deployment of better material management practices can represent as much as $23 billion in cost savings (EHCR, 2001), the healthcare sector has seen little improvements in this area. Furthermore, the lack of success in this area can be attributed, for the most part, to the existence of strong implementation barriers that have hindered the adoption of SCM practices. Thus, there is a strong need to study the challenges embedded in the healthcare sector in order to provide material managers with potential solutions to reduce inefficiencies and achieve supply chain success.

With this motivation, this thesis explores material management in the healthcare sector. Empirical data has been collected through a survey consisting of healthcare providers, group purchasing organizations (GPOs), and vendors, to help identify barriers to implementing SCM practices, and analyze material management best practices. Results of this study may help to inform material managers of the improvements made in the healthcare sector, provide them with a list of areas where efforts are still needed, and recommend potential solutions to become more cost-efficient.

The reminder of the thesis is organized as follows. Paper that defines the healthcare supply chain problem, reviews the literature on SCM practices related to the

healthcare sector, describes the methodology of the study, and summarizes the results of this research. Section 2 discusses overall conclusions from the study, along with the future areas of research.

PAPER

BARRIERS AND BEST PRACTICES FOR MATERIAL MANAGEMENT IN THE HEALTHCARE SECTOR

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Abstract

In this time when competition grows more intense among companies, it is recognized that the efficient management of materials and supplies is a key factor for success. Supply chain management practices, such as use of information technology, information sharing, collaboration and integration of stakeholders, have enabled many industries to improve their supply chain by reducing inefficiencies, improving service, and generating significant cost savings. In spite of the uniqueness and complexity of the healthcare supply chain, opportunities for improvement are plentiful. In the healthcare sector, materials and supplies represent significant hospital expenditures and continue to rise exponentially. Moreover, competition among healthcare providers has intensified, including more demanding quality of healthcare services; thus, material managers are striving for improvements. This pilot study explores material management in the healthcare sector, consisting of healthcare providers, group purchasing organizations, and vendors, to identify best practices and implementation barriers for material and supply chain management principles. The results of this study provide the material manager with potential solutions to increase efficiency and quality, while achieving cost savings.

Keywords: Healthcare, Material Management, Supply Chain Management (SCM)

Introduction

Supply chain management (SCM) can be defined as all the activities involved in delivering a product from raw materials through to the customer, including sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across channels, delivery to the customer, and the information systems necessary to monitor these activities (Lummus and Vokurka, 1999). Supply chain management practices, such as the use of information technology and decision making structures, along with information sharing, collaboration and integration of stakeholders, have enabled many industries to improve their supply chain by reducing inefficiencies, improving service, and cutting operating costs. "However, despite the well-documented evidence of significant competitive advantage and cost reduction resulting from supply chain management practices, the healthcare sector has been extremely slow to embrace these practices" (McKone-Sweet et al., 2005, p.4).

Within an organization the department responsible for contributing to the overall success of a supply chain is often known as *material management*. In the healthcare sector, the term material management refers to the procurement, distribution and inventory control of supplies with the purpose of providing high quality of care at reduced cost. Material and supply costs represent the second largest hospital expenditure, and account for 30% of the operating cost (Schneller and Smeltzer, 2006). Throughout the years, and with the advances in technology and quality of care, these costs have been rising exponentially, making healthcare executives more aware of the importance of an

efficient material management system. It has been recognized that efficient material management can represent many cost savings for hospitals and healthcare providers. In fact, a report from the Efficient Healthcare Consumer Response (EHCR, 2001) identified $23 billion in cost savings opportunities in the management of supplies in the American healthcare sector. While some of these suggestions have been implemented, they have only scratched the surface.

While taking advantage of the emerging technologies, the healthcare sector has shown significant improvements in medical procedures, drugs, devices, and equipment. Many resources have been devoted to addressing new diseases and enhancing patient care (Reid et al., 2005); however, in spite of these improvements, the healthcare industry has not had the same success in modernizing the supply chain. Although there has been some recognition of the cost saving opportunities and benefits that can be obtained through better material management practices, industry experts agree that there are many challenges that need to be overcome to achieve success. Thus, the goal of this study is to provide a better understanding of the material management role in the healthcare sector by identifying barriers to implementation of supply chain management principles and analyzing the best practices for materials management. The results of this study provide the material manager with potential solutions to increase efficiency and quality, while achieving cost savings.

The reminder of the paper is organized as follows. The next section presents background on the healthcare supply chain, along with problem definition. Next, a brief review of SCM practices and their relationship to the healthcare supply chain is provided. Subsequently, the methodology of the study is described, followed by a discussion of the

barriers to implementing SCM practices. Finally, best practices for material management are discussed along with conclusions drawn from the study.

The Healthcare Supply Chain

The healthcare supply chain is as a complex system that involves the flow of different products types and the participation of several stakeholders. The main purpose of the healthcare supply chain is to deliver products in a timely manner, in order to fulfill the needs of those providing healthcare. Based on their functions, stakeholder in the healthcare supply chain can be divided into three major groups: Producers, Purchasers, and Providers. Figure 1 illustrates a healthcare supply chain configuration.

The producer's role is to manufacturer medical products such as surgical supplies, medical devices, and pharmaceuticals. Purchasers on the other hand, include distributors, wholesalers and group purchasing organizations (GPOs). Distributors or wholesalers hold inventory for producers to facilitate the delivery of products. GPOs sign purchasing contracts with producers, by aggregating the volume of GPO members (healthcare providers) to achieve economies of scale. Healthcare providers represent those at the lowest level of the supply chain and with the function to serve patients. Healthcare providers include, among others, hospitals, integrated delivery networks (IDNs) physician's offices, specialized centers, and pharmacies (Burns, 2002). To add to the complexity of the system, there is also the involvement and participation of governmental institutions, regulatory agencies, and insurance companies (Ryan, 2005).

Product Flow

The product flow in the healthcare starts with the manufacturer and ends with the final customer at the healthcare provider. Figure 2 depicts a diagram of the healthcare product flow. Depending on its type, a product can be directly delivered by the manufacturer to the healthcare provider, or pass through a distributor before reaching the healthcare provider. For instance, medical devices and name brand drugs that are often consider low-volume; and high-cost products are produced by manufacturers and delivered directly to healthcare providers. Products of this nature usually require a closer relationship between the manufacturer and the physician using the product in order to better assist physicians with product specifications and usage. On the other hand, surgical supplies and generic drugs are frequently considered high-volume; low cost products. In this case, such products are produced by manufacturers and sent to distributors that hold these products until they are ready to be delivered to the healthcare provider. Moreover, once products reach the healthcare provider they might be distributed throughout several internal departments.

Likewise the procurement of products is initiated at the healthcare provider by material manager, purchasing directors, pharmacists, physicians or nurses. Purchasing functions might also be outsourced to GPOs, who given their size can negotiate better prices with manufacturers.

The Healthcare Problem Definition

"The healthcare supply chain is frequently described as highly fragmented and relatively inefficient" (Schneller and Smeltzer, 2006, p.27). A major problem with the traditional

healthcare supply chain is that each stage of the supply chain operates independently, leading to misaligned incentives and conflicting goals that prevent the supply chain from operating as a system. For example, within the healthcare provider level, physicians represent one of the key decision makers for supplies. They demand preference items, which are usually at a premium, and show relatively little importance to cost. On the other hand, hospitals and healthcare provider executives have vested interest in providing the best quality of healthcare to customers, while at the same time reducing operating costs. Further, manufacturers and distributors are concerned with pushing their products to increase profit and gain market share, and GPOs aggregate volume of their members (healthcare providers) to sign contracts and collect administration fees from manufacturers.

These conflicts, along with other barriers, have hindered the adoption and implementation of SCM practices. Discussion of these issues will be presented in the following literature review that portrays the current situation of the healthcare sector by highlighting the improvements and identifying those remaining major barriers and areas where there is a need for additional research.

Literature on Supply Chain Management Practices in the Healthcare Sector

In the past, experts in the area of supply chain management have documented and discussed the benefits of efficient supply chains. However, many have wondered why the healthcare sector has lagged in this area. Recently, industry and academic researchers have begun to explore material management practices in the healthcare sector in order to discover means for improvement.

Examining these issues, Heinbuch (1995) described an approach to meeting the healthcare cost reduction challenge through the hospital material management function. The work highlights the value of taking a proactive stance to meet the challenge of transferring technology across industry sectors. For example, employing a just-in-time inventory management system in clinical areas of hospital materials management or adopting a win-win managerial philosophy. Beier (1995) conducted a study on inventory management in the healthcare, and found that hospitals hold high levels of safety stocks, which was attributed to poorly implemented inventory management practices techniques and to the use of personal judgment in determining safety stock levels, rather than using more scientific approaches. Likewise, on a broader scope, Brennan (1998) suggested that integrated delivery networks (IDNs) can achieve substantial savings while dramatically improving the speed and quality of the service if they redesign their supply chain. The paper also mentioned that to successfully integrate the supply chain process, IDNs need to meet or exceed best practice performance in five supply management areas: demand, orders, suppliers, logistics, and inventory. Finally, Alverson (2003) discussed the importance of a disciplined inventory management for hospitals, and suggested serious consequences of traditional hospital purchasing, including lack of inventory control, missed contract compliance, excess inventory levels, frequent stock-outs and costly emergency deliveries, workflow interruptions and expensive rework, and increased health system labor requirements. In addition, the paper suggested that hospital will realize significant measurable benefits from redesigning their inventory management processes.

Purchasing practices such as standardization, contract compliance, and outsourcing have also been discussed in the literature. Wagner (2006) described some financial and clinical

benefits from product standardization in the healthcare. These include increased efficiency in the storeroom by reducing the stock keeping units (SKUs) of similar items, improved ordering methods by reducing active SKUs in the item master file, and increased opportunities for better pricing due to increased volume of a particular manufacturer's product. Similarly, Popiolek (2006) highlighted the importance of maximizing contract coverage, improving contract compliance, and streamlining purchasing processes to reach greater efficiencies. Outsourcing inventory management decisions in the healthcare has also been an area of study. Nicholson et al. (2004) addressed the issue of managing inventory cost in a healthcare setting. The study specifically addresses the comparison of inventory costs and service levels of an in-house three-echelon distribution network vs. an outsourced two–echelon distribution network. It was found that the recent trend of outsourcing to distribute non-critical medical supplies directly to the hospital departments using them (i.e., the two-echelon network) not only results in inventory cost savings, but also does not compromise the quality of care as reflected in service level.

Other studies have focused on automated replenishment programs for inventory management such as Vendor Managed Inventory (VMI). Haavik (2000) provided recommendations for hospitals to adopt VMI software to eliminate the problem of overstocking cost in the hospital supply chain, and further suggested that savings to the hospital from having the distributor assume responsibility for the purchase order can be significant because most hospitals do not manage supply ordering and payment well. Kim (2005) designed and developed an integrated supply chain management system for optimizing inventory control and reducing material handling cost of pharmaceutical

products in the healthcare sector. An online procurement system for implementing VMI was adopted to improve material handling efficiency. The developed SCM system enabled hospitals to improve the procurement processes and inventory control of pharmaceutical products, which resulted in decreasing total inventory by more than 30%. It was also found that by sharing information with hospitals, the wholesalers can gather more timely and accurate data regarding inventory usage and status at hospitals, which leads to more accurate demand forecasts and enables needed products to be supplied timely and cost-effectively.

The literature on information technology (IT) also provides some solutions to material management in the healthcare sector. Burns (2002) discussed some of the value proposition of e-commerce and its benefits. For example, aggregation of suppliers and their products through electronic catalogues, visibility of orders and materials all along the pipeline, and efficiency in procurement for buyers. More and McGrath (2002) documented the importance of IT and e-commerce strategies for cost-effective services to its key stakeholders. Smith and Flanegin (2004) highlighted the importance of e-procurement, and suggested that there is a great potential for significant savings through using e-procurement in the healthcare sector. Barlow (2005) mentioned that systems and tools for the management of materials and supplies within healthcare sector will evolve and be adopted at a faster pace as hospitals and delivery networks aspire to realize efficiencies that are commonplace in other industries. Finally, Schneller and Smeltzer (2006) suggested that e-procurement systems can help to significantly reduce purchasing costs through the consolidation of supplier networks and creation of supplier partnerships. The book also mentions that transaction and administration costs can be

reduced through the use of enterprise resource planning (ERP) systems, which provide an automated and paperless format for information to flow throughout an organization.

The literature also provides a description of some of the barriers for implementation of SCM practices in the healthcare sector. While there is limited documentation of these barriers, Burns (2002) provided a good description of the constantly evolving technology of products, high cost for physicians preference items, lack of standardized nomenclature for healthcare products, and lack of information technology infrastructure. Additionally, McKone-Sweet et al. (2005) explored these barriers and found that the slow adoption of SCM practices can be attributed to the lack of executive support, misaligned incentives and conflicting goals, limited education on supply chain management practices, and lack of data collection and performance measurement.

With this motivation, a survey questionnaire was developed to explore barriers to implementation of SCM practices and material management best practices. This paper examines the efforts that have been made to overcome some of these barriers and identify remaining major barriers. Besides portraying the current situation of the healthcare supply chain, this study major contribution is to list and discuss material management best practices and provide with recommendations for adoption.

Study Methodology

After conducting a literature review on material and supply chain management in the healthcare sector a survey questionnaire was developed. In this research, empirical data was collected from material managers, directors, distributors, manufacturers, and GPO

directors from the Missouri area to identify implementation barriers for supply chain management practices and to discuss best practices for successful implementation.

Survey Development

To assist with designing the questionnaire, a small group of material managers and hospital directors from a local regional hospital was asked for input on the questions in order to evaluate the ordering, comprehensiveness and completeness of questions, as well as to verify that the appropriate information would be obtained from those participating in the study. This small group of material managers and hospital directors also assisted in identifying the participants for this study.

While the initial thrust of this research intended to collect information related to SCM implementation barriers in the healthcare sector, the ultimate goal was also to provide some insight on best practices for healthcare material management. The questionnaires were divided in two sets of questions; the first set identifying barriers for SCM implementation and the second set analyzing the best practices for material management. Based on literature review and comments provided by industry experts a preliminary list of potential barriers to implementation of SCM practices was created. This list of barriers was used to develop the first part of the questionnaire in order to identify the extent of such barriers. Questions in the second set included related to supply chain knowledge, inventory control, procurement, use of information technology and decision making structure, information sharing and involvement of GPOs. Three types of surveys were also developed for this study. While most of the questions were repeated in

the three questionnaires, a number of questions were intended for a specific group of participants.

Data Collection

Three groups of participants were involved in the study. The first group represented healthcare providers working in hospitals, physician offices and specialized centers. The second group consisted of sales representatives from distributors and manufacturers of medical products. The third group included directors of GPOs. Though this study focuses on the healthcare provider level (material management), other groups were incorporated to obtain additional opinions from the key stakeholders in the healthcare supply chain. Initially surveys were sent to participants in February 2007 by electronic and regular mail along with a letter explaining the purpose of the survey, the instructions, and confidentiality statement. Participants, representing a sample of healthcare institutions in Missouri, had the option of sending their responses by mail, electronic mail or fax. A reminder was sent two weeks after distribution of the initial questionnaire. In May 2007, a spring seminar and vendors fair was conducted by Missouri Association of Healthcare Purchasing and Materials Management (MAHPMM). Several attendees of this event, which included material managers, GPOs, distributors and manufacturers, completed the survey and deposited them into a confidential box.

The final sample of this study consisted of 35 healthcare providers, 15 manufacturers and distributors, and 2 GPOs. Table 1 shows the list of participants involved in the study.

Data Analysis

The survey questionnaire consisted of closed-ended multiple choice questions. The majority of these questions used the Likert Scale, which is a five point scale commonly used in survey questionnaires were respondents are asked to express their level of agreement with a given statement. In this study answers were given the following values: strongly agree = 2, agree = 1, neutral = 0, disagree = -1, and strongly disagree = -2 (Babbie, 2004). Though questions were closed-ended, a blank space was provided for some questions to capture additional explanation of answers.

Data collected from the survey was codified and analyzed using SPSS™ for Windows 12.0.1. Descriptive statistics (frequency, mode, median, mean, and standard deviation) were calculated for each of the survey questions. Participants had the option of not responding to some questions; consequently, not every question in the analysis had the same number of responses. However, although there were a few cases where participants did not respond to some of the questions, missing questions did not represent a major issue for the data analysis.

Responses were cross-tabulated by categories of healthcare institution and major role variables. Given that data collected did not come from a normal distribution, a non-parametric test was required for analysis. Therefore, the Mann-Whitney U Non-parametric Test (Klugh, 1970) was performed to compare responses from material managers with other participants. The Mann-Whitney U test is a non-parametric test used for testing the hypothesis that two independent groups come from the same population, and thus have the same median. The test allows the two groups to have unequal number of cases and requires data to be ordinal or continuous. It consists of ranking data

measurements in both groups $(n_1 + n_2)$, with the smallest measure in the pool given a rank of 1. Tied measures are given the average rank for the tie. After all measures have been ranked, the sum of ranks (R_1) is determined based only on the n_1 measures. Consequently, the statistic U_1 is calculated using the Equation (1).

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1 \quad (1)$$

The value of U_2 is based on the remaining ranks summed for the n_2 measures, and can be obtained from Equation (2).

$$U_2 = n_1 n_2 - U_1 \quad (2)$$

A significance level can then be determined for the smaller U value. A significant level of P = 0.05 was used in this study.

The following sections show the findings of this research, divided into two sections: Barriers to Implementing SCM Practices and Material Management Best Practices. In these sections, responses have been compared among participants and with existing literature.

Barriers to Implementing SCM Practices

As previously mentioned, in order to identify barriers to implementing SCM practices a list of preliminary barriers was created based on literature review and discussions with industry experts. The final questionnaire was used so participants could discuss the extent of these barriers. The following are a list of these barriers: Executive Support, Conflicting Goals, Skills and Knowledge, Constant Evolving Technology, Physicians Preference,

Lack of Standardized Codes, and Limited Information Sharing. Results for this section are summarized in Table 2.

Executive Support

Executive support has been cited by many authors, including Nelson et al. (2001), as a key characteristic for successful supply chains. In this study participants from the three groups were asked to describe their level of agreement with the statement: "There is executive understanding and support for SCM efforts in my institution". A significantly high percentage of respondents (45%) reported that they agree with this statement. Additionally 7.8% disagreed with the statement, and 15.8% of participants showed a neutral position. Surprisingly, results for this section are inconsistent with McKone-Sweet et al. (2005), which found the lack of executive support as being a barrier. The Mann-Whitney U test at a $P = 0.05$ level did not show any significant difference between participants. Findings in this study might suggest that healthcare executives have become more aware of the importance of materials and supplies and consequently have begun to offer support for SCM practices in their institutions.

Conflicting Goals

In this study conflicting goals regarding inventory choices in the healthcare supply chain was also found to be a barrier. Participants from the three groups were asked to describe their level of agreement with the statement: "There are conflicting goals regarding inventory choices among the stakeholders in my supply chain". Findings were more diverse than for the previous question, with 41.1% participants agreeing, 31.3%

disagreeing, and 27.6% being neutral. No significant difference was seen from the Mann-Whitney U test.

As stated in the literature, management of materials in hospitals and other healthcare provider institutions requires the participation of not only those monitoring inventory. It also requires the involvement of physicians, clinicians, nurses, and executives which are often in disagreement. In view of that, people monitoring inventory at the healthcare provider level were further asked to express their opinion about the conflicting goals regarding inventory choices and levels within their institutions. It was found that 47.1% agreed that there is conflicting goals in their institution regarding levels of inventory. Likewise, a 41.1% expressed disagreement with the statement and 11.8% were neutral. Whereas responses about inventory levels were much divided, when asked about conflicts regarding inventory choices in their institution, more than half of the participants (55.9%) agreed with the statement. Additionally, participants commented that conflicts usually arrive because physicians and nurses demand preference items and large inventories. It was also mentioned that such quantities requested are very high and often exceed realistic usage/history. Table 3 enumerates some of the major reasons for conflicts in healthcare providers as mentioned by participants.

The Mann-Whitney U test showed that there is significant difference between responses from material managers and physician's office directors. Differences were seen for both questions: conflicts regarding inventory choices ($P = 0.003$), and conflicts regarding inventory levels ($P = 0.007$). Findings suggests that physician's offices are less likely to experience conflicts regarding inventory choices and levels, perhaps due to their size and the number of people participating in inventory related decisions. Material

managers on the other hand, are more likely to experience conflicts, probably due to the large number of people involved.

Skills and Knowledge about SCM

Education and training on SCM represents a key factor for implementation success (Fawcett and Magnan, 2001). Therefore, participants from the healthcare providers group and vendors group were asked if there are excellent skills and knowledge about SCM practices at the management level (people monitoring inventory) in their institutions. Survey findings revealed that 50% have excellent skills and knowledge, 26% lack such skills and knowledge in their institution, and 24% responses were neutral. In addition 60% of vendors and 45% of healthcare providers have skills and knowledge about supply chain, indicating that vendors are more educated about SCM than healthcare providers. Again, results from this study appear to be inconsistent with those found by McKone-Sweet et al. (2005) and Burns (2002). This is in light that only a fourth of participants mentioned the lack of skills and knowledge, whereas half expressed having such skills and knowledge. No significant difference was seen from the Mann-Whitney U test.

Moreover, participants from the healthcare providers group were asked about the existence of skills and knowledge regarding SCM practices at the executive level (CEO and directors). Responses revealed that 42.8% of executive have skills and knowledge, 31.5% lack the skills and knowledge, and 25.7% responses were neutral. Findings from this question can be further compared with previous results, where a significant high percentage of respondents (73.5% of healthcare providers) are experiencing executives support for SCM practices. Results from this question (42.8% healthcare providers

having executives with skills and knowledge) may explain the findings that executives are showing support for SCM practices.

Constantly Evolving Technology

Constantly evolving technology of products was also found to be a major barrier in this study. Participants from the three groups expressed their level of agreement with the statement "Constantly evolving technology of product is a major barrier for implementing supply chain management practices in the healthcare sector." More than half (52%) of the three groups of participants agreed that the constant evolving technology of products represents a barrier for implementation, 34% disagree, and 14% responses were neutral. Findings from this section are consistent with Burns (2002). A significant difference was seen between responses from material managers, which are more likely to agree, with physician's office directors (P=0.021), and sales representatives (P = 0.048), which are more likely to disagree.

Physicians Preference

Physicians preference for high cost items, as cited by many in the literature review, remains a barrier. Participants from the three groups described their level of agreement with the statement "Physician preference for high cost items is a major barrier for implementing SCM practices in the healthcare sector". More than half (59.6%) of participants agreed that it is a barrier. Less than one fourth (23.1%) of participants disagreed and 17.3% were neutral. These results are consistent with those found in the literature (Burns, 2002) (McKone-Sweet et al., 2005).

The Mann-Whitney U test revealed significant differences between material managers/ hospital directors (P = 0.045) and material managers/physician's office directors (P = 0.025). Material managers tend to agree that physicians preference is a barrier, while hospital directors and physician's office directors tend to disagree. The tendency of material managers agreeing with the statement that physicians preference represents a barrier, might be attributed to the large number of hospital physicians. Each of these physicians demanding their preferences can make materials managers decisions highly complicated. On the other hand, in physician's offices the task of selecting items can be less complex.

Lack of Standardized Codes

Standardized nomenclatures in barcodes for products and commodities have been cited as essential for product visibility across a supply chain. For this reason, participants from the three groups were asked to express if the lack of standardized nomenclatures in barcodes products represents a major barrier for SCM practices in the healthcare supply chain. About 51% of respondents from the three groups indicated that the lack of standard nomenclatures in barcodes for healthcare products and commodities is a major barrier for implementation. A 15.7% of respondents indicated that it is not a major barrier, while 33.3% indicated a neutral opinion. These results are further supported by Burns (2002) who cited the lack of standardized codes as an implementation barrier. While majority of respondents agree that it is a barrier, significant differences were seen when comparing responses from material managers with sales representatives (P=0.04), and physician's office directors (P=0.034). Most material managers feel that it is a barrier

and sales representatives and physician's office directors disagreed that the lack of codes is a barrier.

Limited Information Sharing

Sharing information across a supply chain can greatly reduce inefficiencies by better matching demand with supply. In this research participants from the three groups were asked if limited information sharing between healthcare providers and vendors is a major barrier for implementing SCM practices in the healthcare sector. About 40% participants indicated that there is limited information sharing between vendors and healthcare providers, 30% of participants disagreed, and another 30% remained neutral. Though responses were divided, the majority expressed that there is a lack of information sharing which represents a major barrier. Again, results for this section appear to be consistent with those who documented that information sharing is a barrier for implementation (Burns, 2002) (McKone-Sweet et al., 2005). No significant difference was seen from the Mann-Whitney U test.

Material Management Best Practices

To analyze material management practices, participants from the healthcare provider group were asked additional questions regarding inventory control, procurement processes, use of IT (information technology) and decision making structure, information sharing, and GPO involvement. In this section material management practices based on survey results are discussed related to six areas: education, inventory control,

procurement, contracting, vendors' relationships, and physicians' relationships. Their benefits are further explained, and recommendations for adoption are provided.

Education

Before participants commented on questions addressing barriers for implementation, they expressed their knowledge about SCM. Participants indicated if they had received formal training in four topics mentioned by Nelson (2001) and McKone-Sweet et al. (2005) as characteristics of successful supply chains. Survey results for training are shown in Table 4.

Most participants seemed to have received formal training in three areas. However, less than half have received a formal training on support from executives. These results show that efforts are being made in the healthcare industry to educate healthcare managers on SCM. Training represents the first essential practice for the improvement of a supply chain.

Inventory Control

The use of IT to assist with inventory control decisions can be considered another best practice in material management. IT systems play an important role in the supply chain because it helps companies collect and analyze information (Chopra and Meindl, 2001). Thus, computer software applications should be used to calculate order quantities, based on demand forecasting, and safety stock levels. This can greatly reduce user interventions and time spent in order processing (Kim, 2005). Results from this study found that 53% of participants indicated the use of computer software applications to calculate reorder

points and quantities. The other 47% indicated that these quantities are calculated subjectively by an employee periodically.

Additionally, having high inventory turn represents another benefit for hospitals and healthcare providers. By increasing the number of inventory turns, healthcare providers can hold less inventories leading to less capital invested at any given time (Alverson, 2003). In this study the average inventory turn is 11-12, and as suggested by Alverson (2003) hospitals should strive for inventory turn rate of 14 turns, and ideally over 16.

Procurement

The use of electronic means such as EDI (Electronic Data Interchange) and Internet ordering can represent a way of improving supply chain transactions like ordering process. Automated ordering using electronic means are clearly more beneficial over traditional methods like fax and phone, which are timely inefficient and have high tendency for errors (Kim, 2005). Internet ordering; however, proves to be even better than EDI because it does not require a direct connection between a company and its customer (like EDI does), it simply requires that both be connected to the Internet (Chopra and Meindl, 2001). Internet also has the power to speed up procurement transactions by automating them, and integrating them into financial and materials managements systems (Burns, 2002).

Results found for the procurement of inventory quantities were not favorable. Over 58% of respondents indicated that a person manually enters orders, while the other 41.2% indicated that the ordering process is automated without a person's intervention.

Moreover, 2.9% of participants use a phone as their most prevalent mean for placing orders, 2.9% fax, 35.5% use EDI, and 25.8% use website.

Contracting

The involvement of healthcare providers with GPOs is not a new purchasing practice. While the value of GPOs has been discussed by many in the material management literature, healthcare providers remain to outsource part of their purchasing to their GPOs. As seen in this study 88.6% of healthcare providers are members of a GPO and 93% of them are satisfied with their relationships. Probably the best practice in this area is to comply with GPO contracts; this will facilitate standardization of products that results into cost reduction. Moreover, effort to standardize products will require the collaboration and communication of physicians, executives, and material managers. However, benefits include fewer contracts and better vendor prices. GPOs in this study indicated that most members comply with their contracts.

Vendors Relationships

Information sharing can noticeably reduce inefficiencies in a supply chain, and therefore, can become a key factor for hospitals and healthcare institutions to achieve benefits. Sharing information creates visibility in the supply chain, for material managers this represents carrying less inventory, increasing inventory turns, and increasing availability of products. Favorable results were seen from this study with 79.5% of healthcare institutions sharing some type of inventory related information with vendors. This is further supported by the finding that more than 75% of participants from the three groups

feel that if inventory related information is shared with vendors, inefficiencies can be reduced.

Even though information sharing appears to be an emerging practice for healthcare providers, the idea of adopting partnerships initiatives such as Vendor Managed Inventory (VMI) is not too accepted. VMI is a partnership that requires information sharing so vendors can make replenishment decisions for customer products to improve efficiencies (Lee and Whag, 1998) (Simchi-Levi et al., 2000). The majority of healthcare providers (80%) are skeptical about the benefits of VMI, whereas 57.1% of vendors are confident that they will benefit from managing customers inventory.

Physicians Relationships

Practices previously mentioned such as product standardization, and contract compliance will require the involvement of physicians. Thus, an additional best practice for material management is to maintain a good relationship with physicians. Material management should work closely with physicians in the product selection. This effort will require the collaboration and communication from both sides; but will lead to higher inventory turns, product standardization, and contract compliance. Such benefits can translate into significant cost savings and better quality of care. Table 5 summarizes the material management best practices identified in this study.

Finally, due to the nature of the industry, a responsive supply chain (customer focused) might be better than an efficient one (cost focused). However, having a responsive supply chain does not necessarily translate into high levels of inventory. The focus of healthcare managers should be on reducing inefficiencies by using inventory

control practices mentioned in this section. This in consequence will free up money closely tied to excessive amount of inventory, without compromising the service level. The majority of participants (75%) mentioned that high service level (availability of products) take precedence in their institution over reduced inventory cost. Results can explain why 65.8% do not experience frequent emergency orders as a consequence of stock outs.

Conclusion

This study has provided an assessment of material management in the healthcare sector. Noticeable signs of improvements in the healthcare sector have been seen in this study. The most favorable results from this research show that there appears to be more executives support, training, skills, and knowledge about SCM in healthcare institutions. These findings may indicate that healthcare executives are becoming more aware of the importance of material management, and the benefits that can be obtained by efficiently adopting SCM practices. Other signs of improvements seen include contract compliance with GPOs, and use of computer software application in the process of calculating reorder quantities.

While information sharing appears to be practiced by healthcare providers, results suggest that it stills represents a barrier. Perhaps, not enough information or not the right kind of information is being shared between healthcare providers and vendors. Thus, healthcare providers should share inventory related information that is accurate, accessible in a timely manner and of the right kind in order to achieve true benefits in their supply chain. Though, there is some indication that healthcare managers are striving

for improvements by adopting better practices, there are still many barriers that need to be overcome, and essential practices that need to be implemented for success. It seems that only through collaboration healthcare institutions will be able to achieve a more efficient yet customer focused supply chain.

Due to the sample size and inequality of the groups of participants in this study, conclusions cannot necessarily be drawn about the general population. Additionally, there is no clear distinction between the types of hospitals and healthcare providers who participated in the study (i.e., rural, urban, for-profit or non-profit). Bias may have also been introduced in this research, given that participants that filled the survey may have been more willing to express their opinions. Future research should consider these limitations and try to expand the scope of this study, for example, by drawing a larger sample of the population, conclusions can be more robust. Still, this study has provided a description of the current situation of the healthcare supply chain, and found potential solutions to enhance material management practices so inefficiencies can be reduced and cost savings can be achieved.

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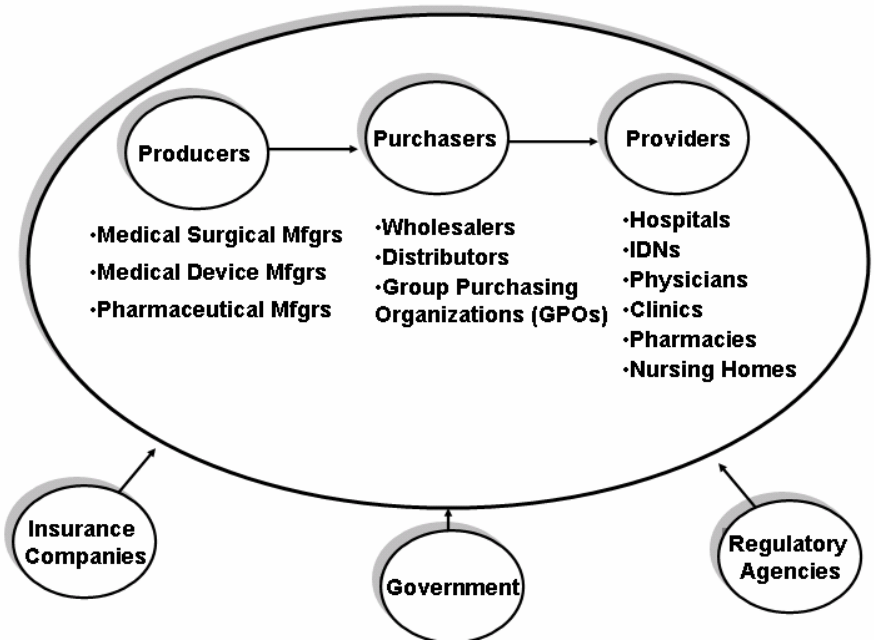

Figure 1. Healthcare Supply Chain Configuration (Adopted from Burns, 2002)

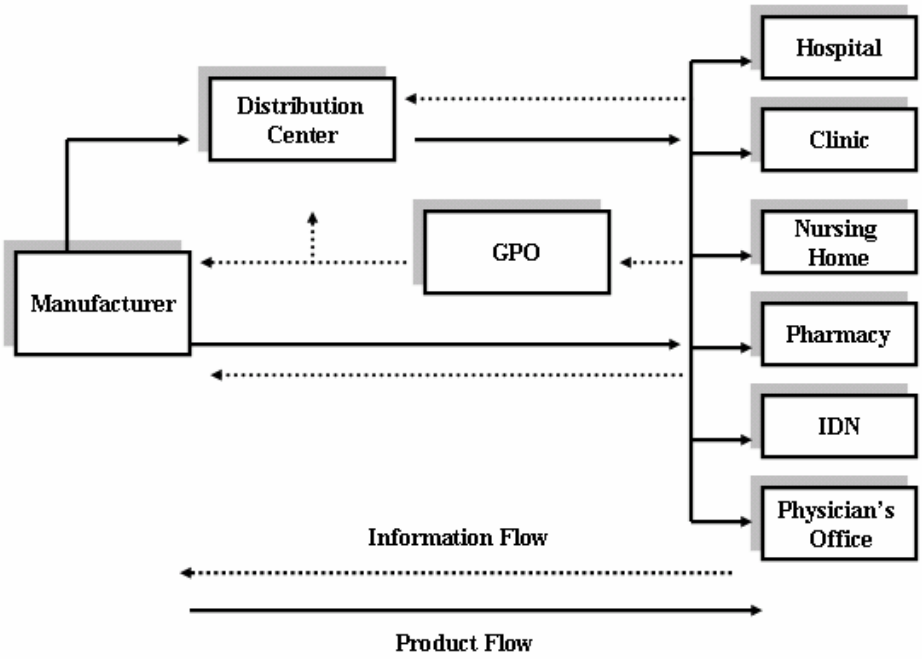

Figure 2. Healthcare Product Flow

Table 1. List of Participants Categorized by Role and Institution

Institution		Role	Number
Healthcare Provider	Hospital	Material Manager	21
		Director	3
		Pharmacist	1
		Store Manager	2
		Buyer	1
		Material coordinator	1
	Physician's Office	Director	4
	Specialized Center	Material Manager	1
		Director	1
Vendor	Distributor	Sales Rep.	6
	Manufacturer	Sales Rep.	7
	Manufacturer/ Distributor	Sales Rep.	2
GPO	GPO	Director	2
		Total	52

Table 2. Summary of Findings Regarding Barriers for Implementing SCM Practices

TOPICS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Have executive support for SCM efforts	0.0%	7.8%	15.7%	45.1%	31.4%
Conflicting goals regarding inventory choices in the supply chain	7.8%	23.5%	27.6%	33.3%	7.8%
Conflicting goals regarding inventory choices within their institution	2.9%	20.6%	20.6%	41.2%	14.7%
Conflicting goals regarding inventory levels within their institution	5.9%	35.3%	11.7%	26.5%	20.6%
Have skills and knowledge about SCM at management level	4.0%	22.0%	24.0%	40.0%	10.0%
Have skills and knowledge about SCM at executive level	2.9%	28.6%	25.7%	37.1%	5.7%
Constant Evolving technology of products represents a barrier	2.0%	32.0%	14.0%	46.0%	6.0%
Physician preference for high cost items represents a barrier	1.9%	21.2%	17.3%	32.7%	26.9%
Lack of standardized nomenclatures in barcodes represents a barrier	2.0%	13.7%	33.3%	37.3%	13.7%
Limited information sharing represents a barrier	0.0%	30.0%	30.0%	34.0%	6.0%

Table 3. Major Reasons for Conflicts in Healthcare Providers

Product standardization
Physicians preference
Lowering inventory costs
Vendors preference
Having enough supplies

Table 4. Survey Results for Supply Chain Management Training

SCM Topics	Formal Training	Informal Training	No Training
Communication and effective work within internal departments in an organization	72.7%	24.2%	3.0%
Information systems for data collection, analysis and sharing	66.7%	21.2%	12.1%
Executive support for SCM efforts	45.5%	27.3%	27.3%
Measurement systems to assess total supply chain costs and performance	57.6%	24.2%	18.2%

Table 5. Material Management Best Practices

AREAS	RECOMMENDED BEST PRACTICES
Education	▪Training and education on SCM principles such as, communication within internal departments, information systems, and measurement systems
Inventory Control	▪Use of computer software applications for calculating reorder point and quantity ▪Increase inventory turns to hold less inventory
Procurement	▪Automated ordering process through electronic means (EDI, Internet)
Contracting	▪Contract compliance with GPOs to achieve cost savings ▪Product standardization to reduce the number of contracts and transactions
Vendors Relationships	▪Sharing inventory related information with vendors for better planning. Information should include: sales data, backorders, and onhand inventory
Physicians Relationships	▪Collaboration and Communication with physician on product selection

SECTION

2. CONCLUSIONS

The paper included in this thesis provides insight information about material management practices in the healthcare sector. With the initial thrust to collect information related to SCM implementation barriers and material management best practices, survey findings revealed that improvements have been made in the healthcare supply chain, primarily in the area of education. Most material managers and healthcare executives seemed to have received formal training and acquired appropriate skills and knowledge about SCM practices. As a consequence, healthcare executive have realized the benefits and importance of the adoption of SCM practices, and have started to offer more support for the implementation of such practices.

Even though healthcare institutions are experiencing support from their executives, full implementation of SCM practices has not been achieved. Moreover, it has been seen in this study that the adoption of these practices is still hindered by the presence of strong implementation barriers. This study suggests that areas such as inventory control, procurement processes, and relationships with vendors and physicians, will require more attention from material managers. Additionally, information sharing between healthcare providers and vendors should also be improved. Improvements in all these areas can become possible with the aid of information technology, along with collaboration and cooperation of physicians, executives, GPOs, and material managers.

This thesis has identified those remaining barriers for implementation of SCM practices, with the purpose of providing stakeholders in the healthcare supply chain with

a clear description of these barriers in order that efforts can be made to overcome them. Additionally, the material management best practices analyzed in this study can greatly help material managers with their continuous improvement efforts, while maintaining quality of care.

While this thesis has provided an assessment of material management in the healthcare sector, there are some limitations to this study. Given the sample size and inequality of the groups of participants, conclusions cannot necessarily be drawn about the general population. Moreover, there is no clear distinction between the types of hospitals and healthcare providers involved in this study, e.g., for profit vs. non-profit or urban vs. rural. The study may be biased by the fact that participants that chose to complete the survey may have been more willing to express their opinions.

Thus, many opportunities for future research have been developed from this study. First, future research should attempt to draw a larger sample of the population to make conclusions more robust. Second, differences among hospitals and healthcare providers regarding their geographical location and type of care should be further explored in order to provide better recommendations to specific institutions and their supply chain. Third, this study showed some major differences between subject categories, especially between material managers and physician's office directors; thus, research that focuses on specific subjects can help better define their characteristics. Fourth, it is not clear why healthcare products have not standardized or adopted universal product numbers for some of their products. Further research should investigate the reasons why such changes have not occurred. At the same time the adoption of new emerging technologies, such as radio frequency identification (RFID) and it benefits to

the healthcare industry should also be explored. Fifth, research that examines the different types of partnerships can help provide healthcare providers with innovative alternatives to improve their efficiencies. Finally, purchasing and contracting practices in material management should be further explored so more specific recommendations can be made regarding product selection and standardization.

APPENDIX A.

SURVEY MATERIALS

LETTER FOR HEALTHCARE PROVIDERS

Dear Healthcare Provider:

I am Carlos Callender, a graduate student pursuing a master degree in Engineering Management at the University of Missouri Rolla. As a part of my thesis work I am conducting a research study under the direction of Dr. Scott E. Grasman. This study focuses on the **Healthcare Supply Chain**, with the purpose of gathering data to identify implementation barriers for supply chain management practices, and to discuss best practices for successful implementation.

We have identified your institution as having the characteristics necessary to participate in this study. For this reason I would like to ask for your help with an initial pilot study that includes local healthcare providers (Missouri area). Along with this letter I have attached a questionnaire. The appropriate person filling out this questionnaire should be a **Material Manager, Pharmacist, Executive, Purchasing Director or person monitoring inventory**. We would very much appreciate your contribution to this study, and ask that you please take 15 minutes of your time to fill out and return this questionnaire.

Answer the multiple choice questions by checking the appropriate box for your answer. On the questions without choices, please fill in your answer in the blank provided.

If you do not know the answer to a question, or if you do not wish to answer a question please just leave blank.

You may email, fax or mail me your finished survey. If you would like to send your finished survey by email please use the survey (submit by email) document attached to this email. If you would like to fax or mail your finished survey you can print the survey (submit by fax or mail) document also attached to this email. Addresses are located below and in the surveys.

All your responses are confidential. You will not be asked to put your name on any of the materials. Moreover, the results of this pilot study will be made accessible to all participants.

Thank you for your time and cooperation. We hope this study will result in a significant contribution to the healthcare sector. Please return your survey to me by 03/30/07

Thank you,

Carlos Callender
Graduate Research Assistant
University of Missouri Rolla
Engineering Management Department
1870 Miner Circle
Rolla, MO, 65409-0370

Fax: 573-341-6567
Phone: 504-452-1323
Email: ccdkc@umr.edu

HEALTHCARE PROVIDERS
SURVEY FORM

Instructions: Check one of the followings (when choosing <u>other</u> please type your response in the provided gray space. Example: type here

After completing the survey please save this document and send it to my email address: ccdkc@umr.edu.

1. Which of the following best classifies your healthcare institution?

☐ a. Hospital
☐ b. Nursing Home
☐ c. Physician's Office
☐ d. Medical Laboratory
☐ e. Pharmacy
☐ f. Ambulance Service
☐ g. Home Health/ Hospice
☐ h. Specialized Center (type of specialization): type here
☐ i. Other: type here

2. What is your **major role** within this healthcare institution?

☐ a. Director/ Chief Executive Officer
☐ b. Material manager
☐ c. Pharmacist
☐ d. Store Manager/Distribution
☐ e. Other: type here

3. Which of the following have you done to expand your knowledge about supply chain management principles? **(Check all that apply)**

TOPICS	a Book & Journal	B Formal Training	c Seminar	d University Course	e Other	f None
Communication and effective work within internal departments in an organization	☐	☐	☐	☐	☐	☐
Executive support for supply chain management efforts	☐	☐	☐	☐	☐	☐
Information systems for data collection, analysis and sharing	☐	☐	☐	☐	☐	☐
Measurement systems to assess total supply chain costs and performance	☐	☐	☐	☐	☐	☐

The following questions aim to identify barriers and challenges to implementing supply chain management practices in the healthcare industry.

Describe your level of agreement with the following statements

4. There is executive understanding and support for supply chain management efforts in my institution.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

5. There are conflicting goals regarding inventory **level** within my institution (i.e., among physicians, material managers and executives).

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

Please specify here:

6. There are conflicting goals regarding inventory **choices** within my institution (i.e., among physicians, material managers and executives).

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

Please specify here:

7. There are conflicting goals regarding inventory **choices** among the key players in my supply chain (i.e., among manufacturers, distributors, vendors, group purchasing organizations (GPOs), and healthcare providers).

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

Please specify here:

8. In my institution there are excellent skills and knowledge about supply chain management practices at the **management** level (i.e., material manager and physicians involved in inventory decision).

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

9. In my institution there are excellent skills and knowledge about supply chain management practices at the **executive** level (i.e., executives and directors)

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

10. Constant evolving technology of product is a **major barrier** for implementing supply chain management practices in the healthcare industry.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

11. Physician preference for high cost items is a **major barrier** for implementing supply chain management practices in the healthcare industry.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

12. Lack of standardized nomenclature/coding in barcodes for healthcare products and commodities is a **major barrier** for implementing supply chain management practices in the healthcare industry.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

13. Limited information sharing between healthcare providers and vendors is a major barrier for implementing supply chain management principles in the healthcare industry.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

The following questions address the inventory management in your institution

14. Who monitors your inventory?
☐a. Physician or clinician
☐b. Nurse
☐c. Material Manager
☐d. Pharmacist
☐e. Vendor
☐f. Other: type here

15. Which of the following ways are used to **calculate** the reorder point and the reorder quantity for your inventory?
☐a. Have a computer software application that calculates these quantities.
☐b. It is done subjectively by an employee periodically.
☐c. Other way: type here

16. Once these quantities are calculated, how are orders placed?
☐a. A person manually enters the order
☐b. A computer automatically places the order without a person's intervention.
☐c. Other way: type here:

17. Which of the following means are used by your institution to place orders?
☐a. By phone **(Check all that apply)**
☐b. By fax
☐c. By email
☐d. Through a website (online)
☐e. By electronic means (Example: EDI (electronic data interchange))
☐f. Other way: type here

Write the letter of the one is the **most prevalent** type here

18. Which of the following generally takes precedence in your organization?
(Check only one)
☐a. High service level (availability of products)
☐b. Reduced inventory cost
☐c. Other: type here

19. Approximately how many **inventory turns** do you experience in a year?
☐a. Less than 8 inventory turns/year
☐b. 8-9 inventory turns/year
☐c. 10-11 inventory turns/year
☐d. 12-13 inventory turns/year
☐e. 14-15 inventory turns/year
☐f. 16 or more inventory turns/year

Describe your level of agreement with the following statement

20. In my institution we experience frequent emergency orders as a consequence of stock outs.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

21. What type of inventory related information do you share with your vendors (i.e., distributor or manufacturer)? **(Check all that apply)**
☐a. Sales data
☐b. On-hand inventory
☐d. Back orders
☐c. Other: type here
☐d. Don't share any of the above information with vendors (go to section 23)
☐e. Share all of the above information with vendors

22. Which of the followings are benefits achieved by sharing information?
☐a. Reduce Cost **(Check all that apply)**
☐b. Lower inventory
☐c. Increase service level (availability of products)

☐d. Other: type here
☐e. None of the above
☐f. All of the above

Describe your level of agreement with the following statement

23. Sharing inventory-related information with vendors will help improve my inventory related efficiencies.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

24. Are you part of a Group Purchasing Organization (GPO)?
☐a. YES
☐b. NO (go to section 26)

Describe your level of agreement with the following statements

25. I am very satisfied with my Group Purchasing Organization (GPO)?

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

Explain your level of satisfaction here:

28. In my institution inventory related efficiencies can be improved if vendors directly manage the inventory.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

Are there any other additional comments you would like to share?

type here:

GPOS SURVEY FORM

Instructions: Check one of the followings (when choosing other please type your response in the provided gray space. Example: type here
After completing the survey please save this document and send it to my email address: ccdkc@umr.edu.

1. What type of GPO are you?
☐a. National (For-profit)
☐b. National (Non-profit)
☐c. Regional (For-profit)
☐d. Regional (Non-profit)
☐c. Other: type here

2. Approximately how many hospitals and healthcare providers (members) do you serve?
☐a. less than 100
☐b.100-200
☐c. 200-500
☐d. 500-800
☐e. 800 or more

The following questions aim to identify barriers and challenges to implementing supply chain management practices in the healthcare industry.

Describe your level of agreement with the following statements

3. There is executive understanding and support for supply chain management efforts in my organization.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

4. There are conflicting goals regarding inventory **choices** among the key players in my supply chain (i.e., among manufacturers, distributors, vendors, group purchasing organizations (GPOs) and healthcare providers).

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

Please specify here:

5. My members have excellent skills and knowledge about supply chain management practices at the **management** level (i.e., people involved in inventory decision).

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

6. Constant evolving technology of product is a **major barrier** for implementing supply chain management practices in the healthcare industry.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

7. Physician preference for high cost items is a **major barrier** for implementing supply chain management practices in the healthcare industry.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

8. Lack of standardized nomenclature/coding in barcodes for healthcare products and commodities is a **major barrier** for implementing supply chain management practices in the healthcare industry.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

9. Limited information sharing between healthcare providers and vendors is a major barrier for implementing supply chain management practices in the healthcare industry.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

10. In my organization most of my members comply with their contracts.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

Describe your level of agreement with the following statement

11. I am very satisfied with my members' relationship?

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

Explain your level of satisfaction here:

12. I am very satisfied with my vendors' relationship?

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

Explain your level of satisfaction here:

13. Inventory related efficiencies across the supply chain can be improved if healthcare providers share inventory- related information.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

14. Hospitals inventory related efficiencies can be improved if vendors directly manage their inventory.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

15. Vendors would benefit if they manage hospitals inventory.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

Are there any other additional comments you would like to share?

type here:

VENDORS SURVEY FORM

Instructions: Check one of the followings (when choosing <u>other</u> please type your response in the provided blank space.

1. What type of products do you sell? **(Check all that apply)**
☐a. Medical Surgical Supplies
☐b. Pharmaceutical
☐c. Medical Devices
☐d. Other: _____

2. What type of vendor are you?
☐a. Manufacturer of products
☐b. Distributor of products
☐c. Manufacturer/ Distributor of products

The following questions aim to identify barriers and challenges to implementing supply chain management practices in the healthcare industry.

Describe your level of agreement with the following statements

3. There is executive understanding and support for supply chain management efforts in my institution.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

4. There are conflicting goals regarding inventory **choices** among the key players in my supply chain (i.e., among manufacturers, distributors, vendors, group purchasing organizations (GPOs), and healthcare providers).

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

Please specify:

5. In my institution there are excellent skills and knowledge about supply chain management practices at the **management** level (i.e., people involved in inventory decision).

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

6. Constant evolving technology of product is a **major barrier** for implementing supply chain management practices in the healthcare industry.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

7. Physician preference for high cost items is a **major barrier** for implementing supply chain management practices in the healthcare industry.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

8. Lack of standardized nomenclature/coding in barcodes for healthcare products and commodities is a **major barrier** for implementing supply chain management practices in the healthcare industry.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

9. Limited information sharing between healthcare providers and vendors is a major barrier for implementing supply chain management principles in the healthcare industry.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

The following questions address the inventory management in your institution

Describe your level of agreement with the following statement

10. Inventory related efficiencies across the supply chain can be improved if healthcare providers share inventory- related information.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

11. How many relationships with Group Purchasing Organization (GPO)? _____

Describe your level of agreement with the following statements

12. I am very satisfied with my Group Purchasing Organization (GPO) relationship?

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

Explain your level of satisfaction:

13. Hospitals inventory related efficiencies can be improved if vendors directly manage their inventory.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

14. Vendors would benefit if they manage hospitals inventory.

☐a. Strongly Agree ☐ b. Agree ☐c. Neutral ☐ d. Disagree ☐e. Strongly Disagree

APPENDIX B.

SPSS OUTPUTS

Table B1. Healthcare Institutions by Type

Healthcare Institutions	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Hospital	29	55.8	55.8	55.8
Physician's Office	4	7.7	7.7	63.5
Specialized Center	2	3.8	3.8	67.3
Distributor	6	11.5	11.5	78.8
Manufacturer	7	13.5	13.5	92.3
Manufacturer/Distributor	2	3.8	3.8	96.2
GPO	2	3.8	3.8	100.0
Total	52	100.0	100.0	

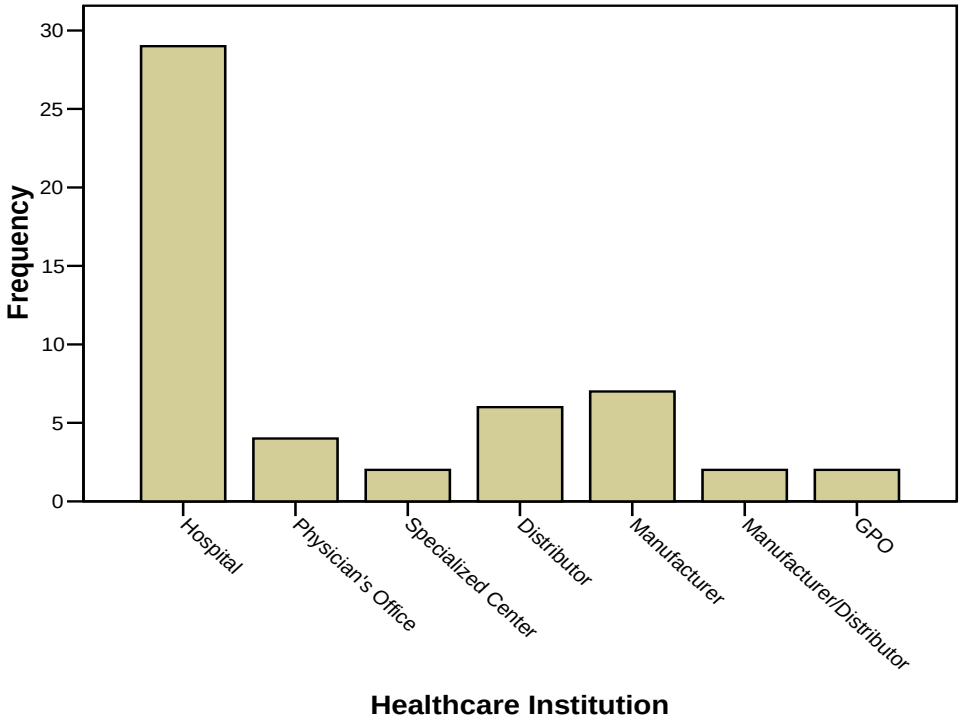

Figure B1. Frequency of Healthcare Institutions

Table B2. Survey Results for Training on SCM Principles

Training on Communication	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Formal	24	46.2	72.7	72.7
Informal	8	15.4	24.2	97.0
No Training	1	1.9	3.0	100.0
Total	33	63.5	100.0	
Not Applicable	17	32.7		
No Response	2	3.8		
Total	19	36.5		
TOTAL	52	100.0		

Training on Information Systems	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Formal	22	42.3	66.7	66.7
Informal	7	13.5	21.2	87.9
No Training	4	7.7	12.1	100.0
Total	33	63.5	100.0	
Not Applicable	17	32.7		
No Response	2	3.8		
Total	19	36.5		
TOTAL	52	100.0		

Training on Support	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Formal	15	28.8	45.5	45.5
Informal	9	17.3	27.3	72.7
No Training	9	17.3	27.3	100.0
Total	33	63.5	100.0	
Not Applicable	17	32.7		
No Response	2	3.8		
Total	19	36.5		
TOTAL	52	100.0		

Training on Measurement Systems	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Formal	19	36.5	57.6	57.6
Informal	8	15.4	24.2	81.8
No Training	6	11.5	18.2	100.0
Total	33	63.5	100.0	
Not Applicable	17	32.7		
No Response	2	3.8		
Total	19	36.5		
TOTAL	52	100.0		

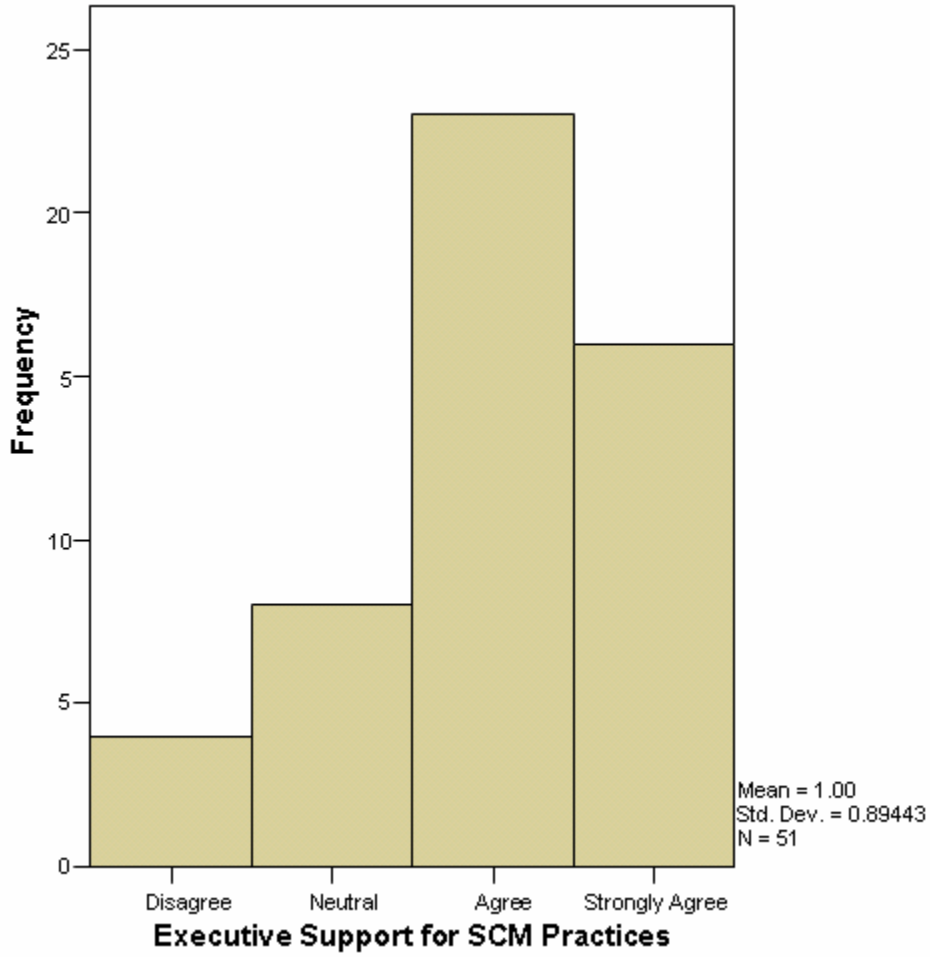

Figure B2. Graphic Results for Executive Support for SCM Practices

Table B3. Frequency on Executive Support for SCM Practices

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Disagree	4	7.7	7.8	7.8
Neutral	8	15.4	15.7	23.5
Agree	23	44.2	45.1	68.6
Strongly Agree	16	30.8	31.4	100.0
Total	51	98.1	100.0	
No response	1	1.9		
TOTAL	52	100.0		

Table B4. Crosstabulation of Results for Executive Support for SCM Practices by Healthcare Institution and Major Role

Healthcare Institution	Major Role	Executive Support for SCM Practices					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Hospital	Material Manager H	0	2	4	12	2	20
	Director Hospital	0	0	1	1	1	3
	Pharmacist	0	0	0	1	0	1
	Store Manager	0	0	0	2	0	2
	Buyer	0	0	1	0	0	1
	Material Coord.	0	0	0	0	1	1
	Total	0	2	6	16	4	28
Physician's Office	Director Physician's office	0	1	0	1	2	4
	Total	0	1	0	1	2	4
Specialized Center	Material Manager SC	0	0	0	1	0	1
	Director SC	0	0	0	0	1	1
	Total	0	0	0	1	1	2
Distributor	Sales Rep	0	1	0	2	3	6
	Total	0	1	0	2	3	6
Manufacturer	Sales Rep	0	0	0	3	4	7
	Total	0	0	0	3	4	7
Manufacturer/Distributor	Sales Rep	0	0	2	0	0	2
	Total	0	0	2	0	0	2
GPO	Director GPO	0	0	0	0	2	2
	Total	0	0	0	0	2	2

Median = 1 Mode = 1 Mean = 1

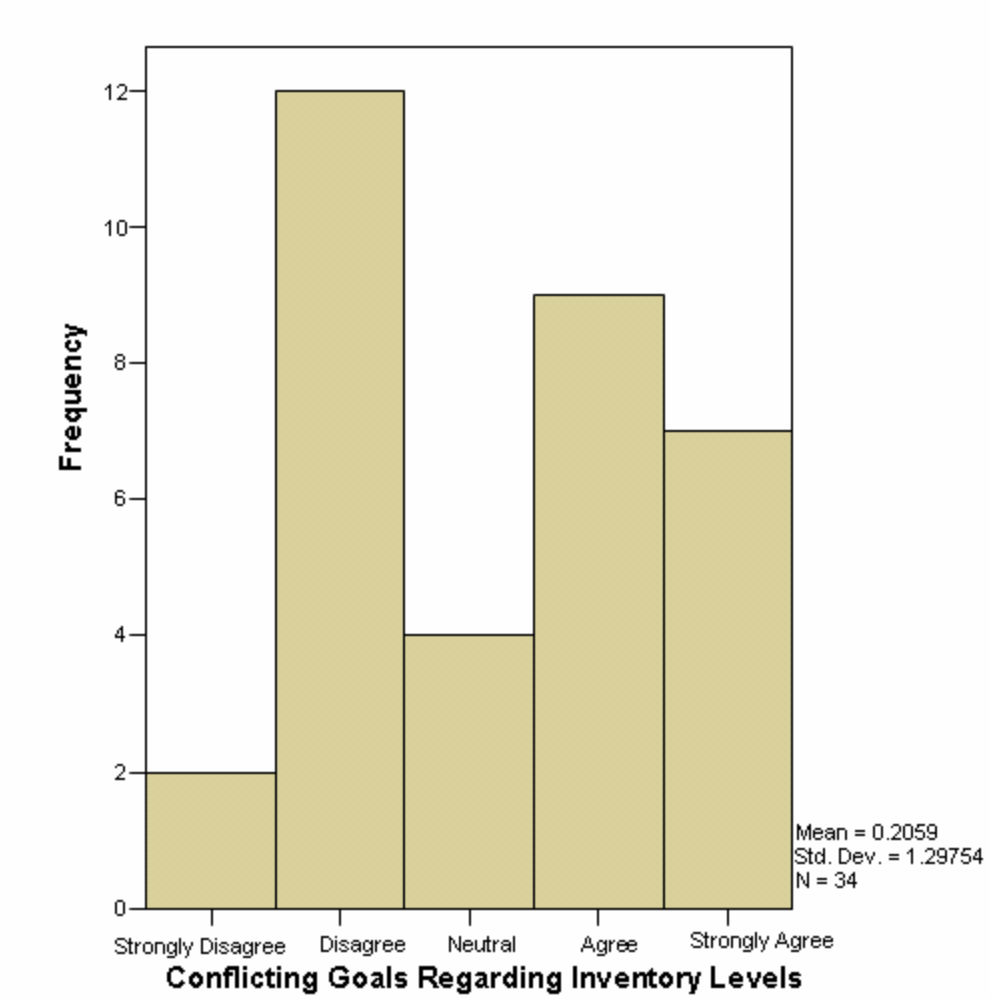

Figure B3. Graphic Results for Conflicting Goals Regarding Inventory Levels in Healthcare Providers

Table B5. Frequency on Conflicting Goals Regarding Inventory Levels within Healthcare Providers

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Strongly Disagree	2	3.8	5.9	5.9
Disagree	12	23.1	35.3	41.2
Neutral	4	7.7	11.8	52.9
Agree	9	17.3	26.5	79.4
Strongly Agree	7	13.5	20.6	100.0
Total	34	65.4	100.0	
Not applicable	17	32.7		
No response	1	1.9		
Total	18	34.6		
TOTAL	52	100.0		

Table B6. Crosstabulation of Results for Conflicting Goals Regarding Inventory Levels within Healthcare Providers by Healthcare Institution and Major Role

Healthcare Institution	Major Role	Conflicting Goals Regarding Inventory Levels					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Hospital	Material Manager H	0	6	3	6	5	20
	Director Hospital	0	1	1	1	0	3
	Pharmacist	0	1	0	0	0	1
	Store Manager	0	1	0	1	0	2
	Buyer	0	0	0	0	1	1
	Material Coord.	0	0	0	0	1	1
	Total	0	9	4	8	7	28
Physician's Office	Director Physician's office	2	2	0	0	0	4
	Total	2	2	0	0	0	4
Specialized Center	Material Manager SC	0	0	0	1	0	1
	Director SC	0	1	0	0	0	1
	Total	0	1	0	1	0	2

Median = 0 Mode = -1 Mean = 0.21

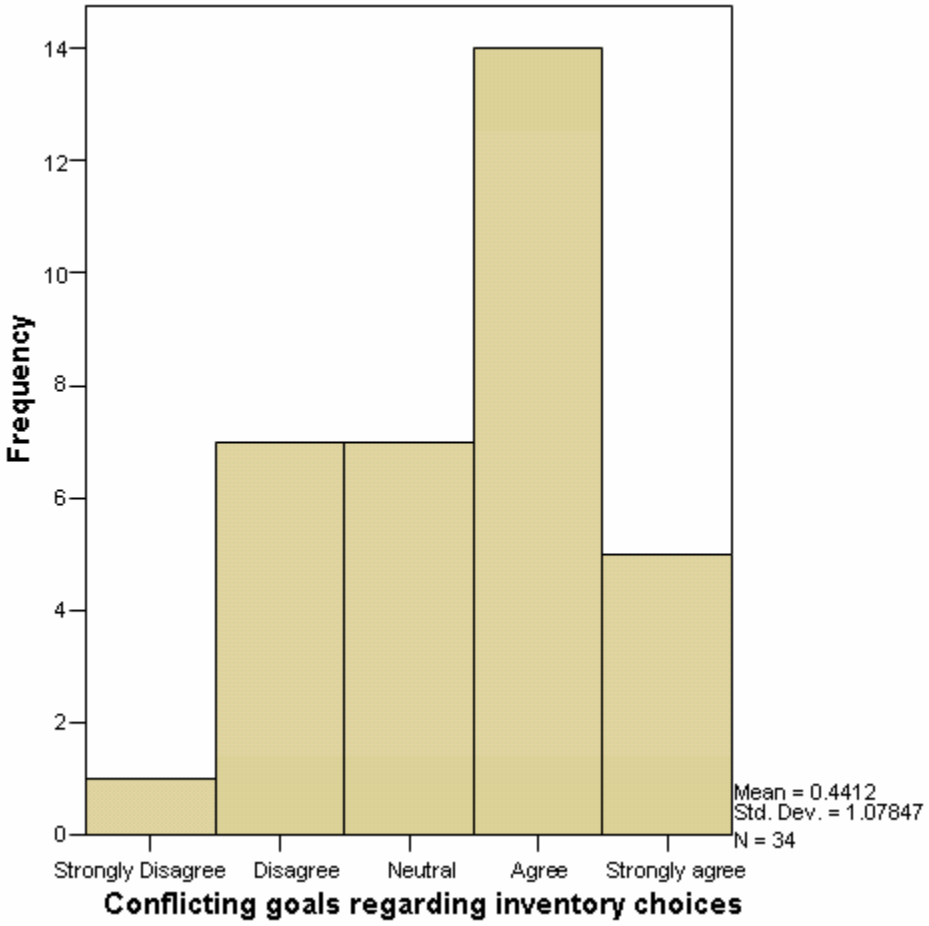

Figure B4. Graphic Results for Conflicting Goals Regarding Inventory Choices within Healthcare Providers

Table B7. Frequency on Conflicting Goals Regarding Inventory Choices within Healthcare Providers

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Strongly Disagree	1	1.9	2.9	2.9
Disagree	7	13.5	20.6	23.5
Neutral	7	13.5	20.6	44.1
Agree	14	26.9	41.2	85.3
Strongly Agree	5	9.6	14.7	100.0
Total	34	65.4	100.0	
Not applicable	17	32.7		
No response	1	1.9		
Total	18	34.6		
TOTAL	52	100.0		

Table B8. Crosstabulation of Results for Conflicting Goals Regarding Inventory Choices within Healthcare Providers by Healthcare Institution and Major Role

Healthcare Institution	Major Role	Conflicting Goals Regarding Inventory Choices					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Hospital	Material Manager H	0	3	3	12	2	20
	Director Hospital	0	0	1	2	0	3
	Pharmacist	0	0	1	0	0	1
	Store Manager	0	0	2	0	0	2
	Buyer	0	0	0	0	1	1
	Material Coord.	0	0	0	0	1	1
	Total	0	3	7	14	4	28
Physician's Office	Director Physician's office	1	3	0	0	0	4
	Total	1	3	0	0	0	4
Specialized Center	Material Manager SC	0	0	0	0	1	1
	Director SC	0	1	0	0	0	1
	Total	0	1	0	0	1	2

Median = 0.44 Mode = 1 Mean = 1

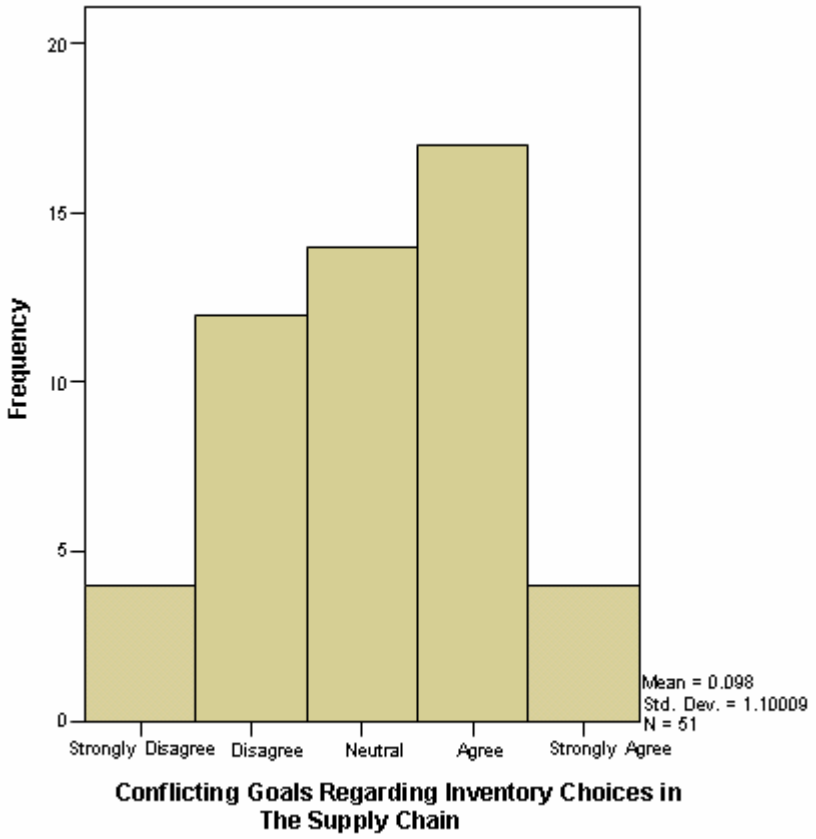

Figure B5. Graphic Results for Conflicting Goals Regarding Inventory Choices in the Supply Chain

Table B9. Frequency on Conflicting Goals Regarding Inventory Choices in the Supply Chain

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Strongly Disagree	4	7.7	7.8	7.8
Disagree	12	23.1	23.5	31.4
Neutral	14	26.9	27.5	58.8
Agree	17	32.7	33.3	92.2
Strongly Agree	4	7.7	7.8	100.0
Total	51	98.1	100.0	
No response	1	1.9		
TOTAL	52	100.0		

Table B10. Crosstabulation of Results for Conflicting Goals Regarding Inventory Choices in the Supply Chain by Healthcare Institution and Major Role

Healthcare Institution	Major Role	Conflicting Goals Regarding Inventory Choices in the Supply Chain					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Hospital	Material Manager H	1	4	5	9	1	20
	Director Hospital	0	2	1	0	0	3
	Pharmacist	0	0	0	1	0	1
	Store Manager	0	1	1	0	0	2
	Buyer	0	0	0	1	0	1
	Material Coord.	0	0	1	0	0	1
	Total	1	7	8	11	1	28
Physician's Office	Director Physician's office	2	1	1	0	0	4
	Total	2	1	1	0	0	4
Specialized Center	Material Manager SC	0	0	1	0	0	1
	Director SC	0	1	0	0	0	1
	Total	0	1	1	0	0	2
Distributor	Sales Rep	1	0	1	3	1	6
	Total	1	0	1	3	1	6
Manufacturer	Sales Rep	0	2	2	1	2	7
	Total	0	2	2	1	2	7
Manufacturer/Distributor	Sales Rep	0	0	1	1	0	2
	Total	0	0	1	1	0	2
GPO	Director GPO	0	1	0	1	0	2
	Total	0	1	0	1	0	2

Median = 0 Mode = 1 Mean = 0.1

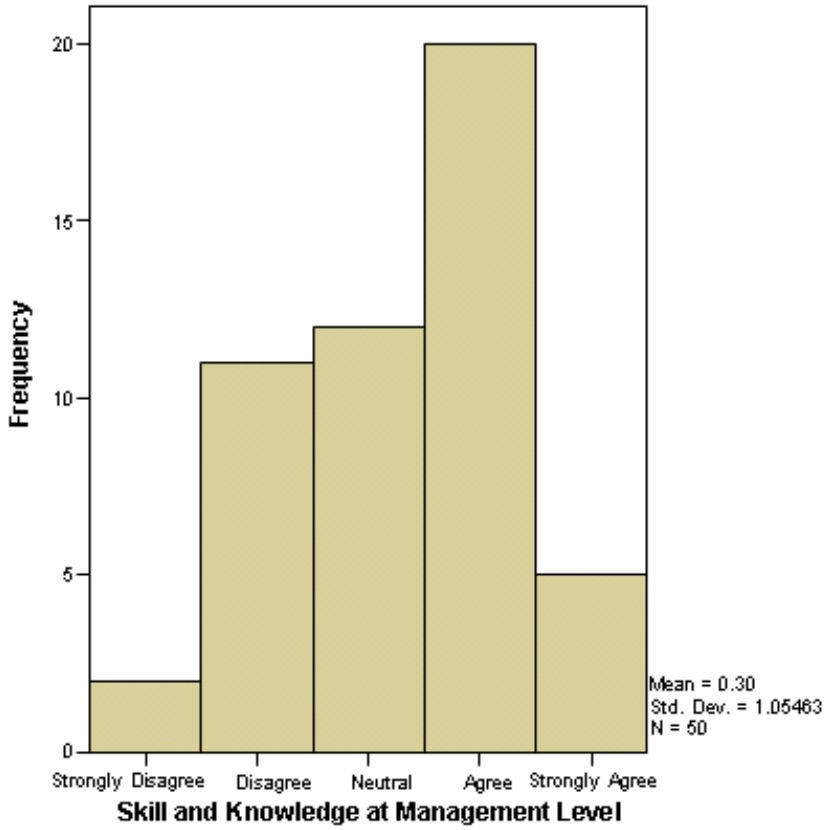

Figure B6. Graphic Results for Skill and Knowledge at Management Level

Table B11. Frequency on Skills and Knowledge at Management Level

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Strongly Disagree	2	3.8	4.0	4.0
Disagree	11	21.2	22.0	26.0
Neutral	12	23.1	24.0	50.0
Agree	20	38.5	40.0	90.0
Strongly Agree	5	9.6	10.0	100.0
Total	50	96.2	100.0	
Not applicable	2	3.8		
TOTAL	52	100.0		

Table B12. Crosstabulation of Results for Skills and Knowledge at Management Level by Healthcare Institution and Major Role

Healthcare Institution	Major Role	Skill and Knowledge at Management Level					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Hospital	Material Manager H	1	4	5	9	1	20
	Director Hospital	0	2	1	0	0	3
	Pharmacist	0	0	0	1	0	1
	Store Manager	0	1	1	0	0	2
	Buyer	0	0	0	1	0	1
	Material Coord.	0	0	1	0	0	1
	Total	1	7	8	11	1	28
Physician's Office	Director Physician's office	2	1	1	0	0	4
	Total	2	1	1	0	0	4
Specialized Center	Material Manager SC	0	0	1	0	0	1
	Director SC	0	1	0	0	0	1
	Total	0	1	1	0	0	2
Distributor	Sales Rep	1	0	1	3	1	6
	Total	1	0	1	3	1	6
Manufacturer	Sales Rep	0	2	2	1	2	7
	Total	0	2	2	1	2	7
Manufacturer/Distributor	Sales Rep	0	0	1	1	0	2
	Total	0	0	1	1	0	2
GPO	Director GPO	0	1	0	1	0	2
	Total	0	1	0	1	0	2

Median = 0 Mode = 1 Mean = 0.1

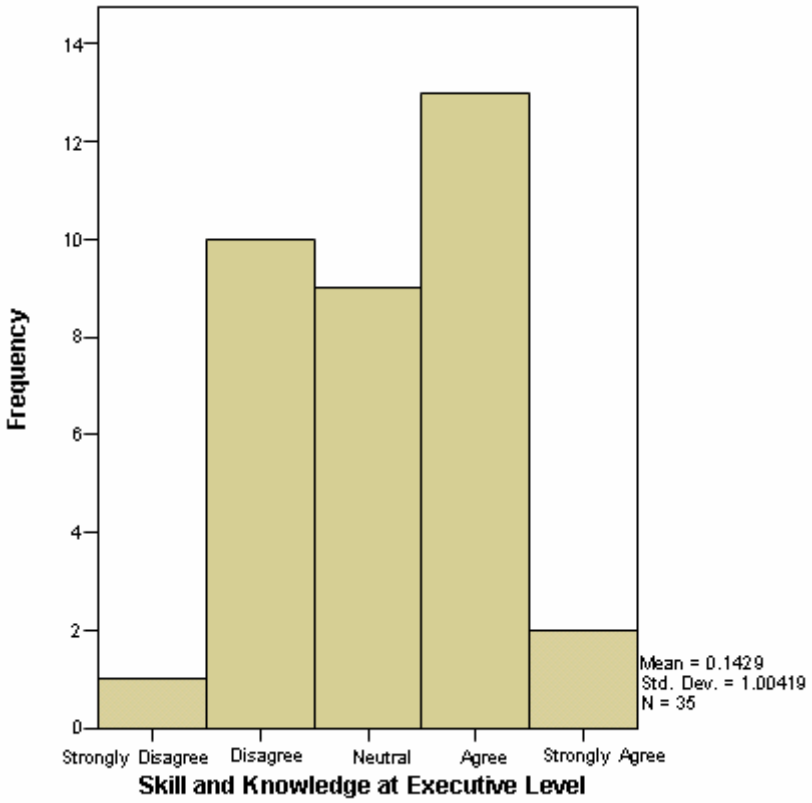

Figure B7. Graphic Results for Skill and Knowledge at Executive Level

Table B13. Frequency on Skill and Knowledge at Executive Level

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Strongly Disagree	1	1.9	2.9	2.9
Disagree	10	19.2	28.6	31.4
Neutral	9	17.3	25.7	57.1
Agree	13	25.0	37.1	94.3
Strongly Agree	2	3.8	5.7	100.0
Total	35	67.3	100.0	
Not applicable	17	32.7		
TOTAL	52	100.0		

Table B14. Crosstabulation of Results for Skill and Knowledge at Executive Level by Healthcare Institution and Major Role

Healthcare Institution	Major Role	Skill and Knowledge at Executive Level					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Hospital	Material Manager H	0	7	5	8	1	21
	Director Hospital	0	1	1	1	0	3
	Pharmacist	0	0	0	1	0	1
	Store Manager	0	1	1	0	0	2
	Buyer	1	0	0	0	0	1
	Material Coord.	0	0	0	1	0	1
	Total	1	9	7	11	1	29
Physician's Office	Director Physician's office	0	1	1	1	1	4
	Total	0	1	1	1	1	4
Specialized Center	Material Manager SC	0	0	1	0	0	1
	Director SC	0	0	0	1	0	1
	Total	0	0	1	1	0	2

Median = 0.14 Mode = 1 Mean = 0

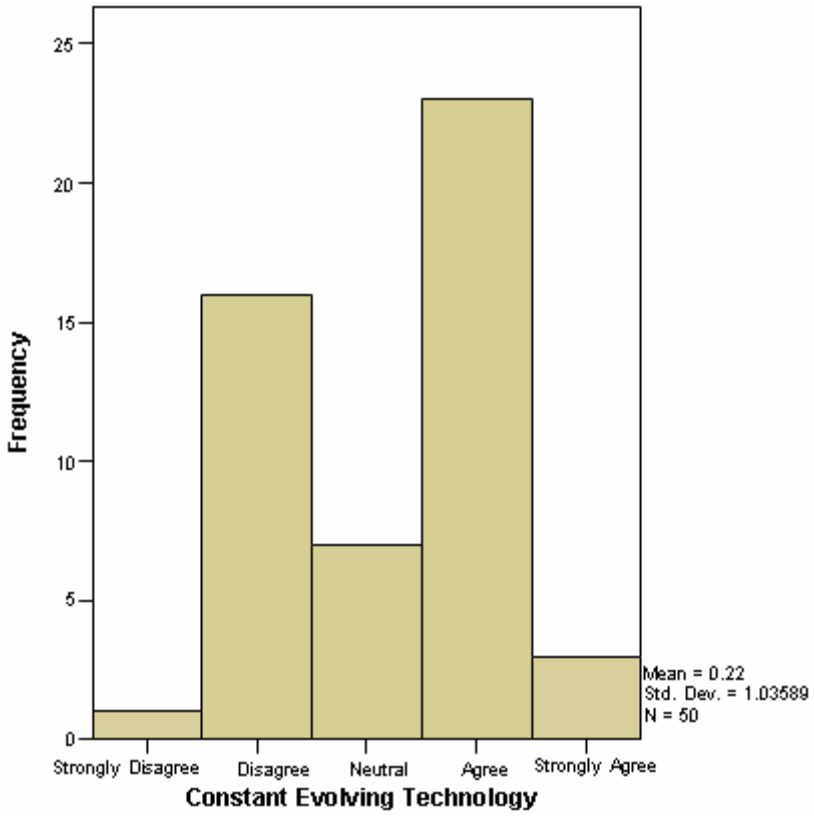

Figure B8. Graphic Results for Constant Evolving Technology

Table B15. Frequency on Constant Evolving Technology

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Strongly Disagree	1	1.9	2.0	2.0
Disagree	16	30.8	32.0	34.0
Neutral	7	13.5	14.0	48.0
Agree	23	44.2	46.0	94.0
Strongly Agree	3	5.8	6.0	100.0
Total	50	96.2	100.0	
No response	2	3.8		
TOTAL	52	100.0		

Table B16. Crosstabulation of Results for Constant Evolving Technology by Healthcare Institution and Major Role

Healthcare Institution	Major Role	Constantly Evolving Technology					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Hospital	Material Manager H	0	3	3	13	2	21
	Director Hospital	0	2	0	1	0	3
	Pharmacist	0	1	0	0	0	1
	Store Manager	0	0	0	1	0	1
	Buyer	0	0	0	1	0	1
	Material Coord.	0	0	1	0	0	1
	Total	0	6	4	16	2	28
Physician's Office	Director Physician's office	0	3	1	0	0	4
	Total	0	3	1	0	0	4
Specialized Center	Material Manager SC	0	0	0	1	0	1
	Director SC	0	1	0	0	0	1
	Total	0	1	0	1	0	2
Distributor	Sales Rep	1	2	2	1	0	6
	Total	1	2	2	1	0	6
Manufacturer	Sales Rep	0	3	0	3	1	7
	Total	0	3	0	3	1	7
Manufacturer/Distributor	Sales Rep	0	1	0	1	0	2
	Total	0	1	0	1	0	2
GPO	Director GPO	0	0	0	1	0	1
	Total	0	0	0	1	0	1

Median = 1 Mode = 1 Mean = 0.22

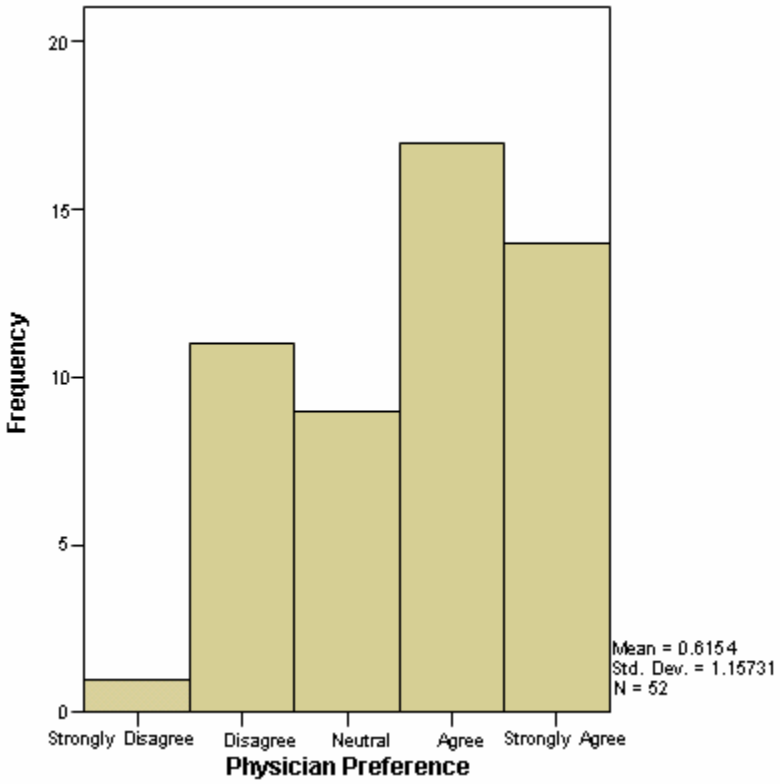

Figure B9. Graphic Results for Physician Preference

Table B17. Frequency on Physician Preference

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Strongly Disagree	1	1.9	1.9	1.9
Disagree	11	21.2	21.2	23.1
Neutral	9	17.3	17.3	40.4
Agree	17	32.7	32.7	73.1
Strongly Agree	14	26.9	26.9	100.0
TOTAL	52	100.0	100.0	

Table B18. Crosstabulation of Results for Physician Preference by Healthcare Institution and Major Role

Healthcare Institution	Major Role	Physician Preference					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Hospital	Material Manager H	0	3	2	9	7	21
	Director Hospital	0	1	2	0	0	3
	Pharmacist	0	0	0	1	0	1
	Store Manager	0	0	0	2	0	2
	Buyer	0	0	1	0	0	1
	Material Coord.	0	0	0	0	1	1
	Total	0	4	5	12	8	29
Physician's Office	Director Physician's office	0	3	1	0	0	4
	Total	0	3	1	0	0	4
Specialized Center	Material Manager SC	0	0	0	0	1	1
	Director SC	0	1	0	0	0	1
	Total	0	1	0	0	1	2
Distributor	Sales Rep	1	2	2	0	1	6
	Total	1	2	2	0	1	6
Manufacturer	Sales Rep	0	0	1	3	3	7
	Total	0	0	1	3	3	7
Manufacturer/Distributor	Sales Rep	0	1	0	1	0	2
	Total	0	1	0	1	0	2
GPO	Director GPO	0	0	0	1	1	2
	Total	0	0	0	1	1	2

Median = 1 Mode = 1 Mean = 0.62

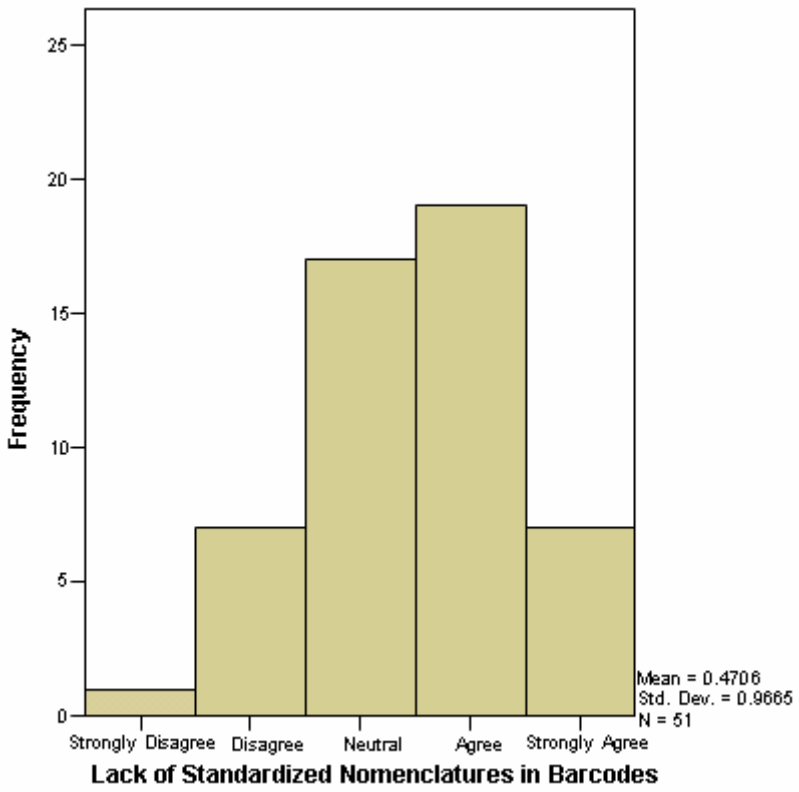

Figure B10. Graphic Results for Lack of Standardized Nomenclatures in Barcodes

Table B19. Frequency on Lack of Standardized Nomenclatures in Barcodes

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Strongly Disagree	1	1.9	2.0	2.0
Disagree	7	13.5	13.7	15.7
Neutral	17	32.7	33.3	49.0
Agree	19	36.5	37.3	86.3
Strongly Agree	7	13.5	13.7	100.0
Total	51	98.1	100.0	
No response	1	1.9		
TOTAL	52	100.0		

Table B20. Crosstabulation of Results for Lack of Standardized Nomenclatures in Barcodes by Healthcare Institution and Major Role

Healthcare Institution	Major Role	Lack of Standardized Nomenclatures in Barcodes					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Hospital	Material Manager H	0	2	4	12	3	21
	Director Hospital	0	1	1	1	0	3
	Pharmacist	0	0	1	0	0	1
	Store Manager	0	0	1	0	0	1
	Buyer	0	0	0	1	0	1
	Material Coord.	0	0	0	0	1	1
	Total	0	3	7	14	4	28
Physician's Office	Director Physician's office	0	1	3	0	0	4
	Total	0	1	3	0	0	4
Specialized Center	Material Manager SC	0	0	0	1	0	1
	Director SC	0	1	0	0	0	1
	Total	0	1	0	1	0	2
Distributor	Sales Rep	1	1	2	2	0	6
	Total	1	1	2	2	0	6
Manufacturer	Sales Rep	0	1	3	2	1	7
	Total	0	1	3	2	1	7
Manufacturer/Distributor	Sales Rep	0	0	2	0	0	2
	Total	0	0	2	0	0	2
GPO	Director GPO	0	0	0	0	2	2
	Total	0	0	0	0	2	2

Median = 1 Mode = 1 Mean = 0.47

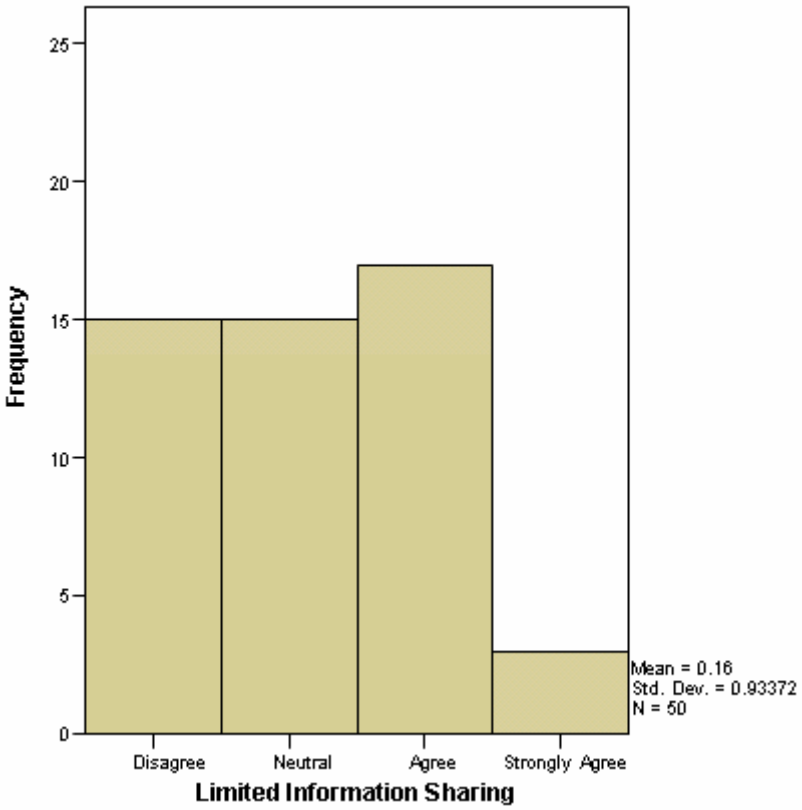

Figure B11. Graphic Results for Limited Information Sharing

Table B21. Frequency on Limited Information Sharing

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Disagree	15	28.8	30.0	30.0
Neutral	15	28.8	30.0	60.0
Agree	17	32.7	34.0	94.0
Strongly Agree	3	5.8	6.0	100.0
Total	50	96.2	100.0	
No response	2	3.8		
TOTAL	52	100.0		

Table B22. Crosstabulation of Results for Limited Information Sharing by Healthcare Institution and Major Role

Healthcare Institution	Major Role	Limited Information Sharing					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Hospital	Material Manager H	0	7	5	9	0	21
	Director Hospital	0	1	2	0	0	3
	Pharmacist	0	0	1	0	0	1
	Store Manager	0	0	1	0	0	1
	Buyer	0	0	1	0	0	1
	Material Coord.	0	0	0	1	0	1
	Total	0	8	10	10	0	28
Physician's Office	Director Physician's office	0	3	1	0	0	4
	Total	0	3	1	0	0	4
Specialized Center	Material Manager SC	0	0	1	0	0	1
	Director SC	0	1	0	0	0	1
	Total	0	1	1	0	0	2
Distributor	Sales Rep	0	2	1	3	0	6
	Total	0	2	1	3	0	6
Manufacturer	Sales Rep	0	1	1	2	2	6
	Total	0	1	1	2	2	6
Manufacturer/Distributor	Sales Rep	0	0	1	1	0	2
	Total	0	0	1	1	0	2
GPO	Director GPO	0	0	0	1	1	2
	Total	0	0	0	1	1	2

Median = 0 Mode = 1 Mean = 0.16

Table B23. Results for Ways of Calculating Reorder Point and Quantity

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Computer Software	18	34.6	52.9	52.9
Subjectively/Periodically	16	30.8	47.1	100.0
Total	34	65.4	100.0	
Not Applicable	17	32.7		
No Response	1	1.9		
Total	18	34.6		
TOTAL	52	100.0		

Table B24. Results for Ways of Placing Orders

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Manually	20	38.5	58.8	58.8
Automated	14	26.9	41.2	100.0
Total	34	65.4	100.0	
Not Applicable	17	32.7		
No Response	1	1.9		
Total	18	34.6		
TOTAL	52	100.0		

Table B25. Results for Inventory Turns

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
less than 8 turns	8	15.4	28.6	28.6
8-9 turns	4	7.7	14.3	42.9
10-11 turns	2	3.8	7.1	50.0
12-13 turns	5	9.6	17.9	67.9
14-15 turns	6	11.5	21.4	89.3
more than 16 turns	3	5.8	10.7	100.0
Total	28	53.8	100.0	
Not Applicable	17	32.7		
No Response	7	13.5		
Total	24	46.2		
TOTAL	52	100.0		

Table B26. Results for Most Prevalent Mean for Placing Orders

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Phone	9	17.3	29.0	29.0
Fax	3	5.8	9.7	38.7
Website	8	15.4	25.8	64.5
EDI	11	21.2	35.5	100.0
Total	31	59.6	100.0	
Not Applicable	17	32.7		
No Response	4	7.7		
Total	21	40.4		
TOTAL	52	100.0		

Table B27. Results for GPO Relationship

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Yes	31	59.6	88.6	88.6
No	4	7.7	11.4	100.0
Total	35	67.3	100.0	
Not Applicable	17	32.7		
TOTAL	52	100.0		

Table B28. Results for GPO Satisfaction

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Neutral	2	3.8	6.9	6.9
Agree	18	34.6	62.1	69.0
Strongly Agree	9	17.3	31.0	100.0
Total	29	55.8	100.0	
Not applicable	21	40.4		
No response	2	3.8		
Total	23	44.2		
TOTAL	52	100.0		

Table B29. Results for Information Sharing

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Do not share information	3	5.8	9.4	9.4
Share information	29	55.8	90.6	100.0
Total	32	61.5	100.0	
Not Applicable	17	32.7		
No Response	3	5.8		
Total	20	38.5		
TOTAL	52	100.0		

Table B30. Results for Sharing Information will Help Reduce Inefficiencies

	Frequency	Percent	Percentage of Participants	Cumulative Percent
Strongly Disagree	2	3.8	4.1	4.1
Disagree	1	1.9	2.0	6.1
Neutral	8	15.4	16.3	22.4
Agree	27	51.9	55.1	77.6
Strongly Agree	11	21.2	22.4	100.0
Total	49	94.2	100.0	
No response	3	5.8		
TOTAL	52	100.0		

Table B31. Results for Efficiencies can be Improved if Vendors Manage Hospitals Inventory

	Frequency	Percent	Percentage of Participants	Cumulative Percent
Strongly Disagree	13	25.0	37.1	37.1
Disagree	15	28.8	42.9	80.0
Neutral	6	11.5	17.1	97.1
Agree	1	1.9	2.9	100.0
Total	35	67.3	100.0	
Not applicable	17	32.7		
TOTAL	52	100.0		

Table B32. Results for Vendors will Benefit if they Manage Hospitals Inventory

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Strongly Disagree	2	3.8	14.3	14.3
Disagree	2	3.8	14.3	28.6
Neutral	2	3.8	14.3	42.9
Agree	8	15.4	57.1	100.0
Total	14	26.9	100.0	
Not applicable	35	67.3		
No response	3	5.8		
Total	38	73.1		
TOTAL	52	100.0		

Table B33. Results for Precedence in Organization

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
High Service Level	24	46.2	75.0	75.0
Reduced Inventory Cost	8	15.4	25.0	100.0
Total	32	61.5	100.0	
Not Applicable	17	32.7		
No Response	3	5.8		
Total	20	38.5		
TOTAL	52	100.0		

Table B34. Results for Emergency Orders

	Frequency	Percent	Percentage of Respondents	Cumulative Percent
Strongly Disagree	8	15.4	22.9	22.9
Disagree	15	28.8	42.9	65.7
Neutral	6	11.5	17.1	82.9
Agree	5	9.6	14.3	97.1
Strongly Agree	1	1.9	2.9	100.0
Total	35	67.3	100.0	
Not applicable	17	32.7		
TOTAL	52	100.0		

Table B35. Mann-Whitney U Test Results for Material Managers in Hospitals and Hospital Directors

Questions	Major Role	N	Mean Rank	Sum of Ranks	Mann-Whitney U	P value Asymp. Sig. (2-tailed)
Executive support for SCM practices	Material Manager H	20	11.75	235.00	25.00	0.61
	Director Hospital	3	13.67	41.00		
	Total	23				
Conflicting goals regarding inventory choices in the supply	Material Manager H	20	12.83	256.50	13.50	0.11
	Director Hospital	3	6.50	19.50		
	Total	23				
Conflicting goals regarding inventory levels	Material Manager H	20	12.38	247.50	22.50	0.48
	Director Hospital	3	9.50	28.50		
	Total	23				
Conflicting goals regarding inventory choices	Material Manager H	20	12.08	241.50	28.50	0.88
	Director Hospital	3	11.50	34.50		
	Total	23				
Skill and knowledge at management level	Material Manager H	21	12.52	263.00	31.00	0.96
	Director Hospital	3	12.33	37.00		
	Total	24				
Skill and knowledge at executive Level	Material Manager H	21	12.62	265.00	29.00	0.82
	Director Hospital	3	11.67	35.00		
	Total	24				
Constant evolving technology	Material Manager H	21	13.26	278.50	15.50	0.12
	Director Hospital	3	7.17	21.50		
	Total	24				
Physician preference	Material Manager H	21	13.55	284.50	9.50	0.04
	Director Hospital	3	5.17	15.50		
	Total	24				
Lack of standarized nomeclatures in barcodes	Material Manager H	21	13.19	277.00	17.00	0.16
	Director Hospital	3	7.67	23.00		
	Total	24				
Limited information sharing	Material Manager H	21	12.93	271.50	22.50	0.40
	Director Hospital	3	9.50	28.50		
	Total	24				

Table B36. Mann-Whitney U Test Results for Material Managers in Hospitals and Pharmacists

Questions	Major Role	N	Mean Rank	Sum of Ranks	Mann-Whitney U	P value Asymp. Sig. (2-tailed)
Executive support for SCM practices	Material Manager H	20	10.90	218.00	8.00	0.70
	Pharmacist	1	13.00	13.00		
	Total	21				
Conflicting goals regarding inventory choices in the supply	Material Manager H	20	10.78	215.50	5.50	0.43
	Pharmacist	1	15.50	15.50		
	Total	21				
Conflicting goals regarding inventory levels	Material Manager H	20	11.35	227.00	3.00	0.23
	Pharmacist	1	4.00	4.00		
	Total	21				
Conflicting goals regarding inventory choices	Material Manager H	20	11.28	225.50	4.50	0.31
	Pharmacist	1	5.50	5.50		
	Total	21				
Skill and knowledge at management level	Material Manager H	21	11.50	241.50	10.50	1.00
	Pharmacist	1	11.50	11.50		
	Total	22				
Skill and knowledge at executive Level	Material Manager H	21	11.24	236.00	5.00	0.36
	Pharmacist	1	17.00	17.00		
	Total	22				
Constant evolving technology	Material Manager H	21	11.93	250.50	1.50	0.11
	Pharmacist	1	2.50	2.50		
	Total	22				
Physician preference	Material Manager H	21	11.55	242.50	9.50	0.87
	Pharmacist	1	10.50	10.50		
	Total	22				
Lack of standarized nomeclatures in barcodes	Material Manager H	21	11.81	248.00	4.00	0.26
	Pharmacist	1	5.00	5.00		
	Total	22				
Limited information sharing	Material Manager H	21	11.55	242.50	9.50	0.87
	Pharmacist	1	10.50	10.50		
	Total	22				

Table B37. Mann-Whitney U Test Results for Material Managers in Hospitals and Buyers

Questions	Major Role	N	Mean Rank	Sum of Ranks	Mann-Whitney U	P value Asymp. Sig. (2-tailed)
Executive support for SCM practices	Material Manager H	20	11.30	226.00	4	0.27
	Buyer	1	5.00	5.00		
	Total	21				
Conflicting goals regarding inventory choices in the supply	Material Manager H	20	10.78	215.50	5.5	0.43
	Buyer	1	15.50	15.50		
	Total	21				
Conflicting goals regarding inventory levels	Material Manager H	20	10.63	212.50	2.5	0.20
	Buyer	1	18.50	18.50		
	Total	21				
Conflicting goals regarding inventory choices	Material Manager H	20	10.55	211.00	1	0.10
	Buyer	1	20.00	20.00		
	Total	21				
Skill and knowledge at management level	Material Manager H	21	11.50	241.50	10.5	1.00
	Buyer	1	11.50	11.50		
	Total	22				
Skill and knowledge at executive Level	Material Manager H	21	12.00	252.00	0	0.08
	Buyer	1	1.00	1.00		
	Total	22				
Constant evolving technology	Material Manager H	21	11.40	239.50	8.5	0.71
	Buyer	1	13.50	13.50		
	Total	22				
Physician preference	Material Manager H	21	11.81	248.00	4	0.28
	Buyer	1	5.00	5.00		
	Total	22				
Lack of standarized nomeclatures in barcodes	Material Manager H	21	11.43	240.00	9	0.79
	Buyer	1	13.00	13.00		
	Total	22				
Limited information sharing	Material Manager H	21	11.55	242.50	9.5	0.87
	Buyer	1	10.50	10.50		
	Total	22				

Table B38. Mann-Whitney U Test Results for Material Managers in Hospitals and Store Managers

Questions	Major Role	N	Mean Rank	Sum of Ranks	Mann-Whitney U	P value Asymp. Sig. (2-tailed)
Executive support for SCM practices	Material Manager H	20	11.30	226.00	16	0.59
	Store Manager	2	5.00	5.00		
	Total	22				
Conflicting goals regarding inventory choices in the supply	Material Manager H	20	10.78	215.50	10.5	0.25
	Store Manager	2	15.50	15.50		
	Total	22				
Conflicting goals regarding inventory levels	Material Manager H	20	10.63	212.50	15	0.55
	Store Manager	2	18.50	18.50		
	Total	22				
Conflicting goals regarding inventory choices	Material Manager H	20	10.55	211.00	9	0.17
	Store Manager	2	20.00	20.00		
	Total	22				
Skill and knowledge at management level	Material Manager H	21	11.50	241.50	15	0.49
	Store Manager	2	11.50	11.50		
	Total	23				
Skill and knowledge at executive Level	Material Manager H	21	12.00	252.00	13	0.36
	Store Manager	2	1.00	1.00		
	Total	23				
Constant evolving technology	Material Manager H	21	11.40	239.50	8.5	0.71
	Store Manager	1	13.50	13.50		
	Total	22				
Physician preference	Material Manager H	21	11.81	248.00	19	0.81
	Store Manager	2	5.00	5.00		
	Total	23				
Lack of standarized nomeclatures in barcodes	Material Manager H	21	11.43	240.00	4	0.26
	Store Manager	1	13.00	13.00		
	Total	22				
Limited information sharing	Material Manager H	21	11.55	242.50	9.5	0.87
	Store Manager	1	10.50	10.50		
	Total	22				

Table B39. Mann-Whitney U Test Results for Material Managers in Hospitals and Material Coordinators

Questions	Major Role	N	Mean Rank	Sum of Ranks	Mann-Whitney U	P value Asymp. Sig. (2-tailed)
Executive support for SCM practices	Material Manager H	20	10.55	211.00	1	0.10
	Material Coord.	1	20.00	20.00		
	Total	21				
Conflicting goals regarding inventory choices in the supply	Material Manager H	20	11.13	222.50	7.5	0.66
	Material Coord.	1	8.50	8.50		
	Total	21				
Conflicting goals regarding inventory levels	Material Manager H	20	10.63	212.50	2.5	0.20
	Material Coord.	1	18.50	18.50		
	Total	21				
Conflicting goals regarding inventory choices	Material Manager H	20	10.55	211.00	1	0.10
	Material Coord.	1	20.00	20.00		
	Total	21				
Skill and knowledge at management level	Material Manager H	21	11.21	235.50	4.5	0.32
	Material Coord.	1	17.50	17.50		
	Total	22				
Skill and knowledge at executive Level	Material Manager H	21	11.24	236.00	5	0.36
	Material Coord.	1	17.00	17.00		
	Total	22				
Constant evolving technology	Material Manager H	21	11.79	247.50	4.5	0.29
	Material Coord.	1	5.50	5.50		
	Total	22				
Physician preference	Material Manager H	21	11.17	234.50	3.5	0.24
	Material Coord.	1	18.50	18.50		
	Total	22				
Lack of standarized nomeclatures in barcodes	Material Manager H	21	11.07	232.50	1.5	0.12
	Material Coord.	1	20.50	20.50		
	Total	22				
Limited information sharing	Material Manager H	21	11.21	235.50	4.5	0.31
	Material Coord.	1	17.50	17.50		
	Total	22				

Table B40. Mann-Whitney U Test Results for Material Managers in Hospitals and Sales Representatives

Questions	Major Role	N	Mean Rank	Sum of Ranks	Mann-Whitney U	P value Asymp. Sig. (2-tailed)
Executive support for SCM practices	Material Manager H	20	15.40	308.00	98	0.06
	Sales Rep	15	21.47	322.00		
	Total	35				
Conflicting goals regarding inventory choices in the supply	Material Manager H	20	17.13	342.50	132.5	0.54
	Sales Rep	15	19.17	287.50		
	Total	35				
Conflicting goals regarding inventory levels	Material Manager H	20	10.50	210.00	*	*
	Sales Rep	0	0.00	0.00		
	Total	20				
Conflicting goals regarding inventory choices	Material Manager H	20	10.50	210.00	*	*
	Sales Rep	0	0.00	0.00		
	Total	20				
Skill and knowledge at management level	Material Manager H	21	16.67	350.00	119	0.20
	Sales Rep	15	21.07	316.00		
	Total	36				
Skill and knowledge at executive Level	Material Manager H	21	11.00	231.00	*	*
	Sales Rep	0	0.00	0.00		
	Total	21				
Constant evolving technology	Material Manager H	21	21.21	445.50	100.5	0.05
	Sales Rep	15	14.70	220.50		
	Total	36				
Physician preference	Material Manager H	21	20.07	421.50	124.5	0.27
	Sales Rep	15	16.30	244.50		
	Total	36				
Lack of standarized nomeclatures in barcodes	Material Manager H	21	21.36	448.50	97.5	0.04
	Sales Rep	15	14.50	217.50		
	Total	36				
Limited information sharing	Material Manager H	21	16.43	345.00	114	0.24
	Sales Rep	14	20.36	285.00		
	Total	35				

* Mann-Whitney Test cannot be performed on empty groups.

Table B41. Mann-Whitney U Test Results for Material Managers in Hospitals and Physician Office Directors

Questions	Major Role	N	Mean Rank	Sum of Ranks	Mann-Whitney U	P value Asymp. Sig. (2-tailed)
Executive support for SCM practices	Material Manager H	20	11.95	239.00	29	0.35
	Director Physician's Office	4	15.25	61.00		
	Total	24				
Conflicting goals regarding inventory choices in the supply	Material Manager H	20	13.93	278.50	11.5	0.06
	Director Physician's Office	4	5.38	21.50		
	Total	24				
Conflicting goals regarding inventory levels	Material Manager H	20	14.20	284.00	6	0.01
	Director Physician's Office	4	4.00	16.00		
	Total	24				
Conflicting goals regarding inventory choices	Material Manager H	20	14.28	285.50	4.5	0.00
	Director Physician's Office	4	3.63	14.50		
	Total	24				
Skill and knowledge at management level	Material Manager H	20	12.26	257.50	26.5	0.23
	Director Physician's Office	4	16.88	67.50		
	Total	24				
Skill and knowledge at executive Level	Material Manager H	20	12.64	265.50	34.5	0.56
	Director Physician's Office	4	14.88	59.50		
	Total	24				
Constant evolving technology	Material Manager H	20	14.57	306.00	9	0.02
	Director Physician's Office	4	4.75	19.00		
	Total	24				
Physician preference	Material Manager H	20	14.60	306.50	8.5	0.03
	Director Physician's Office	4	4.63	18.50		
	Total	24				
Lack of standarized nomeclatures in barcodes	Material Manager H	20	14.38	302.00	13	0.03
	Director Physician's Office	4	5.75	23.00		
	Total	24				
Limited information sharing	Material Manager H	20	14.05	295.00	20	0.08
	Director Physician's Office	4	7.50	30.00		
	Total	24				

Table B42. Mann-Whitney U Test Results for Material Managers in Hospitals and GPO Directors

Questions	Major Role	N	Mean Rank	Sum of Ranks	Mann-Whitney U	P value Asymp. Sig. (2-tailed)
Executive support for SCM practices	Material Manager H	20	10.60	212.00	2	0.02
	Director GPO	2	20.50	41.00		
	Total	22				
Conflicting goals regarding inventory choices in the supply	Material Manager H	20	11.63	232.50	17.5	0.76
	Director GPO	2	10.25	20.50		
	Total	22				
Conflicting goals regarding inventory levels	Material Manager H	20	10.50	210.00	*	*
	Director GPO	0	0.00	0.00		
	Total	20				
Conflicting goals regarding inventory choices	Material Manager H	20	10.50	210.00	*	*
	Director GPO	0	0.00	0.00		
	Total	20				
Skill and knowledge at management level	Material Manager H	21	11.00	231.00	*	*
	Director GPO	0	0.00	0.00		
	Total	21				
Skill and knowledge at executive Level	Material Manager H	21	11.00	231.00	*	*
	Director GPO	0	0.00	0.00		
	Total	21				
Constant evolving technology	Material Manager H	21	11.40	239.50	8.5	0.71
	Director GPO	1	13.50	13.50		
	Total	22				
Physician preference	Material Manager H	21	11.71	246.00	15	0.48
	Director GPO	2	15.00	30.00		
	Total	23				
Lack of standarized nomeclatures in barcodes	Material Manager H	21	11.14	234.00	3	0.03
	Director GPO	2	21.00	42.00		
	Total	23				
Limited information sharing	Material Manager H	21	11.21	235.50	4.5	0.06
	Director GPO	2	20.25	40.50		
	Total	23				

*Mann-Whitney Test cannot be performed on empty groups.

Table B43. Mann-Whitney U Test Results for Material Managers in Hospitals and Material Managers in Specialized Centers

Questions	Major Role	N	Mean Rank	Sum of Ranks	Mann-Whitney U	P value Asymp. Sig. (2-tailed)
Executive support for SCM practices	Material Manager H	20	10.90	218.00	8	0.70
	Material Manager SC	1	13.00	13.00		
	Total	21				
Conflicting goals regarding inventory choices in the supply	Material Manager H	20	11.13	222.50	7.5	0.66
	Material Manager SC	1	8.50	8.50		
	Total	21				
Conflicting goals regarding inventory levels	Material Manager H	20	10.90	218.00	8	0.73
	Material Manager SC	1	13.00	13.00		
	Total	21				
Conflicting goals regarding inventory choices	Material Manager H	20	10.55	211.00	1	0.10
	Material Manager SC	1	20.00	20.00		
	Total	21				
Skill and knowledge at management level	Material Manager H	21	11.21	235.50	4.5	0.32
	Material Manager SC	1	17.50	17.50		
	Total	22				
Skill and knowledge at executive Level	Material Manager H	21	11.55	242.50	9.5	0.87
	Material Manager SC	1	10.50	10.50		
	Total	22				
Constant evolving technology	Material Manager H	21	11.40	239.50	8.5	0.71
	Material Manager SC	1	13.50	13.50		
	Total	22				
Physician preference	Material Manager H	21	11.17	234.50	3.5	0.24
	Material Manager SC	1	18.50	18.50		
	Total	22				
Lack of standarized nomeclatures in barcodes	Material Manager H	21	11.43	240.00	9	0.79
	Material Manager SC	1	13.00	13.00		
	Total	22				
Limited information sharing	Material Manager H	21	11.55	242.50	9.5	0.87
	Material Manager SC	1	10.50	10.50		
	Total	22				

Table B44. Mann-Whitney U Test Results for Material Managers in Hospitals and Specialized Center Directors

Questions	Major Role	N	Mean Rank	Sum of Ranks	Mann-Whitney U	P value Asymp. Sig. (2-tailed)
Executive support for SCM practices	Material Manager H	20	10.55	211.00	1	0.10
	Director SC	1	20.00	20.00		
	Total	21				
Conflicting goals regarding inventory choices in the supply	Material Manager H	20	11.35	227.00	3	0.22
	Director SC	1	4.00	4.00		
	Total	21				
Conflicting goals regarding inventory levels	Material Manager H	20	11.35	227.00	3	0.23
	Director SC	1	4.00	4.00		
	Total	21				
Conflicting goals regarding inventory choices	Material Manager H	20	11.43	228.50	1.5	0.12
	Director SC	1	2.50	2.50		
	Total	21				
Skill and knowledge at management level	Material Manager H	21	11.21	235.50	4.5	0.32
	Director SC	1	17.50	17.50		
	Total	22				
Skill and knowledge at executive Level	Material Manager H	21	11.24	236.00	5	0.36
	Director SC	1	17.00	17.00		
	Total	22				
Constant evolving technology	Material Manager H	21	11.93	250.50	1.5	0.11
	Director SC	1	2.50	2.50		
	Total	22				
Physician preference	Material Manager H	21	11.93	250.50	1.5	0.13
	Director SC	1	2.50	2.50		
	Total	22				
Lack of standarized nomeclatures in barcodes	Material Manager H	21	11.95	251.00	1	0.10
	Director SC	1	2.00	2.00		
	Total	22				
Limited information sharing	Material Manager H	21	11.83	248.50	3.5	0.24
	Director SC	1	4.50	4.50		
	Total	22				

VITA

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In January 2006, he decided to pursue a Master of Science Degree in Engineering Management at the University of Missouri-Rolla. In fall 2006, he attended the American Society of Engineering Management where he presented a paper co-written with Dr. Scott Grasman and published in the conference proceedings entitled, “Improving the Healthcare Supply Chain using Vendor Managed Inventory Techniques.” He worked as a Graduate Research Assistant in the Engineering Management Department. In December of 2007, he received his Master of Science in Engineering Management.